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Development Processes in Construction Management

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Competitive Building

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Development Processes in Construction Management

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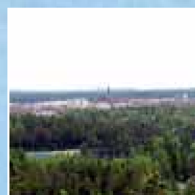

The conference is organized by the Swedish national programme for construction research, Competitive Building and the Construction Management Research Group, Department of Civil and Environmental Engineering at Luleå University of Technology.

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A SYSTEMS APPROACH FOR DEVELOPING A MODEL OF CONSTRUCTION SUPPLY CHAIN INTEGRATION

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ABSTRACT

Construction is dominated by project-based production. As a consequence, the construction supply chain is relatively fragmented, and industry performance has been low. Application of supply chain integration has been deemed a solution to resolve many problems. The work presented in this paper is aimed at building a model of supply chain integration enabling construction parties to develop repetitive and integrated strategies in the supply chain. The model of supply chain integration is built using a systems approach to the supply chain. First, a generic model has been built applying theoretical 'building blocks'. Next, the generic model is being specified and illustrated by adding empirical 'building blocks'. The work will result a supply chain integration model including corresponding guidelines that shifts from being project-based towards a repetitive approach to construction, i.e. from project delivery by occasional coalitions of dispersed firms towards integrated delivery within extended enterprises of aligned firms.

1. INTRODUCTION

In construction, the production system and the supply chain in particular have been deemed to be relatively disintegrated. A more integrated approach to construction has been coined often as a solution for the many problems and deficiencies existing in construction. On the other hand also the restrictions of integration in construction have often been discussed, because of the temporary and complex nature of construction. Here, the idea is to view a construction supply chain as a system, and to apply systems engineering to increase coherence of the supply system. The underlying principle is that a production system like the supply chain that is delivering a single product should not be fragmented, nor consist of distributed functions. Instead supply chain integration must lead to improvement by developing a more stable, repetitive production environment, similar to what is common in other industries. The premise here is that the construction supply chain would function better when approached and (re)built as a single entity, an extended enterprise. In a way, the broader issue here is whether construction could or should develop itself towards the standards and practices of a 'normal', more integrated, supply-driven industry. This paper gives an overview of a research underway applying a systems approach to 'build' a model for supply chain integration in construction. In particular the paper gives an insight in a number of the 'building blocks' found in theory and practice, to be used in the model building process of the research.

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2. LITERATURE REVIEW: THEORETICAL BUILDING BLOCKS

2.1 Viewing the supply chain as a system

Systems theory views the world in terms of collections of resources and processes that exist to meet subordinate goals. Two aspects of systems theory are of particular importance for supply chains: synergy and entropy. Synergy means the parts of a system working together can achieve more than the sum of achievements that each one would achieve separately. Entropy refers to the necessity of feedback across the chain to prevent debilitation of the system (New & Westbrook 2004). Hassan (2006) suggested the application of system engineering to the design and formation of supply chains. The structurist character of systems thinking can be helpful building the structure and operations of the supply chain in a systematic manner, assuring its effective functioning.

In terms of systems typology, supply chains are human activity systems and social systems, consisting of actions performed by individuals and groups of individuals, i.e. firms (Checkland 1981). Supply chains can be characterised as networks between economic actors (e.g. firms), engaged in a voluntary relationship to produce and deliver a product or service. Rouse (2005) considers the nature of firms as systems, and supply chains as 'systems of systems'. This is essential to fully understand and thus be able to find integrated solutions to improve firms and systems of firms (i.e. supply chains). Rigby et al. (2000) underline the importance of systems thinking for organisational change and improvement, but warn for the risk of underestimation of the complexity of reality when translating this reality into a mental model. Systems approaches are not fully capable of capturing 'soft factors' such as power, trust and human factors.

2.2 Supply chain viewed as a social system

In construction the relations between firms are typically maintained for the duration of the project. Supply chains are not merely directed towards minimizing transaction costs, but also towards enhancing the transfer of expertise and systematic feedback on planning, design, construction and maintenance between parties, and ultimately towards striving for joint value maximization. Increased co-operation and integration between supply chain parties enables delivery of a total product with quality guarantees to the market. Bounded rationality and differences in know-how between firms would be resolved by joint product development. Opportunistic behaviour is then replaced by mutual trust, which obviously is necessarily for an open dialogue (language) and an optimal knowledge sharing.

On an industry scale, Dubois and Gadde (2002) distinguish tight couplings in individual couplings in projects and loose couplings in the permanent network within the industry as a "loosely coupled system". The pattern of couplings influences productivity and innovation, and the behaviour of firms. In terms of organizational behaviour, cultural and human issues such as trust and learning have been indicated as major implications on construction supply chains (Love et al. 2002). The social systems approach may therefore improve not only the performance of supply chains, but also the socio-organizational basis of the inter-firm relationships within the supply chain.

2.4 Supply chain viewed as an economic system

In economic terms a supply chain is a series of economic actors, i.e. firms buying from and selling to each other. From an economic perspective the choice of a co-ordination mechanism or governance structure is made by economizing on the total sum of production and transaction costs (Williamson 1979). Transaction cost economics (TCE) provides an explanation for the existence and structure of firms and for the nature of co-ordination within a supply chain (Hobbs 1996). When transaction costs are low, contracting is used (i.e. market structure), while internalization will prevail for high transaction costs (i.e. hierarchy). Intermediate modes are often referred to as hybrid modes (Williamson 1991).

TCE recognizes that transactions do not occur without friction. Costs arise from the interaction between and within firms as transaction costs: information costs, negotiating costs and monitoring costs (enforcement costs) (Hobbs 1996). Transaction costs would be zero if humans were honest and possessed unbounded rationality. Transactions costs for a particular transaction depend on the three critical dimensions of transactions: asset specificity, uncertainty and frequency (Williamson 1985). Besides these key concepts underpinning TCE (bounded rationality, opportunism, asset specificity, uncertainty, and frequency), Milgrom and Roberts (1992) add two other items: difficulty of performance measurement, and connectedness to other transactions. Both are relevant from a supply chain viewpoint, and influence the possibilities to reduce transaction costs. Obviously improved collaboration and communication in the supply chain will reduce transaction costs.

2.5 Supply chain viewed as a production system

The supply chain is aimed at the delivery of a product or service to an end market or a single customer. This implies a production process which is purposive. The management of the production process needs to ensure the purpose of the process is achieved effectively and efficiently by addressing the transformation (conversion), flow and value aspects of production in an integrated manner (Koskela 2000). In terms of the firm, both primary and support activities are aimed at the delivery of customer value, and as a result revenues and profit for the firm (Porter 1985) (Figure 1).

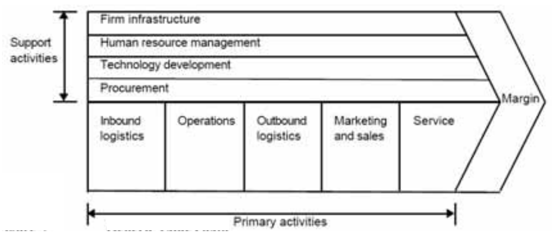

Figure 1. Value chain (Porter 1985)

2.6 Supply chain viewed as an organisational system

Firms as well as supply chains are organisational systems built from various vital elements that make them function as they do. By viewing organisations as systems of flows, Mintzberg (1979) identifies various system representations of organisations, together making up the structure and infrastructure of organisations as systems of formal authority, regulated flows (material, information), informal communication, work constellations, and ad-hoc decision processes. Typically, the supply chain is a 'system of systems', or a 'superstructure' of organisations'. Firms along the supply chain perform distributed production activities and business functions. This raises the issue of core competences of firms (Prahalad & Hamel 1990), together making up an 'extended enterprise'. In construction this relates to the idea of the 'quasi-firm' coined by Eccles (1981).

3. RESEARCH PROJECT

The model of supply chain integration is built using an organisational systems approach viewing the supply chain as a 'systems of systems'. First, a generic model is being built applying theoretical 'building blocks' from the four theoretical perspectives presented above: economic, social, organisational and production system. Next, the generic model is being specified and illustrated by adding empirical 'building blocks' from practical examples, i.e. case studies of supply chain integration inside and outside construction.

3.1 Research problem: fragmented construction supply chain

Often the construction industry has been characterised by complexity, referring to the demography of the industry (many SMEs and specialist firms) and the organisation of construction, including the configuration and coordination of construction supply chains. Indeed construction as such is a less structured industry compared to other industries, with a vast network of actors of different kinds around a project, i.e. the development and construction of a built object (Figure 2).

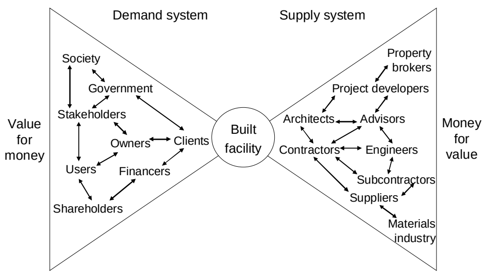

Figure 2: Construction demand and supply systems (Vrijhoef & De Ridder 2005)

The production situation in construction could also be related to assemble-to-order production and “capability oriented production” systems (Wortmann 1992). Alternatively, construction could also be observed as a make-to-order, design-to-order, or even concept-to-order kind production system (Winch 2003). The fact that construction is often a demand-driven process, and design is often disconnected from production lead to various problems of production. The producer is not the designer, and production is very much influenced by craftsmanship. Moreover production involves many crafts and many relatively small firms. This causes problems originating upstream the supply chain to persist and often become worse downstream, because of the mechanisms of causality and interdependence within the supply chain.

In most construction projects the end-customer is of the start as well as the end of the entire process, and therefore the customer and end-users play a dominant role in construction. This also causes reactivity in construction supply chains, and hampers proactivity. This is the reason why in construction products are rarely ‘launched’ and ‘marketed’ as in other industries, and why construction is different than most other industries, e.g. consumer goods. Most contractors are no manufacturers of integrated end-products. Most products are not standard, and processes are not repetitive, and often causing high levels of waste (Vrijhoef & Koskela 2000).

3.2 Research objective: integrating the construction supply chain

One can understand that low levels of integration and repetitiveness in construction lead to problems and underperformance of the construction supply chain as a production system (e.g. Vrijhoef & Koskela 2000). One way of resolving this is to apply concepts that increase integration and repetition within and between project supply chains, such as in partnering arrangements (e.g. Bresnen & Marshall 2000). Previous work points out the need for more alignment and more structured ways of working in the construction supply chain. Systems engineering can help in a sense that systems engineering’s goal here is supply chain integration, and to ‘engineer problems out’ of the supply chain i.e. the production system (Hassan 2006).

Stevens (1989) points out the importance and possibilities of supply chain integration for companies to react to market conditions and reduce cost levels. In order to do so, ‘virtually all firms and functions’ in the supply chain should be connected, operating as it were a ‘factory without walls’. Fawcett and Magnan (2002) argue that often supply chain integration is not fully implemented by companies in a way that the whole channel from ‘suppliers’ suppliers till customers’ customers’ would be integrated. In many cases, they found it is simply impossible to fully integrate an entire supply chain. This is particularly true for temporary and fairly disintegrated construction supply chains. An alternative solution is to integrate both the demand and the supply side separately. This calls for two new central roles in the demand and supply system: the demand system integrator and the supply system integrator (Figure 3). For instance, clients or leading consultants, architects or engineers could take up the demand integrator role; contractors or suppliers could take up the supply integrator role (Vrijhoef & De Ridder 2005).

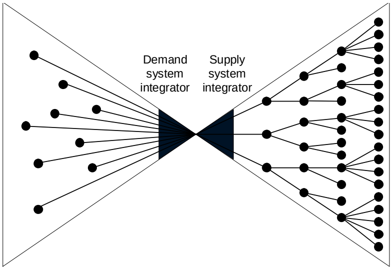

Figure 3. The demand and supply system integrator (Vrijhoef & De Ridder 2005)

3.3 Research approach: theory building through model building

This research follows the ideas of theory building from case studies as introduced by Eisenhardt (1989). The approach is semi-inductive starting from theory and case studies (building blocks), shaping hypotheses, and from there building a theory (model). This corresponds with the ideas of 'constructive research', which combines the analysis of existing phenomena and building new concepts at the same time. This kind of research is aimed at designing solution-oriented research products, rather than deducing analysis-based explanations (Van Aken 2005).

The research approach could be summarised as an engineering approach, i.e. engineering a supply chain integration model as it were a system that should be functional and useful. This engineering process starts by building the generic supply chain integration model using the theoretical 'building blocks' found in the four theoretical perspectives presented above. The generic model built from the theoretical building blocks will next be specified and illustrated by adding empirical building blocks from a few case studies of supply chain integration. These case studies include descriptive explorations of examples of supply chain integration outside and inside construction. This short paper just allows space for the brief description below of four cases studies underway, i.e. two cases outside construction, and two cases within construction.

In the research, the case studies within construction aim at describing the supply chain integration strategies applied by different parties, i.e. firms along the construction supply chain, e.g. clients, architects, contractors and suppliers. The case studies cover a number of types of construction rather than one specific type of construction. Later on, in a later phase of the research, guidelines for supply chain integration for different types of construction are derived from the model built based on case study analyses and expert opinions.

4. CASE STUDIES: EMPIRICAL BUILDING BLOCKS

4.1 Two cases outside construction: truck manufacture and shipbuilding

In the early 90s the Dutch truck industry went to a crisis. After drastic reforms most companies recovered, and are currently doing quite well. One of the measures was to reform and integrate the supply chain. Suppliers have been integrated in product development, planning and logistics. Towards the clients, in Europe, an integrated dealer network has been established, which assures direct follow-up of defects to trucks, and 24h on-road maintenance.

In the Dutch shipbuilding industry, few producers have improved their businesses drastically. They are globally leading companies in few product categories. For those products they have introduced strict standardisation and modularisation, and imposed this on their suppliers. This has improved the profitability and quality dramatically. Some suppliers have become 'external business' units, guaranteeing the close links.

4.2 Two cases within construction: housing and commercial building

In the Dutch housing sector, few builders have transformed their business and became suppliers of completely pre-engineered house. They deliver houses from their catalogues to be built in 1 week. The different types of houses can be customised completely according to clients' wishes. The fully integrated in-house production and pre-installation of the houses assure a smooth process, and prevent delays and quality problems. In addition to the delivery of the house itself, they arrange for the permissions from local governments, mortgage, and other additional issues.

In the Netherlands, many project developers have moved their business towards the 'front end' of the supply chain. They have acquired land and existing building to be developed and redeveloped. Additionally they deliver all services desired by their clients including finances, maintenance, facility management and operations such as security and restaurants of offices. Some project developers have integrated the supply chain to such an extent that they actually became their own clients, in order to find users of their projects after completion.

4.3 Comparing supply chain integration in other industries and construction

When broadly comparing the examples of supply chain integration inside and outside construction, one sees differences as well as similarities. Differences can be found in the possibilities to pre-engineer products, and integrate the supply chain. Outside construction the levels of pre-engineering and integration are higher, because levels of repetition are generally higher. Similarities can be found in the mechanisms to integrate design, follow-up clients, and offer additional services to clients. Apparently these issues are generally valid and play a role in most industrial sectors delivering products to customers.

The characteristics of industries do, however, vary from industry to industry. The production system of each industry has been shaped by the industry characteristics and history. Project production systems in project-based industries such as construction are aimed at a product mix that is ‘one of a kind or few’, process patterns are ‘very jumbled’, processes segments are ‘loosely linked’, and management challenges are dominated by ‘bidding, delivery, product design flexibility, scheduling, materials handling and shifting bottlenecks’ (Schmenner 1993). The fragmentation of the construction industry has been identified since decades as a major point of the complaints about the state of practice (Turin 2003), reflected most characteristically by the predominant one-off approach in construction projects, or ‘unique-product’ production (Drucker 1963).

Construction can be typified as a specific kind of project-based industry. Construction has been related to engineer-to-order products (ETO) viewing construction as a type of project-based production system, rather than a type of manufacturing, referring to Assemble-to-Order (ATO), Make-to-Order (MTO), or Make-to-Stock (MTS) types of production system. ‘Treating construction as a type of manufacturing obviously neglects design, and arguably subordinates value generation to waste reduction, which inverts their proper relationship’, however ‘certain aspects of construction should move into the realm of repetitive making’ (Ballard 2005). Production system types of different industries could be dominated by either (one-off) designing or (repetitive) making (Figure 4).

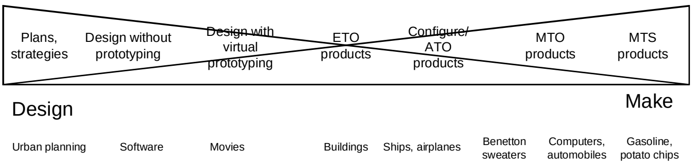

Figure 4. Production system types (Ballard 2005)

5. RESEARCH RESULTS AND INDUSTRIAL IMPACT: IMPLICATIONS OF SUPPLY CHAIN INTEGRATION

5.1 Implications from a demand system perspective

Traditionally, clients have played an important and dominant role in construction (Cherns & Bryant 1984). Also with regard to supply chain integration, the client’s role can be rather critical, while he makes the initial decision to procure construction works and the way in which procurement takes place (Briscoe et al. 2004). Clients who have the power to shift their procurement strategies vis-à-vis the market are in the position to align the supply chain effectively, and implement supply chain integration successfully (Cox and Ireland 2001). In these cases, procurement strategies must therefore be aimed at establishing long-term relationships in the supply chain. Few advanced and professional clients with “buying power” have created multi-project environments and manage their procurement through a portfolio approach (Figure 5), aimed at the increase of repetition and creating similarities between multiple projects, and thus increasing the degree of project certainty and “supply chain stability” (Blismas et al. 2004). Often these clients have successfully introduced a strategic long-term approach to procurement, which has proved to be particularly effective for certain sectors in construction (Cox & Townsend 1998).

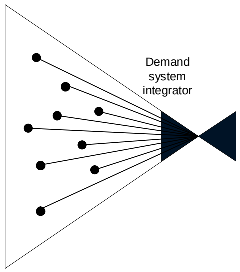

Figure 5. The role of the demand system integrator (Vrijhoef & De Ridder 2005)

5.2 Implications from a supply system perspective

At the supply side, parties have evolved towards more integrated arrangements through project-independent collaboration with other parties in the supply chain as well as internalisation of neighbouring activities or businesses. In both cases operational and competitive advantages, through higher levels of productivity and efficiency as well as delivering better client value are the drivers for this kind of supply chain integration. Normally this development is lead by a focal firm, the system integrator; this could be a main contractor, but also an architect or engineering firm (Figure 6).

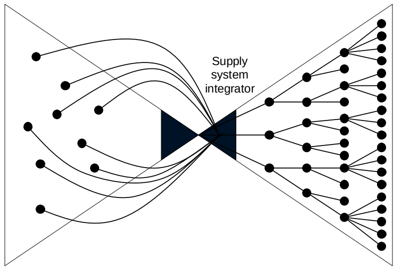

Figure 6. The role of the supply system integrator (Vrijhoef & De Ridder 2005)

6. CONCLUSIONS

Theory as well as examples from other industries claim and demonstrate the value of supply chain integration. This is also true for construction. Due to the characteristics of construction, a specific model for supply chain integration in construction must by adapted and built, including guidelines for firms along the supply chain in different types of construction. A systems approach as proposed in this research is helpful to build the integration model and improve construction supply chains. This exercise includes a 'building exercise' using theoretical building blocks (concepts) and empirical buildings blocks (cases) leading to a 'change model' of 'organisational rebuilding' of existing construction supply chains. In order to do so all functions along a supply chain in fact need to be decomposed, followed by reconfiguration of the functions and the interfaces between these functions. By doing this, the endemic problems and irrationalities should be 'engineered out' of the construction supply chain, and eliminating existing problems including their negative symptoms. The side effect must be that the control of different functions will get more aligned and centralised, transforming the supply chain into an integrated structure, i.e. extended enterprise.

7. ACKNOWLEDGEMENT

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8. REFERENCES

Ballard, G. (2005). "Construction: one type of project-based production system." In: *Proceedings SCRI Forum Event Lean Construction: The Next Generation*. 19 January 2005, Salford. SCRI, University of Salford. 14.
Blismas, N., Sher, W., Thorpe, A., and Baldwin, A. (2004). "A typology for clients' multi-project environments." *Construction Management and Economics*, **22**, 357-371.
Briscoe, G.H., Dainty, A.R.J., Millett, S.J., and Neale, R.H. (2004). "Client-led strategies for construction supply chain improvement." *Construction Management and Economics*, **22**(2), 193-201.
Bresnen, M. and Marshall, N. (2000). "Building partnerships: case studies of client–contractor collaboration in the UK construction industry." *Construction Management and Economics*, **18**, 819–832.
Checkland, P. (1981). *Systems thinking, systems practice*. John Wiley & Sons, New York.
Cherns, A. B. and Bryant, D. T. (1984). "Studying the client's role in construction management." *Construction Management and Economics*, **2**, 177-184.
Cox, A. and Ireland, P. (2001). "Managing construction supply chains: the common sense approach for project-based procurement." In: *Proceedings 10th International Annual IPSERA Conference*. 201-213.
Cox, A. and Townsend, M. (1998). *Strategic procurement in construction: towards better practice in the management of construction supply chains*. Telford, London.
Drucker, P.F. (1963). *The practice of management*. Heinemann, London.
Dubois, A., and Gadde, L.E. (2002). "The construction industry as a loosely coupled system: implications for productivity and innovation." *Construction Management and Economics*, **20**, 621-631.

Eccles, R.G. (1981). "The quasi-firm in the construction industry". *Journal of Economic Behavior and Organization*, **2**(4), 335-357.

Eisenhardt (1989). “Building theories from case study research.” *Academy of Management Review* **14**(4), 532-500.

Fawcett, S.E. and Magnan, G.M. (2002). “The rhetoric and reality of supply chain integration”. *International Journal of Physical Distribution & Logistics Management*, **32**(5), 339-361.

Hassan, M.M.D. (2006). “Engineering supply chains as systems”. *System Engineering*, **9**(1), 73-89.

Hobbs, J.E. (1996). “A transaction cost approach to supply chain management.” *Supply chain management*, **2**(1), 15-27.

Koskela, L. (2000). *An exploration towards a production theory and its application to construction*. VTT Publications 408, VTT, Espoo.

Love, PE.D., Irani, Z., Cheng, E., Li, H. (2002). “A model for supporting inter-organizational relations in the supply chain.” *Engineering, Construction and Architectural Management*, **1**(9).

Milgrom, P. and Roberts, J. (1992). *Economics, organization, and management*. Prentice-Hall, New Jersey.

Mintzberg, H. (1979). *The structuring of organizations: a synthesis of the research*. Prentice Hall, Englewood Cliffs.

New, S. and Westbrook, R. (eds.) (2004). *Understanding supply chains: concepts, critiques and futures*. Oxford University Press, Oxford.

Porter, M.E. (1985). *Competitive advantage*. Free Press, New York.

Prahalad C.K. en Hamel G. (1990). “The core competence of the corporation.” *Harvard Business Review*, May-June, 79-91.

Rigby, C., Day, M., Forrester, P. and Burnett, J. (2000). “Agile supply: rethinking systems thinking, systems practice”. *International Journal of Agile Management Systems*, **2**(3), 178-186.

Rouse, W.B. (2005). “Enterprises as systems: essential challenges and approaches to transformation”. *System Engineering*, **8**(2), 138-150.

Schmenner, R.W. (1993). *Production/operations management: from the inside out*. Macmillian, New York.

Stevens, J. (1989) “Integrating the supply chain”. *International Journal of Physical Distribution and Materials Management*, **19**(8), 3-8.

Turin, D.A. (2003). "Building as a process." *Building Research & Information*, **31**(2), 180-187.

Van Aken, J.E. (2005). “Management research as a design science: articulating the research products of mode 2 knowledge production in management.” *British Journal of Management*, **16**, 19-36.

Vrijhoef, R. and De Ridder, H. (2005). “Supply chain integration for achieving best value for construction clients: client-driven versus supplier-driven integration”. In: *Proceedings QUT Research Week*. 4-6 July 2005, Brisbane.

Vrijhoef, R. and Koskela, L. (2000). “The four roles of supply chain management in construction”. *European Journal of Purchasing & Supply Management*, **6** (3-4), 169-178.

Vrijhoef, R., Koskela, L., and Voordijk, H. (2003). “Understanding construction supply chains: a multiple theoretical approach to inter-organizational relationships in construction.” In: *Proceedings 11th Annual Lean Construction Conference (IGLC-11)*. 22-24 July 2003, Blacksburg.

Williamson, O.E. (1979). “Transaction-cost economics: the governance of contractual relations.” *Journal of law and economics*, **22**, 233-261.

Williamson, O.E. (1985). *The economic institutions of capitalism: firms, markets, relational contracting*. Free Press, New York.

Williamson, O.E. (1991). “Comparative economic organization: the analysis of discrete structural alternatives.” *Administrative Science Quarterly*, **36**(2), 269-296.

Winch, G.M. (2003). "Models of manufacturing construction process: the genesis of re-engineering construction." *Building Research & Information*, **31**(2), 107-118.

Wortmann, J.C. (1992). "Production management systems for one-of-a-kind products." *Computers in Industry*, **19**, 79-88.

RETHINKING COMMUNICATION IN CONSTRUCTION

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ABSTRACT

In the construction industry, effective communication practices have always been regarded as an important aspect of industrializing the construction process. Still, in many industrial lean construction efforts communication has been reduced to a secondary issue in favor of rationalizing the physical design and production processes, as if effective collaborative communication practices are taken for granted. Often, when ICT based communication is discussed and managed in construction it comprises only the technical aspects of information handling, such as modeling, classification and standardization. This paper introduces the subject field of Project Communication, which considers the improvement of organization, group processes, work procedures, as well as the sharing and transfer of knowledge between different professional domains in projects and corporations. The subject area has a special focus on the concept of the integration of project organizations and the creation of an effective platform for collaboration through shared ICT business tools. One prioritized field of research in this area is the problematic issue of creating true usefulness, user acceptance and organizational adoption of ICT in project team work. The paper describes four indicative feasibility studies in Project Communication. It argues that to solve the practical problems that the industry is encountering, as described in the studies, the perspective must be widened so as to include information and communication technology from an organizational and management viewpoint.

1. INTRODUCTION

Within the framework of the national development program in the Swedish construction industry called ‘IT Bygg och Fastighet 2002’, a number of pilot projects were carried out on project networks, digital document management and cooperation on construction information models (IT Bygg och Fastighet 2002). These projects focused on solving the technical problems of information management, although practical experience showed that there is a general resistance towards introduction of the technology within the industry. This resistance is not only based on an awareness of technical shortcomings, there were also significant non-technical elements, such as methods and routines, the roles of the various parties involved, and the legal and economic prerequisites. Similar experiences have been noted in studies carried out in other countries which often have highlighted the need for

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improving integration of design and production and cooperation with the client in construction projects. In recent years it has been identified that the primary causes of the construction industry's poor performance are its ineffective communication practices, its organizational fragmentation and lack of integration between design and production processes (Dainty et al., 2006).

However, until now research and development initiatives in the construction industry have been completely dominated by the purely technological development of ICT. So far, this research has not resulted in a comprehensive understanding of how new technology works in project communication if we consider human, organizational and process-related factors in addition to purely technological factors. Even a former Nordic chairman of International Alliance for Interoperability (IAI), have lately questioned the work approach of IAI in the development of the international building product model standard, Industry Foundation Classes (IFC). After ten years of IFC development, its adoption and use in the construction industry is still marginal. The ambitious approach of IAI may have focused too much on the model based world in stead of the real one, leaving IFC as a theoretical model specification or an academic exercise rather than a useful industry standard for professionals in practice (Kiviniemi, 2006). At the same time, industry has already begun implementing and use new technologies and applications. The large scale adoption of Information and Communication Technology (ICT) in construction stands to derive great advantages only if experience of its use can be gained at an early stage.

It is in this context that Project Communication, a new subject at the Royal Institute of Technology (KTH) in Stockholm, seeks to study ICT in its practical context. Within the realm of this research area, an investigation have been carried out concerning communication in the design stage of two different projects in the construction industry: the design work of a new building for the National Defense College in Stockholm and a project run by AB Storstockholms Lokaltrafik for the rebuilding of the subway train station at Sockenplan (Wikforss, 2006). The scope of the studies was then expanded to include communication during actual construction, focusing on mobile work activities on the construction site and their special need for communication (Löfgren, 2006). Also, a comparative study was made of how four frequently used Internet based project sites function as a means of communication between the project participants. This led to a discussion on the need for information technology specifically designed for project management purposes (Wikforss, 2006).

This paper describes some of the fundamental collaborative communication issues in planning, design and production phases of construction projects. The paper introduces the perspectives of project communication research and outlines an initial conceptual framework for developing communication practices combined with supportive ICT as a facilitator for improved organization and management of future construction projects.

2. COMMUNICATION IN CONSTRUCTION PLANNING AND DESIGN

The first case study considered project communication during the final stage of planning for new building and renovation at the National Defense College and the Swedish Institute of International Affairs in Stockholm. This is a unique project, as, paradoxically, is almost always the case in architecture and building. A project group is put together for one particular occasion and is dispersed once the work has been completed. During the stage of the design work studied here, the need for information exchange between the project participants was intense, time being the crucial factor. Demands on the participants' performance and accessibility steadily increased, while the amount of information they were expected to handle was extremely large. The focus was on detailed control and coordination of various part-solutions to the whole. Time deadlines, financial pressures and shortcomings in previously developed technical documentation affected relations and cooperation between the members of the team. In this environment, the project participants tended to become less careful of how they passed on their information. Communication now more frequently took place via informal, direct channels than via those originally planned, which were based on the storage of project data at a shared site common to the project as a whole. And as different participants focused on different areas and had different, sometimes conflicting interests, the distribution of information and cooperation within the project was badly affected.

The second case study involved the rebuilding of the Sockenplan subway train station. The construction project can be described as a component of a continuously running system of regular renovation of train stations. The participants in this particular project had thus worked together previously and a functional organization for the project management was already available – the ideal conditions, in other words, for ensuring that the project and its communication needs could be managed carefully and in good order. In the case study, it was observed how the project was initiated and planned and how communication was handled during the planning stage. Initially, the project management expressed an ambition to organize and control communication within the project via an Internet based project management network. Project management set up the network, introduced it to the project participants and encouraged its use – which they failed to do on time. On the other hand, once the network had been set up, even the project management did not use it to its fullest extent. Planning documents were not distributed via the project network but were distributed directly among the parties involved, either by e-mail or as regular paper copies. This resulted in that the use of the project network remained limited. Instead, information flowed in an uncontrolled manner among the members of the project team.

The results of these studies highlighted two different perspectives that are diametrically opposed.

The first perspective is that of the project manager. This is the image of the ideal process as it is described in industry-wide documents, contracts, instructions and manuals of various types. It is the image of the orderly process that proceeds in discrete steps clearly defined in advance, traveling along well-signposted information highways. It is an image of the process that is seldom questioned; it constitutes accepted practice. However, project managements have found it difficult to get their teams to adhere to this paradigm. In practice, project participants actually oppose and even obstruct the use of the central project sites that the project managers wish to use for the exchange of information.

The second perspective is that of the planner. This is the image of the design work that will actually be carried out. It is about which issues are important and difficult to tackle, about how ideals, facts and value judgments become inextricably mixed in informal but authoritative design decisions taken in the intervals between the occasions when the formal decisions are to be made. Judgment-based decision-making, planning, improvisation and reflection in action are key concepts. This paints a picture of a somewhat chaotic work process in which informal contact channels – shortcuts – and verbal agreements determine the results that will be achieved. It is a picture of the process that can seldom be discussed openly during the actual project since it is not actually accepted. In this context, it is interesting to note that ICT is also used for a significant proportion of the informal communication, although it differs from the ICT offered at the central project sites. Here, the emphasis is on direct contact and speed of communication.

However, this entails a big risk of losing sight of the big picture and the control of the construction project as a whole. Who, for example, will join up the design process with the preparations needed for production so as to ensure that the proposed building is actually put up? Who ensures that the project team maintains a shared understanding of the project's ultimate objective right up until the time when the building is finally handed over to the customer? What is more, the various specialists involved in such projects all use their own jargon, a kind of professional language that keeps others out and maintains the pecking order between the various groups. Meanwhile, the traditional distribution of roles is controlled by stereotypical notions of what others can do and cannot do, and intentional misunderstandings are part of a technique designed to strengthen one's own role and protect one's own personal space in this ongoing game. In the constant negotiation between the members of the project team, as to exactly where one's duties lie and who is expected to do what, the winner will be the individual who enjoys the advantage of information. For the individual player, the smartest strategy may well be not to communicate everything, not to have heard some piece of information, even to have suffered a slight misunderstanding. This, indeed, may be the real reason why participants are reluctant to publish their information on the common project site. There are perfectly rational reasons for not making a technical solution available to the project network too early on – who wants to risk being held responsible for having spread inaccurate information? Likewise, there are perfectly rational reasons for instead getting in touch directly with a project member you know you can trust, someone you can rely on not to look for faults and demand damages. Project networks are thought up for an ideal situation in which accurate information is exchanged in predictable patterns drawn up in advance. However, the conditions under which real projects must operate are typically unclear and unpredictable, and technical solutions remain imperfect for a long time. Professional skills consist in an ability to manage this ongoing search for the end solution, which is why professionals will wait as long as they can before they publish their information.

Construction projects are assembled by gathering different professions and areas of expertise under one "flag" (Söderholm in Wikforss, 2006). Typical of such assemblies is that each professional group also bears with it a set of principles, rules, knowledge domains and professional skills formulated in a certain manner. At the same time as this helps make the profession strong and successful, it also explains why they cannot cooperate with other professions particularly well. Taking this professional barrier as the starting point, a construction project can be described as a 'battle of the giants' in which each of the professions involved is fighting for supremacy over the others. But the battle is not fought within individual fields of knowledge. Design engineers and other technical consultants know that the design is the responsibility of the architect, and although they may have their views on the subject, the architect's monopoly of knowledge in this respect is not seriously challenged. However, when it comes to organizational tools, duties or constellation forms, of which none of the established professional groups holds a previous monopoly, the battle suddenly becomes important. It is not always a battle for the best solution, but rather a contest to establish whose opinions carry the greatest weight and what sort of information is actually of importance.

Communication tools introduced with a purpose of imposing better control and coordination of construction projects are an arena for such knowledge contests. Communication solutions aim at breaking down barriers that professional groups carefully and successfully have built up over a long period of time. They aim at making construction knowledge more general, thereby challenging the expertise that for decades has become more and more the province of specific professions and home to an every increasing array of professional jargons. These tools also aim at coordinating activities between professional groups, which today all apply their own special routines and have their own particular ideas as to how coordination should be achieved. This may result in communication tools that are so generally conceived, so shallow and so uninteresting that they can be generally accepted but are hardly ever used; or, someone may take control of the tools and modify them to suit their own special needs, thus obtaining a toolkit that is both sophisticated and functional – for a few (Söderholm in Wikforss, 2006).

3. COMMUNICATION IN BUILDING PRODUCTION

In an introductory investigation of problems ahead of an attempt to introduce mobile ICT support at construction sites, the actual work at a construction site north of Stockholm was studied for half a year on regular basis through direct observations, interviews and document analyses (Löfgren, 2006).

The production environment of the construction site involves a very tight time schedule with the full attention to planning, coordination and completion of the building activities. Production managers, construction supervisors and superintendents are needed on site to coordinate work, do inspections, conduct environment and safety rounds, document and follow up ongoing and completed construction activities. The very same persons also need to be located at their computers inside the site office ordering equipment and building materials, exchanging digital drawings between architects and design engineers, e-mail subcontractors about upcoming work, follow up budget figures and invoices as well as prepare deviation reports on construction work with unsatisfactory result. In addition to this, there are daily production meetings that afterwards need to be transcribed in computer documents and e-mailed to all involved parties.

Construction projects of today are dependent on reliable and updated information through a number of ICT based business systems, communication tools and shared storage servers. To solve arisen on-site problems and critical construction issues there is a need for quick access to necessary information. To solve a site problem, production management personnel have to run back and forth between the construction site and their computers inside the site office. This leads to inefficient use of managerial resources due to that the production management team is occupied at their computers a large part of their working hours. Production managers and construction supervisors experience that they often have to be at two places at the same time; at the site office doing administrative work at their computer as well as being out on the site coordinating work (Löfgren, 2006). Documentation of building activities, production meetings and various inspections often has to be carried out twice; once when they are actually occurring and then again in a computer document using different templates.

Even though the intensions of the ICT based business support systems is to improve project communication, they have lead to that production managers, construction supervisors and superintendents are experiencing that they are doing the wrong things. For example, whole days are sometimes spent in front of the computer writing protocols from previous meetings. This has resulted in negative effects on management presence and leadership in the production site environment. Most of the available project oriented ICT tools are meant for formalized office use. These tools only give modest support to the craftsman-like construction activities and the unpredictable and mobile environment that the site personnel work in. Improving information and communication support for the core activities at construction sites has become a strategic challenge for the construction industry to increase efficiency and productivity in the construction process (Samuelson 2003).

4. PROJECT COMMUNICATION – THE DILEMMA OF PROJECT MANAGEMENT

Both planning and production share a need for rapid access to information and communication in real time. An interesting study object is therefore the communication toolkit commonly used for ICT-based project communication today – the project network. Four different project networks were compared with respect to their basic structure and their different functions and methods of use (see Löfgren in Wikforss, 2006). The aim was to identify the potential offered by each of the networks for coordinating communications within a project and to compare this with how the networks were actually used. The results were based on a large number of interviews with users, who described their work procedures and their experience of using the networks.

The study showed that the visions and intended purposes of project networks do not comply with how such systems are perceived and used in practice. Users considered that project networks wasted precious time and were overly complicated. It was difficult to upload and structure documents and to describe them with correct metadata. Users also considered that it was difficult to find the information they needed and that it took time to log on, search for and open documents. They tended to use the networks as little as possible, and if they did use them, it was primarily as a simple pool for storing documents that had already been approved. In other words, project networks were not used as active, dynamic communication networks but as passive, static archives. They did not support the intensive communication needed for the actual problem-solving and decision-making processes. Instead, this vital communication was conducted through other channels, and information was more likely to be distributed in real time rather than being stored and archived in the system.

These information and communication patterns are also highly prevalent in building production where such real-time distribution of information must function in mobile work environments which pose other requirements on appropriate ICT support. No matter how much effort that is put into the design and planning process, as soon as the production work at the construction site starts all kinds of problems and issues arise that calls for immediate attention. In this constant reactive production environment, handling problem situations result in natural communication patterns that are dynamic, spontaneous and informal (Dainty et al., 2006). The recognized problems with information management and project communication at production sites in the construction industry could possibly be explained by a partially misleading conception of what mobility is and what production site based mobile work involves. For more than a decade ICT systems designed for stationary office use have been pushed out to the production environment, which have resulted in that construction management teams are tied up inside the site offices at their desktop computers a large part of their working hours. The ICT implementation at construction sites have gradually forced production teams into partially unnatural and ineffective administrative work routines, due to the inflexibility and fixed nature of the ICT systems. But wirelessly extending these business systems to the construction site using certain mobile computing devices will probably not be a sufficient solution of these problems in the long run. A legacy office based system design will then be forced into a mobile ICT platform that might need an alternative design to better fit the mobile work context. There are differences in how ICT is related to different work types. In office work the computer is often the main tool for performing work, and functions virtually as the workplace itself. In mobile work the main job activities are regularly taking place external of the computer, and often demand high level of visual attention and hands-on execution (Kristoffersen and Ljungberg 1999). Therefore, in mobile work environments like construction sites ICT based systems only play a supportive but important role, if they are designed according to the needs and demands of the mobile workforce.

In the indicative studies described above it was found that communication was going on at two levels at once. The formal, controlled exchange of documents took place on one level, while informal, interactive problem-solving took place on the other. Even though ICT plays a decisive role, communication cannot be viewed as a whole and is impossible to control through formal tools. Although ICT contains tools to enable us to keep track of the entire stock of information, it can also give rise to the information anarchy prevailing in certain projects. To explain this, we need to return to the basic question of how the not-yet-built can be visualized, communicated and understood among the participants involved in a project. Linn (1998) describes how technology based on 'pre-images', is actually a prerequisite for the construction of large complicated buildings, forming architecture as knowledge:

> *"Images enable the pre-conception to be processed step by step. It serves as a workpiece in a visible process that is open to criticism. The various components can be kept apart and can be individually studied in a more analytical manner….The situation is not unlike a game of chess: if the game is illustrated move by move, the consequences of individual measures and the choice of options become clearly visible and are available for action…The significance of pre-image technology as a means of creation lies in the fact that it has enabled us to bring in a screen on which we may project and concretize the game and open it up move by move. The method has functioned extraordinarily well, has given rise to rich building traditions and has dominated the field for over four thousand years. It remains as useful today as ever, although we're now beginning to realize the potential of alternative methods more clearly than before."* (Linn, 1998, p. 75, translated)

Computer modeling has added whole new dimensions to this knowledge technology:

> *"A possible new knowledge technology may be glimpsed in the world of computer modeling. In the computer, an objectified virtual model can be*

> *created. It is not visible in itself...The computer does not primarily create an image but models a 'virtual shape' which it is prepared to visualize in the form of an image displayed on the screen or on paper. This is where the computer has added a new step...What's new is that the model's existence before the image has been split into two separate stages. After the model's first stage in the mental world the computer has inserted a virtual existence in which the model has been made collectively available. Several people can work with an identical model (at the starting point) and the changes they make can be referred back to the model. Its significance, therefore, is to a high degree communicative. So far, we have recognized only some of this new potential."* (Linn, 1998, p. 147, translated)

The vision of a common building information model (BIM) is very much alive, and great efforts are being made all over the world to realize this new means of sharing information – in fact, it has been of interest to researchers for the last 30 years or so. However, there is still a long way to go before it sees full-scale use in architecture and construction. The question of how practitioners can solve their communication problems in the meantime has in many cases simply been ignored. Much has remained as before, although with ICT as an additional factor to be managed in already complex situations.

The accepted practice for ICT-based project communication that has evolved over time is based on the use of web based project networks and central storage of shared documents at project sites. This has given members of the project team immediate access to the information stored in the shared archive but has reduced the flexibility and overall understanding of the project provided by the traditional approach to work and its practices. It is no longer possible to decide who is to receive what information at a given time. The information is available at all times, it is continually changed, and project members do not wait to be given information. They obtain it from the easiest accessible source and hope that it is accurate and up to date. It is from this information that each participant creates his or her own 'pre-image' of the project. The difference between the old and the new approach to work is very large. The project manager cannot control the 'images' of the project that are being spread among the members of the team.

Pressured by tight schedules and concerns about fees, everyone takes a chance on being able to complete their assigned duties at the last minute, which sometimes leads to near chaos. If, as in one of the above studied cases, after a year-long planning process a meeting has to be called on the day after distribution of the tender documentation in order to go through 600 corrections, anyone can see that much remains to be done before order can be brought to the used project communication channels. The point is that although IT enables rapid communication and allows changes to be made at the last minute, it also creates new problems in such important areas as coordination, quality assurance and responsibility (Wikforss, 2006).

The ideal model of good project organization in the construction industry is the linear, hierarchical approach. The planning process is described in linear terms; it is divided into phases and is then successively broken down to an ever finer level of detail. Everything seems to fit logically together. It appears that in construction contexts, the design and production planning processes are treated as a single process, even though the work involved in the design of a building differs significantly from technical planning and work on construction and detailed building solutions. The problem with this mechanistic way of thinking is that the ideas used to describe both the conceptual and actual construction of a building, from the finished whole down to the smallest detail, is also used to plan project organizations, human cooperation and the exchange of ideas between professionals – professionals who have very different educational backgrounds, knowledge and experience and use different technical jargon.

ICT tools, too, are often put together in the form of systems which can be broken down into logical sub-systems and functions. When these systems are used in their intended context, the hierarchy of the organization, it turns out that they do not always produce the expected benefits but rather help to bring about the chaos witnessed by the participants in the project. The real exchange of information takes place via other, informal channels, where other forms of information and communication technology such as e-mail, SMS messaging and mobile telephones, which enable direct contacts between project members in network-like cooperation. The problem is that this communication behavior provides no possibility of ensuring the overall understanding and degree of coordination that a large project requires. How can a planned, mechanistic approach to systems be combined with a flexible, dialectical one so that it enables appropriate communication practices between interacting project members, as a complex project demands? Dahlbom and Mathiassen (1993) discuss the importance of uniting these two perspectives:

> *"One of the challenges of systems developers is to understand and respect the Platonic nature of human knowledge and communication, and to understand the computer not only as a machine for processing data based on Aristotelian concepts but at the same time as a tool to support human beings in using and communicating Platonic concepts."* (Dahlbom and Mathiassen, 1993, p. 37)

5. FROM DILEMMA TO STRATEGY – AREAS FOR FURTHER RESEARCH

The question of how the project management should organize project communication involves much more than the choice of form and technology for representations of the future buildings and whether it should be structured in two, three or four dimensions within a product and process model. A narrow search for standards for information deliveries as the only solution to the serious communication problems encountered during the course of the project obstructs many of the other factors that must also be dealt with by management of construction projects.

A variety of these factors can be identified in the indicative studies described above.

5.1 Formal and informal communication

It is a question of how the project as a whole should be organized in order to facilitate both formal and informal communication (see e.g. Kraut et al., 1990; Whittaker et al., 1994). How can the project management achieve the flexibility of organization and method of work needed to enable the project members to handle the many unexpected situations that almost by definition can be expected to occur during activities organized in the form of a project? How can a project organization and method of work be designed that would support a combination of real-time, interactive, ICT-supported problem-solving and strict, quality-assured information deliveries? How can one facilitate rapid problem-solving and direct contacts between the project members without disrupting the formal structure of the project?

5.2 Communication in the mobile work environment

The mobility of work is increasing in both design and production phases of projects. Mobile work is often seen in relation to a place, for example an office or a desk, from which workers move away. Designing mobile ICT then becomes giving people the same possibilities in the field as they would have at their bases. But mobility can also be a more fluid form of activity, where there is no such thing as a base. In work types like construction site work the mobility is an important component of the work itself. In these work environments people are mobile as the work activities occur, they are not mobile in order to transport themselves to some place to perform the work. This constant 'inbetween-ness' (Weilenmann, 2003) is an important part of genuine mobile work, but also results in contextual unpredictability and heterogeneity concerning job activities and their proactive and reactive assessments. This view on mobility poses new challenges of understanding what ICT is supposed to deliver in various job settings, as well as appropriate system design and use of the technology for different mobile work contexts.

5.3 Roles and incentives

The forms under which the project members are taken on, their individual contracts and the distribution of their individual roles also affect communication. Attempts to define areas of responsibility too closely risk creating barriers between the members of the team, who will all cut down on their individual contributions to communication within the project. Important information is lost and, in problem-solving, participants tend to underperform when there is no incentive to provide information over and above the agreed deliveries. This also raises the question of what obstacles are created when new technical solutions for project communication upset the traditional distribution of roles. How can the project management deal with the resistance to change, which is commonly encountered when different professional groups start defending their own interests?

5.4 Organization and management

As noted in the introduction, construction industry oriented information and communication research has until now concentrated on information modeling and standardization. To solve the practical problems that the industry is encountering, as described in the case studies, the perspective must be widened so as to include information and communication technology from an organizational and management viewpoint (see e.g. Sverlinger, 2000). How should one prepare, assess and decide on ICT strategies for differing purposes and financial conditions? How should one organize the merging of new enabling technologies and ongoing knowledge intensive activities? How should one organize ICT usage, and how should the overall operations be organized? Questions about the role of information technology in project management and its significance for knowledge formation, experience feedback and clear communications in project-oriented enterprises are becoming ever more central issues. It is also a question of how ICT affects the dynamic relationship between the individual and the project or company.

5.5 Usefulness and user acceptance

Achieving actual benefit of ICT tools is a matter of creating acceptance of the technology among the intended users through everyday usefulness in their ongoing work (see e.g. Davis, 1989; Nielsen, 1993). The use of the ICT should not be conducted at the expense of other activities such as social collaborative processes, work practices or project management and leadership. One of the main challenges in this context is to understand the socio-technical gap of what is required socially within a work group and what can be done technically (Ackerman, 2000). It is important to understand how people really work in groups and organizations so that the introduction of new ICT systems do not deteriorate and distort the collaboration process and social interaction. If the technology does not serve and enhance these processes, it will be considered as an obstructive element for effective operations and project delivery, and will therefore not be used as planned. Therefore the technology has to be designed as a supportive resource in everyday work that allows for intuitive and effortless use. In this sense, the usefulness aspect is about balancing the formal use, structure and functions that is embedded in ICT systems technology with the complex fluid and social nature of work practices and collaborative activities.

5.6 Implementation management

New changes, large or small, introduced in any project, corporation or industry will probably not turn into an immediate success. Tweaking both organization and technology will be necessary to achieve an appropriate configuration. The pieces of the puzzle do not fit together from the beginning and it is through the continuous trial and error process of implementation (Fleck, 1994) that eventually will lead to a configuration of technology, communication processes and work practices that fit the social and organizational context. This view on implementation as an enabling process for development involves continuous mutual adaptation between the technology and its environment, and recognizes the crucial role of the people inside the user organization. This collaborative adaptation process is necessary because technology rarely fits perfectly into the user environment (Leonard-Barton, 1988). Collaboration, communication and feedback between users and developers are often critical in achieving the proper fit between technology, organization, and users (see e.g. Rosenberg, 1982; von Hippel, 1988; Voss, 1988). User involvement in the technical development and implementation process therefore plays an important role in achieving long term usefulness and benefit of ICT based collaborative project communication tools.

6. THE ROLE OF PROJECT COMMUNICATION IN CONSTRUCTION

The knowledge obtained in the presented case studies concerns the organization of information technology in project-oriented enterprises. The questions as such are of an interdisciplinary nature, since successful research in the field of project communication will derive from knowledge of developments in ICT along with profound understanding of the theories and practices of management and communication of projects. One of the principle tasks will be to develop an understanding of the type of communication and information management that will be able to cross the many professional, disciplinary and geographical boundaries normally encountered in project organizations.

The improvement of project communication processes and technologies on different functional levels may change the organization of future projects and how its business activities and work routines are designed, planned and performed. This can for example help enabling just-in-time deliveries and the more industrialized and rational business processes that the construction industry in fact is striving for. On-demand access and mobility of information, enhanced communication tools together with new ways of organizing and performing collaborative work could be important components of this development process. The full recognition and determination to improve collaborative communication and information exchange throughout all project phases will probably have considerable effects on the industrialization process of construction projects. These issues have lately started to become a focal point for the construction industry. That is a welcomed change of attitude in a project based industry that historically has seemed to have taken appropriate project communication practices for granted.

7. REFERENCES

Ackerman, M S (2000), The intellectual challenge of CSCW: The gap between social requirements and technical feasibility, *Human-Computer Interaction* **15**(2-3), 179–203.

Dainty, A, Moore, D and Murray, M (2006), *Communication in construction: Theory and practice*, Taylor & Francis, Oxford.

Dahlbom, B and Mathiassen, L (1993), *Computers in context: The philosophy and practice of systems design*, Blackwell, Oxford.

Davis, F (1989), Perceived usefulness, perceived ease of use, and user acceptance of information technology, *MIS Quarterly* **13**(3), 319–340.

Fleck, J (1994), Learning by trying: The implementation of configurational technology, *Research Policy* **23**, 637-652.

IT Bygg och Fastighet 2002, http://www.itbof.com/2002/ITBOF2002.html

Kiviniemi, A (2006), Ten years of IFC development – Why are we not yet there?, CIB-W78 Keynote lecture, in *Proceedings of the Joint International Conference on Computing and Decision Making in Civil and Building Engineering*, Montreal.

Kraut, R E, Fish, R S, Root, R W and Chalfonte, B L (1990), Informal Communication in Organizations: Form, Function, and Technology, in Oskamp S, Spacapan, S (eds.), *Human Reactions to Technology: The Claremont Symposium on Applied Social Psychology*, Sage Publications, Beverly Hills, 145-199.

Kristoffersen, S and Ljungberg, F (1999), Making place to make IT work: Empirical explorations of HCI for mobile CSCW, in *Proceedings of the International ACM SIGGROUP Conference on Supporting Group Work*, Phoenix, 276-285.

Leonard-Barton, D (1988), Implementation as mutual adaptation of technology and organization, *Research Policy* **17**, 251-267.

Linn, B (1998), *Arkitektur som kunskap*, Byggforskningsrådet T10:1998, Stockholm.

Löfgren, A (2006), *Mobile computing and Project communication – mixing oil and water?* Licentiate thesis, Royal Institute of Technology, Stockholm.

Nielsen, J (1993). Usability engineering, Morgan Kaufmann, San Francisco.

Rosenberg, N. (1982). Learning by using, In: Rosenberg, N, *Inside the Black Box: Technology and Economics*, Cambridge University Press, Cambridge, 120-140.
Samuelson, O (2003), *IT-användning i byggande och förvaltning*, Licentiate thesis, Royal Institute of Technology, Stockholm.
Sverlinger, P-O M (2000), *Managing knowledge in professional service organizations: Technical consultants serving the construction industry*, PhD thesis, Chalmers University of Technology, Göteborg.
von Hippel, E. (1988), Users as innovators, In: von Hippel, E, *The Sources of Innovation*, Oxford University Press, Oxford, 11-27.
Voss, C.A. (1988). Implementation: A key issue in manufacturing technology: The need for a field of study, *Research Policy* **17**, 55-63.
Weilenmann, A (2003), *Doing mobility*, PhD thesis, Göteborg University, Göteborg.
Whittaker, S, Frohlich, D and Daly-Jones, O (1994), Informal workplace communication: What is it like and how might we support it?, In *Proceedings of CHI '94 Conference on Human Factors in Computing Systems*, Boston, 131-137.
Wikforss, Örjan (ed.) (2006), *Kampen om kommunikationen: Om projektledningens informationsteknologi*, Research report, Royal Institute of Technology, Stockholm.

PROPOSAL FOR A FOUNDATION OF PROJECT MANAGEMENT THEORY

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ABSTRACT

In *Towards a theory of project management* (Lousberg, 2005), it was concluded that in the theoretical foundation as proposed by Koskela, the product approach, still outweighs the process approach wherein the latter deals with power and politics, as constituent as it is in managing projects. Choosing the *linguistic turn* as a starting point of the paradigm change that has been made in organizational studies makes that approach more of a process. In this paper, the foundations, the theorizing and examples of these studies will be explored. This exploration is based on a literature study and the preliminary results of PhD research on conflicts in complex Public Private Partnership projects in spatial developments. First, the ontological and epistemological starting point of this approach is elaborated by a description of an attempt of Husserl to escape the subject/object dualism. Next, the following theses are worked out: (1) there is not one theory, but there are multiple approaches; (2) there is not one form of managing projects, but there are several; and (3) due to the gap of knowledge of social project management forms research should be focused on practice from an interpretative approach. Based on these theses the paper ends with conclusions about the foundation of a theory of project management.

1. INTRODUCTION

Literature shows that “the underlying theory of project management is obsolete” (Koskela, 2002a), that “in prior literature it has been generally seen that there is no explicit theory of project management” (Koskela et al, 2002a) and that “several prominent authors have raised the need to introduce alternative theoretical approaches to the study of projects, and to identify the implications that they may have for how we organise and manage projects” (Cicmil et al, 2006b). Therefore, the quest for a theory of project management can be stipulated as problematic. Hence, the central question addressed in this article is: what is the foundation of such a project management theory?

2. STARTING POINT: THE LINGUISTIC TURN.

In search for theories that are underlying the PMBOK, (Project Management Body Of Knowledge) as described in the PMBOK Guide of the Project Management Institute, it can be concluded that anomalies that occur in the application of these underlying

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project management theories are regarded as “strong enough for the claim that a paradigmatic transformation of the discipline of project management is needed” (Koskela et al, 2002a). Here it is proposed to take “The linguistic turn” (Rorty, 1967) as the starting point of that paradigm shift.

“The roots of the linguistic turn lie in a stream of work in philosophy concerned with the nature of meaning and experience. The linguistic turn describes a particular philosophical understanding that proposes ‘a particular relation of language to social/historical embedded ‘seeings’ of the world and every person’s situated existence’ (Deetz, 2003)” (Clegg, 2005). It is interesting that Deetz’ article describes the linguistic turn as one of the historical attempts to escape the subject/object dualism and the assumption of a psychological foundation of experience, starting by Husserl (1913, 1962): “In his treatment, specific personal experiences and objects of the world are not given in a constant way but are outcomes of a presubjective, preobjective inseparable relationship between constitutive activities and the ‘stuff’ being constituted. Thus, the science of objects was enabled by a prior but invisible set of practices that constituted specific objects and presented them as given in nature. And, the presence of personal experiences as psychological, required first a constituting perspective, invisible and prereflective, through which experiences were possible. A floating/social/historical/cultural/intersubjective ‘I’ thus always preceded either the objects of science or the psychological ‘I’ of personal experience” (Deetz, 2003). Deetz continues: “Most objects and experiences come to us as a sedimentation from their formative conditions. They are taken as our own or in the world, and the specific conditions of their formation are forgotten. These ‘perspectives’ or ‘standpoints’ are institutionalized and embedded in formed experiences and language, and as such, invisibly taken on as one’s own , while they are reproductions of experiences originally produced somewhere else by others. These ‘positions’ or ‘standpoints’ are unavoidably political (Deetz, 2003).” So language no longer represents reality: it is reality itself. Contrary to “the problem of language as the ‘mirror of nature’ that preoccupied the positivist” (Deetz, 2003) (social) reality is here regarded as a construct.

3. THESES

3.1 Theory and approaches

What strikes in the discussion about project management and its “underlying” theories is that the distinction and interconnection between the concepts of project management, theory, approach and paradigm are often not made clear. It therefore blurs this discussion. With the definition of paradigm of Kuhn in mind- a paradigm is a common accepted scientific achievement that delivers for a certain time model problems and solutions to a community of researchers (Kuhn, 1962) it can even lead to remarkable statements as “Lean production can be understood as a new paradigm” (Howell et al. 2004) Project management is here defined as an act and theory as consisting “primarily from concepts and causal relationships that relate these concepts” (Koskela, 2002a). It is though not always clear whether theory precedes (lies under) this act or is constituted in this act (Glaser & Strauss, 1967). This depends on the approach that is used. From a systems-theory approach other theories about the same subject will evolve than for instance from a social science approach. How different approaches generate different theories is illustrated by the following reflection on success and failure in projects: “Despite the levels of research founded on the presumptions of instrumental rationality in decision-making and control, it is increasingly apparent that accepting and applying such orthodoxy does not eliminate project failures, not does it guarantee project success (Williams, 2004). The issue of ambiguity associated with qualifying a project as success or failure has recently attracted scholarly attention. The debate focuses on a more strategic level of decision making, in which project failure appears to be "strategic" rather than linked to technical problems, and is seen as a result of political processes of resistance in organisations. Table 1 summarises different approaches to understanding project failure by distinguishing three perspectives and linking them to a wider domain of the project management process."

Table 1. Perspectives on project success and failure (adapted from Fincham, 2002: 3) (Cicmil et al, 2006b)

Perspective	**Form of Organizational Behaviour and Action**	**Methodological Focus**	**Success and Failure seen as**
Rational/normative	Organizational goals; managerial and organizational structures surrounding the project	Simple cause and effect	Objective and polarised states
Processual	Organizational and sociological processes; projects as form of a decision outcome	Socio-technical interaction	Outcomes of organizational processes
Narrative	Organizational and socio-political processes; symbolic action; themes	Interpretation and sense-making; rhetoric and persuasion; critical/hermeneutics	Social constructs; paradigms

So different perspectives or approaches lead to different definitions of Success & Failure wherein different concepts are used. Questioning Success & Failure therefore leads to different "concepts and causal relationships that relate these concepts": thus different theories. Hence, this section is concluded with the thesis that there is not one theory, but there are multiple approaches.

3.2 Approaches and forms of management

For the same reason that different approaches lead to different theories, different approaches lead to different forms of management. The same problems – as normative as they are (De Leeuw, 2002) – are described with different concepts, hence the ways to solve them – forms of management – are described in different terms. So it depends on the way a problem is described, what form of management is suitable (Wamelink, 2006). Dominant variable to distinguish between forms of steering is uncertainty/complexity (De Leeuw, 2002). Interpreting De Leeuw's five forms of steering in this paper three kinds of managing projects are distinguished;

they can be placed along an increasing scale of complexity/uncertainty between routine and improvisation: project management (as defined e.g. in PMBOK), programme management and process management.

Table 2. Different forms of managing projects along an axis of increasing complexity

Amount of uncertainty	**Form of steering**	**Form of management**	**Examples**
Very low	Open loop	Routine	Managing industrial fabrication
Average	Feedback	Project management	Managing systems
Reasonable	Feed forward	Programme management	Managing policy
High (also ambiguity)	Meta	Process management	Managing interaction
Very high (also ambiguity)	Intrinsic	Improvisation	Managing brainstorms

To get things sharp, the difference between Project and Process management is elaborated here. Process management is here defined as "managing complexity within people networks" (Teisman, 2001), with as an application for instance agreements on the rules that participants in a project will use in order to reach a decision. An other definition of process management is "management of the development of ideas" (Bekkering et al, 2004), where here also can be stated that it is not per se about the content, e.g. realising a pre conceived idea, but merely about the process to get to an idea. To describe the concept of process management in literature it is presented as opposed to project management. Table 3 is an example of this.

Table 3. Differences between project and process management (Teisman, 2001)

Project	**Process**
One time activity	Multiple activity
One goal	Several goals
Limited time	Long time orientation
Heterogeneous in pattern of action	Heterogeneous, ambiguous and dynamic
Temporarily organization	Organization of interaction
Uncertainty	Uncertainty and ambiguity
Production out of line management	Production in arena's within organization
Violates well known conventions	Seeks new conventions
Disturbs line organizations	Generates dynamics; requires flexibility

Surely this enlightens the differences, but, as indicated here before, several publications tend to emphasise the differences between project/systems management and process/interaction management in favour of process management (see e.g. the section about project success or failure above). This while literature shows that both approaches have their own value, depending of the issue that has to be dealt with; this within one project (Groote et al, 2002, Bekkering et al, 2004). As experienced project managers the writers of this article fully agree on this; as a project manager one has to be able to shift quickly from a project approach to a process approach, wherein contrary to the project approach the content of the project is the result of a development that takes place along the way. So different forms of management are suitable for different problems/questions/subjects. Therefore, these different forms of management can be appropriate within one project. Hence this section can be concluded with the thesis that there is not one form of managing projects, but there are several.

3.3 Gap of knowledge and interpretative research

Although there are different forms of managing projects suitable for different problems or questions, existing project management literature is dominated by a discourse wherein the instrumental project approach and form outweighs the social process approach and form (Lousberg, 2005; Howell et al, 2004), Cicmil et al, 2006 a, b, c). Several attempts have been made to correct this unbalance, but seek the solution in applying again instruments e.g. software as Last Planner or Scrum (Koskela, 2002b; Ballard, 1994, Howell et al, 2004), Aravena, 2005) . This is done even from the notion that "current project management fails to create the conversations necessary to develop a shared background of obviousness and common concerns" (Howell et all, 2004), but this seems not to be based on an understanding – understanding meant here in Max Weber's way as "verstehen": a internalised understanding – of social processes within a project that could lead to alternative ways of handling things. Research programmes should therefore focus on this supposed gap of social knowledge in the project management discourse.

Similar to the idea that there is not one theory of project management, in social science the era of a "grand theory" that could claim to uncover pre-existing and universal explanations for social behaviour, seems to be far gone. Part of contemporary project management research from a mere social science point of view is focussed on the specific, the context-dependent. In the following are some examples of this research.

In their study "*Govern mentality matters, designing an alliance culture of inter-organizational collaboration for managing projects"* Clegg et al, 2002, investigate the Sydney Harbour sewage project as it was successfully completed in terms of time and money before the Olympic games of 2002. The project –designing and building a sewage facility in the harbour of Sydney- was started with an alliance contract that contained a minimum of requirements. The project strategy, specifications and design had to be developed by interaction within the project team and by tuning with the project environment; so by "talking".

The key themes for the analysis "became the project culture and its relationship to a set of Key Performance Indicators (KPIs) of Schedule, Budget, Occupational Health and Safety, Community and Ecology". An extensive research of written texts, artefacts like banners and "talks" like meetings – for instance over 1000 pages of transcripts were analyzed – was done. This led to the findings that "Govern mentality poses an alternative to policing, litigation and arbitration, especially in situations of multiple actors and interests, through the design of a more collective and coherent practical consciousness within which to make sense."

First, the example shows how "the instrumental" can surely play an important role in managing a project. Further: "Design of a more collective and coherent practical consciousness within which to make sense." and "to develop a shared background of obviousness and common concerns" (Howell et al, 2004) seem to be similar. However the instrument is not invented before and then implemented, as it is with software, but invented while talking about the project, so emerging from the challenges that had to be met in the project and therefore leading to other probably far more effective solutions than implementing software, although the latter of course can help.

Another example is the study: *an Inquiry into Project Managers and Skills* (Cicmil, 2006c). In order to obtain an answer to the question of "what it might mean and take to be a high performer or a virtuoso project manager", respondents were asked in open interviews to reflect on themes as key challenges, their own performance, personal careers and the role of training. Interesting in the realm of this article is that the research method used, characterised as originating from a "pragmatic epistemology", and "designed as a participative cooperative inquiry based on active interviewing, involving reflective practitioners and pragmatic researchers." Some of the insights of project management practice that emerged from this cooperative inquiry are "continuous renegotiation of the project's direction and plans, experienced in a social context where conversations and power play an equally important role as documents and procedures" and "understanding project management as a social and political action in context: evaluating the situation using judgment, intuition, previous experience and a holistic, multi-perspective approach as well as logic and universal principles of project management to act and perform in the specific local context of the living present".

These findings confirm the earlier in this article supposed coexistence of the instrumental and social forms of project management. The example also shows that the role of project managers as implementers can be a problematic one. But foremost it illustrates that taking practice as the basis for research, can reveal a different picture of daily project management compared to more common representations in existing project management research literature and make this literature therefore richer.

The last example of research focussed on the specific, context-dependent is part of my PhD-research on conflicts in complex public private spatial planning projects. Bottlenecks in these projects are mainly located in the cooperation between parties involved. These bottlenecks can exist of conflicts that lead to delays and even sometimes a cancelling of the project. The research question is how to deal with conflicts in a way that they are no longer dysfunctional. Part of the research is the analysis of cases to obtain insight in the evolution and possibly the cause of conflicts in the specific context. Literature shows that differences in perception play an important role in the emergence of conflicts. To confront this with practice a method was chosen that analyses "the actual production of meanings and concepts used by social actors in real settings (Gephart, 2004)" (Suddaby, 2006). Purpose of the analysis is to make statements about how actors interpret reality, not to develop scientific truth about reality.

Transcriptions were made of open interviews about the theme's conflict, dysfunctional conflicts and solutions. Next the raw data of each interview were interpreted through comparison with each other into theoretical concepts and relations between these concepts, valid for this particular case. Preliminary findings are that a conflict is experienced as dysfunctional when it becomes personal, rational arguments can trigger a conflict, but the lack of a personal fit and trust is the cause of it.

This research example illustrates how concepts and their relations emerge from data and the following analysis, instead of the other way around: derived from prior theory that guided data collection and analysis (Suddaby, 2006).

What these three examples of specific, context-dependent research have in common is that they:

- choose project management practice as the basis of the research;
- use interpretative qualitative research methods;
- investigate the construction of a shared reality, of shaping theory in reality;
- distinguish between the instrumental/rational and social/personal, but study both; and
- deliver deep insight in the practice of project management.

Therefore this section is concluded with the thesis that the distorted balance between knowledge about the instrumental forms of project management and knowledge about the social forms of project management can be restored in favour of the latter by research that is focused on practice from an interpretative approach.

4. CONCLUSIONS

The central question addressed in this article is: what is the foundation of a project management theory that meets the practice of practioners?
Three theses have been elaborated:

1. there is not one theory, but there are multiple approaches;
2. there is not one form of managing projects, but there are several;
3. due to the gap of knowledge of social project management forms research should be focused on practice from an interpretative approach.

This choice for a research method has everything to do with the research question. It is the quest for more knowledge of what is happening in a project and what insights can we get from it for managing a project that justifies a plea for the emphasis on interpretative qualitative research, grounded as it is in what practioners say about practice. In this sense only – practice as it is described by practitioners – I propose that the foundation for a theory of project management is practice itself.

5. REFERENCES

Aravena, J.L. (2005), *Speech Act Theories for Computer Aided Collaborative Design*, http://www.aech.usyd.edu.au/kcdc/journal/vol3/dcnet/avarena/abstract.html
Ballard, G. (1994), *The Last Planner,* Monterey (CA): Northern California Construction Institute.
Bekkering, T., Glas, H., Klaassen, D. & Walter, J. (2004), *Management van processen*, Utrecht: Het Spectrum.
Cicmil, S., Williams, T., Thomas, J. & Hodgson, D. (2006a), *Rethinking Project*

Management: Researching the actuality of projects, International Journal of Project management, **24**, 675-686
Cicmil, S. & Hodgson, D. (2006b), *New possibilities for Project Management Theory: A critical Engagement*, Project Management Journal, **73**(3), 111-122.
Clegg, S., Pitsis, T., Rura-Polley, T. & Marosszeky, M. (2002), *Govern mentality matters, designing an alliance culture of inter-organizational collaboration for managing projects*, Sydney: School of Management, University of Technology.
Clegg, S. (2005), *Talking Construction into Being,* inaugural address, Amsterdam: Vrije Universiteit.
Deetz, S. (2003), *Reclaiming the Legacy of the Linguistic Turn,* Organization, **10**(3), 421-429.
De Leeuw, A.C. (2002), *Bedrijfskundig management – Primair process, strategie en organisatie,* Assen: Koninklijke Van Gorcum.
Glaser, B.G. & Strauss, A.L. (1967), *The discovery of grounded theory: strategies for qualitative research.* New York: Aldine.
Groote, G. Hugenholtz-Sasse, C. & Slikker, P. (2002), *Projecten Leiden*, Utrecht: Het Spectrum.
Howell, G., Macomber, H., Koskela, L. & Draper, J. (2004), Leadership *and project management: time for a shift from Fayol to Flores* Copenhagen: IGLC-proceedings.
Koskela, L. & Howell, G. (2002a), *The underlying theory of project management is obsolete,* Pennsylvania: Project Management Institute.
Koskela, L. & Howell, G. (2002b), *The theory of project management: explanation to novel methods* Pennsylvania: Project Management Institute.
Kuhn, T. (1962), *The Structure of Scientific Revolutions*, Chicago: University of Chicago.
Lousberg, L.H. (2005), *Towards a theory of project management*, Delft: Proceedings SCRI-Symposium 2005.
Rorty, R. (1967), *The Linguistic Turn, Essays in philosophical method*. Chicago: University of Chicago Press.
Suddaby, R. (2006), *Form the editors: what grounded theory is not*, Academy of Management Journal, **49**(4), 633-642.
Teisman, G. (2001), *Besluitvorming en ruimtelijk procesmanagement*, Delft: Eburon
Wamelink, J. (2006), *Inspireren, Integreren, Innoveren,* Delft: inaugural address, Delft University of Technology.

THE ASPHALT PAVING PROCESS: PLANS FOR ACTION RESEARCH

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ABSTRACT

Recent significant changes in public sector procurement in the Netherlands are forcing road construction companies to professionalize one of their primary processes: on-site asphalt paving. This paper describes an initiative aimed at improving quality in the process. A literature review confirmed that research into the asphalt paving process seems to be in a state of infancy. Interviews with on-site plant operators confirmed that operational choices in the asphalt paving process depend heavily on craftsmanship and that the work methods and equipment are mainly selected on the basis of tradition and custom. Also, the operators were reluctant to use new (available) technologies. Since improving the paving process requires integrating new technologies with the learning of new work methods, this paper proposes an action research strategy. Such an approach involves operators and researchers in addressing the apparent mismatch between current technology development, work methods and the operators' (tacit) operational strategies.

1. INTRODUCTION

Over the last three years, since the parliamentary enquiry into the construction sector, the business environment within the road construction sector has changed dramatically in The Netherlands. According to Dorée (2004) the collusion structure that regulated competition has fallen apart. Public clients have introduced new contracting schemes containing incentives for better quality of work (Sijpersma and Buur, 2005). These new types of contracts, tougher competition and the urge to make a distinction in the market, spur the companies to advance in product and process improvement. These changes have significantly altered the playing field for competition. The companies see themselves confronted with different "rules of the game" than what they were used to. Performance contracting and longer guarantee periods create a new set of risks and business incentives. In general, the companies experience the pressure of new types of competition and other rules and trends, but at the same time, they acknowledge the opportunity to distinguish themselves.

In an effort to outperform competitors, asphalt-paving companies seek better control over the paving process, over the planning and scheduling of resources and work, and over performance. Improved control would also reduce the risks of failure of the paving during the guarantee period. To be able to achieve these goals, the relevant operational parameters need to be known and the relationships between these

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parameters need to be thoroughly understood. For the asphalt paving companies to be able to improve product and process performance, they now more than ever acknowledge they need to develop intricate understanding of the asphalt paving process and the interdependencies within the process.

2. RESEARCH OBJECTIVES

This work forms part of an overall project focusing on the improvement of the Hot Mix Asphalt paving process aiming at improved quality and consistent reduction of quality variability. This paper reports on the development of a research strategy to address two key research questions. The first question is what are the main causes of variability in the asphalt paving process and the second is what will the effect of revised operational strategies be on quality in the process.

3. METHODS

During a workshop conducted by Dorée and ter Huerne (2005), national experts and representatives of agencies in the asphalt field were confronted about the state of asphalt paving construction in The Netherlands. The experts suggested that.

- little or no research effort is put into systematic analysis and mapping of the asphalt paving process;
- the asphalt paving process depends heavily on craftsmanship;
- work is carried out without the instruments to monitor the key process parameters; and
- the selection of work methods and equipment is based on tradition and custom.

We then undertook three tasks in response to the anecdotal suggestions made during the workshop. First, we conducted an extensive literature review to assess the state of research into the asphalt paving process. Second, we conducted one-on-one on-site interviews with twenty-eight machine operators. The purpose was to gain insight into operational strategies in the asphalt paving process from operator perspectives and therefore confront the suggestions made by the national experts. Last, we developed a research strategy to move the process forward in attempting to answer the key research questions mentioned above.

4. STATE OF THE ART

4.1 State of research into the asphalt paving process

Several dedicated asphalt research agencies and organisations exist in The Netherlands and abroad. A scan of literature on asphalt issues showed a field of asphalt research which is well developed. One area dominates the core of our knowledge base to date viz. the characteristics of asphalt from the perspective of construction material (mixtures, recipes, strengths, elasticity, etc). However, efforts to systematically map and analyse the process of asphalt paving are few. Approximately 100 papers were published in the *International Journal of Pavement*

Engineering during the period 2002 to 2005 with only one being in the construction process research area. A similar situation applies to the *International Journal of Pavements* during that same period with a mere two papers out of 65 (approximately 3%) speaking directly to construction modelling. A scan of publications in the *Journal of Computing in Civil Engineering* revealed that six papers (approximately 5%) were published in the areas of modelling and simulation of construction processes. This out of 133 papers published during the same period analysed for the Pavement Engineering journals.

Abudayyeh *et al.* (2004) investigated construction research trends in technical papers published in the American Society of Civil Engineering's *Journal of Construction Engineering and Management* between 1985 and 2002. 879 technical papers were analysed. The top research topical areas were reported as scheduling, productivity, constructability, simulation and cost control. These topics formed approximately 18% of the total number of papers published during that period. It's interesting to note that the modelling of construction processes comprised less than 2% of the total number of papers published during this period and that it only ranked 17th out of a list of 29 research areas. Despite the apparent neglect of construction process research, a positive trend appeared in the period 1997 to 2002 with an increase in the number of construction simulation papers published (Sawhney *et al.*, 1998; Halpin and Martinez, 1999; Naresh and Jahren, 1999; Kartam and Flood, 2000; Halpin and Kueckmann, 2002). This trend continued after 2002 (Zayed and Halpin, 2004; Zhang and Tam, 2005) albeit with few papers published relating to the simulation of the asphalt construction process (White *et al.*, 2002; Jiang, 2003; Nassar *et al.*, 2005; Choi and Minchin, 2006).

We can therefore conclude that the majority of the research and the papers deal with the characteristics of asphalt from the perspective of construction materials. Research into the asphalt paving process is in a state of infancy.

4.2 Mapping the asphalt paving process

There have been several organized industry-aided research efforts for the development of state-of-the-art technologies for real-time locating and positioning systems for construction operations (Abourizk and Shi, 1994; Pampagnin *et al.*, 1998; Bouvet *et al.*, 2001; Hildreth, 2003; Navon *et al.*, 2004). They include efforts to develop automated methods for monitoring asphalt laying and compaction using GPS and other IT technologies.

Li *et al.* (1996) reported on a system to map moving compaction equipment, transform the result into geometrical representations, and investigated the use of Geographic Information System (GIS) technology to develop a graphical illustration depicting the number of compactor passes. Krishnamurthy *et al.* (1998) developed an Automated Paving System (AUTOPAVE) for asphalt paving compaction operations. Peyret *et al.* (2000) reported on their Computer Integrated Road Construction (CIRC) project. This aims to develop Computer Integrated Construction systems for the real-time control and monitoring of work performed by road construction equipment, namely compactors (CIRCOM) and pavers (CIRPAV). Oloufa (2002) described the development of a GPS-based automated quality control system for tracking pavement compaction. The Compaction Tracking System (CTS) allows tracking of multiple compactors.

Several experiments to map the asphalt paving experience were conducted in recent years. However, although some of these experiments were developed into industrial applications, it appears that few have been accepted widely by industry and are frequently used on the construction sites. Although some equipment manufacturers now provide GPS as an option for clients, GPS is not yet part of operational strategies and working practice in asphalt processes. Therefore, although GPS technology has been subject of study in asphalt construction processes, and is now available on roller equipment, it is not yet adopted and integrated into operational strategies and methods.

5. RESULTS OF THE ON-SITE INTERVIEWS

The interviews revealed several tensions between theory and practice. One of the major practical problems roller operators deal with is that whilst they are responsible for the final compaction level of the asphalt mat, they are not able to measure the degree of compaction during the compaction process itself. When final rolling has stopped the target density should ideally have been achieved since it would be difficult to achieve further compaction when the asphalt mat cools down (Timm *et al.*, 2001). However, most roller operators interviewed indicated that they were not informed of the final density of the completed layer – not during the site operations and even not afterwards - despite its importance. This is a significant shortcoming in terms of quality control. It shows an absence of “closing the feedback loop” (Montgomery, 2005) and as such negatively affects any learning that could occur. In addition, the number of roller passes and the roller patterns directly influences compaction (Leech and Powell, 1974; NCAT, 1991). Whilst indicating that they used prescribed roller patterns during the compaction process, a concern is that most operators did not keep track of the number of passes completed during rolling. They also appear to base key operational decisions on what they “feel” and “see” since they do not know what the actual temperatures and the material characteristics are during the process of compaction. Roller operators indicated that they specifically looked for the occurrence of “cracking” and “shoving” and the rapid cooling of the asphalt during the compaction process. Interestingly, the speed of the asphalt paver was not considered an important point of discussion between screed and roller operators. This raises the issue of whether they were aware of the effect of temperature differentials if the paver was too far away from the roller’s working zone. The influence of temperature differentials on hot mix asphalt paving has been studied extensively (Chadboum *et al.*, 1998; Timm *et al.*, 2001; Stroup-Gardiner *et al.*, 2002; Willoughby *et al.*, 2002). The relevance of temperature issues seems in stark contrast with the road crews' (lack of) attention to this parameter during the paving process.

Evidence of barriers to technology adoption was revealed in a number of ways. Most operators frankly acknowledged that they hardly made use of the available technology on the machines. Of the operators that had temperature measurement tools at their disposal, only a minority confirmed to use these. They showed an awareness of the importance of the cooling process of the asphalt and they considered weather conditions, the temperature of the asphalt mix and changes in layer thickness to be important factors to pay attention to during the paving process. Also, they understand that a change in layer thickness directly affects the cooling rate of the asphalt mat. It is easier to achieve target density in thicker layers of asphalt than in thinner layers. This is because the thicker the mat, the longer it retains the heat and the longer the time during which compaction can be achieved (Asphalt-Institute, 1989). However, in practice the roller operators are mostly uninformed about the discontinuities because of adjustments made by the paver and screed operators – such as paver speed, layer thickness and screed vibration.

The interviews conducted with operators confirmed anecdotal evidence which suggested that in The Netherlands, work in the asphalt paving process depends heavily on craftsmanship, that work is being carried out without measuring the key process parameters (temperature, density and layer thickness) and that the work methods and equipment are selected based on tradition and custom. There is also evidence that no direct feedback is given to machine operators. Machine settings are done mainly on the basis of "feeling and experience". Although the interviewees all refer to common and proven practice in machine setting, the actual settings and operational strategies varied widely from team to team. Asphalt paving in many ways still is a process driven by craftsmanship, heavily dependent on tradition, and on operators' experience, gut feeling and tacit knowledge. Therefore, there is not really one common practice, but a wide array of "common practices". This wide array must lead to extensive variability in the quality of final product.

6. ACTION RESEARCH STRATEGY

Given that craftsmanship still rules the operational choices in the paving process and that the operational strategies are typically tacit; Can new technologies provide an impetus towards a more professional approach? This is not a straightforward "yes" as often assumed. Our interviews indicated that operators are not comfortable with new technologies. Over the last decennia several technologies were developed to improve process information and process control (see the pervious section). New features and functions were added to the equipment. Most operators acknowledged that they hardly made use of the available technology. They just do not know how or why to use the new "gadgets". Another new technology is GPS. Although equipment manufacturers now provide GPS as an option for clients, it is not yet adopted and integrated into operational strategies and methods. The data provided by GPS systems does not help the operators because they do not know that these data might be relevant for their operational choices and work methods.

The adoption of technology process may also be hindered by scepticism and reluctance of the operators - who feel that their workmanship is being devalued or that management could use the technology to track their movements and possibly use it punitively (Simons, 2006). Several authors argue that the construction industry typically lags behind other industries in adopting technology (AbouRizk *et al.*, 1992; Halpin and Martinez, 1999; Halpin and Kueckmann, 2002; Bowden *et al.*, 2006).
For evaluating the adoption of technology one could use the innovation adoption factors as given by Rogers (Rogers, 2003). When the data produced by the GPS systems do not match with the operators' operational reasoning, at least three of Rogers' five attributes will not be fulfilled – and adoption will be problematic. At the same time, tailoring the GPS solutions to overcome this mismatch is difficult because the operational reasoning of the operators is tacit and implicit.

Factors for likelihood innovation adoption (Rogers 2003)

- relative advantage
- compatibly
- complexity
- trialability
- observability

6.1 New research approach

Developing better operational strategies requires adoption of new technologies, but new technologies are not adopted due to insufficient understanding of current operational strategies (the common practice). This resembles a chicken or egg problem, a causality dilemma. Against that background, the research project follows an action research strategy alternating steps of technology introduction and mapping of operational strategies (see Figure 1). Through monitoring of the learning processes of the operators, and evaluating the operational choices with them, the tacit knowledge of the "common practice" will become explicit. This provides the opening for further development of process understanding, tools and operational strategies. Qualitative heuristics will be confronted with quantitative process data.

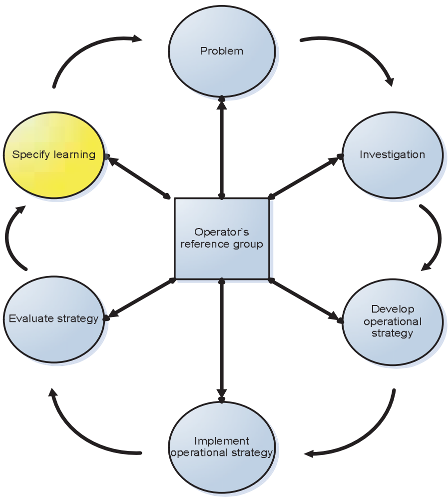

Figure 1. Action research strategy for the asphalt paving process

The proposed strategy implies that it firstly, involves the asphalt machine operators directly in the research project and secondly, it includes a statistical modelling and computer simulation component that aims to test and validate models developed during the research. The explicit models will facilitate the practitioners in synthesizing their tacit knowledge and promote learning processes. Trochim (2001) suggests that "there is so much value in mixing quantitative and qualitative research. Quantitative research excels at summarising large amounts of data and reaching generalisations based on statistical projections. Qualitative research excels at telling the story from the participants viewpoint, providing the rich descriptive detail that sets quantitative results into their human context".

The aim is for operators and researchers to jointly develop operational strategies using an iterative process (see Figures 2 and 3) of problem definition, operational strategy development, implementation, evaluation, and consciously specifying the learning taking place. This is expected to lead to:

- better understanding of the asphalt paving process;
- the development of innovative tools and technologies to assist understanding of the paving process; and
- adoption and wider acceptance of innovative tools and technologies and its associated benefits.

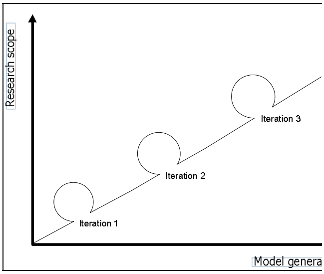

Figure 2. Iteration process

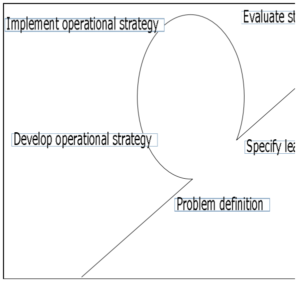

Figure 3. Typical iteration

A qualitative paradigm should provide insight and understanding from the perspective of those actually involved in the asphalt construction process. One of the major distinguishing characteristics of qualitative research is that the researcher attempts to understand people in terms of the own definition of their world (Mouton, 2001). By utilising a qualitative approach, an attempt will be made to understand the asphalt construction process, from the subjective perspective of the individuals involved. These individuals include the operators involved in the actual paving process. The complexities can only be captured by describing what really happens when they are doing their job, incorporating the context in which they operate, as well as their frame of reference. In other words, there needs to be a commitment to the empowerment of participants and the transfer of knowledge. Chisholm and Elden (1993) advises that one should strive for the full involvement of the client (in this case the machine operators) and researcher. The involvement of participants enhances the chances of high construct validity, low refusal rates and “ownership” of findings. The validity should also benefit by several iterations and expansion of the research scope across iterations. This is shown in Figure 2.

A qualitative approach therefore has the potential to supplement and reorient our current understanding of the asphalt paving process. Key research questions using an action research strategy are normally of an exploratory and descriptive nature. Exploratory in that you are attempting to firstly, assess what is happening during the asphalt paving process and secondly, to identify the key factors that affect the process. Descriptive questions also provide opportunities for finding correlations between variables affecting the paving process.

The quantitative paradigm is aimed at developing and validating accurate models of the somewhat complex asphalt paving process. The overall objective is to build process models of the asphalt paving process and to bring these models together in an event scheduling system. The models to be developed need to be checked and validated in practice. This requires the involvement of stakeholders closest to the asphalt construction process. Several causal and predictive questions have to be addressed during this modelling phase. What are the main causes of variability in the paving process? Is variability the main cause of reduced quality, productivity and efficiency within the paving process? What will the effect of a revised operational strategy be on the asphalt paving process? Will a revised operational strategy lead to improved quality, productivity and efficiency?

With this action research strategy, the chicken-or-egg problem (the causality dilemma of technology development and adoption) is side-stepped by progressing in small steps involving the practitioners. The described action research strategy has an added benefit. Since progress in the research project coincides with actual learning and growth of operational knowledge and capabilities, the companies are happy to take part in the research - instead of just being the object of study. It breaches the classical divide between science and practice. It not only challenges the practitioners' presumption of the paving process, but also their opinions of the value of academics and academic work.

7. CONCLUSIONS

A parliamentary inquiry into collusion in the Dutch construction industry sparked new public procurement strategies and altered the business environment for road paving companies. Performance contracting and extended guarantee periods drive the companies towards the improvement of product quality and process control. Since the density of the pavement is a key factor in the strength and durability of the road surface, operational strategies are a cardinal focus for research. The attention for these issues exposed that site operations and operational strategies are driven by "common practice" – the tacit knowledge and heuristics of the site crew built on years of personal experience (and often idiosyncratic). Building an objective picture of site operations is difficult since site operations are not documented. Knowing the exact location of asphalt construction vehicles, their speed and their motion characteristics, can provide essential information for the understanding of asphalt pavement construction processes. This can be done using GPS technology. That is not straightforward. Experiments of such technology introduction show problems of adoption. To be adopted the technology should be tailored to the prevailing operational strategies, but at the same time the technology has to be adopted to make the prevailing operational strategies tangible. To overcome this causal dilemma we propose an action research approach.

This action research approach provides opportunities for developing a framework to capture the operational characteristics of the asphalt paving process in a more holistic manner. It diverts from previous process modelling studies where key role players have been left out of the process. Latham as cited in (Blockley and Godfrey, 2000) observed that "there is an acceptance that a greater interdisciplinary approach is necessary, without losing the expertise of individual professions." He recognised that all concerned with construction are interdependent and need to behave as a team. Blockley and Godfrey (2000) also argue that "we need to have a whole new view of process" and in order "to do that we need to include factors that are particularly needed when co-operation between people is important". The key issue here is that the operators need to be involved in, and take responsibility for the process. They are in fact largely responsible for the success of the process.

The selected action research methodology involves the researcher, innovative technologies and most importantly, the machine operators "driving" the asphalt construction process. The first steps in this project show that the approach selected, taps into the enormous wealth of tacit knowledge and experience of operators – it provides insights necessary in analysing important operational characteristics in the asphalt paving process. The unravelling and confronting of the practitioners view is expected to lead to improved control during the asphalt paving process and consequently to improved product and process performance.

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9. REFERENCES

AbouRizk, S., Halpin, D. & Lutz, J. D. (1992) State of the art in construction simulation. *Proceedings of the 1992 Winter Simulation Conference.* USA.
Abourizk, S. & Shi, J. S. (1994) Automated Construction-Simulation Optimization. *Journal of Construction Engineering and Management-Asce,* **120**, 374-385.
Abudayyeh, O., Dibert-DeYoung, A. & Jaselskis, E. (2004) Analysis of trends in construction research: 1985-2002. *Journal of Construction Engineering and Management,* **130**, 433-439.
Asphalt-Institute (1989) *The Asphalt Handbook*, The Asphalt Institute.
Blockley, D. & Godfrey, P. (2000) *Doing it Differently - systems for rethinking construction,* London, Thomas Telford Publishing.
Bouvet, D., Froumentin, M. & Garcia, G. (2001) A real-time localization system for compactors. *Automation in Construction,* **10**, 417-428.
Bowden, S., Dorr, A., Thorpe, T. & Anumba, C. (2006) Mobile ICT support for construction process improvement. *Automation in Construction,* **15**, 664-676.
Chadboum, B. A., Newcomb, D., Voller, V. R., DeSombre, R. A., Luoma, J. A. & Timm, D. (1998) An Asphalt Paving Tool for Adverse Conditions: University of Minnesota,
Chisholm, R. F. & Elden, M. (1993) Features of Emerging Action Research. *Human Relations,* **46**, 275-298.
Choi, J. & Minchin, R. E. (2006) Workflow management and productivity control for asphalt pavement operations. *Canadian Journal of Civil Engineering,* **33**, 1039-1049.
Dorée, A. & ter Huerne, H. (2005) Workshop proceedings - Development of Tools and Models for the Improvement of Asphalt Paving Process. University of Twente.
Dorée, A. G. (2004) Collusion in the Dutch construction industry: an industrial organization perspective. *Building Research and Information,* **32**, 146-156.
Halpin, D. & Kueckmann, M. (2002) Lean Construction and Simulation. *Proceedings of the 2002 Winter Simulation Conference.* USA.
Halpin, D. & Martinez, L. (1999) Real World Applications of Construction Process Simulation. *Proceedings of the 1999 Winter Simulation Conference.* USA.
Hildreth, J. C. (2003) The Use of Short-Interval GPS Data for Construction Operations Analysis.
Jiang, Y. (2003) The effects of traffic flow rates at freeway work zones on asphalt pavement construction productivity. *Transportation Quarterly,* **57**, 83-103.

Kartam, N. & Flood, I. (2000) Construction simulation using parallel computing environments. *Automation in Construction,* **10**, 69-78.
Krishnamurthy, B. K., Tserng, H.-P., Schmitt, R. L., Russell, J. S., Bahia, H. U. & Hanna, A. S. (1998) AutoPave: towards an automated paving system for asphalt pavement compaction operations. *Automation in Construction,* **8**, 165.
Leech, D. & Powell, W. D. (1974) Levels of Compaction of dense coated macadam achieved during pavement construction: Transport and Road Research Laboratory, UK,
Li, C. C., Oloufa, A. A. & Thomas, H. R. (1996) A GIS-based system for tracking pavement compaction. *Automation in Construction,* **5**, 51.
Montgomery, D. C. (2005) *Statistical Quality Control,* New York, John Wiley & Sons.
Mouton, J. (2001) *How to succeed in your Master's & Doctoral Studies - A South African Guide and Resource Book,* Pretoria, Van Schaik Publishers.
Naresh, A. L. & Jahren, C. T. (1999) Learning outcomes from construction simulation modeling. *Civil Engineering and Environmental Systems,* **16**, 129-144.
Nassar, K. M., Nassar, W. M. & Hegab, M. Y. (2005) Evaluating cost overruns of asphalt paving project using statistical process control methods. *Journal of Construction Engineering and Management-Asce,* **131**, 1173-1178.
Navon, R., Goldschmidt, E. & Shpatnisky, Y. (2004) A concept proving prototype of automated earthmoving control. *Automation in Construction,* **13**, 225-239.
NCAT (1991) *Hot Mix Asphalt Materials, Mixture Design and Construction*, NAPA Research and Education Foundation.
Oloufa, A. R. (2002) Quality control of asphalt compaction using GPS-based system architecture. *Ieee Robotics & Automation Magazine,* **9**, 29-35.
Pampagnin, L.-H., Peyret, F. & Garcia, G. (1998) Architecture of a GPS-based guiding system for road compaction. *Proceedings - IEEE International Conference on Robotics and Automation.* Leuven, Belgium, IEEE.
Peyret, F., Jurasz, J., Carrel, A., Zekri, E. & Gorham, B. (2000) The Computer Integrated Road Construction project. *Automation in Construction,* **9**, 447-461.
Rogers, E. (2003) *Diffusion of innovations*, Free Press, New York.
Sawhney, A., AbouRizk, S. M. & Halpin, D. W. (1998) Construction project simulation using CYCLONE. *Canadian Journal of Civil Engineering,* **25**, 16-25.
Sijpersma, R. & Buur, A. P. (2005) *Bouworganisatievorm in beweging*: Economisch Instituut voor de Bouwnijverheid, Amsterdam, The Netherlands
Simons, B. J. A. G. (2006) Op weg naar een beheerst asfaltverwerkingsproces. Enschede, University of Twente.
Stroup-Gardiner, M., Wagner, C. T., Hodgson, D. T. & Sain, J. (2002) Effect of temperature differentials on density and smoothness. *ASTM Special Technical Publication.* 1433 ed.
Timm, D., Voller, V. R., Lee, E. & Harvey, J. (2001) Calcool: A multi-layer asphalt pavement cooling tool for temperature prediction during construction. *The International journal of Pavement Engineering,* **2**, 169-185.
Trochim, W. M. K. (2001) *The Research Methods Knowledge Base,* Cincinnati, Atomic Dog Publishing.
White, G. C., Mahoney, J. P., Turkiyyah, G. M., Willoughby, K. A. & Brown, E. R. (2002) Online tools for hot-mix asphalt monitoring. *Construction 2002*, 124-132.
Willoughby, K. A., Mahoney, J. P., Pierce, L. M., Uhlmeyer, J. S. & Anderson, K. W. (2002) Construction-related asphalt concrete pavement temperature and density differentials. *Construction 2002*, 68-76.
Zayed, T. M. & Halpin, D. W. (2004) Simulation as a tool for pile productivity assessment. *Journal of Construction Engineering and Management,* **130**, 394-404.
Zhang, H. & Tam, C. M. (2005) Consideration of break in modeling of construction processes. *Engineering, Construction and Architectural Management,* **12**, 373-390.

MODES OF TRUST PRODUCTION IN PROJECT-BASED INDUSTRIES

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ABSTRACT

Appropriate levels of trust may have important benefits for inter-organizational cooperation. In the construction industry, concerns are often raised that higher levels of trust would improve performance. In this paper, we review literature on trust to identify key modes of trust production in this project-based industry. Trust is a complex and multidimensional construct, involving conscious calculation as well as emotions and intuition. Processes on the individual, organizational and societal levels interact in shaping trust. Further, since trust is strongly related to interaction between individuals, organizational processes primarily serving purposes of communication and coordination also influence trust. In construction, the temporary and unique project organizations entail high needs for information processing. Extensive industry-level standardization of roles and procurement routes has been developed, while the amount of face-to-face mutual adjustment is kept down. We conclude that trust production in construction is characterized by a strong emphasis on institutional trust (thin trust), while relational trust (thick trust) is neglected. In this weak trust context contracts influence trust negatively, since changes tend to produce tensions. To improve collaboration, more resources need to be spent on project-level communication. Also, industry level standardization should be better adapted to goals of flexibility and joint explorative learning.

1. INTRODUCTION

The last two decades, interorganizational trust has become a critical construct in socio-economic research as well as in organizational practice (Rousseau *et al*, 1998; Bachmann, 2001; McEvily *et al*, 2003). Because neither formal contracts nor informal agreements suffice to ensure an effective relationship between partners, the threat of partner opportunism turns trust into a central notion for business relationships, acting as a key coordinating mechanism of participants' actions (Cruz and Costa-Silva, 2004).

However, research on interorganizational trust appears to be full of paradoxes (Nooteboom, 2006). For instance, trust can be based on contracts and control, but can also rely on affection and norms of reciprocity and fairness, in which case

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formalized control sometimes may hamper trust. There is a tendency to have a picture of trust as always being good, going together with the absence of conflict. However, although trust may reduce transaction and agency costs (Becerra and Gupta, 1999), one may also trust mistakenly. And trust may enable openness and flexibility, but can also be so strong that it limits the variety of business relations needed for learning and innovation (Nooteboom, 2002).

Furthermore, trust does not only arise in direct interaction in specific exchange relationships, but is also influenced by more general contextual characteristics. The contracting environment, involving legal and educational institutions as well as ethical norms and other cultural aspects, interacts with formal contracts and the behaviour of individuals in shaping trust development in a specific relationship.

In the construction industry trust is often considered to be too scarce, resulting in inefficiencies and conservatism. The purpose of this paper is to identify the major modes of trust production in construction as well as their causes. We assume a multilevel approach, focussing on the interaction between institutional and relationship-specific foundations of trust. More specifically, we discuss how mechanisms to solve problems of information-processing and coordination affect the development of inter-organizational trust. First, we outline main points in literature on trust development in order to identify relevant forms of trust and processes of trust production. Then, we review literature specific on trust and contract and briefly discuss the relationship between organizational structure and needs for information processing. Subsequently we identify central characteristics of the construction industry and discuss their relationship to derived modes of trust production.

2. LITERATURE REVIEW

2. 1 Forms of trust and modes of trust production

The growing amount of trust literature clearly demonstrates that there are different forms of trust, linked with different processes of trust production. Economists (e.g. Williamson, 1993) tend to view trust as calculative, while social scientists (e.g. Granovetter, 1985) emphasize the social embedded character of trust, shaped by interpersonal relationships. Bachmann (1998) furthermore notes that the analysis of interorganizational trust has to be connected with understanding the role of the institutional framework in which business relations are embedded (see also Möllering, 2006). Arrighetti *et al* (1997) refers to the ‘contractual environment’, meaning the ‘broad normative frame of laws, customs and assumptions within which inter-firm relationships are embedded’. This institutional trust includes prevailing notions of what constitutes ethical behavior in business relations. Institutional factors such as culture, education bodies and legal systems can act as broad supports for the critical mass of trust within an exchange relationship that sustains further risk taking and trusting behavior (Gulati, 1995; Sitkin, 1995). Rousseau (1998) suggests that trust can be considered as a meso concept, integrating micro psychological processes with macro level institutional arrangements. Another important classification pertains to the object of trust. Competence trust refers to the trust one has in for instance the technical and organizational competences of a partner, while intentional trust refers to the trust one has in the intentions of a partner towards the relationship, particularly in refraining from opportunism (Klein Woolthuis et al., 2005).

Moving to the relationship level, much research emphasize that in trust development, rational, calculus-based considerations interact with more intuitive, psychological processes (Nooteboom, 2002; Möllering, 2001; Rousseau et al., 1998) la of trust. A rational assessment of someone's trustworthiness implies a conscious evaluation of the trustee's objective self-interest and competences. Trust develops or breaks down in finding out how far trustworthiness goes (Sako, 2000; Lewicki and Bunker, 1996). When people meet first and no relational experience has taken place before, initial levels of trust - or ex ante trust - will be based on institutions-based trust in combination with an assessment of the other's interests - as determined by for instance dependency and prospects of short term gains or future exchange, and his opportunities for actions - as determined by for instance contractual arrangements. Nooteboom (2002) states that people in this phase of a relationship will actively look for sources of trustworthiness of their partners (see also Williams, 1988 and Lindenberg, 2000). Because these sources are impersonal, not yet involving direct personal interaction and experience, this form of trust is called 'thin' trust.

When interorganizational relationships develop and interaction between individuals becomes at the heart of the trust development process, such calculus-based trust (Rousseau et al., 1997) can be extended with or replaced by a form of trust that has been labeled as relational trust (Rousseau *et al*, 1998), process based trust (Zucker, 1986) or affect-based trust (McAllister, 1995). It implies that feelings of personal attachment and tacit mutual understanding will arise and influence actions taken (Ring and Van de Ven, 1994). Foundations of such benevolence or goodwill trust tare perceptions of empathy, openness, loyalty and dedication (Mayer *et* al, 1995; Klein Woolthuis et. al, 2005). Nooteboom (2002, p 48), defines trust as "an expectation that things or people will not fail us, or the neglect or lack of awareness of the possibility of failure, even if there are perceived opportunities and incentives for it". Thus, this form of trust requires that trustworthiness goes beyond what can be prescribed in a formal contract. It is personalized and arises within a specific exchange relationship, and is often seen as a more 'thick' or 'strong' kind of trust.

For the purpose of this paper, we make a distinction between trust that arises from direct, personal interaction and trust that is based on indirect and impersonal sources. In line with Rousseau (1998), we state that the development of both rational *and* relational forms of trust is influenced by formal and informal institutions on a society level, an industry level and an interorganizational relationship level (see also Zucker, 1986).

2.2 Trust, contract and control

For an effective interorganizational relationship performance, partner firms need to manage emerging risks and uncertainty adequately by understanding the conjoint roles of trust and control (Das and Teng, 2001). Economists tend to focus on calculus-based trust and thus presume contractual safeguards and related formal control activities as conditional to trust (Williamson, 1985, 1993). However, as indicated by the definition by Nooteboom (2002) quoted above, the relationship between trust and control is ambiguous and complex (Bradach and Eccles, 1989; Klein Woolthuis et al., 2005; Long and Sitkin, 2006), and although collaboration may be induced by contracts, strong forms of trust have been found to require evidence that a person (or organization) chooses to collaborate despite incentives to pursue self-interest at the trustor's expense (Malhotra and Murninghan, 2002). As a consequence, trust and control may be seen as substitutes where high trust allows for (or requires) limited formal control (see also Knights *et al*, 2001, and Das and Teng, 2001). However, empirical research has shown that contracts and other aspects of formal control may strengthen trust, and thus that trust and control should be viewed as complementary constructs (Zaheer & Venkatraman, 1995; Poppo and Zenger, 2002; Vlaar et al., 2006).

Both trust and control reduce the perceived probability of undesirable outcomes. Trust entails a positive expectation about a partner's competences and/or intentions, leading to a lowered risk perception, while distrust induces negative expectations regarding another's conduct, leading to vigilance, suspicion and so to a heightened risk perception (Sitkin and Roth, 1993; Vlaar et al., 2006). In contrast, control is an interventionist approach and leads to lower risk perception by actively limiting and/or influencing the behavior of a partner (Das and Teng, 2001). Das and Teng (2001) suggest that in interorganizational cooperation there is the risk of a partner not cooperating satisfactory (relational risk) in addition to the risk of unsatisfactory cooperation performance (performance risk). Relational risk has to do with the intentions and integrity of a partner, particularly in refraining from opportunism, while performance risk is about the sense of confidence one has that a partner is capable of accomplishing given tasks (Nooteboom, 2002; Klein Woolthuis et al., 2005).

During cooperation, intentional trust reduces the perceived level of relational risk, while a firm's competence trust in a partner firm will reduce its perceived performance risk (Das and Teng, 2001). Both types of risk can be actively restrained by formal, measure-based control and informal, value-based control (Eisenhardt, 1985). Formal control is about establishing and utilizing contracts, formal procedures and monitoring policies. It is aimed at limiting relational risk (by mitigating opportunities and incentives for opportunism (by contracts) in order to acquire evidence of intentions) and performance risk (by monitoring the outcomes of activities in order to acquire evidence of competence) (Nooteboom, 2002). Informal control is about purposefully establishing norms, values and routines, to reduce discrepancies in goal preferences and inclinations towards opportunism (both critical for a satisfactory relationship performance). Consequentially, informal control reduces relational risk through the establishment of shared values. Performance risk is also reduced, because a shared understanding encourages partner firms to establish reasonable and achievable goals (Das and Teng, 2001).

An important aspect regarding the ambiguous trust-control/contract relationship, concerns the level of the business relationship. In practice, inter-firm relations consist of a number of ties between individuals at different levels in the organizations. In some cases, organization level trust is very weak, and relationships may then follow individuals when they change employer. Boundary-spanners such as sales people may pursue personal goals in the relationship with customers, and also develop loyalties to their exchange partners that may override those to their organization (Bradach and Eccles, 1989). Thus, trust may vary considerably between different levels in an inter-organizational relationship.

2.3 Trust and information processing

In much of the literature on trust and contract, contracts are seen mainly as devices to reduce the risk for opportunistic behavior. However, contracts are also key tools for communication, coordination and sense making. For example, Vlaar et al. (2006) emphasize that contracts and other types of formalization are important to focus partners' attention and increase their knowledge of the agreement, thus promoting a shared understanding that both coordinates action and supports trust. Conversely, we may ask how systems developed to serve needs of coordination and information processing influence partner trust.

Albeit in an intra-organizational setting, Madhok (2006) distinguishes between two types of management activities (or costs): costs for measures taken primarily to mitigate opportunism and costs related to measures to organize information processing and knowledge management. These activities can be distinct, but may also be either complementary or supplementary, much in the same way as the relationship between trust and control described above. To identify organizational activities and structures related to information processing we may use the conceptual framework of contingency theory (Thompson, 1967; Galbraith, 1973), where the need for communication and coordination is seen as the main determinant of organizational structures. Depending on the type of interdependence between activities, planning, hierarchy, mutual adjustment and standardization may be used as coordinating mechanisms. Mintzberg (1983) identifies three types of standardization.

1. Standardization of work processes, used to control behavior in routine situations;

2. Standardization of output, applicable when the results of the work can be specified;

3. Standardization of skills and knowledge, used when neither work processes nor output can be specified in advance. Then, authority may be delegated to individuals on the basis of their expertise, skills and often also a value orientation acquired by socialization into a professional community.

When activities are mutually interdependent, there is a need for information exchange during their execution. Such mutual adjustment is costly and therefore used only when it is absolutely necessary. To economize on information processing, a firm may develop company specific routines and roles. However, standardization is also prominent on a society level, and systems that produce institutions-based trust may originally have been developed for purposes of coordination.

2.4 Theoretical conclusion

From our overview of literature on trust development, it appears that generally three forms of trust can be distinguished: rational trust (based on a conscious evaluation of the other's trustworthiness), relational trust (based on feelings of personal attachment and tacit mutual understanding) and institutional trust (based on formal and informal institutions). Trust can be aimed at the competences and intentions of a partner. To understand trust production and trust problems in a specific context such as the construction industry, we need to consider all three types of trust, as well as how processes of trust production on individual, company and industry level interact. Moreover, we have take into account how these forms of trust are related to different types of risk (relational risk and performance risk) and how they cohere with a more actively restraining risk approach, i.e. formal and informal control. The starting point of the discussion in this paper is that the organization of the construction industry is fundamentally shaped by the nature of its outputs, and that organizational structures developed to solve problems of coordination also shape conditions for trust production.

3. TRUST IN CONSTRUCTION

3.1 Causes of project-based organizing in construction

The complexity and immobility of buildings has profound implications both for how the construction industry is organized and for the relationships between the principal actors. Buildings (and civil works) are distinct from most other products in that they are *technical monopolies*, meaning that once a building occupies a piece of land it can not be replaced without huge costs. It is not possible to simply return a faulty building to the producer/contractor, and some defects may be hidden and/or irremediable once put in place. This irreversibility makes the client very vulnerable to design deviations and quality defects.

Further, despite effort to increase pre-fabrication, all buildings are inevitably to some extent unique prototypes. Most buildings are composed of a combination of site production and standardized components, which are manufactured in a factory and assembled on site. The construction industry operates by *temporary multi-organizations* (Cherns and Bryant, 1984), composed of a number of specialized units, generally related to a system (heating, structure, cladding, restaurant, etc) or, especially in the case of consultants, to a functional competence (aesthetics, management, fire safety, drilling, acoustics). The organization becomes more complex as the complexity of the building increases. However, the degree of specialization is dependent on local market conditions: densely populated growth areas will sustain a much more specialized industry than more remote locations, where companies need to be more general. Except for very large and specialized building works, construction is a local service industry.

Thus, the immobility and complexity of buildings are two factors that both have important organizational implications. Immobility leads to site-specific, unique products and organizations, in turn resulting in high levels of uncertainty and high needs for inter-organizational communication. It should be noted that although various project based industries share a temporary orientation, there are also considerable differences between them. The immobility aspect distinguishes construction from other project-based industries.

3.2 Trust, contract and control

Transaction cost analysis based on transaction frequency, asset specificity and uncertainty clearly demonstrates why costs for setting up and managing project-based contracts are high in construction (Winch, 1989). The industry is often mentioned as an example of a context with a hybrid governance structure, either because of long-term relationships between actors (Eccles, 1981; Bradach and Eccles, 1989) or because contracts incorporate important hierarchical aspects (Stinchcombe, 1985; Bradach and Eccles, 1989). Such hierarchical elements are client control/inspection of site activities and, perhaps most important for trust, the exclusive right a contractor has to carry out additional work, due to changes and contractual omissions, on cost-reimbursable terms. This is seen by Stinchcombe (1985) as a concession that the client has to make in return for the contractor's obligation to adapt to the client's changing preferences and other contingencies.

The monopoly position of the contractor in pricing change work creates room for opportunistic strategies, especially in combination with procurement auctions with price as the main choice criterion. Then, a contractor may put in a low bid and expect to compensate this with income from claims for extra work. Another option is to shirk on quality, given the possibilities to hide work and to substitute high quality materials for cheaper, lower quality. Also "honest" contractors are affected by this opportunism option, since they compete for contracts on a price basis.

This issue has implications for both calculus-based trust and relational trust. First, because of the opportunities that the contractor has to take advantage of the situation, a "rational" client often adopts a defense strategy, based on monitoring and close analysis of all claims (although large and regular clients may count on reputation effects moderating opportunism). As for contractors, there are rational reasons for them to question the competence of especially the design team but also of the client, who have collaborated in producing the contract specifications. Thus, for both sides a certain level of distrust and opportunism can be defended on calculus-based grounds. On the other hand, uncertainty and uniqueness calls for collaborative solving of upcoming problems, and a bad relational climate may then be costly.

Moreover, as stated in the section on trust and control, intuitive psychological rules of reciprocity implies that distrust tends to start a vicious circle and become a self-fulfilling prophecy. This implies that a contractor who is closely monitored by a suspicious client may perceive an opportunistic claims' strategy as expected by the client. Furthermore, a suspicious attitude will make the client more inclined to interpret all contractor suggestions as self-interested rather than motivated by a concern for the project that signals trustworthiness. Thus, calculus-based defense strategies will easily produce behaviors that are not compatible with requirements of goodwill, benevolence and loyalty that characterize developments of relational trust.

This is not so much of a problem in relatively standard contexts, where specifications are simple, changes not many and norms of quality undisputed. When change negotiations are few and cause little conflict, the traditional contracts are functional. Both trust and quality/efficiency ambitions then tend to be institutionalized on a moderate level, not requiring too much contract management. A design-build approach may further economize on transaction costs, since the number of negotiations is lower when specifications pertain to systems and functions while detailed design is a contractor responsibility.

When uncertainty and uniqueness increases, however, traditional contracting becomes more risky. With detailed but less complete specifications and more frequent changes, interaction is dominated by negative issues. Claims' considerations may strongly influence both parties' strategies. If uncertainty is moderate, a design-build approach may reduce the number of relationship-threatening discussions, but the client's possibilities to influence quality in details is reduced when risk is transferred to the contractor. With still higher levels of complexity and uncertainty, a partnering contract on cost-reimbursable terms becomes more attractive. In this case, management strategies will focus on building trust and enabling knowledge sharing rather than on mitigating opportunism. However, there are trust problems also in this case, mainly in relation to the contractor's motivation to keep costs down. Thus, more control of norms and values is required, and transaction costs for monitoring relational risks are replaced by costs for establishing relational trust and systems for joint cost/quality management.

3.3 Trust and information processing

In this section, we will further elaborate on how information-processing and knowledge management aspects more generally impact on the development of trust and collaboration in construction. In an industry where firms regularly form temporary constellations, it is obvious that industry-level standardization is more powerful than firm-level standardization when it comes to reducing needs for coordination. Accordingly, we find a variety of industry-level standards in construction, pertaining to organizational aspects as well as to physical artifacts. For building components, national and international norming bodies provide important output standardization. On the organizational side, there are standard contract agreements that regulate responsibilities as well as how to handle contingencies and specify requirements. Following Vlaar (2006) and Arrighetti et al. (1997), standard contracts may be conductive to trust in that they increase the confidence in contracting as an organizing principle and a belief that the contractual terms are fair. This is a likely effect of standard contracts also in construction.

Further, strong expectations of knowledge and attitudes are tied to the various actors in the field, often based on a combination of cultural and formal characteristics. Both individuals and firms may be subject of certification and accreditation, performed by independent institutions. Especially consultants, but to some extent also craftsmen and contractors, are trusted because of their specialist knowledge and professional/crafts ethics. Thus, since standardized processes and roles provide both predictability and legitimacy, the same system that economizes on transaction costs also functions as an important source of institutions-based ex ante trust. However, we should also mention prejudice between different categories of participants, or institutions-based distrust, perhaps most pronounced in the case of architect-contractor relationships.

This standardization of roles is a fundamental organizing principle in the construction industry. Although each project organization is unique in terms of the competences and specific companies involved, there is a limited set of organizational models (procurement routes) and only some competence combinations available on the market. Companies are designed to fit into specific "slots" in the project organizations, and individuals and firms to a great extent perform similar tasks in all projects. An important function of this industry level standardization of roles, knowledge and responsibilities is to reduce the need for communication and negotiation between parties. Although construction firms are decentralized, the freedom of the project organizations is strongly constrained by contextual factors (Bresnen et al, 2004).

There are implications of the standardization of roles also for relational trust. In the traditional procurement route (and, to a lesser extent, in design-build options), the project is divided into distinct phases where the output takes the form of documents (brief, drawings and specifications). As mentioned above, changes and additions after the contract is signed are expensive. Consequently, project control is strongly directed towards minimizing changes, aiming at producing documents that are as flawless as possible. This has as a side-effect that participants in different project phases have little contact, and that the interaction that occurs tends to be conflict oriented. Although trust does not always arise in interpersonal relationships, relationships without any interaction and communication will hardly bring about more robust forms of trust. Thus, that a construction project is sub-divided into phases and standardized work packages also has implications for the opportunities that different participants have to build relational trust. In general, participants active in different phases will have little contact. However, standardization also reduces the need for communication within phases. When a specialist consultant or contractor is brought into a project, there is seldom an organized introduction or team building session; the new team member is expected to know what to do and start to perform immediately. Levels of interaction also vary between different participants within a phase, depending on scheduling and the size and importance of their contribution.

A related aspect, which partly overlaps with the phase effects, is how geographical movements in space affect spontaneous trust building. Co-location of teams often brings about strong interpersonal trust and efficient work practice (Scarbrough et al., 2004), but this is only possible in larger projects. Instead, most design interaction takes place in scheduled meetings and there is little room for spontaneous socializing between individuals from different firms. This contrasts strongly with the construction phase, during which the construction site is the principal physical hub and meeting location. Here, the building contractor, as a main contractor and coordinator, is the key actor who has opportunities to build relations with other contractors as well as the client representative and other site visitors. Site level trust may moderate distrust on higher organizational levels and is often considered indispensable to efficient problem-solving. However, the result may also be compromises where, although not necessarily intentionally, the interests of consultants, users or even the own company are overlooked. Thus, patterns of interaction contribute to the development of both loyalties and distrust.

4. CONCLUSIONS

The starting point of our discussion was that the products of the construction industry – the buildings - are the roots of the project-based organization of the industry. To handle vast amounts of uncertainty and save on transaction costs in this context, extensive formal and informal industry-level standardization has been developed. This system for knowledge management and information processing strongly favors exploitation of knowledge before exploration (March, 1991), and thus has implications for the propensity for innovation. However, there are consequences also for trust building and collaboration. We may conclude that trust production in construction is characterized by a strong emphasis on institutional trust.

Such strong industry standardization to economize on communication and mutual adjustment means a reliance on weak forms of trust, while the development of relational trust is hampered. Although standard contracts might reduce the needs for contract parties to communicate (Vlaar, 2006), in construction standardization of roles is perhaps a more important cause of absent joint sense-making across organizational boundaries. Relational management is underdeveloped compared to opportunism management. Left unmanaged, building of relational trust is limited to spontaneous socializing in the interaction that is brought about by the production system, mainly taking place on the construction site. Inter-organizational relationships are multilevel, and in client-contractor relationships and contractor-subcontractor relations – relationships that are low trust on an organizational level due to contract characteristics – may be high trust on site level due to interaction effects between individuals. In consultant–contractor relations, on the other hand, contract effects combine with absent interaction to produce distrust. There is reason to be more attentive to how such spontaneous, emergent trust building influences project outcomes.

As for the debated relationship between trust and contract, contracts may seem to be responsible for much of the distrust in construction. However, at a closer look it is not the contracts per se that are problematic, but rather that there are uncertainties that are hard to solve by contracts only. Clauses are introduced to handle change management, but changes remain important sources of conflict. More detailed contracts may counteract trust, but primarily so when uncertainty is high and changes frequent. However, using less detailed contracts entail trust problems related to quality. Since there are no calculus-based solutions to the contracting problems of construction, a transition to more open and flexible contracts requires an approach were relationship and knowledge management takes prominence of opportunism control.

However, this implies that more resources have to be invested in expensive project-level communication, partly related to unlearning of institutionalized behaviors developed in a traditional weak trust context. Prevailing institutionalized coordination mechanisms seem increasingly outdated when requirements for flexibility raise, and perhaps buildings and construction project organizations have already become too complex to handle with a weak trust approach. Also, new information-processing technology presents new opportunities. Thus, we could ask what industry level standardization could serve the needs for efficient coordination and institutions-based trust, but is better adapted to goals of flexibility and explorative learning.

5. REFERENCES

Arrighetti, A., Bachmann, R. and Deakin, S. (1997), Contract law, social norms and inter-firm cooperation, *Cambridge Journal of Economics*, **21**, pp171-195.

Bachmann, R. (1998), Conclusion: trust – conceptual aspects of a complex phenomenon, In: C. Lane and R. Bachmann (eds.), *Trust within and between organizations*, 298-322, Oxford University Press

Bachmann, R., Knights, D. and Sydow, J. (2001), Editorial: Trust and control in organization relations, *Organization Studies*, **22**(3), 1-4.

Becerra, M. and Gupta, A. (2003), Perceived trustworthiness within the organization: the moderating impact of communication frequency on trustor and trustee effects, *Organization Science*, **14**(1), 32-44.

Bresnen, M., Goussevskaia, A. and Swan, J. (2004) Embedding New Management Knowledge in Project-Based Organizations, *Organization Studies*, **25**(9), 1535-1555.

Eccles, R. (1981) The Quasifirm in the Construction Industry, *Journal of Economic Behavior and Organization*, **2**, 335-357.
Bradach J.L. and Eccles, R.G. (1989), Markets versus hierarchies: from ideal types to plural forms, In: W.R. Scott (ed.), *Annual review of sociology*, **15**, 97-118.
Cherns, A. B. and Bryant, D. T. (1984) Studying the client's role in construction management, *Construction Management and Economics*, **2**, 177-84.
Cruz, J.G. and Costa-Silva, S. (2004), Trust: theoretical framework and underlying disciplines, conceptualization, antecedents and consequences, *Paper for the EURAM conference.*
Das, T.K. and Teng, B.S. (2001), Trust, control and risk in strategic alliances: an integrated framework, *Organization Studies,* **22**(2), 251-283.
Eisenhardt, K.M. (1985), Control: organizational and economic approaches, *Management Science*, **31**, 134-149.
Galbraith, J. (1973) *Designing Complex Organizations*. Reading (MA): Addison-Wesley.
Granovetter, M.S. (1985), Economic action and social structure: A theory of Embeddedness, *American Journal of Sociology,* **91**, 481-510.
Gulati, R. (1995), Does familiarity breed trust? The implications of repeated ties for contractual choice in alliances, *Academy of Management Journal*, **30**(1), 85-112.
Klein Woolthuis, R., Hillebrand, B. and Nooteboom, B. (2005), Trust, contract and relationship development, *Organization Studies*, **26**(6), 813-840.
Knights, D., Noble, F. Vurdubakis T. and Willmott H. (2001) Chasing shadows: control, virtuality and the production of trust, *Organization studies*, **22**(2), 311-336.
Lewicki, R.J. and Bunker, B.B. (1996), Developing and maintaining trust in work relationships, In: R.M. Kramer and T.R. Tyler (eds.), *Trust in organizations: frontiers of theory and research,* Thousand Oaks: Sage, 114-139.
Lindenberg, S. (2000), It takes both trust and lack of mistrust: the working of cooperation and relational signaling in contractual relationships, *Journal of management and governance,* **4**, 11-33.
Long, C.P. and Sitkin, S.B. (2006), Trust in the balance: how managers integrate trust-building and task-control, In: Bachmann, R. and A. Zaheer (eds.), *Handbook of Trust Research*, Cheltenham: Edward Elgar, 87-106.
Madhok, A. (2006), Opportunism, trust and knowledge: the management of firm value and the value of firm management, In: Bachmann, R. and A. Zaheer (eds.), *Handbook of Trust Research*, Cheltenham: Edward Elgar, 107-123.
Malhotra, D. and Murninghan, J. K. (2002) The Effects of Contracts on Interpersonal Trust. *Administrative Science Quarterly*, **47**, 34-559.
March, J. G. (1991) Exploration and Exploitation in Organizational Learning. *Organization Science*, **2**(1), 71-87.
Mayer, R.C., Davis, J.H. and Schoorman, F.D. (1995), An integrative model of organizational trust, *Academy of Management Review,* **20**, 709-734.
McAllister, D.J. (1995), Affect- and cognition-based trust as foundations for interpersonal cooperation in organizations, *Academy of Management Journal,* **38**(1), 24-59.
McEvily, B., Perrone, V. and Zaheer, A. (2003), Trust as an organizing principle, *Organization Science*, **14**(1), 91-103.
Mintzberg, H. (1983) *Structure in Fives. Designing Effective Organizations,* Englewood Cliffs: Prentice-Hall.
Möllering, G. (2001), The nature of trust: from George Simmel to a theory of expectation, interpretation and suspension, *Sociology*, **35**(2), 403-420.

Möllering, G. (2006), Trust, institutions, agency: towards a neoinstitutional theory of trust, In: Bachmann, R. and A. Zaheer (eds.), *Handbook of Trust Research*, Cheltenham: Edward Elgar, 355-376.
Nooteboom, B. (2002) *Trust.* Cheltenham: Edward Elgar.
Nooteboom, B. (2006), Forms, sources and processes of trust, In: Bachmann, R. and A. Zaheer (eds.), *Handbook of Trust Research*, Cheltenham: Edward Elgar, 247-264.
Nooteboom, B. (2006), *Trust: forms, foundations, functions, failures and figures,* Cheltenham: Edward Elgar.
Poppo, L. and Zenger, T. (2002), Do formal contracts and relational governance function as substitutes of complements? *Strategic Management Journal,* **23**, 707-725.
Ring, P.S. and Ven de Ven, A.H. (1994), Developmental processes of cooperative interorganizational relationships, *Academy of Management Review,* **19**, 90-118.
Rousseau, D., Sitkin, S., Burt, R. and Camerer, C. (1998), Not so different after all: A cross discipline view of trust, *Academy of Management Review*, **23**(3), 393-404.
Sako, M. (2000), Does trust improve business performance?, In: C. Lane and R. Bachmann (eds.), *Trust within and between organizations*, Oxford University Press, 88-117.
Scarbrough, H., Swan, J., Laurent, S., Bresnen, M., Edelman, L. and Newell, S. (2004) Project-Based Learning and the Role of Learning Boundaries, *Organization Studies*, **25**(9), 1579-1600.
Sitkin, S. B. and Roth, N. (1993), Explaining the limited effectiveness of legalistic ‘remedies’ for trust/distrust, *Organization Science*, **4**(3), 367-392.
Sitkin, S.B. (1995), On the positive effect of legalization on trust, *Research on negotiations on organizations,* **5**, 185-217.
Stinchcombe, A. L. (1985) Contracts as Hierarchical Documents. In: Stinchcombe, A. and Heimer, C. *Organization Theory and Project Management. Administering Uncertainty in Norwegian Offshore Oil.* Bergen: Norwegian University Press.
Thompson, J. D. (1967) *Organizations in Action*. New York: McGraw-Hill.
Vlaar, P.W.K., Van den Bosch, F. and Volberda, H.W. (2006), On the evolution of trust, distrust and formal coordination and control in interorganizational relationships: towards an integrative framework, Forthcoming in Group & Organization Management.
Winch, G. (1989) The construction firm and the construction project: a transaction cost approach. *Construction Management and Economics*. **7**, 331-345.
Williams, B. (1988), Formal structures and social reality, in D. Gambetta (ed.), *Trust: making and breaking of cooperative relations,* Oxford: Blackwell, 3-13.
Williamson, O.E. (1985), The economic institutions of capitalism: firms, markets, relational contracting, New York: The Free Press.
Williamson, O.E. (1993), Calculativeness, trust, and economic organization, *Journal of Law and Economics*, **36**, 453-486.
Zaheer A. and Venkatraman, N. (1995), Relational governance as an interorganizational strategy: An empirical test of the role of trust in economic exchange, *Strategic Management Journal*, 373-392.
Zucker, L.G. (1986), Production of trust: institutional sources of economic structure, In: Barry, Staw and Cummings, *Research in Organizational Behaviour,* **8**, 53-111.

AUTONOMY AND INNOVATION IN CONSTRUCTION TEAMS IN DENMARK

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ABSTRACT

A grassroots model for innovation targeted at small construction firms and skilled workers is being developed using an inductive research approach involving a series of case studies, workshops, literature reviews and lectures. A study of experience with autonomy in Danish construction teams has drawn an outline of the competences required of skilled workers in future and has revealed a need for training in innovation with frontrunners as a driving force. A framework model for innovation has been developed with local trade schools as the focal point. The purpose is to expand collaboration between research, technical schools and small construction firms. The model is currently being tested in practice in the bricklayer trade to serve as an illustrative example for other trades. Preliminary results from this one-to-one testing are very positive and, hopefully, can be documented later in 2007.

1. INTRODUCTION

Poor quality, many errors, low efficiency, high prices and low credibility characterise the Danish construction sector's image with the general public and government authorities. At the same time, the sector is going through tremendous change. Production at building sites is shifting to industrial production. New forms of partnerships and models of organisation are being introduced in and between enterprises. A multitude of new materials and products are replacing old familiar ones, and the sector is under pressure to use digital models and 3D-visualisation in communicating with end users and collaboration partners. In addition, Danish authorities have a vision of more user-driven innovation in all parts of society.

How do specialist contractors and small firms respond to these challenges? What is the role of the skilled worker in this development? And how can firms and workmen contribute to a solution to these problems and improve their position and opportunities for development?

We will try to give some answers to these questions in our research. As the object of our research we have chosen the small construction firm, the skilled worker and the work of the work gangs at the building site. We will look into their competition opportunities and the development of autonomous and cross-disciplinary work gangs as a supplement to the narrower specialist work gang. This study is a first step, aimed at finding a structure and a model for national efforts to increase their competences in innovation. The study is also to encourage testing of key measures, competences and better collaboration with other trades, education, and research in the bricklayer sector.

2. LITERATURE REVIEW AND INNOVATION MODEL

The literature review was carried out in several phases as the need arose in the course of the series of small case studies which this action research has been building on. This cyclical approach between literature review, case study and reflection over key themes is an approach which Barrett and Sexton (2006) also utilised. They say: "This hybrid approach loosens the disadvantage of grounded theory, that it can be unduly limited by the cases and the researchers".

2.1 Segments, categories and drivers of innovation

Literature and text books about innovation have different focus depending on whether the author is an economist, technical specialist, designer or sociologist. There is also a great difference in the language used by researchers, management consultants, developers, enterprise leaders and ordinary employees. In a comparative study of cultural differences between the Danish and the British construction sector, Hancock (2002) shows that there is a greater difference of culture between the trades and specialist groups than between the two nations. Understanding of these differences is crucial when attempting to transfer experience from one trade or sector to another.

In a common Nordic productivity study (Ingvaldsen, 2004), an attempt was made to compare the productivity of the countries and to make suggestions for improvements and developments. There were two approaches: productivity and innovation from the point of view of the contractor or from the value-oriented point of view of the owner/client. The study also discussed differences between new buildings and renovation, and between housing construction and other contraction works. The study proposed that future development should distinguish between different segments of the construction sector and different types of players. Furthermore, the study identified a gap between national statistics and day-to-day construction practice experienced by the parties involved in construction projects.

The division between different segments in the construction sector was discussed further at a WG meeting of the Northern Dimension region countries in Stockholm in January 2007 (Bertelsen, 2007). It was suggested e.g. to divide process/product into the segments: owner and end-user, planning and design, construction site and industrial production. Across these the following four competence categories could be dealt with: Lean construction; information and ICT; quality and defects; and economy and LCC. Furthermore, it was suggested to invest work in improving national statistics and creating common methods for case studies, since the former were erroneous and no common practice existed for the latter.

In a more extensive literature review on innovation in small, project-based construction firms, Barrett and Sexton (2006) emphasise the importance of the role played by small firms in industrial markets and in technological change. They also conclude that owners of small firms have a dominant role in driving innovation activities, and that there are two modes of innovation: Mode 1 – Single-project and cost-oriented client relationship, and Mode 2 – Multi-project and value-oriented client relationship. Here, the division between project/firm and cost/value, as we suggest in figure 1, seems better able to describe the differences between different modes.

Barrett and Sexton (2006) also emphasise the wish for a more holistic and dynamic approach combining the following drivers: technology-driven, market-driven and owners' resources. A knowledge-driven approach could also be an option in this connection, if one believes that research, development and education can be drivers of innovation. In their conclusion, Barrett and Sexton stress, that policies for large construction firms are not necessarily appropriate for small construction firms, and vice-versa, and that the research focus on innovation in small, project-based firms is very much in its embryonic stage.

Case studies on renewal of old multi-storey housing in Denmark propose a hypothesis as to who are the drivers of changes (Bertelsen, 2004). First it is stated that a certain difference must exist between the poorest and the best firms in the market. As illustrated in figure 2, through innovative thinking and continuous improvement, frontrunners create a pull in the market. There is a constant pressure from the market on the poorest-performing players, forcing them to respond either with an innovative 'jump' (jumpers) or by leaving the market (losers). Our hypothesis is that motivation can be used to woo frontrunners to pull the market forward, and that regulated pressure on potential 'losers' and 'jumpers' will ensure the right difference of supply.

The above is summarised in table 1 below showing a list of the most important segments, categories and drivers. These are expected to be useful in one way or other in further work on building a model for understanding autonomy and innovation in construction teams.

Table 1. Different segments, categories and drivers of innovation

National actors	**Building**	**Process / -product**	**Competences**	**Firms and project**	**Innovation driver**	**Types of actors**
Public and national	Housing, new	Owner and end-user	Lean construction	Big firms, multi-project	Technology (external)	'Losers'
Building sector	Housing, renewal	Planning and design	Information and ICT	Small firms, multi-project	Market (external)	'Jumpers'
Other sectors	Others, new	Construction site	Quality and defects	Single projects	Resources (internal)	'Movers'
Research education	Others, renewal	Industrial production	Economy and LCC	Individuals and teams	Knowledge (internal)	'Frontrunners'

	Cost and process	Value and product
Single-project	Mode 1	?
Multi-project	?	Mode 2

Figure 1. Different innovation modes (Barrett and Sexton, 2006).

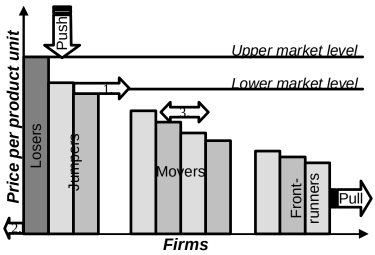

Figure 2. Different types of players (Bertelsen, 2004).

2.2 Models and tools for building an innovative environment

Barrett and Sexton (2006) propose a generic innovation model in five elements: 1) Innovation focus and outcomes, 2) Enhanced performance, 3) Context in innovation, 4) Organisational capabilities for innovation, and 5) Innovation process (figure 3). They conclude from the study that there are eight research gaps concerning innovation in small, project-based construction firms, e.g. gap 8 "Are the process of innovation rational and/or behavioural in nature?" They propose in addition the following organisational factors used in the innovation model: Organisation of work, People, Technology and Business strategy/market positioning (figure 4), which cover both Mode 1 and Mode 2 in figure 1. The factors resemble the four drivers in table 1.

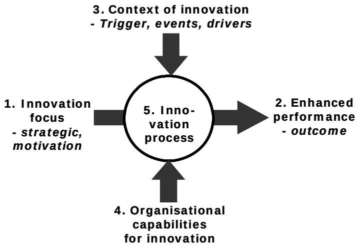

Figure 3. Generic innovation model (Barrett and Sexton, 2006).

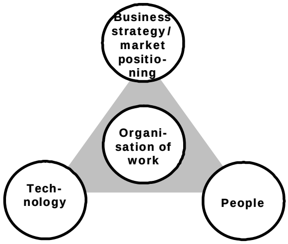

Figure 4. Organisational factors in innovation (Barrett and Sexton, 2006).

Senge, Roberts, Ross, Smith and Kleiner (1994) define personal mastery as exceptional skills or a master of a craft, and it is one of the fifth disciplines in developing a learning organization. Having a clear picture of one’s current reality and the vision will create a "creative tension" in the innovation process that looks for ways to move closer to what we want, our vision. The tension between reality and vision is like a "rubber band" and a central element in personal mastery. Current reality corresponds to "1. Innovation focus" in figure 3, vision corresponds to "2. Performance and outcome", and "the rubber band" is the external tension that creates "5. Innovation process".

Roberts (1994, pp 226-229) stresses that personal mastery also includes being able to handle "both a reactive response to events and a creative response to reach the future and vision you want". This corresponds well with Barrett and Sexton's (2006) ideas about the rational and/or behavioural nature of innovation. However, why not imagine the rubber band extending also to "3. Context of innovation" and "4. Organisational capabilities" providing a double tension for "5. Innovation process". At the general level, Senge, Roberts, Ross, Smith and Kleiner (1994) in many ways supplement the specific study of small construction firms by Barrett and Sexton (2006). For example, they give several proposals for different tools which can be used in the innovation process and which might help close the eight gaps in the model.

Story telling is one of these tools, which provides opportunity for describing the correlation between cause and effect in an entertaining manner, as a spring board for learning and innovation. Senge, Roberts, Ross, Smith and Kleiner (1994) suggest expanding the tool at four levels: events/context of innovation, pattern of behaviour, systemic structure and mental models. Through pattern of behaviour the process, trends, and responsibilities are described. Furthermore, connections and relations may be described in a systemic structure, as a part of systems thinking - the second element of the fifth discipline. In the mental model, the third element of the fifth discipline, the ladder of interference is described in the following steps: 1) observe 'data' and experiences, 2) select 'data', 3) add meanings, 4) make assumptions, 5) draw conclusions, 6) adopt beliefs and 7) take actions. Reflection is a loop back from step 6 to step 2.

3. RESEARCH OBJECTIVES AND METHODOLOGY

The target group for the research is small construction firms and skilled workers. The research objective is on developing a grassroots model for innovation, and to test it on small bricklayer firms and bricklayers. The test serves as an illustrative example for other trades, small construction firms and skilled workers. The vision is to build a simple model for innovation in small construction firms which can be applied by highly skilled workers and supported by a local innovation network around technical schools. The goal is to answer four key questions through the research, which are carried out as three sub-studies. The first part of the studies is reported here, and the final sub-study will be completed in 2007.

3.1 Project description and objectives

The research focuses on innovation in the target group of small construction firms and skilled workers, including how they can contribute to solving some of the construction sector's many problems, such as poor competitiveness, quality and image. The primary objective of the research is to build and describe a simple innovation model, which can be understood and applied by the target group, enabling them to carry out innovation themselves and improve their innovation competence in practice. The supporting objective is to launch testing of the model in a delimited segment where local technical schools are to make up the creative framework for developing an innovation network of small construction firms and skilled workers.

3.2 Research methodology

The research is carried out as an inductive research in close collaboration with technical schools, construction firms, skilled workers and their organisations. A number of small case studies on construction teams and small construction firms were carried out oscillating between development of the model and literature reviews. This cyclical approach has gradually lead to a number of insights that have been 'tested' on different players in the sector (skilled workers, construction firms, teachers, architects, engineers and researchers) through lectures and discussions in working groups. In this way, simplicity and clarity have been sought for the model, so as to make it easily applicable and effective for the target group, while at the same time basing it on a research foundation. This inductive method dates back to 1637 when René Descartes described it in "The Method" (French: Descous de la Méthode).

The skilled workers and the small construction firms were chosen as the target group from the beginning, because they play an important part in the construction sector. At the same time we can see that research is sparse in this area. Next, it was decided to look into the possibilities for developing autonomy in teams and cross-disciplinary collaboration at the construction site, as an alternative development string for specialisation. This also provides opportunity for assessing future competence development for the target group. Finally, it was decided to focus on the bricklayer trade as an example for other trades. This choice was made in collaboration with unions etc., because the bricklayer trade is known for its well-established traditions, as well as its need for renewal, and it may therefore serve as a good example for other trades.

Through literature reviews and knowledge of the needs of the trades, the following important questions emerge which need answering through research.

1. Can a simple "double rubber band model" be developed based on figure 3 and experience from other industries, which small construction firms and skilled workers can use in developing their business and competences?
2. Can frontrunners be developed, cf. figure 2. who may serve as a locomotive for development and learning on the construction site, in the firms and at the schools?
3. Can the technical schools be local development centres and the innovative link between research and small construction firms and skilled workers, and can knowledge be the fourth innovation driver, cf. table 1?
4. Can small construction firms and skilled workers achieve competences in all four modes in figure 1 and in this way contribute to speeding up industrial development and creating better productivity and value for clients.

These four themes will be analysed through the three sub-studies, of which the two first have been completed and the third has been launched and will be completed in 2007.

The first sub-study is an analysis of autonomy in construction teams and future competences for skilled workers. This study was carried out in three parts. The first part consisted of ten workshops with a group of experts and union/organisational representatives to set the framework for future development. The second part was a study of general theories and experience from team work, communication and autonomy aimed at skilled construction workers, which was to show experience from other sectors applied to the target group. The third part consisted of on-site interviews with four highly qualified skilled teams and their mastermen from different geographical parts of Denmark. Based on findings from these three inputs, the idea was to provide an overview of required future competences for skilled workers and to point out key areas for development.

The second sub-study was a study of small bricklayer firms and strategies for developing efficient methods to control processes, logistics and quality in teams and in small construction firms as an example of the first step in an innovation process.

The third sub-study will start a long-term test and development project in the bricklayer trade. Development will take place through local competence centres in collaboration with research institutes, design schools, business schools and local innovative bricklayer firms and bricklayers.

4. RESEARCH RESULTS AND INDUSTRIAL IMPACT

The results of the first and second sub-studies have been reported in Bertelsen (2005) and Gottlieb and Bertelsen (2006). The third sub-study has been initiated but results have not yet been reported, so only preliminary experience has been included from this illustrative test of establishing an innovation network for bricklayer firms and skilled workers.

4.1 First sub-study – Autonomy in construction teams

The first sub-study was launched through the following three activities:

1. Ten workshops with a group of Danish experts and organisations
2. A literature review. The references are not included in this paper but can be seen in Bertelsen, 2005
3. Interviews on autonomy of four construction teams.

It was clear from the ten workshops with experts (researchers, architects, engineers and teachers) and representatives from organisations that their knowledge primarily was on the framework conditions for construction teams and skilled workers. They knew something about education, collective agreements, the project material, client requirements and legislation (points 6, 5 and 4 in figure 5), but they only knew a little about the specific work of the teams and their development opportunities (points 1, 2 and 3 in figure 5).

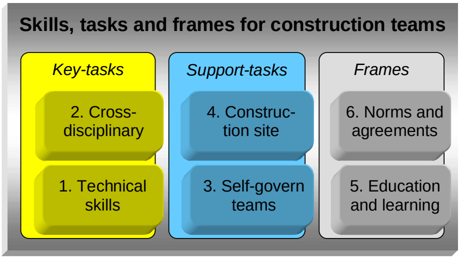

Figure 5. Important skills, tasks and frames for construction teams and workers.

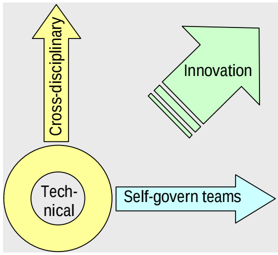

Figure 6. Four development strategies for competences.

In the conclusion from the workshops the participants indicated ten important development areas, five of which aimed at technical skills, one at cross-disciplinary collaboration, two at self-governing teams and two at external frames (see figure 5). They advised against starting development concerning public norms and agreements because this would take a long time and it is likely that there would be very little effect.

The literature review showed that there is a lot of general experience of autonomy, collaboration and innovation etc., but little of this had been adapted to the special needs and conditions of small construction firms and teams. This matches well with the experience of Barrett and Sexton (2006).

The four teams and firms interviewed were selected by the organisations as some of the best, and they represented different trades and geographical areas in Denmark. The interviews showed that the skilled workers had very good technical competences, they worked very autonomously, and that the firms wanted to give them more responsibility. One team was particularly interesting as it had developed new tools itself which provided both more efficient processes and better physical health and safety. This development was supported by the firm and many of the tools have been developed further and are now used by other firms.

Overall, this sub-study showed that developments in the future will very much build on the high technical competences possessed by skilled workers, and there is a trend towards more autonomous teams, although developments related to cross-disciplinary collaboration are not moving so rapidly. Grassroots innovation in small construction firms is possible, fuelled by innovative skilled workers and mastermen, and this is being practiced in many places in Denmark. However, there is no doubt that there is a lack of education and knowledge on how this can be implemented and improved (see figure 6).

4.2 Second sub-study – Innovation of process control in small firms

Four small bricklayer firms took part in this sub-study; they were selected as the best in a local area north of Copenhagen and they represent different sizes and organisation. A simple illustrative method of process and quality control for small project-based construction firms was described for them and proposed as a future management tool. This first drawing-board prototype of the tool was used at the interviews as an alternative to the current practice, and on the basis of this the firm's development opportunities and wishes were discussed.

None of the four firms had special project management tools, other than their financial systems, and they did not believe they needed them because they were not required by their customers and the firms could manage things via mobile phones. All firms wanted more education and training if they were to use the new tool anyway, and the tool should be fully developed and provide quick results.

	Business	Technique
Tool	Mode 1	Mode 3
Commu-nication	Mode 2	Mode 4

Figure 7. Proposed future development steps 1, 2, 3 and 4. Today's focus is only on mode 3.

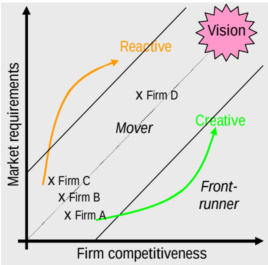

Figure 8. The four firms in the rubber band 2nd tension.

The four firms were thinking primarily in mode 3, see figure 7, and although they wanted results from the project management tool, it was hard for them to discus the business aspects, see mode 1 in figure 7. This was despite the fact that financial and quality assessments of the firms' work showed that they did have a need and that there were financial benefits to be made. As a result of this it was concluded that future development of the tool should follow the specific order of events in figure 7.

The response to pressure from the market was reactive and non-creative, and three firms (firms A, B and C) had sought out a niche in the market where demands from the market were limited, nicely befitting their low competitiveness. It was surprising that among the four there was no frontrunner or only one which had a goal of moving the firm to a higher level of competitiveness. This leads to the conclusion that today a market push and a technology pull (see table 1) are not adequate drivers of innovation, and that the resources of owners and profit are protected rather than applied for innovation. Furthermore, it is assessed that an innovation pull from role models in the trade or sector (frontrunners) is required, and that there is a need for knowledge about and training in innovation for all modes shown in figures 1 and 7.

4.3 Third sub-study – Establishing an innovation network for bricklayers

In 2006, this project was launched by employers, employees and trade schools in the bricklayer trade in cooperation with researchers and with a total support of € 0.3 mill from different sources. The first two innovation networks have been established and they have implemented education and training in innovation and development of new inner walls and bathrooms. Preliminary experience has been very positive, and we hope to be able to confirm the following preliminary experience later this year when the first part of the project has been reported:

- Frontrunner among skilled workers, small construction firms and teachers make up efficient drivers of innovation in small firms and in teams.
- The local innovation network is an efficient link between research and small construction firms, but there is a lack of competence in innovation and teaching in addition to technical skills, both in the firm and on site at a mastery level.
- A simple innovation model based on "a double rubber band tension" as a framework for the innovation process and which is easy to use for the target group, seems the practicable solution, however experience with use in practice by the target group is lacking
- Many development elements have been put into play concurrently in the project providing many synergy effects, and it is necessary for the usability. It is also important to have broad skills and pedagogic approach characterised by great adaptability, rather than specialisation and heavy research.

5. CONCLUSIONS

The bricklayer trade and trade schools have welcomed the new innovation network which is headed by local technical schools and intended to support the long-term development of the innovation competences of small bricklayer firms. It is anticipated that testing this grassroots model for user-driven innovation on a selected trade will spread to small construction firms in other trades, e.g. carpenters, floor fitters, and plumbers. The new innovation network is to be a bridge between research, technical schools and small construction firms in an equal, collaborative relationship and supporting the innovative frontrunners and the dissemination process.

This report has sought to explain four key themes in a model for innovation in small construction firms. The model is a simple "double rubber band model" providing creative tension to the innovation process, and it seems to also provide the outer framework for development of the area. Frontrunners appear to be an essential driving force both at the construction site, in firms and at technical schools. Furthermore, it appears that technical schools have a need to develop their innovation competence and for balanced development collaboration with firms and construction sites, if as suggested they are to serve as centres for the local innovation networks. After the first tests, moreover, it looks as if the target group of small construction firms and skilled workers will be able to carry out accelerated development in different modes toward industrial production.

Documentation of experience so far is not complete, however it is expected that later in 2007 we will be able to present documentation of the field studies in progress. We also hope that there will be occasion for subsequent implementation of more tests to underpin the model's usability, and that international collaboration can be created concerning further development and documentation of experience.

6. REFERENCES

Barrett, P. and Sexton, M. (2006), Innovation in Small, Project-Based Construction Firms. *British Journal of Management*, 17, 331-346.

Bertelsen, N.H. (2004), *Better productivity in renewal – Case-studies on planning, managing and follow-up.* Copenhagen, Danish Building Research Institute, By og Byg Dokumentation 061.

Bertelsen, N.H. (2005), *The self-governing construction site (In Danish: Den selvstyrende byggeplads).* Copenhagen, Danish Building Research Institute, SBI Report 2005:11.

Bertelsen, N.H. (2007), *How to reduce building costs – Danish initiatives.* Copenhagen, Danish Building Research Institute, project 741-079, memo 26/1 2007.

Descartes, R. (1637), *The method (French: Discours de la Méthode).* Translated from French into Danish by Brøndal, V. and Valdemar, H. (1996). Copenhagen, Gyldendal.

Gottlieb, S.G. and Bertelsen, N.H. (2006). *Construction control for subcontractors (In Danish: Byggestyring for fagentreprenører).* Copenhagen, Danish Building Research Institute, SBI Report 2006:12.

Hancock, M.R (2000), *Cultural Differences between Construction Professionals in Denmark and United Kingdom.* Copenhagen, Danish Building Research Institute, SBI report 324.

Ingvaldsen, T., Lakka, A., Nielsen, A., Bertelsen, N.H. and Jonsson, B. (2004), *Productivity studies in Nordic building- and construction industry.* Oslo, Norwegian Building Research Institute, Project report 377.

Senge, P.M., Roberts, C., Ross, R.B., Smith, B.J. and Kleiner, A, (1994), *The Fifth Discipline Fieldbook – Strategies and Tools for Building a Learning Organization.* London, Nicholas Brealey Publishing Limited.

CORPORATE STRATEGIES – FOR WHOM AND FOR WHAT?

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ABSTRACT

The strategic-management literature has been highlighting ineffective communication as one of the main causes of strategy-implementation failure, but what is meant by communication? Empirical studies that focus on the communicative aspects of strategy work remain scarce. Based on a longitudinal case study of a large Swedish construction company's strategic work during a change process, this paper focuses on the ways in which the new strategies were communicated and interpreted at four organizational levels. Drawing on theories from the strategy literature we have used a socio-cultural lens to view our findings. We found that different perspectives on the function of organizational strategies as well as on the meaning of the term communication gave rise to different managerial approaches to strategy work. This in turn led to different values being ascribed to the strategic process, which consequently gave rise to different interpretations of the strategies themselves. This paper shows that communication is a complex and dynamic socially constructed process that is inherently intertwined with other organizational activities. It therefore needs to be continuously discussed and evaluated in the same way as other processes and activities.

1. INTRODUCTION

In today's globalized world, effective strategic management is becoming an increasingly important issue both for practitioners and management scholars. Not only is the formal process of formulating and implementing strategies given a higher priority, but the role and meaning of the strategies are also changing (Price, 2003). In the construction industry, however, few companies seem as yet to have an established formal strategy process, even though the industry is becoming more aware of the importance of effective strategic management to enhance performance and profitability (Junnonen, 1998). In the purportedly conservative construction industry, actors prefer adhering to the "business as usual" mindset, which often results in a drift of strategic meanings and ultimate blurring of the organization's strategic position (Johnson et al., 2005).

Following a large number of recent reports of company failures to implement strategies (e.g. Allio, 2005; Corboy and O'Corrbui, 1999; Kaplan and Norton, 2001), the attention of researchers and practitioners is now shifting from the formulation process to the implementation dilemmas (Aaltonen and Ikavalko, 2002). The already growing body of research on strategy implementation seems to agree that one of the

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main reasons for these failures is ineffective organizational communication due to lack of consideration of the social environment at the strategy-execution level of the organization (e.g. Miniace and Falter, 1996). However, what is meant by the term “communication” is not defined, and only very few studies actually focus on the discursive and rhetorical aspects of strategy communication (e.g. Fairhurst et al., 1997; Johansson, 2003; Müllern and Stein, 1999). These studies typically describe managerial strategic communication as being transactional rather than interactional, monologic rather than dialogic, top down rather than bottom up. They also characterize strategic rhetoric at top-management level as abstract rather than concrete, idealistic rather than realistic and distanced rather than proximal.

To our knowledge, no such studies have been carried out in the construction industry. The overall purpose of this paper is therefore to report preliminary results from a longitudinal case study of the strategy work carried out in a large Swedish construction company during a period of organizational change. Our concern here is the ways in which the new strategies are communicated down the chain of command in the company: from top-management levels via middle management to project management. We focus on the face-to-face communicative approaches used by the different managerial levels to disseminate the corporate strategies and the implications these approaches have on the ways in which the strategies are interpreted and understood. What interest us in these interactions are the underlying reasons for the different approaches towards strategy implementation. We hope to contribute some insight into the complexity of communicative processes and practices and argue that organizations need to view discursive processes and practices as an integral part of organizing.

2. FRAME OF REFERENCE

The word *strategy* gives rise to a multitude of meanings and definitions depending on the perspectives of the writers. It is a term that has been widely treated throughout history, giving rise to different, and often conflicting, views (Price, 2003). Scholars have tried to classify the different views or schools of thought concerning strategies e.g., Bailey and Johnson (1992), Chaffee (1985), Whittington (1993) and Mintzberg et al. (1998). As in all such classifications, there is always a fair amount of overlap between the categories (Faulkner and Campbell, 2003).

Here we discuss Whittington’s (1993) classification of strategy into four perspectives: *Classicist*, *Evolutionary*, *Processual* and *Systemic*. Depending on the perspective or approach toward strategy management, the processes through which the strategies are generated and the implications for the outcomes will differ (Fig. 1). We will concentrate on three of the perspectives: Classicist, Processual and Systemic perspectives.

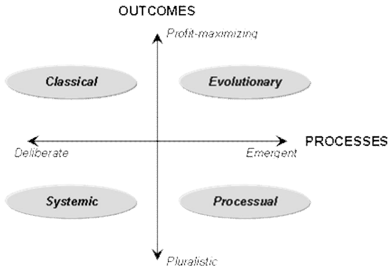

Figure 1. Generic perspectives on strategy. (Whittington, 1993 p.3).

The *classicist* perspective originated in eighteenth century economics, drawing on the militaristic ideals of Ancient Greece. For *classicists,* profitability is the ultimate business goal, and rational planning is the only means of attaining it. The classical approach in business only emerged as a coherent discipline in the 1960s (Whittington, 1993) with the idealization of the CEO who commands his people to carry out his formulated strategies without question.

The *Processual* perspective views strategies as emergent, generated in response to the chaotic environment of organizations and markets. Cyert and March (1963) claim that people are only “boundedly rational, ” which they explain as follows:

> *[W]e are unable to consider more than a handful of factors at a time; we are reluctant to embark on unlimited searches for relevant information; we are biased in our interpretation of data; and finally we are prone to accept the first satisfactory option that presents itself, rather than insisting on the best (Cyert and March (1963) in Whittington (1993 p.23)).*

Furthermore, the processual perspective sees organizations as made up by individuals, who bring their own needs, wishes and biases to their places of work. To work toward an organizational vision and goal in such heterogeneous groupings requires negotiation. The consequences are most often that several goals will apply, and these may not always be aligned with each other. Negotiations combined with bounded rationality may, according to Whittington, lead to strategic conservatism and resistance to change. Moreover, in this perspective, strategies emerge retrospectively and are seen as a management tool to describe and simplify a chaotic world.

The *systemic* perspective sees organizational behavior as deeply rooted in employees social networks and strongly influenced by family, education, background, religion and ethnicity (Swedberg et al., 1987; Whittington, 1993). Thus, the strategies reflect the social systems in which they are formulated and enacted. The concept of formally planned strategies is a culturally constructed phenomenon, predominantly advocated in Anglo-Saxon culture. From the systemic point of view formal planning is sociologically efficient although maybe not economically so. Since formal planning does satisfy a fundamental human need to order one’s environment, it is therefore beneficial to organizations.

These perspectives on organizational strategies entail different approaches to strategy formulation and implementation. How strategies are used and understood at the managerial levels may be very different from how they are interpreted and understood at the operational levels. Consequently these perspectives presuppose very different communicative approaches and discourses. The classical perspective assumes a top-down, one-way, transmission approach in which strategies are seen as information or orders to be carried out by middle management and down the chain of command. In the systemic and processual perspectives strategies are seen as constructed entities that are negotiated by heterogeneous groups and may be enacted, but may also give rise to resistance and non-action. With these views, communication becomes a means of reaching a consensus and shared knowledge. This would assume a two-way, interactive communication.

As mentioned earlier, managers seem to lack communicative competence (e.g. Johansson). This seems to apply in the construction industry as well, which has been criticized for its patriarchal and conservative mindset (Knauseder, 2007; Gluch, 2005). In our view, this lacuna cannot only be bridged by attending prescriptive "how-to" communication courses. What is needed is a theoretical understanding of the cognitive processes that take place over a chain of communicative acts where ideas or propositions are conveyed and interpreted. One explanatory lens is that provided by Czarniawska and Joerges (1996), who see ideas (be they in non-materialized forms such as thoughts and talk, or materialized in artefacts, such as textual inscriptions) as travelling through different times and spaces. As the ideas move between humans or from humans to artefacts and back again, they take on altered states as they collide with competing ideas.

Traditionally, innovations and new ideas have been viewed as being spread through a diffusion process (Rogers, 1995). The weakness of the diffusion model is that the recipient of an idea is regarded as a willing receiver, whose slate is empty. Diffusion is therefore a model of a linear, one-way communicative process (Powell and DiMaggio, 1991). Moreover, the diffusion model also presupposes that ideas do not alter as they are transferred from individual to individual or group to group. In contrast to the diffusion model, Czarniawska and Joerges, following Latour (1991), show how ideas go through chains of translations, namely they alter as they move from sender to receiver in order to suit new contexts of use and new users (Meyer, 1996).

One limitation of the "travels of ideas" metaphor is that it does not contribute to a full understanding of *what happens* and *why* when an idea surfaces and is caught by actors in a particular local space. It shows *that* ideas travel and change, but not *how* this change takes place or what factors may contribute to the change on organizational, group or individual levels.

3. METHOD

The empirical analysis is based on a longitudinal case study (Yin, 1994) carried out between 2005 and 2007, on strategy implementation in a construction company in a period of change. The case organization, hereafter called *Constructo*, is a large global construction corporation, and the largest domestic contractor with approximately 12.000 employees. The case study only involves the domestic branch. The new organizational pyramid consisted of the top-management and its operational-development team, 26 regions and 107 districts. For the purpose of this paper, strategic work at one region and its four districts were studied.

Three iterative approaches were used to collect the data for this part of the study. The first approach consisted of 13 semi-structured interviews of which 2 were follow-up interviews. The group of interviewees consisted of: 1 Regional Managers, 1 Regional Staff Manager, 4 District Managers, 1 Project Managers and 4 Production Managers. The interviews lasted 45 min to 105 min, were audio recorded and transcribed in full. The second approach consisted of field observations, where the researchers participated in 7 meetings on strategy work at one business unit, hereafter referred to as Region A. All the meetings were audio recorded and field notes were taken. After each meeting, the data was reviewed and analyzed by the group of co-authors. The third approach was an analysis of documents, business plans, power-point presentations and personal notes as well as follow-up documentation collected from the participants.

4. DIFFERENT APPROACHES TO CORPORATE STRATEGIES

At the time of the study, the organizational structure at *Constructo* consisted of a top-management team supported by an operational-development team. Below top management, the organization was divided into functional and geographical regions, e.g. Housing, Road Construction and Civil Engineering. The regions were divided into districts, operational units that executed the business in local markets. The function of the regions was to manage, support and coordinate bundles of four to eight districts.

The different management groups at *Constructo* were formed so that there would be a certain overlap of functions. Thus the district managers were part of the regional-management group and the project managers were part of the district-management group. Accordingly, each manager attended strategy meetings at two organizational levels.

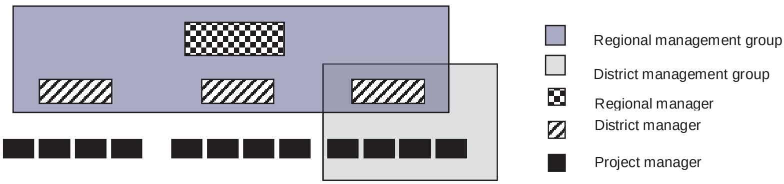

Figure 2. The management group affiliation for managers at *Constructo*

4.1 Intended work process according to top management

Annually, top management reviewed the strategies and aligned them with company operations. Although the strategies applied to the whole organization, they were mainly formulated to address regional managers, who received the strategic document by email attachment. The work process advocated by top management was that the regional-management groups should review the strategies and prioritize among them according to their own local contexts. Moreover they were to formulate action points for fulfilling the strategies. The idea was that the resulting regional business plans would be sent to top management for review and approval and then to the district managers for further processing. The districts in turn were to focus on the execution of the strategies by designing district-specific action points.

The key question for prioritizing among the strategies was supposed to be "Do we currently work according to this strategy today?" and not "Is this strategy important?" In other words, top management gave regional managers a certain freedom to choose the strategies that applied especially to their line of work although it was made clear that all the strategies were important from the company's perspective:

> *The idea is for each region to review the strategies and ascertain how well they fulfil each one. If performance is not up to the region's desired level, then [that strategy] should be prioritized and something should be done. If [the region] is already satisfied with the work done in another strategic area, it does not have to work that much with that particular strategy at that time. But [the strategy] remains important* [Member of the operational development team].

Top management emphasized that the regions should prioritize among the strategies according to their current status within each strategy. However, we found that managers still prioritized among the strategies according to their perceived importance for the region, which was contrary to top management's implicit intentions:

> *I have heard people say that 'No, we did not choose that strategy. It was not important for us'. But that is not the intention and it is serious if it is perceived as such* [Member of the operational development team].

From the documents we collected and our interviews, we witnessed a prevalent worry among managers concerning employee engagement and commitment to the strategies. How to instil these attitudes in lower-level managers and employees was neither discussed nor problematized. The attitude at top-management level was that the need for improvement should spur the necessary engagement for the strategies and generate action points.

Strategy work at the lower levels, district and project levels, was relatively free from top-management intervention, but since there was very little feed-back on the resulting business plans and action points, the freedom risked being interpreted as lack of interest. What senior and top management were mainly interested in was the overall company progression. If a region was underachieving, top management wanted this to be made visible so that they could intervene and wield control.

4.2 Strategy work at the regional level

At the regional level the strategy-management process adhered mostly to the intentions of top management. The regional management group was called to a two-day off-site workshop to discuss the new formulations of the 2006 strategies. At the start of the meeting the regional manager gave his interpretation of the purpose of the strategies and of the meeting.

> *[The strategies are originally formulated] by our top management. They have looked at how we should work with certain issues in* Constructo*. They look at these issues from a top-management perspective and now it is our task to establish what we should do in our region in order to work in the same direction* [Regional manager].

Each strategy was then discussed in the group to ascertain the status of the region vis-à-vis the strategy. As the meeting progressed, the discussion started to blur when the good of the company as reflected in the strategy formulations and the good of the region as experienced by individual members of the group were in conflict. For example, as a response to a complaint made by one district manager, who announced that he felt that they were doing this work for somebody else and not for the benefit of their unit, the regional manager countered by arguing that their job was to decide what was meaningful for the region as a whole. As a result of this exchange, the regional manager asked the rest of the group to brainstorm what they considered the five most important tasks for the region for the following year. These lists were then briefly ticked off to ensure that all the tasks would be included in the business plan. However, some tasks were difficult to include, such as “Having fun at work” as the group could not find a suitable strategy among those advocated by top management.

The regional management group prioritized 18 out of the 30 strategies that were proposed by top management, and action points were formulated for each one. After this business plan was approved by top management, it was the districts turn to prioritize and formulate their action points.

4.3 Strategy work at the district level

All the management groups at the district level within Region A used face-to-face meetings, as advised, to discuss the strategies and the regional business plan. While most of the districts mainly discussed only those strategies prioritized at the regional level, one district discussed all 30 strategies. The rationale for this procedure, according to the district manager, was that in the regional business plan the strategies had been prioritized from a regional perspective, in the district, however, different strategies may need to be prioritized to suit the district’s local context. The result was that this particular district prioritized 16 of the 30 strategies. Out of the 18 strategies prioritized at the regional level, 12 were kept and four were abandoned. It is interesting to note here that communication in these types of groups tended to be a dialogic interplay between all the parties present and the participants did not hesitate to ask questions and even contradict their manager. However, not all the groups at district level were equally interactive.

At the district level we also saw a shift in approach to strategy work compared to the senior organizational levels. Here the key question became “Is this strategy something that we should be working with?” The districts put more focus on the perceived importance of the strategy from the district perspective, that is, the district’s business plan had to “fit” the current business and primarily lead to profitability for the district. Here focus was put on trying to engage project managers and project members hence the applicability of the strategies to these contexts took on a central roles. Thus, what the district wanted and needed was deemed as more important than what benefited *Constructo*, which was clearly reflected in the discourse used. As expressed by one district manager:

> *[The discussion concerning the district's own priorities] is what is most important. We have to know what we want [...] The business plan may be one issue. However, for us the discussion is perhaps more important* [District manager].

While top management rarely mentioned the words "commitment", "engagement" or "learning" these terms or synonymous expressions often appeared in both the meetings and our interviews at district level. According to one district manager, the failure of strategy implementation in the organization was often due to the lack of pedagogical skills among top management and their inability to "sell" the strategy to the lower levels of the organization.

> *They [Top management] use the wrong pedagogy when trying to sell [the strategies] by arguing from a top-management perspective and not from a project perspective* [District manager].

At the district level the managers' attitudes toward strategy work was that it consisted of a constant negotiation in which the strategies had to be properly packaged in order to be effectively "sold" to the rest of the district. This packaging meant that the strategies had to be perceived as being beneficial to the district first and foremost and then to the organization as a whole. One district manager explained his role in this communication:

> *My role is obviously to implement [the strategy], to break down and adapt it to our business. That is, to create commitment for [the strategy] based on our needs, the way we work and the people that work here*. [District manager].

As an example of the increased focus on commitment, one district started the process of working with the strategies with a two-hour brainstorming session where all the attendees were asked to write down the tasks they thought to be most important. This was done prior to the review of the strategies advocated by top management. Based on the resulting list of tasks, decisions were made regarding what strategies to prioritize. The district manager used this method in order to create commitment in the team: "*I want commitment to the strategies we prioritize in my district."* [District manager].

This is in line with the statement of another district manager who believed that the most important outcome of the strategy work and development of the business plan were the dialogues within the management groups.

> *... by working with the business plan during a whole week of the year, I believe that we incorporate a lot of ideas from the strategies in our daily routines* [District manager].

The outcome of each district's strategy process was a district business plan with action points adapted to suit the local context of each district. Action points that concerned the projects were to be entered into the project plan for detailed execution.

4.4 Project level

At the project level, the district's business plan was adapted for the project activities with specific action points. However, we perceived that attitudes toward the project plan and its importance varied among the project managers. Although some claimed that in the last few years the focus on strategies and strategic issues had markedly increased, the impact of this increased interest on the projects was less discernable. Neither business plans nor project plans were given much attention in the day-to-day activities. One reason for this neglect, as expressed by a project manager, was that he could not find anything in the business plan that inspired him in his daily work. Another project manager considered the strategies and business plan as enforced by top management for control purposes. Thus they gained concentrated attention for a short period and then were forgotten during the rest of the year. The reason for this state of affairs, he said, could be found in the wide gap between top management's intended work process and how the work was actually realized.

> *[Constructo] works at two separate levels. The strategic level of our organization is never present at the work site and does not care how things actually work out there. They have their ideas and opinions on how things should be done, but it is out there that the work is done most effectively* [Project manager].

As we can see from these brief glimpses into the strategy work at three organizational levels, different approaches were adopted largely dependent on the personal engagement, objectives and competence of the different managers. In this chain of strategy communication, different ways of translating and packaging the messages have taken place, leading to different ways of identifying with the strategies. In the following we will provide a brief example of this travel of ideas.

4.5 An illustration of how strategies travel across organizational levels

As the strategies travelled through time and space, from one level to the next in the organization, their meanings were altered through translation. Some aspects may have been lost, while other aspects may have been gained. To exemplify this journey, we will follow one strategy as it travels, namely "[We shall] communicate actively with the outside world". This strategy was defined in the strategic documentation as:

> *External communication via for example the media constitutes an important channel for creating credibility and knowledge about our development work, our values and our collective competence* [Excerpt from strategy documentation]

The rationale behind the strategy was explained by a member of the operational development team:

> *The background for this strategy is that we want to measure our media image. [...] [the indicators] is the amount of positive mentions in the*

*media in relation to our total media exposure. [...] We [*Constructo*] are simply not very good at projecting our image and doing so is important* [Member of the operational development team].

Already at the regional level this strategy caused some tension. While the regional manager's choice of words projected the importance of this strategy and pointed out the region's weaknesses in this area, he failed to translate this urgency to the district managers. The district managers did not view communication with the press as being part of their responsibility, especially since there was a special organizational function for this kind of task. The regional manager, however, did not agree with the interpretation of the "outside world" as only including the press, but advocated taking part in debates or participating in research projects. The plausibility of these alternatives for the district managers, with their heavy schedules, could be debatable. The discussion ended in the decision to prioritize the strategy at the regional level, and as action point the district managers were to contact *Constructo's* information department whenever they had something newsworthy to share.

Even though the district managers agreed to prioritize the strategy at the regional meeting, in their own meetings they continued to struggle with its meaning. Several district managers could not understand how they could operationalize the strategy. To them it was far from clear how the strategy would add value to their business. In fact they were wary of conveying contradictory messages to the general public via the media and they felt that communication with the media had not been part of their training.

I am supposed to manage my business, be profitable and manage projects. I can, of course, take part in the external communication, but it is not my responsibility [District manager].

It is this indicator especially and this strategy that I feel I have no way of controlling. They both feel very distant from the activities at our district [District manager].

Moreover, according to one district manager, the formulation of the strategy failed to convey what he thought to be the actual purpose of the strategy.

What we really want with the communication is to create a positive image of Constructo *as a responsible company that wants to take part in the development of a sustainable society. But the strategy does not say that* [District manager].

Even though the strategy was prioritized in most of the districts, little was done during the year to realize it. When failing to grasp the rationale and purpose of the strategy, as applied to their business, the district managers assumed a "business as usual" attitude regarding this strategy, which resulted in its being ignored or being paid lip service.

In this example, we see how the meaning of a strategy shifted as it was translated from one level to another in the organization. Although this strategy was deemed as very important for the company as a whole, both the original formulation and the translation at regional level, failed to convey this urgency to the district and project levels. We have tried to show that the reason for this communicative mismatch does not only reside in the choice of words. The interlocutors' perspectives on the role and function of strategies as well as their loyalties – organization versus unit – also play important roles.

5. DISCUSSION AND CONCLUSIONS

At top management level, strategies were considered a vital tool for organizational planning and control. The strategies were formulated by top management without involving other levels and were then presented to the managers, who were to disseminate them in the company. The strategies were in a sense regarded as orders that were to be acted upon by a capable workforce who shared top managements' values and assumptions. Top management also established the strategic work procedure for the different levels. These characteristics correspond well with the definitions of the classicist approach to strategy as described by Whittington (1993). Moreover, this perspective correlates with the transmission model of communication and the abstract rhetoric used by managers in the studies of Johansson (2003), Fairhurst et al. (1997) and Müllern and Stein (1999).

As the strategies traveled down the chain of command at *Constructo*, we saw a marked shift in perspective on the strategies. At district level there was concern for the applicability of the strategies and their value for the local unit. The strategies had to "fit" the current local contexts if they were going to generate commitment and action. Likewise, more weight was given to how the strategies were formulated and interpreted. At the district-management level, the strategy-implementation process was viewed as a continuous negotiation process, both up the chain of command as well as down. The content and intent of the strategies had to be understood by those who were going to execute them.

At the district level the process of developing a business plan served more as an opportunity for reflection on the local business for the coming year. Thus, the continuous negotiations to find an adequate fit between the needs and resources of the local unit and the organizational strategies reflected a processual approach to strategies as described by Whittington (1993). In the same way as the classicist approach, the processual approach influenced the ways in which the strategies were conveyed and interpreted.

The different perspectives on strategies at the different levels in the organization seemed to be deeply rooted in the mindsets of the managers at different levels. The clash in perspectives renders understanding impossible, which in turn negatively affects the prospects of a successful implementation process. However, formal planning, as viewed by classicists is not likely to disappear as a management tool in the foreseeable future. For example, the concept of analyzing and planning is very appealing on paper, and gives authority to decisions, and may function as a "security net" in a turbulent environment (Whittington, 1993). Since the processual perspective of the lower-management levels is just as likely to prevail, there is a need to merge these two perspectives by combining resources from both.

The diametrically opposed approaches to strategies at *Constructo* created communication barriers, which resulted in the intended strategy process differing from the realized implementation process. Even if the lower organizational levels were not pursuing entirely different strategies than those advocated by top management, the fact that they approached strategies differently had practical implications for the *outcomes* as well as the *processes*. So, what implications may these heterogeneous approaches within one and the same organization have, for example, for the way strategies are interpreted and become embedded in an organization's activities and discursive practices? And, what may be done to facilitate the strategy implementation process?

First, top management needs to be aware of the fact that an implementation process is not equal to a diffusion process (Rogers, 1995), which presupposes that the diffused idea, i.e., the strategy, does not change as it moves from one organizational level to another. Instead, strategy implementation could be seen as a translation process (Czarniawska and Joerges, 1996), where meaning changes as the strategy moves from sender to receiver. Different groups' or individuals' mental frameworks, or mindsets, influence the way strategies are framed within a specific context as we have seen in this study (see also Weick, 1995). That is, how strategies are interpreted and understood is a context-dependent process. This view of the implementation process can be compared to the systemic approach to strategy (Whittington, 1993). That is, the organizational members' behaviour is rooted in their social networks and consequently the strategies reflect the social system in which they are enacted. However, the Systemic approach does not address the presence of different approaches within one and the same organization.

Moreover, without a common understanding of the strategies and how they are to be managed in an organization, there is a risk that tensions in both interpretations and commitment among organizational members may prove destructive for the strategic work. In order to achieve such an understanding, the two levels need to understand the underlying forces that influence interpretation and drive action. Especially the top-management levels need to acquire better knowledge of the affordances and constraints associated with the cognitive aspects of organizational communication in general and strategy communication in particular. Although our study did not find evidence of any counteractions among the organizational managers, the way that the strategy "[We shall] communicate actively with the outside world" was approached, illustrates that some managers distanced themselves from the strategy and responded with non-action.

The different approaches to strategies at various organizational levels may not *per se* obstruct mutual understanding. It is rather the unawareness of the fact that other groups may have different ways of approaching strategy work that creates obstacles in the understanding of the others' rationales for acting. For the effective implementation of strategies, different groups in an organization need to first understand the meanings embedded in the strategies and then accept that there are different ways of enacting them. Such an acceptance can only be achieved through interaction and communication. Our contribution has been to highlight some of the intangible underlying reasons for the mismatches.

This paper has shown how different perspectives on the roles and functions of strategies in organizations give rise to different approaches to strategy work. In turn, these different approaches influence the ways in which strategies are interpreted and understood at the different levels. The ways in which strategies are understood influences the way in which they are acted upon. Our intention has been to raise awareness of the complexity of strategic communication and encourage further research in this area.

6. REFERENCES

Aaltonen, P. & Ikavalko, H. (2002) Implementing strategies successfully. *Integrated Manufacturing Systems*, **13**(6), 415-418.

Allio, M. K. (2005) A short, practical guide to implementing strategy. *The Journal of Business Strategy*, **26**(4), 12.

Bailey, A. & Johnson, G. (1992) How Strategies Develop in Organizations. In: Faulkner, D. & Johnson, G. (Eds.) *The challenge of strategic management*. London, Kogan Page [with] Cranfield School of Management.

Chaffee, E. E. (1985) Three Models of Strategy. Academy of Management. *The Academy of Management Review*, **10**(1), 89-98.

Corboy, M. & O'Corrbui, D. (1999) The seven deadly sins of strategy. *Management Accounting*, **77**(10), 29-30.

Cyert, R. M. & March, J. G. (1963) *A behavioral theory of the firm*, Englewood Cliffs, N.J., Prentice-Hall.

Czarniawska, B. & Joerges, B. (1996) *Travel of Ideas*. In: Czarniawska, B. & Sevón, G. (Eds.) Translating organizational change. Berlin, de Gruyter.

Fairhurst, G. T., Jordan, J. M. & Neuwirth, K. (1997) Why are we here? Managing the meaning of an organizational mission statement. *Journal of Applied Communication Research*, **25**(4), 243.

Faulkner, D. & Campbell, A. (2003) *The Oxford handbook of strategy*. 1, A strategy overview and competitive strategy, Oxford, Oxford University Press.

Gluch, P. (2005) *Building Green - Perspectives on Environmental Management in Construction*. Institutionen för bygg- och miljöteknik, Byggnadsekonomi. Chalmers Tekniska Högskola.

Johansson, C. E. (2003) *Visioner och verkligheter. Kommunikationen om foretagets strategi*. Sweden, Uppsala Universitet (Sweden).

Johnson, G., Scholes, K. & Whittington, R. (2005) *Exploring corporate strategy: text and cases*, Harlow, Financial Times Prentice Hall.

Junnonen, J. M. (1998) Strategy formation in construction firms. *Engineering Construction and Architectural Management*, **5**(2), 107-14.

Kaplan, R. S. & Norton, D. P. (2001) *The strategy-focused organization: how balanced scorecard companies thrive in the new business environment*, Boston, Mass., Harvard Business School.

Knauseder, I. (2007) *Organisational Learning Capabilities in Swedish Construction Projects*. Institutionen för bygg- och miljöteknik, Byggnadsekonomi. Chalmers Tekniska Högskola.

Latour, B. (1991) Technology is society made durable. In: Law, J. (Ed.) *A sociology of monsters : essays on power, technology and domination*. London, Routledge.

Meyer, J. W. (1996) Otherhood: The Promulgation and Transmission of Ideas in the Modern Organizational Environment. In: Czarniawska, B. & Sevón, G. (Eds.) *Translating organizational change*. Berlin, de Gruyter.

Miniace, J. N. & Falter, E. (1996) Communication: A key factor in strategy implementation. *Planning Review*, **24**(1), 26-30.

Mintzberg, H., Ahlstrand, B. W. & Lampel, J. (1998) *Strategy safari: a guided tour through the wilds of strategic management*, New York, Free Press.

Müllern, T. & Stein, J. (1999) *Övertygandets ledarskap: om retorik vid strategiska förändringar*, Lund, Studentlitteratur.

Porter, M. E. (1996) *What is strategy?* Harvard Business Review, **74**(6), 61.

Powell, W. W. & Dimaggio, P. J. (1991) *The new institutionalism in organizational analysis*, Chicago, University of Chicago Press.

Price, A. D. F. (2003) The strategy process within large construction organisations. Engineering, *Construction and Architectural Management*, **10**(4), 283-296.
Rogers, E. M. (1995) *Diffusion of innovations*, New York, Free Press.
Swedberg, R., Himmelstrand, U. & Brulin, G. (1987) The paradigm of economic sociology. *Theory and Society*, **16**(2), 169-213.
Weick, K. E. (1995) *Sensemaking in organizations*, Thousand Oaks, Calif., Sage.
Whittington, R. (1993) *What is strategy – and does it matter?* London, Routledge.
Yin, R. K. (1994) *Case study research: design and methods*, Thousand Oaks, CA, Sage.

EXPLORING THE IMPORTANCE OF ORGANISATIONAL CULTURE IN A MERGER OF TWO CONSTRUCTION COMPANIES

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ABSTRACT

Mergers can be seen as a part of a strategy designed to achieve corporate growth. Generally, when a merger of two companies is carried out, the culture of their organisations in a similar way are expected to merge into one. In this situation, staff can experience confusion and sometimes resentment. Hence, there is a risk that staff show less commitment or even disloyalty to the new company. As a result, productivity can be decreased and in the long run these actions will show in the turnover. Studies show that most failures when merging two companies result from poorly managed cultural integration. A sound integration should consider both cultural as well as organisational aspects and a tool in these processes is communication. By performing interviews and studying literature on organisational culture and mergers, the study presented investigates the merging of two mid-size construction companies based in the Gothenburg region. The results indicate that cultural differences between merging organisations need to be managed in order to support the development of a common organisational culture. In this process, the structure and content of communication in the organization is of vital importance.

1. INTRODUCTION

Mergers in the Swedish construction industry are fairly common, as economical aspects make it harder for mid-size construction companies to grow into larger organisations. In addition, mergers can be seen as a part of a strategy designed to achieve corporate growth. Initially, when merging two companies, employees within both firms might experience confusion, stress or even fright due to the uncertainty they experience in the new situation. On organisational level, these experiences can be shown in lowered commitment and productivity as well as in increased dissatisfaction and disloyalty (Buono & Bowditch, 1989). In addition, Buono & Bowditch (1989) state that many companies seem to overestimate the potential benefits rising from combining two organisations such as the increase of market shares, as well as the ease with which a merger can be made successful. Studies show that most failures origin from either lack of communication, differences in management styles or cultural differences. Also, it has been confirmed that as much as 80 percent of the risks associated with mergers and acquisitions originate from poorly managed cultural integration (Brahy, 2006).

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In this study a merger of two mid-sized construction companies in the Gothenburg region is investigated. These companies are considered to be a good match by the parties since they operate within different fields of the construction market. However, when merging, not only optimized joint activity must be considered. Other factors, such as cultural differences and different styles of management also have impact on whether a merger will be successful or not. When studying the merger between the two construction companies, company A and company B, questions on how the merger could become as efficient as possible arose. The most distinguished difference between the two companies is that company A mainly focuses on its construction projects and economy in order to gain profit, while company B also give priority to the organisation and its employee's personal development.

Since cultural differences tend to be overlooked during mergers, it is one of the main focuses in this study. In addition, to overcome cultural differences communication is an essential tool according to Doherty (1988). The aim of this study is therefore to outline how these construction companies can manage cultural differences by using different ways of communication.

The introduction of this paper will give a background to the merger of the two construction companies and the paper continues by describing the methods used for carrying out the study. Previous research with in the fields of mergers and organisational culture followed by the results from the interviews serve as a base for how the findings later are interpreted and concluded.

1.1 Background

Almost ten years ago, a large construction group started to develop in the western region of Sweden by founding company A together with employees breaking out from another construction company. During these ten years of activity, company A has been successful and has had a continuous growth on the market. Company B was founded in 1981 and has had a similar development process to company A. Both companies have looked at different ways to expand whiteout taking on to much overhead costs and found merging with another construction company the best way forward.

Company A is owned by a majority of the employees together with the large construction group. In May 2006, an acquisition was made of company B by the large construction group with the intention to merger with company B in March 2007. Since the large construction group is a joint-stock business, the employees within these construction companies could not be informed about the merger or the acquisition before the official announcement.

Thoughts about an acquisition arose when company B had made an internal investigation on raising capital in order to enlarge the company. The result of that survey showed that there were many obstacles to overcome before such a change could be made and it would lead to new problems. Furthermore, all organisational changes come with a risk, hence, the acquiring process, starting in the summer of 2007, where the large construction group is buying full ownership of company A might also create an unusual situation for the employees.

The acquisition of company B was a strategic move by the large construction group to gain market shares and to increase presence in the western region of Sweden.

Furthermore, the reasons for acquiring company B was that, all though they were competitors on the local construction market, their specific competences within the market would be a complement to company A. Hence, the united organisation that company A and company B merger into would be able to offer the construction markets a greater range of competence. When accepting the tender by the large construction group, an important aspect for company B was that their organisational values, e.g. setting the organisation and employees in focus, was shared by the acquiring company. Only top managers within both construction companies, negotiating the conditions for the merger, knew about the ongoing procedure. The plans of the merger needed to be kept secret due to the legislation related to the stock market. Information about the merger was given to the employees at a meeting arranged the same day as the merger became public.

2. METHOD

This study is based on literature concerning cooperate culture, merger and communication and seven semi-structured and individual interviews with employees of two merging construction companies three months prior to the actual merger. Individual interviews with open-ended questions were carried out to make interviewees speak more freely about their thoughts and feelings regarding the merger. Questions were formulated to outline how and to which extent communication was used to spread information throughout the organisation and to reveal any informal communication patterns. The interviewees were selected to obtain different aspects on how the communication is carried out within the two organisations and were selected from various positions within the two organisations; two CEO's, one Head of Information, one employee working with calculation for Construction, one Quality and Environmental manager and one Head of Department for civil works. Thus, both managers who are in charge of the strategic information as well as employees from different levels receiving the information were interviewed.

3. LITERATURE REVIEW

When trying to find a definition of organisational culture it is clear that several definitions exist. One of the definitions is quoted below.

> *"The pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external integration, and that have worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to these problems*."
>
> (Schein: 1985, p. 6)

Furthermore, Doherty (1988) points out ways of acting to resolve cultural conflicts based on experience from eight mergers. More, he declares that it is essential to quickly establish who is in charge; subsequently it will be easier to resolve practical issues. Resolving issues at an early stage serves to avoid anxiety and rumours. Furthermore, Doherty (1988) emphasize that it is important to choose a leader who believes in the merger and that can convince employees as well as clients. In addition, the companies must take into consideration the individual employee and if possible, arrange one-to-one meetings between manager and employee. The gain with straight communication is that the anxiety created by uncertainty can be reduced. Reducing anxiety is an aim when merging since concern shines through when the employee is in contact with clients.

3.1 Organisational structure's affect communication

Well-performed communication leads to fewer problems within an organisation, according to Jacobsen & Thorsvik (2006). Moreover, information tends to be focused to top managers, who disseminate what they find to be relevant information to their staff, thus the information is given one way. Jacobsen & Thorsvik (2006) argue that alternatives for staff to inform their leaders have to be established as well. Furthermore, according to Hall (1972), the more levels there are within an organisation, the more information tends to be left out on the way. However, Mintzberg (1979) states that this does not necessarily have to be negative, the information that is less important or poorly augmented do not reach the management and therefore they can focus on relevant information.

Jacobsen & Thorsvik (2006) state that information with the intention of being given horizontally in an organisation is not guaranteed to reach all concerned. According to Egeberg (1984), information decreases considerably when crossing an organisational boundary. Hence, when an organisation stays small, informal communication may be enough and no structural communication strategy or tools are needed. In situations when organisations are expanding or merging, informal ways of communicating will not satisfy the need for exchanging information. The need of structured communication grows as the organisation does (Egeberg, 1984).

Organisational structure has, according to Jacobsen & Thorsvik (2006), three general effects on behaviour; stability, restriction and coordination. A position within the organisation comes with certain assignments and routines to solve them, which creates stability and gives restrictions on what to work on. More, the coordination of different assignments may lead to a better performance of the organisation than the performance of each single individual working on their own (Jacobsen & Thorsvik, 2006). This is in line with previous studies on team effectiveness and as pointed out by Johnson & Johnson (2006) working in teams result in higher individual productivity than working competitively or individualistically. A functionally based organisation structure means that similar working tasks or assignments are brought together in the same organisational unit. According to Jacobsen & Thorsvik (2006), this way of organizing an organisation has both advantages and disadvantages. The most important advantages are maximum specialisation on similar assignments and the avoidance of double work. As main disadvantages Jacobsen & Thorsvik (2006) mention lack of interest in and understanding for others work and coordination problems between departments.

3.2 The importance of organisational culture and communication

Factors that contribute to a common organisational cultural spirit are artefacts, standards, values, views and assumptions (Schein, 1985; Hatch, 2001) Artefacts are concrete physical objects and ways of acting that express underlying norms, values and assumptions. According to Jacobsen & Thorsvik (2006) artefacts serve as symbols and have to be interpreted in order to act as such. Also, artefacts act as intermediary for information and organisational culture. However, when studying organisational culture one has to recognize that artefacts have more than a symbolic value, Jacobsen & Thorsvik (2006) also state that artefacts can be used to solve assignments.

Collins & Porras (1994) state that a strong connection between a solid organisational culture and success is evident. They also stated that companies with a united organisational culture have concrete methods to socialise the employees into sharing the company's core values. In addition, Kotter & Heskett (1992) acknowledge that a strong organisational culture is connected to the performance of an organisation. Moreover, Mayo (1945) studied subcultures and declared the difficulty to rule a group with formal means when the group had strong values of its own. Also, Mayo (1945) states what Kotter and Heskett (1992) later confirmed; that the achievement of the group is connected to the organisational culture. Hence, organisational culture affects the way that the employees communicate with each other. In organisations where cultural difference has a major appearance, communication has to be forced on, in order to grow into a natural part of the organisation. Communication may be used to create a social situation; this social bond will then serve as a base for the trust that is needed for the communication to work properly (Jacobsen & Thorsvik, 2006).

4. FINDINGS

4.1 The merger of two mid-sized construction companies

The general opinion among top management within both construction companies is that the merger will become an advantage for their clients. However, some of the staff members have a different opinion on the merger and find it hard to describe its advantages with their clients, although the dominating view is that the new organisation will have a wider and better range of experiences and competences. All interviewees believe the merger will lead to improved competitiveness on the market were clients can receive a wider range of services. For a successful merger the interviewees also consider it necessary for the top management to be clear with the goal and mission for the new company.

4.2 Company A

Company A is owned by a majority of the employees together with the large construction group. According to the interviewees, the company has reached its organisational limit and the preferable way to have additional growth is by merging with a equally sized construction company. Therefore, the upcoming merger with company B has been met with optimism by the majority of the employees. However, one interviewee maintains that the two construction companies have different concerns about the merger. During the interviews it became evident that the employees with company A considered company B's employees more concerned about the merger than themselves.

As mentioned before, company A has been managed by a majority of the employees since the start. As a result, communication within the company has mostly been conducted through meetings with top management and leaders at project level. The results from these meetings are, according to the interviewees, distributed throughout the company by e-mail. The work conducted within the organisation is also reviewed in their internal newsletter which is distributed to all employees.

The merger process where the construction group is buying full ownership of company A might, according to the interviews, create an unusual situation for the employees. Also, interviewees feel that the merger changes the abilities to have influence on the organisational progress, such as strategic work and management control. Throughout the interviews carried out at company A, the abilities to influence the daily work has been of great importance to the employees. Moreover, this has created a united spirit among the employees since the decisions made are being supported within the organisation. Thus, the interviewees experience that it is important to continue with meetings to keep the ability to influence within the new organisation.

More, interviewees with company A experience a great difference in the way the two construction companies carry out their work.

> *"We have a large pool of staff and workers for all our three working groups, where as company B is working more closely together in small teams who function almost like small companies."*
>
> *Employee, company A*

Interviewees believe the new organisation has to function in a similar way to be able to continue to take contracts from a wide range of clients. However, interviewees with company A also think that a certain amount of staff and workers have to change position within the new organisation in order to create a common organisational culture.

4.3 Company B

According to the interviews carried out at company B, the thoughts about an acquisition arose when the company had made an internal investigation on raising capital in order to enlarge the company. Therefore, the company found that a merger with another construction company would be the best way to expand without taking on too much overhead costs. Only top managers within both construction companies, negotiating the conditions for the merger, knew about the ongoing procedure. The plans of the merger needed to be kept secret due to the legislation related to the stock market. Information about the merger was given to the employees at a meeting arranged the same day as the merger became public. However, before the acquisition became public, company B experienced a lot of rumour-mongering in the corridors. As one interviewee mentioned:

> *"A lot of things were put on ice without any explanation. Today, information is given more informally, for example at the coffee table or in the corridor."*
>
> *Employee, company B*

Despite any rumour-mongering, interviewees firstly spoke about the surprise they experienced and later the feeling of anxiety as questions about their continued function with the new construction company arose. The information given at the first meeting mainly consisted of, what looked like, a perfect match between two mid-sized construction companies. At this first information meeting, interviewees experienced that little attention was given to the human side of the merger, such as the employee's feelings and questions about the future. The information stated that everyone within the two organisations would have a place in the new organisation, but not their position.

Also, many of the interviewee's state that the pipelines used to communicate within the organisation after the announcement were not sufficient enough to ease the staff member's minds concerning the merger. During the interviews with employees at company B it became clear that staff wanted more individual information regarding their new function within the new organisation. In addition, new ideas on how to disseminate information throughout the new organisation were given, e.g. proper use of the intranet and e-mails with information to all staff. Also, they stated that with communication it is possible to complement each other and exchange experiences between the two old organisations. According to the interviewees, they wanted clear and early formal information to avoid rumour-mongering, which they said could create bad spirit. Furthermore, the interviewees noted that the different information aspects are crucial for a successful merger and to avoid a "them and us" culture.

> *"It is of enormous importance to communicate to make the different cultures fit together"*
>
> *Employee, company B*

The employees at company B have since the time of the announcement express their anxious about the cultural differences in management between the two companies. Many employees in company B's organisation are content with the familiarly atmosphere within the organisation and are keen to keep this in the new organisation. Another impression during the interviews is that they want to keep mid-size company spirit; symbolized by standing up for the individual. Top management must keep the respect and contact with the individual so the staff feels themselves wanted; in spite of duplication of the staff.

Also, interviewees feel that the new organisation needs a common way to communicate with their clients and staff in order to make them comfortable and believe in the new organisation. As an example one interviewee mentioned;

> *"We need a new common logo-type, not three as we're going to use. Neither client nor employees will experience a continuance if they find three different signs everywhere...."*
>
> *Employee, company B*

5. DISCUSSION

According to the literature review it is evident that communication can be used as a tool in the process of merger between companies with different organisational culture. When forming a new organisation Jacobsen & Thorsvik (2006) point out several circumstances which increase the possibility to create a common culture. Focus on the work with disseminating information in the organisation must be taken into consideration. According to Hall (1972) information tend to be left out on the way as organisations grow, the more levels an organisation consists of the more important it is to use clear pipelines. It is relevant when two companies merger that the management clearly focuses on the employees. By giving information in an early and correct formal way staff will experience the merger in a harmonious perspective. This is of great importance to make the merger effective.

The interviews show that in an early stage of the merger lack of information made employees insecure. An anxious staff will become ineffective which in the long run affects the day to day business. By communicating in greater extent, relevant information will reach the employees and by doing so staff can focus on their work.

Creating a joint organisational culture within the new organisation is of great importance as stated by Collins & Porras (1994). According to their study, there is a direct connection between organisational culture and success. A successful organisation has concrete methods to make employees share the company's organisational culture. Although our interviews show that no clear strategy has been worked out on how to reach a common culture, interviewees with higher positions within both companies state that it is important to avoid a "them and us" culture when merging.

The need of information and communication is declared as an important factor, but it does not seem that top management has reflected about the actual meaning of it. It seems that most work before the physical merger has been focused on functional and practical issues. The management has kept existing groups of employees from both origin organisations as far as possible in the new organisation. The reason for this is to have the opportunity to mix different kind of composition in project rather than examine if this is the best for the staff. Doherty (1988) maintains the focus on the employees is the most important thing in a merger. There is an urge for individual information according to the interviewees.

Formal communication between managers and employees can avoid uncertainty and rumours. It is necessary for the staff in the organisation to have the possibility to create a positive opinion of the other company. There are several indications on both original organisations that their own culture is much unlike the other. If this is the case formal communication must manage this difference in an early stage. If the culture differences are more resembled than anyone could predict, it is important to have clear information which clarifies this resemblance for the employees.

Many aspects must be taken into consideration to create a united cooperation culture. A general opinion within top management is that a physical object such as logotype is not crucial for a common organisational culture spirit. After the merger the organisation will use a combined logotype, consisting of the two origin logotype. However, clear and distinct message to the market may be a good start for the new organisation. According to Schein (1985) and Jacobsen & Thorsvik (2006), artefacts, e.g. a new corporate logotype, are the first step for a cooperate culture. It is important to show clients and the market the new company culture by agreeing on a new logotype. Further this can overcome problems that may arise during to the merger. Keeping a logotype with combined original appearance may initially make clients secure but in the long range a new developed logotype show a stronger united organisation, as well as for the clients as for the employees.

Ways for staff to inform their managers have to be established as well as managers informing their staff. Company A's way of disseminating information by regular meetings would implement the united culture, something that company A wants to develop. Furthermore, both companies use an internal newsletter which has to be developed into a united pipeline. By developing this way of informing employees within the new organisation, opportunity is given to convey the organisational core values.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the study were intended to help two merging construction companies to handle communication in a way that would benefit a common organisational culture.

As the merger of these two construction companies is considered to be a good match, owners and management tend to focus more on the function and practical issues of the actual merger, rather than on the employees opinion on the outline of it. As a result, the study shows, staff experience uncertainty for the future, partly due to lack of information. Therefore, it is our recommendation that management carry out a structured information process with all employees in order to bring forward any misunderstandings regarding their future employment and give information regarding their new role in the new organisation.

As the merger is realised in March 2007, the new organisation will become twice as large as each organisation is today. This will set new and higher demands on structured organisational communication to give all employees the necessary information they need to perform their duties. Hence, it is concluded that the new organisation needs a new, organised system for meetings to ensure the disseminating of information. Moreover, it is suggested that a new, joint intranet, can be outlined where employees can access necessary information. In order to disseminate information to the organisation as a whole, and to create a common culture for both employees as workers in the field, we recommend a written regularly report form each site and department. The report can consist of anything from a greeting from one site to another, funny incidents or histories to organisational information concerning all employees. All contributions are summarised and are later published in the new common company newsletter that should be developed at present time.

Based on the outcome of the interviews and previous studies we recommend that the new organisation also through symbolic actions like introducing a new joint logotype to symbolise and support the identity of the new organisation. The measures, suggested in this report, will help creating a common culture and make all employees experience a sense of belonging to the new organisation as well as showing the market a united front.

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8. REFERENCES

Brahy, S. (2006). *Six Solutions pillars for Successful cultural Integration of International M&As, Journal of Organisational Excellence,* **25**(4), 16.

Buono, A.F. Bowditch, J.L. (1989). *The Human Side of Mergers and Acquisitions.* San Francisco: Jossey-Bass Inc, Publishers.

Collins, J.C. & J.I Porras (1994). *Built to Last. Successful Habits of Visionary Companies*. New York: Harper Business.

Doherty, T. A. (1988). Resolving culture conflicts during the merger, *Chief Executive*, 45, 18.

Egeberg, M. (1984). *Organisasjonsutformning i effentlig virksamhet.* Oslo: Aschehoug/Tanum-Norli.

Hall, R.H. (1972). *Organizations. Structure and Process.* Englewood Cliffs: Prentice-Hall.

Hatch, M. J. (2001). *Organisationsteori*. (2. uppl.) Lund: Studentlitteratur.

Jacobsen, D. I. & Thorsvik, J. (2006) *Hur morderna organisationer fungerar*. Poland: Pozkal.

Johnson, D.W. & Johnson F.P. (2006). *Joining Togeheter – Group Theroy and Group Skills.* USA: Pearson education, Inc.

Kotter, J.P. & J.L Heskett. (1992). *Corporate Culture and Performance*. New York: Free Press.

Mayo, E. (1945). *The Social Problems of an Industrial Civilization.* Boston: Harvard University.

Mintzberg, H. (1979). *The Structuring of Organisations,* Englewood Cliffs: Prentice-Hall

Schein, E.H. (1985). *Organisational Culture and Leadership*. San Francisco: Jossey-Bass.

THE TRANSFER OF EXPERIENCE IN A CONSTRUCTION COMPANY

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ABSTRACT

The low degree of transfer of experience gained within the building process to those participating in it has been noted frequently – a weakness that reflects the lack of a natural forum for the distribution of information. An overall aim of this study was to analyze how knowledge and experience can best be built up and be made continually available to those in need of it. Case study methodology and document analysis were used in the study of a construction SME firm. The study illustrates how the acquisition and assembling of knowledge and the sharing of experience can function and points out certain specific weaknesses in the quality management system. The firm's taking note of nonconformities can be seen as representing externalization, as tacit knowledge becoming explicit. Use of appropriate terms in designating them appears to make it easier both for explicit knowledge to be collected and for knowledge to be internalized. When a system for adequate codification of knowledge was lacking, it was difficult for externalized knowledge to be combined further and subsequently internalized.

1. INTRODUCTION

The low degree of transfer of experience gained within the building process to those participating in it has been noted frequently, a weakness that reflects a lack of a natural forum for the distribution of information. Since each building project conducted by a building firm is separate economically from every other one, it can be difficult to link production and administration with each other in some comprehensive way. There is a need of having some system for reporting experience that has been gained one designed in such a way that all those engaged in the chain of tasks to be performed can gain access to knowledge of the experience of others, both during a project and afterwards. If no such transfer of knowledge and experience takes place, there is the risk of the firm's failing to take advantage of what has been learned and of its making the same mistakes again that it made earlier.

The assembling of information relevant to a project is part of the requirements of the managerial system generally, as expressed in the set of international standards "Quality management systems – Requirements" (ISO 9001:2000) and "Environmental management systems – Requirements with guidance for use" (ISO 14001:2004), which are used in the construction sector at the level of the individual firm. The complexity of the construction process means, however, that special measures are called for if the collection of information of relevance, including that concerning with experience that has been gained, and if making it available to those in need of it, is to function properly. The continual public debate regarding what takes place within the construction sector is considered by many to reflect flaws in the quality assurance system and the lack of a well-functioning system for collecting and distributing knowledge. There is very good reason for the construction sector's endeavour to identify ways in which the functioning of these two systems can be improved.

2. LITERATURE REVIEW

2.1 The value of knowledge

Regarding the value of the knowledge an organization possesses, on can note that the stock market value of a firm differs from the book value of it. The difference between the two is often referred to as the firm's intellectual capital. The stock market value of one of the largest construction firms in Sweden is about 2.5-3 times as high as its listed equity. This is a sign of the firm's intellectual capital being valued higher than its fixed assets. According to Sveiby (1997), a trend of this sort in stock quotations has been evident since the mid-1990s.

Intellectual capital can be defined as the assets in the areas of knowledge, practical experience, organizational technology, customer relations and professional skills which serve to provide a firm with competitive advantage in the market (Edvinsson and Michael 1997). Intellectual capital can be viewed as knowledge that can lead to profit (Sullivan 2001). According to Sveiby and Risling (1986), knowledge management represents the creation of immaterial assets. Human capital is the value that the knowledge of the personnel, to a large extent the tacit knowledge represents.

According to Sveiby, the human being rather than the production process or the firm's financial capital is at the center in a knowledge-based firm. A knowledge-based firm is thus quite different from an industrial firm, just as it also differs from a construction firm. Much of what characterizes an industrial firm is also typical of a construction firm, although there are certain aspects of a building entrepreneur firm that are also typical of a knowledge-based firm. This can be seen in the fact that for both of the latter two types of firm the handling of information and of knowledge is important and that the attention directed at this is increasing. Dancy (1985) emphasizes how difficult knowledge is to define and the traces developments the concept has undergone over the years. He, as well as Holden and von Kortzfleisch (2004), provide examples of both the rational and the empirical direction in conceiving of knowledge. Rationalists declare that knowledge can be derived by use of mental constructs in the form of concepts, laws and theories, whereas empiricists claim that knowledge can only be generated on the basis of experience and observations.

2.2 Concepts of Knowledge Management

Polanyi (1966) places basically an equality sign between knowledge and the ability to know that ”Knowledge is an activity which would be better described as a process of knowing”. Polanyi and Drucker (2003) take up the idea of knowledge always being found in a social and political context. Since knowledge is bound to the individual it is basically silent (tacit). Tacit knowledge – including its transfer, its content and the processes involved – is poorly understood (Foos 2006). There are numerous examples of attempts that have been made to gain an understanding of the knowledge of the expert by documenting as thoroughly as possible all of the expert's reflections and thoughts. Those who have tried to obtain an adequate grasp of it in this way can witness to the difficulties involved. It is extremely difficult to describe one's tacit knowledge, to make it explicit.

According to Nonaka and Takeuchi (1995), Plato defined knowledge as a ”justified true belief ”. They describe tacit knowledge as ”deeply rooted in actions and in the individual's engagement in a particular context”. Organizations differ in the tacit knowledge they possess, its being a function of the experience an organization has amassed over the years. It is impossible to communicate tacit knowledge simply by use of diagrams and printed material. Marcotte et al. (2000) maintain that tacit knowledge, according to Polanyi's definition of it, is most frequently found in scientific and technical areas. Polanyi declares that no completely explicit and codified knowledge exists at all, since behind every bit of explicit knowledge there is also tacit knowledge about which one is not conscious.

Davenport and Prusac (1998) describe a dynamic process of attaining knowledge involving four stages, those of generation, codification, transfer and realization. Generation consists of all processes concerned with the acquisition of knowledge. Codification involves the processing of knowledge in a manner that puts it into a structured format, one that allows it to assume the role of explicit knowledge. The transfer of knowledge involves its being communicated to other persons or being converted to other forms. In the final stage, that of realization, both the recipient of knowledge and the organization to which the person belongs profit from it, the information having value for both.

The transfer of knowledge within and between that of the tacit and the explicit types can be divided up, according to the SECI-model (Nonaka and Takeuchi 1995) into knowledge transfer of four different types: socialization, combining, externalization and internalization. There are different starting conditions that lead to knowledge transfer. The first of these is Socialization, which in order to start requires that a space for interaction be created, one that enables participants to communicate with each other their experiences and their ways of looking at things. The second is externalization, which is supported by a meaningful ”dialog or collective reflection” that helps participant to express their tacit knowledge, which otherwise is difficult to communicate. The third is combining, which is activated by network activity concerned with such knowledge as that of new products, jobs or leadership systems and involves persons from different parts of the organization. Internalization, finally, is brought on by explicit knowledge being utilized within the framework of learning by experience. The chain of knowledge transfer thus described can be regarded as a spiral that rotates turn after turn within the organization.

Nonaka and Takeuchi point out that individuals generate new knowledge and that an organization needs to learn to mobilize knowledge accumulating at the individual level. The tacit knowledge that the organization has at its disposal can be increased by means of the four basic methods of knowledge transfer described in the SECI model. The spiral type process described can lead to both the tacit and the explicit knowledge the organization has access to developing and expanding. This learning spiral of the organization begins at an individual level through the interaction of individuals (socialization). The level of knowledge then continues to rise through the processes of combining, externalization and internalization.

2.3 Other aspects

In the section on the theoretical framework, examples were presented of different ways in which the acquisition of knowledge can be studied. Nonaka describes the development of knowledge in terms of an ontological dimension of *individual – group – organization – sector*. One can ask where on this scale knowledge of a particular sort lies and where bits and pieces of knowledge of various types are located. How is knowledge shifted between different points or regions on the scale? One problem is that the scale is not a linear one. Often an individual is a member not simply of a group but also of an organization and a sector. Knowledge of a particular sector represents knowledge that those within the sector generally possess and are in agreement about. (Persson 2006)

Another way of dividing knowledge up is in terms of the shifting perspectives a temporary organization can have, which one can liken to the different phases of the construction process, those of Designing (or Creating), Producing (or Carrying out) and Administering (or Storing), and the knowledge that relates or can be applied to them. Carrying out a construction project is often described as a kind of relay race in which information is passed on from one actor to another (Söderberg 1994). Such information or knowledge can be of the temporary character that it is for many of those participating in a project, who only need to apply their knowledge during that part of the distance to be covered in which they hold the baton. The anchor runner hopes to be in a good position when handed the baton. Similarly, some of the information available in a temporary organization at a particular time may not be needed until later on, when it can be very valuable to have. Knowing how knowledge from the project being carried out will be dealt with later or will affect those for whom the project was conducted can be important. The needs, wishes and expectations of those who are to later own, use and maintain the object which is being created is conveyed in many separate steps and stages to those who are working with the project, as it proceeds from the planning, to the production, to the administrative phase. An alternative way of looking at this is to consider the various interest groups involved in a project, such as those of the owner, the user, the architect, the technical consultant, the workplace boss, the foreman, the head of the work team, the carpenter and the administrator. This chain that exists often has side-chains and recursive loops that can make a construction project a very complicated undertaking (Persson 2006).

A third way of dividing up knowledge is from the perspective of a permanent organization, which in the present case concerns the question of how the firm manages the knowledge it has acquired from the training and experience of its employees and the construction projects it has carried out, and how this knowledge can be used in a manner enabling the firm to be as effective and as competitive on the market as possible, for which reason the firm endeavours to develop its management system, the competence of its personnel, and the processes involved in its work.

The surroundings, in which knowledge is embedded, such as the expectations placed on a particular sector of the economy or pressures for change, can be added to each of the three perspectives just referred to. During the last 10 years, new ways of organizing construction projects, based on the idea of greater cooperation and openness, have come to the fore. Considerable emphasis has also been placed on making the construction process as rational and effective as possible (Persson 1997).

Permanent and temporary organizations can be seen as examples of the dimensions of matrix organizations. Parallels can be drawn to various discussions of matrix organizations in the project management literature, such as in PMBOK. The assembling of knowledge and the sharing of experienced are particularly important in the permanent or hierarchical organization. There the possibilities are particularly good for the extensive sharing of experience with colleagues and with others (Persson 2006).

In temporary organizations, knowledge of a specific project and the use of routine checklists often play a central role. Knowledge and information often need to be handed on to the next actor in a sort of relay race. Some professional groups, such as the craftsmen engaged in a project, need to assimilate in various ways information of momentary importance, such as written material to be internalized and what they are told at the work site by those in charge.

It can be difficult at times for the craftsman to understand from explicit sources how a particular step in the construction process is to be carried out. Tacit knowledge can play a major role under such circumstances, meaning doing what one is accustomed to, without studying drawings or written materials first. The readiness to work in this way (figure things out on the spot) can be a positive trait, especially when no drawings or descriptions of the exact procedures to carry out are available. Yet it can lead to insufficient precision and result in quality requirements not being met.

3. RESEARCH PROJECT

The research findings are based on the analysis of documents in a SME construction firm its being felt that examining a large organization instead might more easily provide misleading results. The management of knowledge by SMEs was seen as differing from large organizations above all in SMEs having very understandable constraints on the resources they have available (Desouza, 2006).

3.1 Aim of study

An overall aim of the study was to analyze how knowledge and experience can best be built up and be made continually available to those in need of it, a system being designed to serve these ends as effectively as possible. A more specific aim of the study was to investigate how a particular construction company deals with the knowledge potentially available to it and how the organizational work of the company supports its knowledge management efforts. (Persson et al 2006)

3.2 Method

The study involves use of case study methodology and analysis of documents. Although the study was carried out 2005 the data that was collected pertained a six-year period. While the study was being conducted a reference group consisting of people with long experience with construction companies and a deep understanding of the circumstances affecting them were involved, the members of this group being selected from different companies and organizations.

The attempt was made in the study to determine the types of knowledge and information that appeared to be most important to the firm and the impact these had on the organization’s functioning, an approach adopted from Kolb (1984).

The management system used in the company, that of ISO 9001, served partly as the basis for deciding on the measurements and assessments to be made within the organization. The quality standard ISO 9001:2000, Quality management systems – Requirements contains requirements and principles concerning the organizational work that needs to be done for ensuring the quality of the products made or services provided and the improvement and learning that take place within the organization. Greater openness to contact within the organization is also aimed at (Deming 1986) and programs are to be organized for breaking down barriers and increasing people’s engagement both in others and in the task at hand. Individual learning (Senge 1990) is emphasized. One of the eight fundamental principles for quality management in ISO 9000 is that of continual improvement. This is defined as “recurring activity to increase the ability to fulfil requirements”, the following comment being made: “The process of establishing objectives and finding opportunities for improvement is a continual process through the use of audit findings and audit conclusions, analysis of data, management reviews or other means and generally leads to corrective action or preventive action” (ISO 9000:2005).

The document management system (DMS) of the firm was an important a source of information. It was implemented around the year 2000 and all working documents were gathered there. The DMS contains modules for the following.

- Document templates and project documents storage
- Handling and storage of drawings
- Time scheduling
- Budget and cost estimate
- Time spent working at various tasks
- Business and suborders
- Follow-up
- Nonconformities and change orders
- Diary of work conducted
- Library of reference literature on the building and construction industry, and
- Collections of documents and protocols.

One heading used in the DMS system is that of “Nonconformities and change orders". It involves database information stored locally at production sites and at the head office. Under the library heading documents and protocols concerning managerial reviews pertaining to ISO 9000 and “experience meetings” were collected. All protocols generated by the firm were available for investigation.

A total of 23 construction projects in which the firm that was studied had been engaged were selected for investigation. The total number of nonconformities that were noted was 962, they're stemming from 12 of the projects that were investigated, there being no nonconformities noted for the 11 projects that remained.

Protocols of all the management reviews the firm had conducted were stored in the DMS system. A total of 34 of them were completed in accordance with the certified quality maintenance system employed during the period of July 1, 1997 to May 25, 2004 were studied.

4. RESULTS

4.1 Overall analysis of the nonconformities reported

The firm employs a very broad definition of the term nonconformity, which also includes adjusting of the scope of the contract from what had been planned originally. Many of the nonconformities recorded give the impression of being what are termed within project management (PMI 2004) "changes in scope" rather than their involving the failure of the product to meet the requirements placed on it.

The fact that DMS lacks clear and distinct terms for certain matter that are dealt with means that a given term may be lacking in specific content. The concept of "nonconformity" should probably best be reserved for what ISO 9000 designates as *non-fulfilment of a requirement*, work involved in changing a product's scope being best referred to then in a manner distinct from this, such as by designating it as change orders, a term readily applicable within the construction industry.

The term "nonconformity" can also be associated with critical comments made at the time of an inspection, yet the DMS system provides no information about the results of inspections. This means that no total picture of the nonconformities present can be obtained, also reducing the possibilities for the assembling of knowledge and the sharing of experience, that information of this sort could provide.

The registering of a nonconformity is an example of externalization, of tacit knowledge becoming explicit. Use of appropriate terms makes it easier both for explicit knowledge to be collected and for knowledge to be internalized. The lack of an adequate system for proper codification resulted in the externalized information not being usable for further combination or for subsequent internalization.

In discussions in the reference group it was suggested that the time factor leads easily to strong emphasis being placed on being as productive as possible. Construction site managers were seen as being under particularly strong pressure and having a difficult work situation. Economic results and customer satisfaction were both given high priority. Much less emphasis was placed on the accuracy and adequacy of the classifications and codifications that were arrive at.

Another possible reason for nonconformities sometimes not being documented by the firm and for the limited attention directed at them there can have to do with the working culture of the firm, which is not a bureaucratic one in which documentation is regarded as particularly important, there instead being a conversational culture in which the social network and people's discussions with each other are regarded as the major ways of spreading knowledge and information, although this is a matter that was not investigated systematically (Gluch 2005).

4.2 Management reviews

The analysis of the protocols of the management reviews indicated that it was primarily concrete process-oriented questions that the management reviews took up (77%). The protocols of the management reviews revealed certain basic tendencies regarding how they were conducted. Questions placed on the agenda tended to remain there until a final answer was found. The agendas also appeared to stimulate discussion of the matters included in them. Questions raised in internal audits of the quality management system were also often taken up later in the managerial reviews. Half of the questions dealt with in the managerial reviews concerned routines, checklists and approaches to consultations. These are important topics in the manuals, both in connection with the tacit knowledge presented within the firm, and for the management system generally. An overall impression of the managerial reviews was that tacit knowledge possessed by the individuals who attended tended to be externalized there to become explicit knowledge that found expression in various documents, in the approaches taken in consultations, and in the computer systems utilized, as well as in the protocols of the managerial reviews.

Some of the items on the agendas of the managerial reviews involved the reporting of information that was not analyzed further. This applies above all to nonconformity reports in which the facts presented were not regarded as calling for any particular measures being taken. This was because of the nonconformities in question usually represented either changes having been made in what had originally been agreed to contractually or supplements to it.

The wording of the protocols is precise and correct, thus meeting the requirements of the certifying organization and of ISO 9000, all of which is very positive. The protocols also provide useful checklists one can consult so as to be sure of not forgetting various matters of importance. At the same time, the form and organization of the protocols makes it difficult to combine various aspects of the information contained in them in a manner allowing it to be incorporated into the DMS system. Both the form and the somewhat limited availability of the protocols make it somewhat difficult as well for employees to gain ready access to their contents of the protocols and to apply them. At the same time, the firm makes efforts to present information to employees concerning various of the conclusions arrived at in the managerial reviews in a manner aimed at helping them internalize many of the ideas involved.

4.3 Meetings for the sharing of experience

Those attending the meetings for the sharing of experience were primarily customers, as well as those at the firm who were in charge of the project in question, consultants from outside and few suppliers. The firm's management reported that the interest customers had in coming appeared to be only lukewarm. After each meeting a protocol was prepared, one it was hoped would give potential customers the impression that the firm works with questions of quality in a systematic way and could thus be expected to contribute to the marketing of projects, although what the firm considered most important was to identify anything with which customers or others were dissatisfied.

It can be argued that such a firm should best hold meetings of two types for the sharing of experience pertaining to specific projects, the one dealing with experience reported primarily by external sources and the other with experience reported entirely by internal sources. The meetings currently held are of the external type, concerning how the individuals and organizations that the firm works with experience collaboration with the firm and the contracts that are drawn up, and the ways in which they feel collaboration could be improved. In contrast, in meetings of the internal type, those participating were all from the firm itself, making it easier to discuss matters such as those of profitability, budgeting and monetary calculations of other types, as well as whatever weaknesses there appeared to be in the firm's organization. These are matters that could be discussed much more openly if those from outside were not present.

Protocols of meetings for the sharing of experience are examples of the externalizing of experience. Just as in the case of managerial reviews, the information itself may be somewhat commonplace on the surface and not be particularly accessible in depth, but it does satisfy the need of providing information for those who want to report on the functioning of the quality system.

5. CONCLUSIONS

5.1 Support for knowledge acquisition through use of quality management

What the firm that was studied referred to as nonconformity had to do primarily with changes, i.e. as compared to what had been planned and additions to what had originally been intended. Parts of the system for registering nonconformity could in principle be used for combining information from external sources, although no use of them of this type was made. In the protocols of the managerial reviews and of the meetings for the sharing of experience, nonconformity tended to be handled in a rather undifferentiated way. The analysis of nonconformities concerned primarily how these should be taken up in contacts with customers. In the managerial reviews themselves, questions of whether nonconformity reflected poor planning, inadequate coordination of the work, failure of standards to be met, and the like were sometimes discussed, i.e. nonconformity involving mistakes.

Nonconformity due to changes in plans or to supplementary work could have to do with special situations that developed, wishes of customers or contacts with suppliers. For a building contractor, supplementary work to be carried out or changes decided upon need not be a serious problem. The firm needs simply to document and administer them and see to it that it is paid for them. It is possible that a more thorough analysis of the work needed for making changes and providing supplements would show there to be certain flaws in the processes and routines involved. Information should also be present within the system that, if adequately combined and integrated and also communicated by way of socialization or externalization, would enable the extra costs for changes and for supplements to be markedly reduced.

Nonconformity as defined in terms of ISO 9000 should represent an ideal point of departure for learning and for the transfer of knowledge. A permanent firm has the possibility of continually increasing its knowledge with the aim of avoiding mistakes. Nonconformity with ISO 9000 can be taken note of in managerial reviews, which concern primarily matters of documentation, routines and procedures of a general sort. One reason why it may be difficult in a business organization to deal adequately with both major problems and minor ones is that there is much greater profit for a firm in using most of the limited resources it has for business matters of major import than in concentrating to an inordinate extent on overcoming weaknesses in areas of little import financially. Managerial reviews were concerned in part with questions of the quality management system. Discussions of many of the questions taken up resulted in the updating of routines, checklists and other documents. Questions of training and of special courses to be provided were also discussed and were followed up. This made such meetings a good forum for considering questions of the assembling of knowledge and the sharing of experience generally. It appears uncertain, however, that the firm has a definite strategy or any concrete plans for assembling the knowledge that has been acquired and spreading the results of the experience gained throughout the organization. Neither the protocols of these meetings nor of those for the sharing of experience contain any appreciable information regarding the development of production methods and products. This is definitely a weakness in terms of knowledge acquisition and experience sharing. It should be of interest to the firm to follow developments in both these areas with the aim of enhancing the firm's effectiveness and financial competitiveness. The same comment can be made concerning the firm's purchasing, cost planning and logistics. These important processes appear, according to the protocols of the management reviews, to not be considered there at all.

The protocols of the management reviews make note of certain important matters of experience taken up in the meetings for sharing experience. Certain comments by customers are also contained in these protocols. There appears to be a lack of effort in the protocols, however, to combine and integrate the information from different sources taken up in the meetings.

5.2 The reliability and validity of the study results

The study illustrates, with the help of examples, how the acquisition and assembling of knowledge and the sharing of experience can function within a firm. The firm in question was selected because it has a quality management system in accordance with ISO 9000, one which is viewed very positively and for which it has received an award. Accordingly, the firm can be expected to have maintained a high level of quality work as compared with other firms within its sector. The study nevertheless points out certain specific weaknesses in the firm's quality management system. It is reasonable to expect that similar weaknesses are found in other firms within the same sector.

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7. REFERENCES

Dancy J. (1985) *An Introduction to Contemporary Epistemology*, Basil Blackwell.
Davenport T.H. & Prusak L. (1998) *Working knowledge – how organizations manage what they know*, Harvard Business School Press.
Deming W. E. (1986) *Out of the crises*, Cambridge University Press
Desouza, K C. & Awazu, Y. (2006) Knowledge management at SMEs: five pecularities, *Journal of knowledge management*, **10**(1), 32-43
Drucker P.F. (2003) "*The new realities*", Random House Value Publishing.
Edvinsson L., Malone S. M. (1997) *Intellectual Capital: Realizing Your Company's True Value by Finding Its Hidden Brainpower*, HarperCollins, New York.
Foos, T., Schum, G. & Rothenberg, S. (2006) Tacit knowledge transfer and the knowledge disconnect, *Journal of knowledge management*, **10**(1), 6-18.
Gluch P. (2005) *Building Green - Perspectives on Environmental Mangagement in Construction*, Göteborg.
Holden N. J. & Von Kortzfleisch H. F. O. (2004) Why cross-cultural knowledge transfer is a form of translation in more ways than you think*. Knowledge and process management*, **11**(2), 127-133.
ISO 9000 (2005) *Quality management systems -- Fundamentals and vocabulary (ISO 9000:2005)*.
ISO 9001 (2000) *Quality management systems - Requirements (ISO 9001:2000)*.
ISO14001 (2000) *Environmental management systems - Requirements with guidance for use (ISO 14001:2004)*.
Kolb D. (1984) *Experiential learning: experience as the source of learning and development*, Prentice Hall, New Jersey.
Marcotte C. & Niosi J. (2000) Technology Transfer to China – The issues of Knowledge and Learning. *Journal of Technology Transfer*, **25**(1), 44.
Nonaka I. & Nishiguchi T. (2001) in *Knowledge emergence: social, technical, and evolutionary dimensions of knowledge creation*. New York: Oxford University Press.
Nonaka I. & Takeuchi H. (1995) *The knowledge-creating Company*, Oxford University Press, New York.
PMI (2004) *Project Management Body of Knowledge* (PMBoK) Project Management Institute.
Persson M. (1997) *Ny byggprocess - Svedalamodellen – Slutrapportering byggskedet*, Lund.
Persson M. (2006) *Lessons Learned on Knowledge Management – The case of Construction*. ISBN 91-85258-97-4
Persson M., Landin A. & Andersson A. (2006) *Kunskapsuppbyggnad och erfarenhetsåterföring i byggföretag – en fallstudie*. ISBN 91-85257-96-6
Polanyi M. (1966) *The tacit dimension*, Gloucester, Mass. Peter Smith.
Senge P. (1990) *The Fifth Discipline: The Art and Practice of the Learning Organisation*. Doubleday, New York.
Sullivan P. H. (2001) *Profiting from Intellectual Capital Extracting Value from Innovation,* Wiley, New York, USA, 2001.
Sveiby K.E., Risling A. (1986) *Kunskapsföretaget - seklets viktigaste ledarutmaning?* 1:5, Malmö: Liber.

Sveiby K. E. (1997) *The new organizational wealth: Managing & measuring knowledge-based assets*, Berrett-Koehler Publishers Inc, San Francisco

Söderberg J. (1994) Byggprocessen nu och i framtiden, From the antology: *Från nyproduktion till fastighetsföretagande*, T3:1994, Byggforskningsrådet, Stockholm.

MANAGING KNOWLEDGE TRANSFER EFFECTIVELY

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ABSTRACT

Knowledge transfer has been taken as instrumental in enhancing performance of construction organisations. This paper has investigated the knowledge transfer process of construction organisations and contemplated on a tool that could be used to monitor and transfer knowledge effectively so as to manage change. Two independent studies were made: an initial survey was undertaken in 2001 that was followed by a case study in 2002 and 2003 of four construction organisations in Tanzania. A 5-process knowledge transfer model was used as a data collection and analytical tool. The model established the characteristics of the knowledge transfer process in construction organisations as unstructured, implicit and incidental. The paper further proposes the use of the IDEF0 method as an effective tool of monitoring the knowledge transfer process in organisations in the context of managing change.

1. INTRODUCTION

Despite the fact that effective knowledge transfer is viewed as central to a firm's success, with few exceptions, the strategic management literature has neither specified nor tested the processes or mechanisms through which knowledge transfer occurs in organisations (Argote and Ingram, 2000). Further, scholars (Cordey-Hayes and Gilbert, 1996; Sverlinger, 2000; Bhatt, 2001) purport that the capacity of a firm to create and acquire knowledge is a pre-requisite in the knowledge transfer process whether inter or intra. Hence it is justifiable to make a presumption that for firms to acquire knowledge from each other, their intra-organization transfer processes have to be efficient. To make the intra-organisation transfer process efficient it is essential to have a tool that can map the process, hence identifying possible areas of improvement. It is from such a background that the paper studies the characteristics of the knowledge transfer process in specific construction organisations and suggests a method that would best monitor and manage the process. This is significant as managing knowledge is key to performance of an organisation (Probst et al, 2000). Although the paper focuses on a research of construction organisations in Tanzania, it is believed the findings are relevant to a wider community in the construction industry.

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Specifically, the paper addresses the following research questions:

- What are the characteristics of the knowledge transfer process of construction organisations?
- What tool can be used to effectively monitor and illustrate the knowledge transfer process in a construction organisation?

2. LITERATURE REVIEW

2.1 Knowledge transfer defined

Argote and Ingram (2000) consider knowledge transfer in organisations manifests itself through changes in knowledge or performance of recipient units; and that such changes can be used as a measure of knowledge transfer. Bröchner et al., (2004) emphasized the transmission process inherent in knowledge transfer – that, one sends or presents knowledge to a potential recipient and the recipient absorbs. This study, has taken a functional definition of knowledge transfer, knowledge transfer as a process constituting the following: information and knowledge acquisition, information distribution, making meaning, organisational memory and retrieval of information and knowledge. The process is illustrated in Figure 1 that shows the sub-processes and their activities.

2.2 Mechanism of knowledge transfer

With various writers explaining the mechanism of knowledge transfer differently, the paper has categorised the mechanism into four schools of thought: knowledge reservoirs (Argote and Ingram, 2000; Roth et al, 2001), organisational characteristics and managerial practices (Goh, 2002; Vito et al, 1999; Davenport and Prusak, 1998), a knowledge conversion process (Nonaka and Takeuchi, 1995) and knowledge transfer process (Sverlinger, 2000; Vito et al, 1999; Cordey-Hayes and Gilbert, 1996).

2.3 The knowledge transfer model adopted by the study

The knowledge transfer model adopted is based on Eliufoo’s (2005), Sverlinger's (2000) knowledge transfer models, Dixon' s (1992) organisational learning model and Nonaka and Takeuchi's (1995) knowledge creation concept. The models have been adopted as they provide attributes that enabled an investigation of the paper’s research questions. Both have identified activities as media of conveying knowledge, a factor that the author considers practical and realistic in the recognition of activities’ essential role for achievement of organisation goals. The model adopted is illustrated in Figure1.

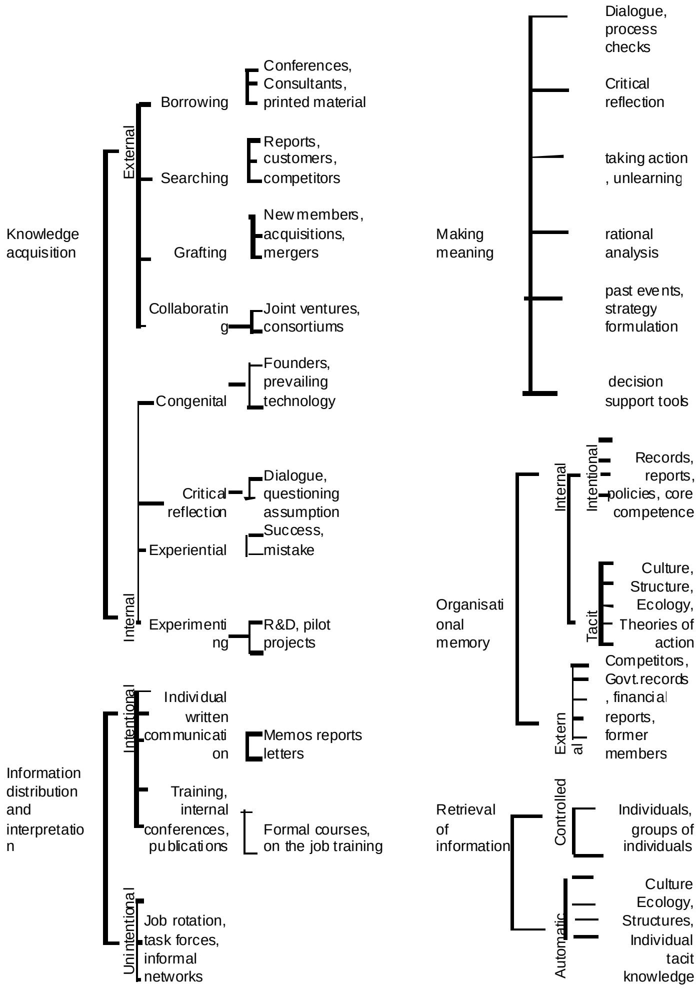


Figure 1. The knowledge transfer process

3. RESEARCH PROJECT

3.1 Research description and objectives

The research had investigated using a survey and a case study approach, how construction organisations in Tanzania transfer knowledge. The study explored the mechanism of transfer of knowledge by construction organisations. To facilitate such analysis a 5 - process knowledge transfer model was adopted (Figure 1). The outcome of the analysis highlighted the status quo of the knowledge transfer process for construction organisations in the Tanzania construction industry. Acknowledging the limitations in the model of analysis, an optimal method of conveying the knowledge transfer process was proposed using a business process model, the Integration Definition Language 0 (zero) for Function Modelling (IDEF0).

3.2 Research methodology

A case study approach was opted as the strategy of inquiry against other qualitative strategies such as ethnographic, phenomenology, ground theory or narrative strategies of inquiry, based on three major attributes: the nature of investigation, that, it is exploratory, the fact that case study gives an opportunity of studying in a natural setting and third, capturing a holistic view of a social phenomena.

Pilot study – the 5-process knowledge transfer model was used to test the ability of the model to capture mechanisms of transfer in organisations and also identify organisations for the main study. Data for the pilot study was collected through questionnaires supported by interviews from practicing construction firms in Tanzania. 60 questionnaires were sent to contracting firms, of which 49 responded, hence giving a response rate of 81.6%. For professional consulting firms, out of 25 questionnaires sent, 19 where returned giving a response rate of 76 %. Part of the results for the pilot study is shown in Figure 2.1 – 2.5.

Main study – four construction organisation in the Tanzania construction industry were used as case studies; two of which are professional consulting firms, NEDCO Ltd. and Inter- Consult Ltd. and two are contracting firms, Konoike Construction Co. Ltd. and Masasi Construction Co. Ltd. Data was collected by observing to what extent the organisations applied activities identified in the knowledge transfer model shown in Figure 1.

A triangulation method was used in collecting data that included: (i) documentation and archives (ii) interviews (iii) direct observation (iv) walking around and talking (v) studying the office or construction site, and (vii) participant observation.

4. RESEARCH RESULTS

4.1 Results

Although the data collection and analyses for both the pilot study and the main study covered all the 5-sub-processes and their activities as shown in Figure 1, the paper only illustrates part of the results as it is the author’s opinion that these results are adequate to disseminate the research results to this audience.

External knowledge acquisition: consultants
Information sought from respondents regarding means of external knowledge acquisition included: number of conferences attended in the last five years, links with other consulting/contracting firms, relations with clients, recruitment of new members as a means of acquiring knowledge, collaboration arrangements, subscription to construction journals, and access to technical, economic and social reports.

At least 47 % of the firms had attended one conference per year. At least 78% of the firms have inter-firm linkages that facilitate sharing of information mostly through regular project meetings. However one architectural firm commented that although it has linkages with other architectural firms, such links are not on sharing construction information. Respondent explained, lack of trust obstructs such sharing, and if there is any sharing of useful architectural information this is done on individual, and not firm basis. He cited for instance, the firm shares information with a UK based firm since they are working in different markets; but will not share the same information with a local architectural firm. External sourcing of information from documents is high. At least 16 out of the 19 firms subscribe to journals both local and international. Incidentally the same number of firms reported links with competitors and perceive clients and customers as a source of knowledge acquisition. The same however, cannot be stated on collaboration as a means of acquiring knowledge. Only two firms had mergers and 12 firms had jobs through joint ventures. Part of the findings is shown in Figures 2.1 and 2.2.

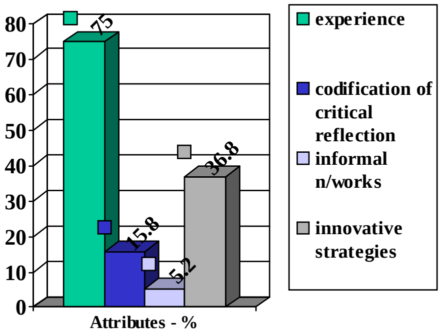


Figure 2.1. Internal knowledge acquisition: consultants (experience dominant means)

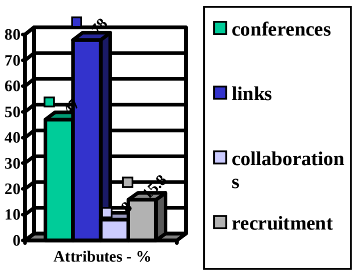


Figure 2.2. External knowledge acquisition consultants (inter-firm linkages highest source)

Information distribution: consulting firms
The enquiry included the mode of transferring information through memos, reports, or verbal means, number of formal courses attended by employees and the existence of training programmes, on-the-job training, job rotation, the practice of

task forces in solving problems, internal publications such as brochures, journals, newsletters, internal seminars, workshops, courses and informal networks. Although training programmes was reported by executives to exist in at least 50% of professional consultant firms, employees are not aware of the programmes. However about 68.4% of firms reported to have their employees attend formal courses. The practice of on-the-job training is noted to be high (84.2%), while internal seminars and workshops are non-existent. Job rotation for professional consulting firms is at a very low level (10%); however, firms perceive an individual going through the whole process of a project, as equivalent to job rotation, a term they refer to as, “full cycle exposure”. Task forces and informal networks are not common; only around 21% of the firms reporting them being used. Figure 2.3 illustrates the results.

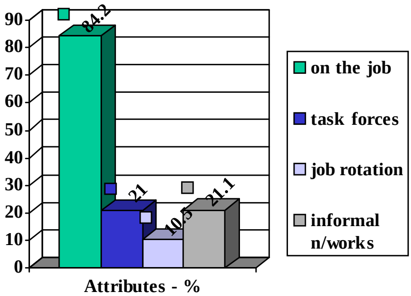


Figure 2.3. Information distribution: consultants
(on the job training dominant)

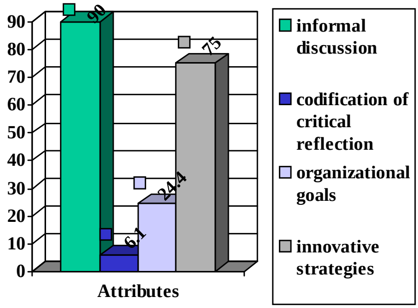


Figure 2.4. Internal knowledge acquisition: contractors
(informal discussions dominate)

Internal knowledge acquisition: contractors

Responses revealed that at least 75% of the both large and medium contracting firms have innovative activities. However, noted codification of such innovation is completely absent. All contractors affirmed the existence of developing their own strategy to enhance work. Individuals in 40% of large contracting firms are knowledgeable of the firm’s objectives and strategic goals, while for the medium contractors it is only 6.8%. Writing down strategic goals is almost non-existent in both the large and medium contractors. It is only one firm in the large contractor’s category that reported the practice, and no firm at all for the medium contractors. Codification of critical reflection of the firm’s performance is at a very low level; only an insignificant number for both the medium contractors (2 out of 29) and the large contractors (1 out of 20) have the practice of codifying reviews made on performance. On the other hand, a high proportion of contracting firms (90%) have informal discussions of problems and successes in their work, and this is done mostly during breaks. R & D activity is absent.

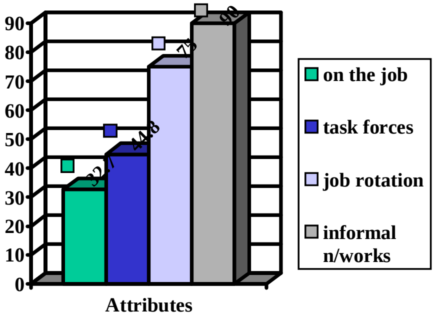
Figure 2.4 illustrates outcome of data collected for contractors in the internal knowledge acquisition process

External knowledge acquisition: contractors
Inter-firm linkages observed at low levels for contracting firms; with only 5% and 17.2% reporting such links in both large and medium contractors. Only about 30% of contracting firms recruit individuals to bring in knowledge to the firm and respondents retorted: *"One recruits when there is a need... a job"*. Collaboration arrangements such as joint ventures, mergers, and consortium are at a low level.

Information distribution: contractors
The practice of on-the-job training noted to differ markedly between the large and medium contractors. 68.9% of large contractors reported the practice and only 40% for the medium contractors. One firm acknowledged the benefit of on-the-job training by stating that: "over time, a carpenter is able to acquire painting skills and hence is engaged in the project over a longer period – otherwise we would have to let him go*"*.

Firms reported not common to send individuals to formal courses. However between the two groups, it was noted, medium contractors relatively have more individuals (55.2%) attending formal courses than large contractors (30%). Internal seminars and workshops are non-existent. Job rotation is predominant in large contracting firms (75%), while insignificantly reported in medium firms. The use of task forces in solving problems exists, reported by 44.8% of firms. Informal networks in firms are a dominant feature in contracting firms surveyed, with 90% affirming to its existence.

Part of the data analysis is portrayed in figure 2.5 that shows an information distribution pattern of contractors.



Informal networks as a means of information distribution predominant

Figure 2.5. Distribution and sharing of information: contractors

Results of one consultant firm and one contracting firm are illustrated for the main study for two sub-processes of the model. These are given in Figures 3.1, 3.2 and 3.3.

Knowledge acquisition: Inter-Consult Ltd
The knowledge acquisition process of Inter-Consult Ltd., a consultant firm, is as shown in Figure 3.1. As can be noted from the figure, new activities like travel tours emerge and for experimenting, adaptive changes are reported in lieu of R & D activities.

Information distribution: Inter-Consult Ltd
This is a process by which an organisation shares information among its units and members; taken to occur explicitly as in written communications, training or implicitly as in job rotation, task forces or informal networks. Fig. 3.2 shows the mode of information distribution in Inter-Consult.

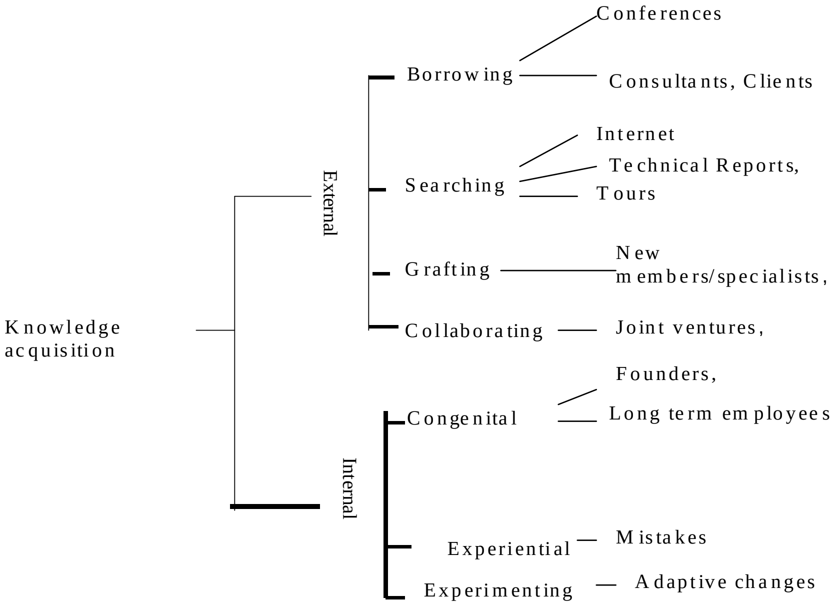


Figure 3.1. Knowledge acquisition Inter-Consult Ltd

Knowledge and information acquisition: Masasi
An illustration of information and knowledge acquisition modelled by the study is given in Figure 3.3. It is noted, opportunities for internal acquisition of knowledge exists largely from its long-term employees and entrepreneurial skills.

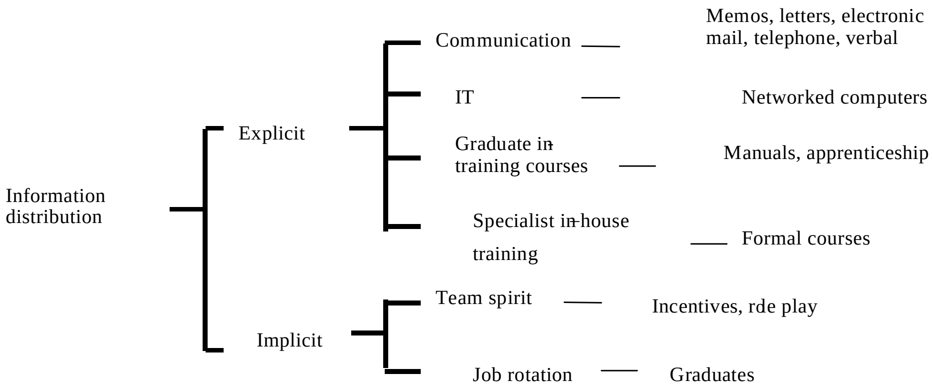


Figure 3.2. Information distribution – Inter-Consult

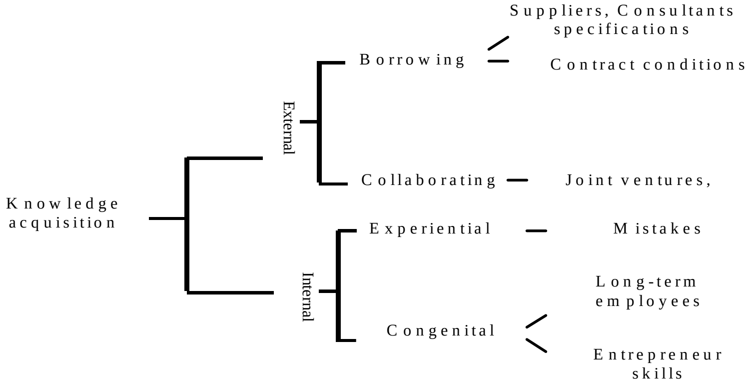


Figure 3.3. Information distribution – Inter-Consult

4.2 Implementation: proposing an effective model

Analysis of the model used to show the knowledge transfer process though has enabled the achievement of the first research question, that of identifying the knowledge transfer process of construction organisations studied, a better tool could be adopted to enable effective mapping and understanding of the process. The model used has however fallen short in indicating important information in the process such as: constraints on activities or resource requirements for the activities. Further, the model has equally fallen short of illustrating cause and effect relationships of activities at various levels in the organisations. These shortcomings, coupled with a need to provide a base on which organisations can plan and manage change, a better tool has to be sought. An Integration Definition Language 0 (zero) for Function Modelling (IDEF0) is hence being proposed for use.

IDEF0 is among the process models that have been successfully used for construction process modelling (Karhu, 2001). It is a functional model that originated from the Structural Analysis and Design Technique (SADT), which was a modelling method, developed to describe a system and its environment (Lundgren, 2002) and first used by the US Air Force in 1973. Characteristically, this model has ability to analyse a subject by studying how it operates, by modelling the operational details, and identifying room for improvement.

Develop a knowledge transfer model using IDEFO

The subsequent section illustrates the strong features of the IDEF0 method whereby a hypothetical model for a knowledge transfer process is developed. The model commences by a primary objective for an organisation such as “Perform business” diagram (Figure 4.1). The diagram shows key *inputs* required as: organisation management of which an incentive system is a core part, external and internal information, and finance. It also shows how these inputs are transformed into products or services the business offers, or organisation goals (*outputs)*. The model acknowledges that in converting inputs to products and services such a transformation is controlled by external *constraints* of which the market reward system for performance is central, organisational policies, procedures, rules, norms, and budgets.

As stated in the paper, for firms to perform they need to take knowledge management as a key asset, and subsequently then, knowledge strategies need to be made. One way this can be achieved is to have an effective knowledge transfer process in place. Figure 4.2 Diagram A0 illustrates how firms can perform with such a strategy whereby three key activities are identified: establish a knowledge vision, establish knowledge strategies and transfer knowledge.

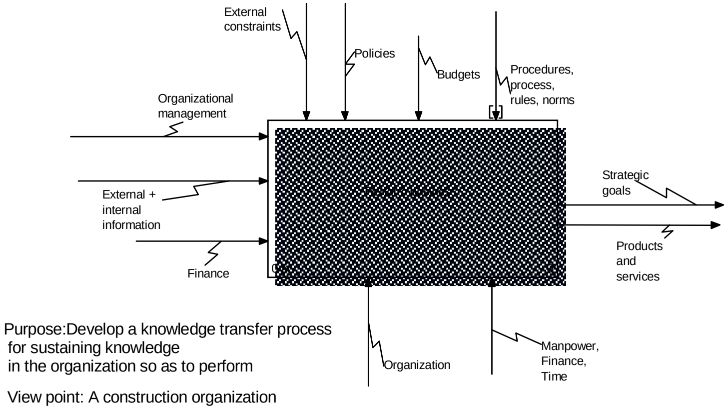


Figure 4.1. Diagram A-0: Perform business (Purpose)

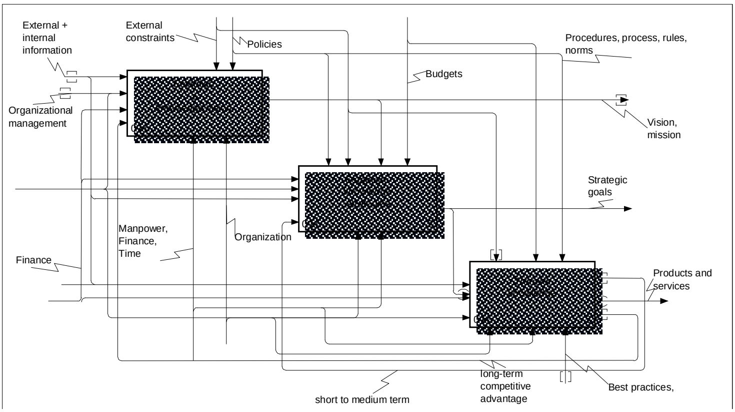


Figure 4.2. Diagram A-0: Perform business

For the activity “transfer knowledge” to be operational in an organisation, it has to be in a form that can easily be understood so as to be effective. This is achieved by detailing it through what the model refers to as a decomposition process. In decomposing the transfer of knowledge activity as appearing in figure 4.3 diagram

A3, one notes that although the transfer process constitutes the five sub-processes as the model that had been used in the analysis of the case studies, the sub-processes in this case are more informative. They now show inputs and resources required to achieve the desired outputs and the constraints that exist for each sub-process. For instance best practices of the firm although not appearing in the A-0 diagram despite being an integral resource, it appears in subsequent levels.

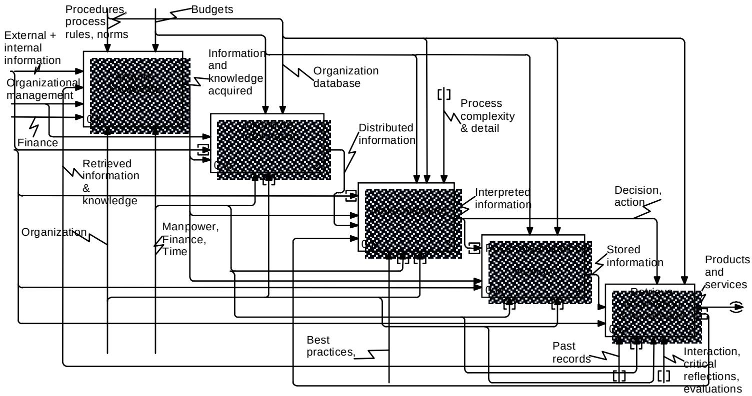


Figure 4.3. Diagram A3: Transfer knowledge

The level of detailed information can be further increased in the model when decomposed; that is, when sub-activities within are identified and illustrated producing what is known as a child diagram. Decomposing the first sub-process, “acquire knowledge”, more information is provided on what the organisation can do to achieve this condition and the constraints available. Such decomposition continues to a level of detail where the primary purpose for an organisation or process is achieved.

5. CONCLUSIONS

The use of a simple knowledge transfer model has enabled the characterization and understanding of the knowledge transfer process in construction organisations and has established that organisations fail to pursue the process in a strategic manner, as they do not identify activities as media of transfer. The typical knowledge transferred is the day-to-day knowledge that is found in business undertakings, hence making the knowledge situational. Codification of knowledge is limited thus knowledge remains unstructured and implicit within organisations.

Such understanding identifies potential areas of improvement in the management of knowledge enabling organisations acquire a competitive edge. This is significant as managing knowledge is key to performance of an organisation (Probst et al, 2000);

that effective knowledge transfer would facilitate organisations to incrementally build on this key resource for enhancing capacity.

The paper has proposed use of a modelling tool that can effectively monitor and illustrate the knowledge transfer process in a construction organisation; the use of an IDEF0 model. Such a tool, the paper has shown enables effective understanding and communication of a process. Its simple graphical language makes it easy to understand concepts and communicate, hence a better tool of managing knowledge effectively.

6. IMPLICATIONS FOR CONSTRUCTION ORGANISATIONS

Consultants and contractors in the construction industry need not consider enhancement of capacity in performance as confined to acquisition of finance or capital goods. There is a need to identify knowledge or "know-how" as used in this paper as a key resource in capacity building. However, identification by itself is not enough, rather organisations have to innovate ways on how to manage it effectively. The simple model illustrated, and the tool proposed in this paper, serves as one aspect of how the management of knowledge can be facilitated. Construction organisations can, as a starting point of managing knowledge, adopt and modify the model to suit their circumstances. Initially it is proposed for them to establish an "as-is" situation and then propose the "ideal" knowledge transfer process.

7. REFERENCES

Argote, L. and Ingram, P. (2000). Knowledge transfer: a basis for competitive advantage in firms. *Organisational Behaviour and Human Decision Processes*, **82**(1), 150 –167.

Bhatt, G. D. (2001). Knowledge management in organizations: examining the interaction between technologies and people. *Journal of Knowledge Management*, **5**(1), 68-75.

Bröchner, J. Rosander, S. and Waara, F. (2004). Cross-border post-acquisition knowledge transfer among construction consultants. *Construction Management and Economics*, **22**, 421-427.

Cordey-Hayes, M. and Gilbert, M. (1996). Understanding the process of knowledge transfer to achieve successful technological innovation. *Technovation*, **16**(16), 301- 312.

Davenport, T. H. and Prusak, L. (1998). *Working knowledge: how organisations manage what they know*, Harvard Business School Press, Boston, Massachusetts.

Dixon, N. M. (1992). Organizational learning: A review of the literature with implication for HRD professionals. *Human Resource Development Quarterly*, 3(1), 29-48.

Eliufoo, H.K. (2005). *Knowledge creation and transfer in construction organisations in Tanzania*. Doctoral thesis in Building and Real Estate Economics, Royal Institute of Technology, Stockholm, Sweden.

Goh, S. C. (2002). Managing effective knowledge transfer: an integrative framework and some practice implications. *Journal of knowledge Management*, **6**(1), 23-30.

Karhu, V. (2001). *A generic construction process modelling method: a model based approach for process description*. Doctoral thesis, Industrial Economics and Management, Division of Construction Management and Economics, Royal Institute of Technology, Stockholm, Sweden.
Lundgren, B. (2002). *Model Based Business Development – A case study of the communication of generic process models*. Licentiate thesis, Department of Infrastructure, Division of Systems Analysis and Economics, Royal Institute of Technology, Stockholm, Sweden.
Nonaka, I. and Takeuchi, H. (1995). *The knowledge creating company: how Japanese companies create the dynamics of innovation*, Oxford University Press, New York.
Probst, G. Raub, S. and Romhardt, K. (2000). *Managing knowledge: building blocks for success*, John Wiley and Sons Ltd., West Sussex.
Roth, J. Florein, H. and Ingelgard, A. (2001). *Knowledge creation in the context of continuous improvements*. Fenix WP 2001:9. Fenix Research Programme, Chalmers University of Technology and Stockholm School of Business, Sweden.
Sverlinger, P-O. (2000). *Managing knowledge in professional service organisations*. Doctorate thesis, Department of Service Management, Chalmers University of Technology, Gothenburg, Sweden.
Vito, A. Garavello, A. C. and Schiuma, G. (1999). Knowledge transfer and inter-firm relationship in industrial districts: the role of the leader firm. *Technovation*, **19**, 53-63.

HOW TO ORGANIZE AND FACILITATE KNOWLEDGE TRANSFER BY INTRODUCING A TECHNICAL PLATFORM CONCEPT

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ABSTRACT

Due to external pressure and in order to successfully compete within the building industry, there is an overhanging and proclaimed need to be more efficient and cut costs in the building process. As a response to this pressure, NCC has started an initiative called *technical platforms* which aims at creating a more standardized building process. These platforms are assumed to reduce costs and mistakes in the building process and thus achieve a more efficient and faster process. Additional benefits can be reached from large scale purchases and the possibility to use technical solutions better adapted for production. However, to obtain acceptance for this new way of working might require changes in the company culture as well as in production practice. This paper investigates the organizational and social features related to the use of technical platforms. This paper especially focuses on the organizational mechanism behind a successful knowledge transfer system. The questions asked is: what determining factors are essential for a successful knowledge transfer of the technical platform projects? Literature studies and interviews were used as the primary research method. Three interviews were conducted with employees at NCC who were either involved in the development of the technical platform concept or in the planning of the first housing project in Gothenburg where the technical platform is used. Furthermore an evaluation of the current IT-based knowledge transfer system, Erfa, was made. This study discovered five cornerstones that are essential for the implementation of a knowledge transfer system: attitude, commitment, communication, clear directives and cooperation. Additionally it found that experiences from the existing program for knowledge transfer in NCC, Erfa, can be used in the development of a knowledge transfer system within the technical platform.

1. INTRODUCTION

NCC is currently developing a system for standardization of the building process in order to make it more efficient and reduce costs and mistakes. The system for standardizations, called a technical platform, consists of several construction and process solutions suitable for a large selection of housing projects. 17 pilot projects, of which one is located in Gothenburg, are under process in Sweden using the technical platform.

NCC Teknik has been responsible for the development of the technical platform. The development process has however involved representatives from different units within NCC. An important part to ensure is how knowledge acquired within the building projects will be kept once the projects are finished. The technical platform concept can be seen as a step towards preserving knowledge between projects and reducing quality mistakes.

Repeated quality mistakes often have its origin in lack of knowledge transfer from one project to another. In the research “Quality in building process – quality mistakes costs” (Josephson, 1994), the mistakes costs are divided into categories considering to what function they have in the building process. The conclusion made is that production management stands for 28 % of the total quality mistake costs. According to “Skärpning gubbar” (2002) costs related to mistakes is still a problem. To be able to continuously develop the technical platform cross-project learning will be necessary. This will be a challenge for NCC. The purpose of this paper is to identify determining factors that are essential for a successful knowledge transfer from the technical platform projects. To do this the paper investigates organizational features related to the use of the technical platform concept.

2. THE TECHNICAL PLATFORM CONCEPT

NCC is one of the leading construction and property-developing companies in Scandinavia, with 21000 employees and a turnover 2005 of 50 billion SEK (www.ncc.se, 2006-11-28). The company operates in several fields of construction such as residential and commercial property projects and builds offices, industrial facilities, housing, roads, civil-engineering structures and other types of infrastructure.

NCC’s technical platform concept consists of a series of standardized technical solutions for house and office building. When planning a housing project with the new concept there will be a limited selection of materials, installations, ventilation, heating options and building processes to choose from. By limiting the large variety of possibilities and making the building more standardized, NCC is trying to create a product offer. Treated as a product the concept will hopefully give better possibilities to learn and improve the production. Every new housing project will become less unique in its character and hopefully the number of problems and mistakes can be reduced. Furthermore NCC hopes that by reducing the selection of materials and building parts they can achieve large scale purchase benefits and thus lower their overall costs. The building process for a housing project built with the technical platform concept will not change significantly compared to a house built in a “usual” way. The technical platform concept does not have a specific goal to use more prefabricated goods, but during its development the project group has tried to learn from industrialized building to find solutions that could benefit the technical platform.

3. METHOD

The study is based on individual and group interviews with employees at NCC involved in the technical platform project. The interviewees were project managers at NCC Teknik and the project leader of Utlanda höjd, the first housing project in Gothenburg using the technical platform. All together the study included three interviews.

A qualitative approach to the interviews was chosen with open-ended questions. This type of interviews allows for flexibility where random and follow-up questions can be asked during the interviews. One of the disadvantages with interviews is however that the interviewee's answers might be stained by how they interpret the questions, which might affect the objectivity and validity of the result (Bryman, 2002).

The main focus of the interviews depended on the interviewees experience and role in NCC's platform project as well as previous projects handling knowledge transfer within NCC. Each interview lasted between one to two hours. To avoid misunderstandings and to be certain of statements all interviews were recorded. This gave the opportunity to confirm the interviewees' answers after the interviews were held.

Literature and articles in the field of interview methodology, knowledge transfer, knowledge management and company organization was studied. Information about the technical platform was also acquired through the technical platform manual documents from NCC.

NCC´s present knowledge transfer database, Erfa, was tested at NCC's office in Gothenburg. To evaluate the system it was tested by three of the paper authors under supervision of a project manager from NCC. During 2-3 hours the system was used to search information about the projects that had been stored in Erfa. The test was conducted with the main focus on usability and *searchability*.

4. KNOWLEDGE MANAGEMENT THEORY

Knowledge transfer lies within the field of Knowledge Management, which is a wide theoretical field of study with several different schools and scholars. The general topic is however the focus on the management of specific knowledge assets and development and cultivation of the channels through which knowledge flows. It refers to practices used by organizations to identify, create, represent, and distribute knowledge for reuse, awareness and learning across the organization. Malhotra (1998) provides a definition of Knowledge Management.

> "*Knowledge Management caters to the critical issues of organizational adaption, survival and competence in face of increasingly discontinuous environmental change. Essentially, it embodies organizational processes that seek synergistic combination of data and information processing capacity of information technologies and the creative and innovative capacity of human beings*"

Knowledge transfer is described by Argote and Ingram (1999) as "the process through which one unit (e.g. group, department, or division) is affected by the experience of another". Furthermore, they emphasize that results of knowledge transfer can be observed as changes in the recipient units. The changes can be in for example knowledge, performance or new routines.

Organizations would like to transfer early experience of members to solve task related obstacles of others (Earl, 1997). Earl (1997) expresses that knowledge transfer, by its nature, depends upon communication, why communication media are often cited as a means to facilitate transfer. According to Szulanski (1996) the transfer of knowledge in organizations, such as best practices, can be quite difficult to achieve. Knowledge transfer is therefore more than a communications problem. Problems with knowledge transfer depend on many factors such as motivational issues and incentives, faulty information, generational differences, geography or distance, internal conflicts (for example, professional territoriality), the inability to recognize & articulate "compiled" or highly intuitive competencies – tacit knowledge idea, and problems with sharing beliefs, assumptions and cultural norms (Nonaka & Takeuchi 1995) (Gailbraith 1990).

Furthermore the factors that contribute to mistakes can be referred to the fact that there are humans involved. The numbers showed below are examples of categories and distribution in percent of the total mistake costs and what caused them according to Augustsson (1989).

- Commitment 54%
- Knowledge and experience 23%
- Communication 13%
- Stress 5%
- Other 4%

According to Sverlinger (2000), knowledge transfer needs to consider the processes and the humans in the organization. The figures above indicate that engagement together with lack of knowledge and experience are major factors when it comes to reducing mistakes in the building industry.

4.1 Implementing knowledge transfer

Methods to handle knowledge transfer are often associated with IT technology systems. IT is a tool for information management which can facilitate the knowledge transfer process. However, Robinson *et al.* (2005) mention that IT alone is not capable of capturing all tacit knowledge without losing its context. Tacit knowledge is a non-linguistic, non-numerical form of knowledge that is highly personal and context specific and deeply rooted in individual experience, ideas, values and emotions (Nonaka & Takeuchi, 1995). One of Michael Polanyi's famous aphorisms is: "We know more than we can tell." In the field of knowledge management the concept of tacit knowledge refers to a knowledge which is only known to you and hard to share with someone else. The opposite is explicit knowledge which is knowledge that can be articulated, codified, and stored in certain media. Explicit knowledge is commonly expressed through manuals, documents, procedures, and stories but can also be audio-visual or works of art and product design, where human skills, motives and knowledge are externalized (www.wikipedia.se, 2006-11-28).

Robinson *et al.* (2005) further states that an IT-system requires incentives to get the employees to share information and ideas. Barrett *et al.* (2004) point out problems with lack of trust when only applying virtual interaction, like a shared database. A knowledge transfer system has to consist of both IT and non-IT tools to be able to transfer both explicit knowledge and tacit knowledge. Other critical factors when implementing knowledge transfer in an organization are upper management support, allocated resources (Robinson *et al.*, 2005) and involvement from everyone in the organization in all job roles (Barrett *et al.*, 2004).

Stymne (2001) describes a previous attempt at Ericsson Software Engineering where complications aroused when trying to implement a database for knowledge transfer.

The system had been constructed and implemented without analyzing how the knowledge transfer did take place in the organization. In reality, knowledge was transferred through spontaneous meetings. The solution at Ericsson was to increase the spontaneous meetings by introducing persons with the task to know where knowledge could be found in the organization and where it was needed and arrange meetings them between. The Ericsson example shows the importance of an extensive investigation before implementing a system for knowledge transfer. The knowledge that should be transferred and suitable channels for its transfer have to be identified before implementation. Stymne (2001) means that the reason the database did not work out was that knowledge needs to be adapted to the new situation which is not possible with a standardized database. It is unusual that the two situations are identical so knowledge has to be adapted to the new situation before it can be used.

4.2 Organizational culture

Organizational culture is unique for every company and an important issue to consider in order to implementing an appropriate process for knowledge transfer. Organizational culture has been defined as "the specific collection of values and norms that are shared by people and groups in an organization and that control the way they interact with each other and with stakeholders outside the organization" (Hill & Jones, 2001). Culture is complex in many aspects and hard to change. An organization culture can be described in terms of power and gender. The conditions consist of informal and formal rules of norms within the organization. In a situation where the power is kept by one person conflicts often occur. In a group were the power is shared between many employees that feel important for the business conflicts can be avoided to higher extent (Alvesson, 2001).

Cultural change could be seen as an organic movement which means that groups within an organization follow the new ideas, which eventually will lead to a cultural change within the organization. In order to allow this type of change to have a strong influence on an organization the management must share and support the ideas and perceptions (Alvesson, 2001). The characteristics of cultural change is that many are confronted with something that means changing their perceptions, ideas and values which will result in changes without the highest management having any important role in this.

Working by praxis is supported by a strong organizational culture. Values and norms make it difficult to change existing roles. Actions that contributes to changes often faces resistance due to the existing culture (Bresnen *et al.*, 2005). Organizations in the building industry are formed mainly by the project based way of working and that these projects are more or less temporary. A challenge for these organizations is to accomplice to get a more permanent structure of the organization and the activities in the projects (Kadefors, 1995).

4.3 Previous knowledge transfer studies within the building industry

At Luleå University of technology, Enquist & Lindström (2002) carried out a master thesis which aimed at examining how knowledge transfer can be optimized within project environments. Enquist and Lidström stated that the absence of reporting and insufficient routine job resulted in a non working knowledge transfer.

Another study was made by Söderholm (1999) at KTH with the purpose to investigate conditions for the introduction of a system for preserving knowledge at NCC. Within the study Söderholm conducted 89 interviews with employees at NCC in the Nordic countries. In addition to the interviews, two questionnaires were made; the response rate was 55%. A survey was made for production and calculation personnel. The results of the study showed that the personnel within NCC expected that the outcome of such a system would be good. Information that should be included in the database was, according to the local managers, contact, methods, project information, space for own ideas and mistakes. At the time for the study made by Söderholm (1999) the reasons for the knowledge transfer not functioning properly were the lack of a jointly system; lack of directions from the management; existing company culture; and work under pressure.

5. RESULTS FROM THE ERFA SYSTEM AND THE INTERVIEWS

In this chapter the reader will be presented with results from the literature studies, interviews, and the Erfa system survey. The results will then be analyzed to finally come up with the determining mechanisms behind a successful implementation of a knowledge transfer system.

5.1 Applying experiences from the Erfa system

Figure 1 illustrates a comparison between the Erfa system and the technical platform concept presented in chapter 2. The Erfa database is an IT-based knowledge transfer system. It was first created back in 1998 as an attempt to share knowledge from projects throughout Sweden. However the development of the system was canceled in 2001 when Alf Göransson (the then new CEO) decided to change priorities in the organization.

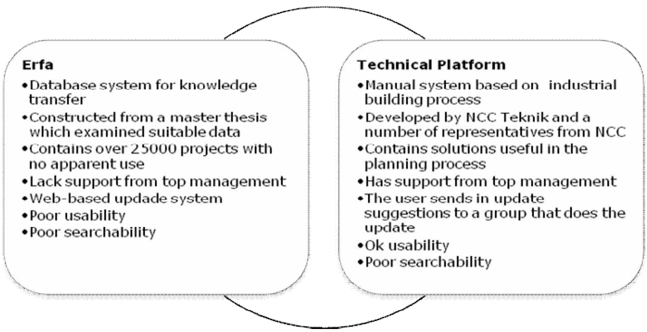

Figure 1. Comparing Erfa and the technical platform concepts

The Erfa system was put to a trial by the authors of this paper. During the trial the authors did unfortunately not find anything useful about the system. This may be due to the fact that the system was not fully functional at the time of the trial. The flaws of the current Erfa system were:

- non-working search function;
- no apparent function for the current data in the database;
- outdated interface;
- poor usability.

Despite these problems, experiences can be drawn from the current system. Lack of top management support is one of the main causes why the system failed. Top management support is essential for a successful implementation. In similarity with the Ericsson case previously described, the Erfa system does not take into consideration how knowledge is actually transferred. This may be due to lack of thorough surveying of needs and mechanisms behind a successful knowledge transfer system before trying to implement it.

5.2 Determining factors for a successful knowledge transfer system

The purpose of this paper was to identify determining factors for a successful knowledge transfer system. These factors were found both from the literature studies and from the interviews.

Communication: is the cornerstone of all kinds of knowledge transfer. Without proper communication, knowledge transfer will not work.

Attitude: this factor is related to the corporate culture. According to the interviews it is especially common within the construction industry that employees believe they know what is best and do not bother asking for help. It is of great importance that the employees keep an open minded attitude towards the introduction of new systems.

Cooperation: this factor is included since it was found from the interviews that different knowledge transfer workgroups work in different directions.

Clear directives and support: top management need to give their full support to any attempt at implementing a knowledge transfer system. The interviewees indicated that unnecessary work is being put into the Erfa system, something that would be prevented with clear directives.

Commitment: this factor can also be drawn from the experiences from the Erfa system. It is obvious that commitment from the organization is not present. Commitment as a determining factor is strongly supported in Nonaka's paper from 1994 "A Dynamic Theory of Organizational Knowledge Creation". Additionally commitment was found to be most important factor for preventing errors in the 1989 survey made by Augustsson.

6. DISCUSSION AND CONCLUDING REMARKS

The factors presented in figure 2 should be seen as the cornerstones for implementing a successful knowledge transfer system. Although the findings are neither surprising nor new, they give an indication of what is required for the step against a cohesive organizational determination aimed at creating an effective knowledge transfer system. Important to notice is that none of the cornerstones can function effectively alone. For instance, without direction from the top management, communication will not work and conversely without communication, the directives will not root.

It is suggested that experiences from the existing program for knowledge transfer in NCC, Erfa can be used in the development of a knowledge transfer system within the technical platform. The experiences of Erfa stress the importance of management support to keep right directions. Furthermore incentives for sharing data have to be found to provide conditions for a positive attitude and motivate to use the system. Using a system for knowledge transfer system based on Erfa can bring benefits of uniformity and simplicity by using only one system in the organization. This can create conditions or better communication between different units.

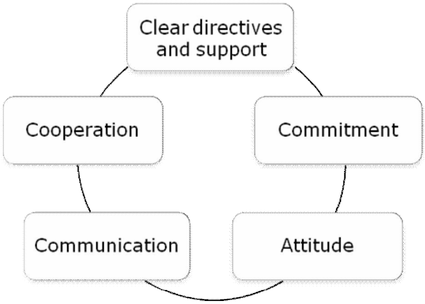

Figure 2. Determining factors behind a successful knowledge transfer system

The technical platform is apparently a good ingredient for a more effective planning and production process. Therefore it would be wise to use the knowledge transfer element from Erfa and implement it into the technical platform concept. However it is important to realize that a database system is not the final solution to a knowledge transfer system. In reality knowledge transfer often take place during person to person meetings. Why it is important to consider personal contact as an important tool in the knowledge transfer process and that it is hard to imitate the social process in a database system.

Furthermore one more problem was identified connected to the project based structure. As the project groups all work individually and they do not have incentives for sharing knowledge between each other. On the contrary the project leaders often see sharing knowledge as an extra burden and unwanted responsibility. Therefore a database in combination with incentives would be an intelligent solution to the knowledge transfer problem within the project based organization.

7. REFERENCES

Al-Ghassani A.M, Robinson H.S, Carrillo P.M. and Anumba C.J (2005), Knowledge management practices in large construction organisations, *Engineering, Construction and Architectural Management*, 12(5).

Argote, L., Ingram, P. (1999), Knowledge transfer A Basis for Competitive Advantage in Firms, *Organizational Behavior and Human Decision Processes*.

Augustsson, R. (1989), *Kvalitet i byggandet – kvalitetsfelkostnader*, Chalmers University of Technology, Göteborg.

Barrett, M., Cappleman S., Shoib G. and Walsham G. (2004) Learning in Knowledge Communities: Managing Technology and Context, *European Management Journal* **22**(1), 1-11.

Bresnen, M., Goussevskaia, A., Swan, J. (2005) Implementing change in construction project organizations: exploring the interplay between structure and agency. *Building Research and Information*, **33**(6), 547-560.

Governmental report, *Skärpning gubbar*, SOU 2002:115.

Josephson, P.-E. (1994), *Orsaker till fel i byggandet – en studie om felorsaker, felkonsekvenser, samt hinder för inlärning i byggprojekt*, Thesis of doctorate 1038, Chalmers University of Technology, Göteborg

Kadefors, A. (1995), Institutions in building Projects: Implications for flexibility and Change, *Scandinavian Journal of Management*, **11**(4), 395-408.

Malhotra, Y. (1998). Knowledge Management, Knowledge Organizations & Knowledge Workers: A View from the Front Lines.

Nonaka, I. (1994), A Dynamic Theory of Organizational Knowledge Creation, *Organization Science*, **5**, 14-37.

Nonaka, I. and H. Takeuchi (1995). *The knowledge-creating company*. Oxford University Press, New York.

Stymne, B. (2001), *Kunskapsåtervinning eller lärande?*, in *Lärdilemman i arbetslivet*, Backlund T., Hansson H., Thunborg C. (ed), Studentlitteratur, Lund, 195-214.

Sverlinger, P.M. (2000), *Managing Knowledge in Professional Service Organizations*, Department of Service Management, Chalmers, Göteborg.

Szulanski, G. (1996), Exploring internal stickiness: Impediments to the transfer of best practice within the firm, *Strategic Management Journal*.

Söderholm, F. (1999), *Experience feedback in construction management*, Examination paper 361, KTH, Stockholm

Wikipedia, *Knowledge transfer*, homepage of Wikipedia, <http://en.wikipedia.org/wiki/ Knowledge_transfer >, 2006-11-28.

LEARNING IN DEMONSTRATION PROJECTS FOR SUSTAINABLE BUILDING

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ABSTRACT

The process by which novel technology is implemented within project teams is explored. The interest of the investigation is focused on how energy-efficiency goals in building affect the current practice of a project team. The study adopts a cognitive approach and looks at the project team as a social setting and as the fundamental organization of construction enterprises. It is assumed to be the core of individual, firm and organizational learning, but also acts as the link where the possibilities for the introduction of innovations in buildings are tested, proposed or discarded. It is a dynamic system where learning continuously goes on, individually and collectively. But how and what do professionals learn within projects? Where are these goals more appropriately introduced in the design process? Simultaneously, many efforts are under way and the process is split among practitioners and projects. Some are based on earlier attempts; others start from scratch. If there were any evident solutions, standard technology would suffice.

1. INTRODUCTION

The study tries to figure out a model to describe and gain a deeper understanding of what happens within a construction project when environmental performance, and especially energy efficiency, is on the agenda. A projectteam is assumed to be the context in which learning about building and technology is generated. An innovation process is continuously going on at a very slow rate.

Energy efficiency is both a purpose and a problem to be solved within the project. As a problem it is accompanied by lots of sub-problems and it easily becomes ill-defined. Hence, energy efficiency can be looked at as innovation and as technological change. It should be better understood as both simultaneously, but that should be more difficult. It is at one extreme a necessary, compulsory global goal, the realization of which *needs* a worldwide commitment towards sustainable development. At the same time it needs lots of innovations (technological as much as conceptual and strategic) and change to be implemented inside local contexts. Both innovations and change have to penetrate the disciplinary organization of knowledge inducing change towards sustainable development respecting and understanding the “heterogeneous engineering” needed.

Different terms are introduced: Problem, Solution, Technology, Knowledge, Hypotheses, Models, Purpose, Principle and Effect are terms for the analyses,

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abstract terms, not used in project-terminology but functional abstractions as tools used to identify the continuous passage from induction to deduction, using as big parts of intuition and behaviour as of rational analyses and theory.

2. LITERATURE REVIEW

The practice in projects is considered here to be central for the implementation of different sustainable building approaches, in need of new clarifying descriptions as to learning processes and the development of technologies within its limits.

The transition to more sustainable building practices appears as “heterogeneous engineering”, using a term introduced by John Law (Bijker and Law, 1992). The assumption of this term gives us the impulse to look for all factors that are needed for the successful implementation of an idea throughout a process in time. “Heterogeneous engineering” seeks to associate entities that range from people and skills, to artefacts and natural phenomena. A step aside from other usual approaches of analyses may give new and useful understandings. What Law (Bijker, 1987) maintains is that for a real innovative technical change to succeed, a non-linear combination of interacting casualties is needed. “From this point of view sustainable building will succeed in increasing its energy efficiency when it will become *a network of artefacts and skills* converting small quantities of energy into allied in the struggle to master the power of climate” (Rubino, 2006). Law suggests that “heterogeneous engineering” needs three stages:

1. the *process of shaping technologies*, as applications and inventions*, and scientific knowledge*;
2. a *social engineering* which constructs a network of practices associated with developed tools and components, broadening the field of contextual applications, converting *esoteric scientific knowledge* into a widely applicable practice and identifying the *weakest link* in the attempt to create a stable network of elements;
3. the definition of *a point of return,* meaning that all decision making during the process may not be possible without a *scale of reference. Technological testing* implies the construction of a background against which to measure success.

From this point of view it may be assumed that the construction sector is currently challenged by a societal push towards a technological change that has become political and economic. Energy efficiency seems to be the core question of this change.

Energy efficiency in buildings is argued to find main hindrances in knowledge barriers (Nässen and Holmberg, 2005; Femenias, 2004). Knowledge about specific issues is regrettably lacking by some of the parties involved (clients, architects, builders and others). It is assumed to make use of experience and to depend on feedback-mechanisms. The need to transfer experience in different directions within the organisations of the sector is identified by some scholars (Sprei, 2007), while others point out the management of organizational capabilities in order to diffuse new knowledge and competence inside firms and organizations (Zollo and Winter, 2002).

An impediment that is often named, mostly by practitioners, concerns the many different measurements used for different aspects of energy efficiency in buildings. Normally the energy *end-use* is measured (KWh/m^2yr) for heating or hot water or the two together, and for household electricity or for the total energy consumed. But energy efficiency concerns also the insulating properties of materials and/or technological components of whole parts of the building (U-value). Energy efficiency is finally also affected by life cost analyses of materials, components and technical assemblies.

Scientific knowledge has been developed for some decades now, even if the knowledge domain of “sustainability” is so new that all agendas have to be revamped. Still the framework of studies about “sustainability” belongs by nature of its origin to the scientific domain and constitutes an esoteric scientific knowledge difficult to translate into widely applicable practice. The processes of shaping technologies and of scientific knowledge do not seem to develop hand-in-hand. Technologies in construction appear to be shaped as a part of the process of social engineering of a change into contextual applications and networks of practices. A huge amount of practitioner-research within project-teams is actually shaping technologies in construction, confining scientific knowledge to the theoretical formulations of rules, problems and solutions led by analytical rationality. Scientific knowledge developed in academic environments, on the other hand, has never really accepted the fragmented, not easily accessible, knowledge environment of practitioners, complaining about their resistance to change and innovations and about the diffused “non-rational approach” used in problem-solving and decision-making.

The last decade has seen an increased interest in introducing social science theories into the field of investigations about building research. As a result of this, projects are now studied as complex social settings, as learning environments, as communities of practices where a specific collaboration is taking place (Bresnen *et al,* 2005). A cognitive approach is widespread essentially as to its assumptions about the participation of individuals with their beliefs, assumptions, history of experience. Looking at projects as time dependent activities which produce learning more than knowledge, the focus on projects has discarded many hypothesis of definitions of knowledge as codified or tacit or articulated, giving power to the one or the other interpretation (Wenger, 1998; Koskinen *et al,* 2003; Prencipe and Tell, 2001).

The aim of this paper is to render a distillation of observations about the kind of learning going on in projects as to its elements and procedures. Investments in learning may be questions of more time at disposition in projects, but also of encouraging actions of deliberate learning in project environments. The study is based on empirical observations made within the framework of a research project financed by FORMAS and BIC and which is still underway.

The research project is initially briefly presented in section 3 in order to provide a background to the questions concerning learning in projects raised in this paper. The material presented in section 4 constitutes a result but also an interpretation of a multitude of details surfaced during the investigation, which somehow should disappear in *a posteriori* reconstruction of a project’s organization.

3. A PROJECT-BASED APPROACH FOR RESEARCH AND PRACTICE

3.1 Aims and objectives

The general aim of this research project has been to understand the role played by demonstration projects in the implementation of sustainable building practices and to shape a multi-actor arena for the people-to-people enactment of the different hypotheses, the new models and the solutions proposed in these projects. Demonstration projects are investigated as *social engineering* within the ongoing technological change towards sustainable building, where theoretical context-independent knowledge is translated into context-dependent praxis. Demonstration projects are then considered as contexts of change where a huge amount of learning is produced and as possible to be monitored in the interactions between heterogeneous actors/agents, skills, technological components at disposition and the possibility to connect them all in a whole responding to a need. Results are dependent on the initial definition of goals (mostly centred on energy efficiency and then both quantitative and qualitative) and on the achievement of outcomes (always quantitative) which must be technologically tested in order to measure the success of the project.

The field of investigation is an instance of a local construction reality and comprises of six projects which all define themselves as wanting to provide examples for the future. They are evolving at present time and concrete. The agents, actively participating in the research investigation, are working as engineers, architects, clients and developers and have within the framework of the project emerged as individuals, as representatives for firms and companies, as members of project-teams, representing different ways of working, decision-making, solving problems and learning. The projects represented define a context of parallel distributed processes. These could reveal patterns that could help finding answers to the research questions.

3.2 A multi-mode approach: interviews, focus groups and workshops/conferences for an action research focused on learning

The approach has been to gather a network of practitioners, who have carried out demonstration projects, in order to exchange experience and hopefully to establish more efficient processes for internal learning as well as external communication. A group of “change agencies” was tied to the network early on. They represent stakeholder organisations that in different ways conduct information or educational activities. These are meant to collect the findings from the projects and transform them into different kinds of learning material that can be used to initiate either the mainstreaming of sustainable building or new demonstration projects.

The first kick-off general meeting provided the guidelines for the development of a qualitative multi-mode method consisting of 1) Semi-structured interviews with the practitioners and the clients involved; 2) Focus group meetings, organised and held on specific issues; 3) Feedback seminars with end-users of finished demonstration projects or experts; 4) Follow-ups of project meetings of three cases, of which one has been reported (Rubino, 2006a). Together they shape what we call a ‘multi-actor arena’. All meetings have been monitored and followed up with notes, a draft has been sent to all participants for reviewing. Tops of learning have been reached in workshops where feedback to projects was provided from users or property owners. Tops of interest and public participation were achieved at a half-time conference organized by the CMB (Centre for Management in Building at Chalmers, Göteborg), where the demonstration projects were presented to a broader public. Engineers, architects, clients and project managers presented specific aspects of their work as to the problems which have been faced, the tools that have been developed, the ideas and the provisional results.

3.3 Research methodology

As to its purpose and methods the actual research project has been structured around features that categorise it as Action Research. This has initially been due to its objective of fostering change towards Sustainable Development. At the same time it has many of the typical characteristics discussed about Action Research when trying to give definitions of it: “Action research is not a ‘method’ or a ‘procedure’ for research but a series of commitments to observe and problematize through practice a series of principles for conducting social enquiry” (Malterud, 1998). “The research needed for social practice can best be characterized as research for social management or social engineering. It is a type of action-research, a comparative research on the conditions and effects of various forms of social action, and research leading to social action. Research that produces nothing but books will not suffice.” (Lewin 1946, reproduced in Lewin 1948: 202-3). Lewin’s original approach involves a spiral of steps, ‘each of which is composed of a circle of planning, action and fact-finding about the result of the action’. The basic cycle involves the following features in a revised version drawn on Malterud (1998):

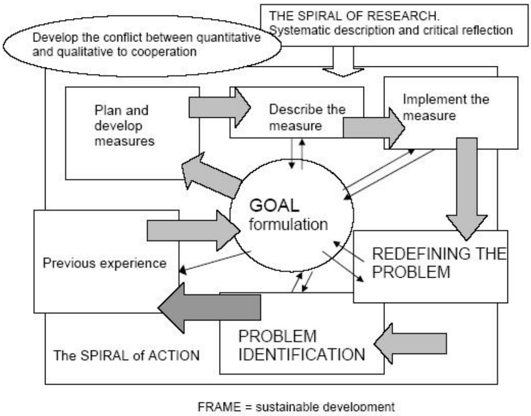

Figure 1. The spiral of steps in action research (drawn on Malterud, 1998)

The action research spiral was never taken as a leading method; hence it can be useful as an explanation of what has been happening during the research. It is a processual study and has resulted in overwhelming empirical material. Working with empirical data can become like treading on well-known paths making us blind to unknown pathways, unless we actively search for them.

3.4 A follow-up study

It actually was a follow-up study that led the questioning of the research project along *unknown pathways*. The project to be followed-up was, according to the first approach, likely to clearly confirm all the initial hypotheses: that a clear vision, a best-practice attitude, well-defined problems and goals, transparency of results, were the *rational receipt* for energy efficiency and for the implementation of environmental goals in buildings. The project looked like the model enterprise, the single project in which all preconditions were satisfied, in which all regulations on environmental and energy efficiency performances had been fulfilled. The model of deductive, analytical rationality was expected to be met in this kind of organization: the model, which on the surface of things and inside *a posteriori* reconstructions of things, appears to apply, and theoretically is supposed to apply in construction praxis, was strangely absent in the in-depth details of the case. What was instead present there within the project was an enormous amount of practice-related research going on at every stage of the project, the human capability of coping with complicated situations and the enormous incentive given by just formulating ”we are demonstrative!”. The actors involved did not sleep at night exalted by the challenge of solving a problem. The case study became a critical case (Flyvbjerg, 2001) as its conclusions became: “If they find it difficult then surely all others do too!” They were supposed to show the “how”, the right way, knowledge and technology were at disposition. It was likely that the same problems would exist in other projects that were less careful with rules and goal-settings.

A series of random events showed up under the closer examination of the process. Decision-making was never linear, a number of hypotheses were tried and discarded, the formulation of problems changed continuously, the lack of objects to refer to was frustrating, an elephant was going to be built with an aunt as model. Moreover the important decisions seemed never to be made within the project-team: the team presented regularly integrated hypotheses, the “message” of which were filtered by other groups, the group of chiefs, the ‘group for the silhouette of the town’, the group for the total environmental management and others. The use of energy performance components, the use of solar panels, the general layout and the car and cycle parking solutions were decided in other separate rooms as to their performance as cultural signs, political statements, end-user friendly solutions.

The individual learning which was going on within the project was strictly connected with the process of testing hypotheses and rejecting them: Feedbacks from the others in the group seemed to be crucial and recursive, each project-meeting was an outcome and a point of departure on the path towards a solution. The way from the formulation of a problem to its solution is difficult.

Monitoring a project from within gives the possibility to observe agents making the act of taking decisions. The follow-up gave a lot of empirical evidence about the messy process we try to describe. While it happens it does not make sense with any rationality at all. The empirical results combined with the analytical model elaborated by Brian Arthur (1994; 2000; 2006) in economics, gave the lines for the following tentative description model.

4. INSIDE THE BLACK BOX

A project is what is to be found between the formulation of a problem and its solution. It is a social setting and it uses to unfold in time following a structure, which is not necessarily its formal organization. Projects are self-organizing settings in the direction of a reification of the participative work of agents with heterogeneous origins. Moreover projects are time dependent processes. As the project for a new building unfolds, different rationalities interact with increasing complicatedness. Agents organize in order to cope with problems, which are always transformed into ill-defined problems, and rationality is bounded.

4.1 Rationality and the definition of projects

There is a diffuse tendency among both practitioners and academics to call for well-defined problems and rational deductive analyses. Changes in the environment of project work are recurrent. Objective, well-defined, shared assumptions are expected to characterize the process. A belief in human rationality – perfect, logical, deductive rationality – is rooted in an aspiration to control the outcomes of projects.

If one sets up a Problem and assumes rationality in decision-making, a well- defined Solution is expected to follow. Building is simple from this point of view: from the Problem follows the Solution. How agents get from Problem to Solution is often considered a Black Box: and whether indeed agents can arrive at the Solution cannot be guaranteed unless we look into this box. If we open this box building becomes difficult. Complications arise. “Rationality, so useful in generating solutions to theoretical problems, demands much human behaviour, more than it can usually deliver”. Rationality breaks down under complications (Arthur, 1994; 2000). This used to happen in two conditions. Firstly, beyond a certain complicatedness the human logical apparatus ceases to cope, rationality is bounded. Secondly, in interactive situations of complications, agents cannot rely upon the other agents they are dealing with to behave under perfect rationality, and so they are forced to guess their behaviour. Objective, well-defined, shared assumptions cease to apply. “In turn, rational, deductive reasoning – deriving a conclusion by perfect logical processes from well-defined premises – itself cannot apply. The problem becomes ill-defined” (Arthur, 1994).

4.2 Opening the box – a cognitive approach

If deductive approach and perfect rationality have limited functions, then the real problem is what people ‘put’ instead of rationality, not whether perfect rationality works. From behavioural psychology we learn that in situations that are complicated or ill-defined, humans use characteristic and predictable methods of reasoning. These methods are not deductive, but *inductive.* This assumption makes a great difference and as Arthur (1994) suggests “it makes excellent sense as intellectual process; and it is not hard to model”. Individuals together find optimal solutions to complex questions.

Professional decision-makers do not back off from a problem because it is difficult or unspecified. Solutions may stop matching reality and stop existing as such. When problems are too complicated to afford solutions or when they are not well specified, agents do not face a problem but a *situation*. They must deal with that situation:

they frame the problem, and that framing in many ways is the most important part of the decision process. Cognition more than knowledge or learning is at play here. Mind, associations, meaning are central questions of a cognitive approach, but not at the level of this inquiry. Hence, one element is relevant for understanding what happens inside the project: people do not only think deductively, people think associatively and use inductive reason.

4.3 Induction, hypothesis and learning

How do agents cope with these situations that are complicated or ill-defined? Psychologists, again, say that they see or recognize or match patterns. Mostly humans look for patterns and simplify problems by using these to construct *temporary internal models or hypotheses or schemata* to work with.

Agents shape localized deductions based on current hypotheses and act on them. Feedback from the team comes in, this may strengthen or weaken their beliefs in their current hypotheses, discarding some when they cease to perform, and replacing them as needed with new ones. In other words where they cannot fully reason or lack full definition of the problem, they use simple models to fill the gaps in their understanding. This kind of behaviour is *inductive*.

As the project unfolds, agents hold onto hypotheses or mental models that prove plausible or toss them aside if not, generating new ones to put in their place. In other words they use a sequence of >*pattern recognition* > *hypotheses formation* > *deduction using currently-held hypotheses* > *replacement of hypotheses* as needed. This behaviour enables agents to deal with complications constructing plausible, simpler models that they *can* cope with. It also enables them to deal with any lack of definition. When they have insufficient definition, their working models fill the gap. Arthur (2006) claims that in fact this is the way science itself operates and progresses. Also this research project follows this behaviour.

It is possible to model induction. All building problems are problems that play out over time, with a collection of heterogeneous agents. Then we assume that agents form mental models or hypotheses or subjective beliefs. These beliefs may come in several forms, some mathematical expressions that can be used to describe or predict some variable or action; some statistical hypothesis; or prediction rules. They are normally subjective, which means that they differ among agents. Moreover an agent may have one at a time in mind or a number of them at the same time. Each agent normally keeps track of the performance of his/her private collection of these 'belief-models'. As the project unfolds and choices must be done, he/she acts on the currently most credible, most profitable, one. He/she keeps the others at the back of her/his mind. Expert professionals generally hold many hypotheses in mind and act on the most plausible one. Problems may arise when only a few or no hypotheses are on hand. This procedure makes action possible, and when action is taken "an aggregate picture" is updated as a possible Solution, and each agent updates the track records of all their hypotheses. Each project-meeting is a point of transition. The process is path-dependent.

Inside this system learning takes place. Agents *learn* which of their hypotheses work and discard poorly performing hypotheses from time to time. In their place they put newly generated *ideas* which are applied in the current project, or not (they may be applied in the next project). The currently most plausible hypotheses and belief models are clung onto until they no longer function well, and then they are dropped in favour of better ones. A belief model is not “clung to because it is *correct* –there is no way to know this– but rather because it has worked in the past and must accumulate a record of failures before it is worth discarding” (Arthur, 1994). There is evidence for a general, constant, slow turnover of hypotheses acted upon. Arthur calls them a system of temporary fulfilled expectations—and he means that the beliefs or hypotheses or models are only temporary fulfilled and never perfectly fulfilled, and that this fact opens the way to different beliefs or hypotheses when they cease to be fulfilled. Where do these hypotheses or mental models come from? They are generated behaviourally in cross-fertilization between cognition, object representation, pattern recognition. Agents are somehow endowed with *focal models* (Arthur, 1994) – patterns or hypotheses, which are obvious, simple, and easily dealt with mentally. A “bank” of them can be generated and distributed. But they have to be obvious, simple and easily dealt with and are not examples to be applied, but instead *models to focus upon*. Not solutions rather tools to work with. Also focal models become worth discarding. As problems become ill-defined so do the expected solutions.

4.4 Technology at work in projects

Technology is not necessarily developing parallel to knowledge and the way it works maybe also depends on interacting behavioural processes of inductive reason. Technology is a means to fulfil a human purpose (Arthur, 2006). The purpose can be explicit, well-defined or not. Technology is also a body of practices and components, “the totality of the means employed by people to provide themselves with the objects of material culture” (Webster). Hence, as a means to fulfil a purpose “a technology may be a process or a method or a device” (Arthur, 2006). It is normally put together or combined from component parts or assemblies, sub-systems and sub-technologies.
Technology always proceeds “from some central idea or concept—the *method of the thing*” (Arthur, 2006). This is the *base principle or base concept* of the technology which does not need to be simple. “Passive house” is a base principle for building from which the choice of technology proceeds. A principle is an idea, a concept, which the agents within a project agree on, or adapt to or shape together. It proceeds from something usable or exploitable. The principle normally proceeds from an effect or phenomenon (set of phenomena) it exploits. Energy efficiency can be considered as an effect. A technology that exploited nothing could achieve nothing: the phenomenon exploited need not to be physical. It can use an effect from nature, a logical combination, a behaviour, an organization. Buildings usually proceed from a number of effects to be combined and exploited, several principles of which may be adverse to each other. When energy efficiency in building is on the agenda it is often presented as if technology exploited one single central effect.

A technology consists of a central assembly – this constitutes the central backbone of the device, or method, that executes its base concepts and exploits one or more base effects – plus other assemblies suspended from this, to make this workable and regulate its function. These components or assemblies function together in a *working architecture* or a whole system (Arthur 2006). Technologies are almost always adaptable in architecture, constantly changing in configuration and purpose as different needs require.

It is important to understand the Principle and how this translates into components that share a working "architecture". It is fundamental to recognize and make a clear distinction between principles and phenomena. A phenomenon is just a "natural effect" while a principle is the idea of using this effect for some purpose. In our context, energy efficiency can be considered as a Purpose, as a Principle and as an effect. This confusion may actually become a barrier to learning.

Changes in purpose or components or architecture normally imply a *modified* technology, but not a novel technology. A change in the base Principle by which the Purpose is achieved is a more seldom phenomenon and is a good candidate for a novel technology. A novel technology is then the one that achieves the same purpose by using a new or different base Principle than used before.

Sub-problems arise as a certain component piece becomes necessary in order to achieve a certain principle; or if a certain component piece is a pre-condition for a larger solution to follow. Each candidate principle brings up its own particular difficulties and these pose sub-problems. Principles are often borrowed, appropriated from other purposes or devices that use them. Anyhow principles can be arrived at from two ends: from a *need* or from a *phenomenon*, with the difference that a principle can be *sought from a need, but is suggested by the phenomenon.*

In projects there comes a moment of connection where the original Problem is connected with a principle – an effect in use – that can handle it. The solution tends to be appropriate, elegant and as simple as possible. Very seldom do projects in building arrive at that point, decisions being made very early during the process.

The process is *recursive:* it repeats until each problem (and sub-problem and sub-sub-problem) resolves itself into one that can be dealt with using existing components, locally at disposition. It further becomes a building-block, a multi-dimensional knowledge aimed at being used in future projects. What exactly are these *building blocks* used in projects? At a first look they are already existing technologies in the form of components, assemblies or methods and technologies. Conceptually, in the project agent's mind, they are thought of as *functionalities,* generic actions or operations that lie at hand in order to shape temporary hypotheses. But knowing functionalities is not enough. What is of most importance is knowing what is likely *not* to work, what methods to use, whom to talk to, what theories to look at, and "above all of how to manipulate phenomena that may be freshly discovered and poorly understood." (Arthur, 2006; Polanyi, 1967)

5. CONCLUSIONS

In energy efficient building projects what is sought is a base principle, the idea of some effect or a combination of effects, in action that will fulfil the requirements of the problem. Outcomes depend on the interactions between agents within the specific context of a project. "Next time I'll make it another way, I have much clearer ideas now, and I know exactly what a better and simpler solution is." But next time will be exactly the same. The subjective belief-model interacting with other agents' belief-models will adapt, change, co-evolve and make choices in that context, which once more will shape new belief-models worth using and to discard others. The co-evolutionary aspect of learning in projects is important. Each agent's subjective beliefs evolve and condition the evolution of the beliefs of others. Hence on closer examination the projects may highlight ambiguous attitudes in the formulation of the Purpose or of the basic technological Principle. At a first glance, many of the projects may show particular focus on the effect to fulfil. Some of them use advanced and expensive components, while others try to simplify the technical solutions and the choice of systems as much as possible. All the variables on play have interactive effects for the evolution of the projects, and as far as our experience goes, the fact that they are not exactly defined induces unusual conversational activities in the team, a pre-condition for learning (Wenger, 1998).

Problems of complication and ill-definition usually occur in projects. Actors struggle within new formulations of goals and their own experience, their understandings – the associations and meanings they have derived from their history of previous actions and experiences. Copying with standard problems of building, we can ignore this. In the larger issues of sustainable development and sustainable building, we cannot. We have to take cognition seriously.

The aim of developing the arguments above has been to show the logic that is encountered in project practices with variations from case to case and to provide a structure on which the analyses of the new demonstration projects for sustainable building practices can be made possible. It also contributes with some mental models or hypotheses (functionalities?) to be proved in the next stages of the research project.

6. REFERENCES

Arthur, W. B. (1994). Inductive reason and bounded Rationality (The El Farol Problem). *American Economic Review (*Papers and Proceedings) **84,** 406-411.

Arthur, W. B. (2000) Cognition: the Black Box of Economics. In Colander, D. ed, *The Complexity Vision and the Teaching of Economics.,* Northampton, Mass.

Arthur, W. B. (2007) The structure of invention. *Research Policy* **36,** 274-287 .

Bresnen, M., Goussevskaia, A. and Swan, J., (2005) Managing projects as complex social settings. *Building Research and Information,* **33**(6), 487-493.

Bijker, W. E. ed., (1987). *The Social Construction of Technological systems New Directions in the Sociology and History of Technology*, (MIT Press).

Bijker, W. E. and Law, J., (1992). *Shaping Technology, Building Society*. Massachusetts Institute of Technology Press.

Femenias, P. (2004), *Demonstration Projects for Sustainable building: Towards a Strategy for Sustainable Development in the Building Sector based on Swedish and Dutch Experience,* Chalmers University of Technology, Gothenburg, Sweden (Dis.)

Flyvbjerg, B. (2001), *Making Social Sciences Matter*. Cambridge University Press UK.

Gann, D. M. and Salter, A. J. (2000), Innovation in project-based, service-enhanced firms: the construction of complex products and systems. *Research Policy*, **29**, 955-972.

Koskinen, K. U., Pihlanto, P. and Vanharanta, H. (2003), Tacit knowledge acquisition and sharing in a project work context.. *International Journal of Project management*, **21** 281-290.

Lewin, K. (1946/48) *Action Research and minority problems.* In Lewin, G. W., *Resolving social conflicts.* New York, Harpers & Row.

Malterud, K. (1996) *Kvalitativa metoder i medicinsk forskning*. Studentlitteratur, Lund

Nässén, J. and Holmberg, J. (2005), Energy Efficiency – a forgotten goal in the Swedish Building sector? *Energy Policy* **33**, 1037-1051.
Polanyi, M. (1967) *The Tacit Dimension*, Anchor Books, New York USA .
Prencipe, A and Tell, F. (2001) Inter-project learning: processes and outcomes of knowledge codification in project-based firm. *Research Policy* **30**, 1373-1394.
Rubino, B. (2006) *Challenging problems for a new generation of demonstration projects.* Proceedings of the 6th International Postgraduate Research Conference in the Built and Human Environment, Delft, The Nederlands.
Rubino, B. (2006a) *"Pilotprojektet" Hamnhuset. Dokumentation och uppföljning av projekteringsprocessen.* Boverket/Chalmers, Göteborg, Sweden.
Sprei, F. (2007) *Challenges for end-use energy efficiency.* Chalmers, Göteborg, Sweden.
Wenger, E. (1998). *Communities of Practice. Learning, meaning and identity.* Cambridge University Press, New York USA.
Zollo, M and Winter, S. G. (2002), Deliberate learning and the evolution of dynamic capabilities. *Organizational Science,* **13**(3), 339-351.

ASPECTS OF STAKEHOLDER ENGAGEMENT IN THE PROPERTY DEVELOPMENT PROCESS

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ABSTRACT

There is uncertainty of how external factors will affect property development costs. Clarification and mapping of these external factors and how they impact the property development process is needed in order to gain insights into total development costs in the early stages of a project. The objective of the research reported in this paper is to understand the impact of external factors, for example stakeholders, in the property development process and to determine the extent to which they have influenced the project. The research is based on a case study consisting of two property development projects in south-west Sweden. The cases showed that the total direct impact would amount to 25% of the purchase price for the land. In addition, an indirect impact of about equal size due to delays in the process has to be considered. The total external impact, thus, amounts to 50-60% of the purchase price for the land. In the light of these findings, the paper concludes with a suggested strategy for future property development projects.

1. INTRODUCTION

In the early phases of a property development project there is uncertainty as to how the project will be affected by external factors such as stakeholder influence. In the municipal planning and development process there is the clear possibility for various stakeholders to affect project outcomes, which increases the risk of additional costs to the project. There is, therefore, a need to understand this process better and to clarify the costs that it brings in order for property developers to gain knowledge of the total costs of a development.

The research aims at defining the costs that arise from the impact of external factors in the planning and development process leading up to final approval by local authorities. The research has a focus on the direct costs resulting in real payments. However, the indirect costs in the form of internal interest rates and delayed revenues are also discussed. This paper has the aim of discussing two approaches to the engagement of external stakeholders and from that to suggest an appropriate strategy for similar development projects in the future.

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2. LITERATURE REVIEW

2.1 Stakeholder theory

Freeman (1984) describes the concept of stakeholders as any group or individual who can affect, or is affected by, the achievement of a corporation's purpose. This definition is a development of the first stakeholder definition, which Freeman (1984) had traced back to a memo from Stanford Research Institute in 1963. The memo states that stakeholders are those groups without whose support the organisation would cease to exist. In conclusion, Freeman (1984) states that the stakeholder approach is about groups and individuals who can affect the organisation, and is about managerial behaviour taken in response to those groups and individuals. Phillips (2003) adds that stakeholder theory should be concerned with who has input in decision making as well as who benefits from the outcomes of such decision. Thus, for property development projects, it is the responsibility of the project manager to respond to the needs and expectations addressed by the project's stakeholders and to be concerned with how the decision making process is carried out.

There has been debate on how to define stakeholders. Freeman's (1984) definition, those that affect or are affected, is viewed as being broad, because it merits all to be stakeholders. If everyone is a stakeholder of everyone else there is little value-added in the use of the stakeholder concept (Phillips 2003, Sternberg 1997 and Mitchell et al. 1997). The view expressed in the Stanford definition – those without whose support the organisation would cease to exist – is regarded as narrow since relevant groups would be excluded. Post et al (2002) state that the fundamental idea is for stakeholders to have a stake in the organisation, and they define the stakeholders as those that contribute voluntarily or involuntarily to the organisation's wealth creating capacity and activities: they are, therefore, its potential beneficiaries and/or risk bearers. Donaldson and Preston (1995) identify stakeholders through the potential harms and benefits that they experience or anticipate experiencing as a result of the organisation's actions or inactions. In the early stages of a property development project the most influential stakeholders, apart from the developer, are the municipality and those members of the public who consider themselves to be affected by a development (Olander and Landin 2005, and Olander 2007).

2.2 The planning process and development agreements

The planning process is about setting frameworks and principles in order to guide the location of development and infrastructure (Healey et al., 1999). It involves rules and regulations giving certain groups or individuals the right to use land and provides authorities with the means to exert their influence on land use (Larsson, 1997). The planning process includes local and national policies, rules and regulations and planning traditions. The key resource in a property development process is land and the central role is exercised by the land owner (Verhage 2002, Barker, 2003). There is a delicate balance between public activities, for instance, the control of land use and the right of landowners to develop land according to their own wishes (Larsson, 1997).

In the Swedish planning process, the municipalities have, by law, significant control of land development within their municipality. It is the municipalities that exclusively decide which property developments to approve and can with a development agreement control the outcome of such developments. Additionally, vague rules and legislations concerning the planning process and development agreements adds to the uncertainty perceived by property developers (Riksdagens revisorer 2001, Olander 2005). The risk is that the municipality uses its advantage in the process to force the developer into an unbalanced development agreement (Kalbro 2002) that adds costs to the property development.

The development agreement is the municipal tool for controlling land use within its borders. It regulates issues about purchase of land (if the municipality is the present land owner), type of facilities to develop, time frames, responsibilities for public streets and green spaces etc. The development agreement is made within boundaries of civil law (Miller 1993, Sohtell and Sundell 1993). Thus, the development agreement is basically dependent upon the respective bargaining positions of the developer and the municipality. At the signing of a development agreement there can be two situations; one is that the municipality is in need of a particular development and may be willing to take a larger economic responsibility for it. In cases where the developer is initiating the development, the municipality may consider itself to have a stronger position and may place tougher economic responsibilities on the developer (Wedegren 1997)

Barker (2004) argues that a more effective planning process would be characterised by a decision making process that considers the wider costs and benefits of the proposed development in response to market signals. The importance of information and communication in the planning process and how the different intervening stakeholders (e.g. property developers, planners, local authorities and the public) may use or perceive it should not be neglected (Silva, 2002). The extent to which developers perceive different aspects of the planning process, rightly or wrongly, may have an effect on their decision to engage in new property developments (Olander 2005, Olander 2006).

2.3 Perspectives of the planning process

Planning policy can be interpreted and implemented differently in response to local circumstances (Midgley, 2000). Planning authorities and their policies set the framework within which a development takes place (Verhage, 2002), within the limits of national laws concerning the development of the built environment. At the local level, the planning process may adopt different approaches to new development. Some authorities wish to limit new development, whilst others may welcome almost any development (Monk and Whitehead, 1999).

Designated land use through the planning process is one constraint, among others, on land supply (Barker, 2003). The planning process is complex and timescales are often seen as unacceptably long and the requirements of planning can be used to prevent development (Barker, 2004). This process influences the amount of land that is made available and is one reason for high development costs. The planning process has reduced its focus on integrated planning, concentrating instead on promotion and the development of separate projects (Healey et al. 1999, Khakee and Barbanente, 2003), which forces housing developers to have a more or less developed project with resources already bound in land acquisition and design before the planning process can begin.

Developers face a range of significant market and planning risks. These result in a sector that is reluctant to invest over the longer term (Barker, 2004). The level of uncertainty in the planning process increases the level of risk for developers (Barlow, 1993). This uncertainty can act as a constraint for new organisations wishing to engage in housing development, because they do not have the economic strength to endure a long and uncertain planning process. The active role of stakeholders in the planning process can, in some situations, become an adversarial process where conflict arises between different stakeholder interests (Olander and Landin, 2005). This adds to the uncertainty housing developers might already experience from the process.

2.4 Other aspects

In recent years, there has been a debate in Sweden about how the planning process affects the property development process (Henecke, 2006, Henecke and Olander, 2003, Boverket, 2002, and Riksdagens revisorer, 2001). When land supply is locally regulated, lobbying for and against a development becomes more extreme and easier to organise (Barlow, 1993). Furthermore, the local political framework is more prone to pressure from special interest groups. In Sweden, the potential resistance from locally-based special interests has been highlighted as one problem facing the planning process for new developments. However, there is also a view that the handling of locally-based special interests is an integral part of a democratic planning process. Thus, there is a balance between a time and cost efficient land development process and a democratic process of influence from locally-affected stakeholders (Henecke, 2006) that needs to be addressed by planners as well as developers.

3. RESEARCH PROJECT

3.1 Project description and objectives

The research is based on a case study consisting of two property development projects in south west Sweden. In each project, documents have been studied and interviews with stakeholders have been carried out. The study is limited to direct costs visible in documents and to the early stages of the property development process up to the final approval of the project by the municipality. Additionally, the length of this process has been studied, enabling a discussion on the indirect costs that internal rates of return and delayed revenues would bring.

3.2 Research methodology

The purpose of this research is to map the type of effects, and the costs that they bring, found in the property development process. The case study approach was chosen as a research method in order to obtain in-depth knowledge of external impacts in the process. The purpose has not been to create a model for analysing the external impacts, but rather to gain an understanding of them in a way that could eventually be utlised in further studies.

A questionnaire survey could have been an alternative method for obtaining the relevant information. The benefits of choosing this method would have been the opportunity to obtain information and knowledge from a multitude of property developers and projects. The chosen research method (i.e. case study) describes the qualitative phenomenon of external impacts in the property development process. The results and analysis of the case study research presented here could, however, be a baseline for the design of a questionnaire for a more comprehensive study of these impacts and how property developers react to them.

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin 1994). Case studies can be either quantitative or qualitative; in the present research, a qualitative approach was chosen. A qualitative case study focuses on matters of insight, discovery and interpretation rather than testing a hypothesis. A qualitative case study can be defined as an intensive analysis of a single phenomenon, at the same time as the whole is under scrutiny (Merriam 1994).

The case study consists of two projects in south west Sweden: both are located in expansive communities. The projects, Västra Hamnporten in Malmö and Lomma Hamn in Lomma, are relatively similar considering size and location and are developments in areas close to the sea. They are considered attractive for both residential and commercial users. A criterion of choice was that final approval of the chosen projects was not more than two years in order to ensure that the information gathered from documents and interviews was reasonably up-to-date.

The main similarity in the projects, described below, is that they are large developments in centrally-located harbour areas. Both areas are no longer used for their original purpose; instead, they are being developed into residential and commercial areas where the selected projects are part of a larger development. There are, however, some differences. The municipalities, Malmö and Lomma, are different in size and have thus not the same organisational resources. On the other hand, the smaller municipality, Lomma, does not have as many development projects as Malmö, which enables it to focus harder on the ones they have. Their respective property development companies, JM and Midroc Property Development, are also different in terms of size, resources and number of ongoing projects.

3.3 Project 1, Lomma Hamn

Lomma is a medium sized municipality of about 18,000 inhabitants with good communications to the central areas in the region, mainly Lund and Malmö. Lomma Hamn is an entirely new town district and will increase the population of Lomma by 3,000. The development consists of housing, commercial and public buildings that require completely new infrastructure in terms of roads, water supply and sewage system. The former use of the property was mainly industrial. Until 1977, there was a factory producing asbestos cement, which was closed after health risks were identified.

The part of the development that is the subject of this study is owned by JM. In addition, two development areas are owned by other developers. The property studied here consists of about 43,000 square metres (gross floor area) and 330 dwellings, and there may be an opportunity to combine these with commercial areas. The following specific conditions for the project were identified.

- There was a project team assigned by the municipality with the aim of coordinating the concerns of the developer with those of the municipality.

- One developer, JM, has taken the entire financial risk of providing infrastructure for the new town district.
- There were delays in the project due to appeals of the municipal decision to approve the proposed development.

3.4 Project 2, Västra hamnporten, Malmö

The municipality of Malmö is the third largest in Sweden with nearly 300,000 inhabitants. The development studied here is a part of the development area that consists of Västra Hamnen (Bo01), Turning Torso and Dockan. The entire area was formerly used for industrial purposes, and the proposed development consists of dwellings, hotels and offices totalling 42,300 square metres (gross floor area). The property is owned by the developer, Midroc Property Development, and the following specific conditions for the project were identified:

- There have been many changes in the proposed development due to additional evaluations and shifts in market conditions.
- The position as a key property in an expansive area has contributed to the municipality's interest in the size, shape and design of the development.
- The property is located at the main entrance to the development area of Västra Hamnen and Dockan, and has resulted in increased costs for infrastructure.

3.5 Data gathering

The empirical data consist of project documents and interviews. The former were invoices covering costs that have affected the project budget and public documents concerning planning and development agreements. The interviewees were project developers, project managers and municipal planning officials. A total of nine semi-structured interviews were undertaking covering subjects such as project implementation and perceptions of the public planning and development process. Analysis and evaluation of the empirical data have provided an in-depth insight into the projects and external impacts upon them.

4. RESEARCH RESULTS AND INDUSTRIAL IMPACT

4.1 Results

The external impact can be divided into direct and indirect. The direct impact is mainly those commitments, which the property developer agrees to undertake when signing the development agreement with the municipality. In the two projects, direct impact can be described as follows.

- Transfer of land within and outside the proposed development from the property developer to the municipality without monetary compensation.
- Responsibility for decontamination and preparation of the land and adjacent properties.
- The construction of roads and other public facilities outside the proposed development.

- Parts of the proposed development are to be reserved for the purpose of social services (e.g. child care and schools) without monetary compensation.

In addition, costs have arisen in the planning process from further investigations and evaluations demanded by the municipalities.

The total direct costs related to external impacts for project 1 were 22 MSEK[11], and 14 MSEK for project 2. Both projects have planned gross floor areas of about 43,000 square metres. Some of the costs for project 1 arose from a more thorough analysis early in the planning process. In both projects the developers have been willing to accept the costs of providing public facilities because of the promising forecast for future revenues.

The direct impact in relation to the total investment for these projects is about 2%, which in one sense could be seen as reasonable. However if the costs are instead related to the purchase price for the land it amounts to 25%. This indicates that a property developer will need to cover substantial additional costs before a purchased piece of land can be developed.

Another important aspect is the impact of the length of the planning process on indirect costs. In both projects there have been substantial, additional evaluations, which have prolonged the planning process. The developers assess, in addition, that the planning process has been delayed by one year due to ineffective municipal management. For both projects the total time of the planning process amounts to 4.5 years compared with a normal period of 1.5-3.5 years: this will cause indirect costs.

If an internal rate of return is reasonably assumed to be 7% the indirect cost due to the binding of capital in the purchase of land will amount to approximately 25 MSEK for project 1 and 18 MSEK for project 2. If the delay in the planning process in relation to a normal length is assumed to be 2 years and the revenue is assumed to be 1,000 SEK per square metre (gross floor area) the indirect costs due to delayed revenues will be, for both projects, 8.6 MSEK. These figures should be viewed as examples of possible indirect costs based on assumptions of future revenues and rates of return. However, it shows that if these indirect impacts are added to the direct impact the total external impact will amount to 50-60% of the purchase price for the land. This indicates that the hidden cost of binding capital is the considerable part of the external impact and due mainly to a prolonged planning process.

4.2 Implementation and exploitation

This study should be seen as a baseline for future studies. It shows that the external impact on a new property development will mean substantial costs, both directly and indirectly. This will be an obstacle for small companies wishing to engage in property development, which can contribute to weaker competitiveness, because of the substantial organisational and financial resources needed to manage the uncertainty and bear the costs that will arise in the process.

[11] Swedish crowns

5. CONCLUSIONS

The external development costs identified in the study are not entirely unreasonable for the developer to accept. Several of them are necessary for the accomplishment of the project and for securing acceptable quality in the proposed development. However, the uncertainty of which external impacts, and the costs related to them, that will occur in the planning process and in the development agreements are relevant barriers to consider when purchasing land for a development. Clear regulations and policies are necessary in order to estimate the duration of the planning process and the costs likely to be incurred over that time.

The municipality, as the representative of the community, has an interest in the quality of property development. The management of the planning process can be improved by enhancing the early planning stages and by identifying the central issues that should be a part of the property development process. The enhancement of the early planning stages should give the municipality and the developer common ground for future decision-making in the process. These actions should decrease the uncertainty related to external impacts in the planning process.

A monopolistic position for the municipality means that it is a strong player in the planning process with the power to decide what is reasonable in each project. A signed development agreement is a condition for final approval of a proposed development, which often makes the developer the weaker partner when negotiating the conditions of the development. The developer needs to have a clear understanding of the influence that various stakeholders will have on the project. The municipality is one of the major stakeholders to consider and can, if the relationship is sufficiently well managed, be a positive force in property development rather than a constraint.

6. REFERENCES

Barker, K. (2003) *Review of Housing Supply, Securing our Future Housing Needs, Interim Report – Analysis.* London: HM Treasury.

Barker, K. (2004) *Review of Housing Supply, Delivering Stability: Securing our Future Housing Needs, Final Report – Recommendations,* London: HM Treasury.

Barlow, J. (1993) Controlling the Housing Land Market: Some Examples from Europe, *Urban Studies,* **30**(7), 1129-1149.

Boverket [National Boards of Housing, Building and Planning] (2002) *Bostadsbyggandet i planeringen [Production of housing and the planning process]*, Karlskrona: Boverket

Donaldson, T. and Preston, L. (1995) The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications. *The Academy of Management Review*, **20**(1), 65-91.

Freeman, R.E. (1984) *Strategic Management – A Stakeholder Approach*, Marshfield, Massachusetts: Pitman Publishing Inc.

Healy, P. Khakee, A. Motte, A. and Needham, B. (1999) European Developments in Strategic Spatial Planning. *European Planning Studies*, **7**(3), 339-355.

Henecke, B. (2006) *Plan och protest, en sociologisk studie av kontroverser, demokrati och makt i den fysiska planeringen [Plan and protest, a sociological study of controversies, democracy and power in the planning process]*. Lund: Department of Sociology, Lund University

Henecke, B. and Olander, S. (2003) *Missnöjda medborgares säkerhetsventil, en studie av överklagade detaljplaner [The safety valve of dissatisfied citizens, a study of appealed detailed community plans]*. Lund: Construction Management and Department of Sociology, Lund University

Kalbro, T. (2002) *Rättsliga begränsningar för exploateringsavtal – en sammanfattning [Legal limitations för development agreements – a summary].* Stockholm: Royal Institute of Technology.

Khakee, A. and Barbanente, A. (2003) Negotiative Land-use and Deliberative Environmental Planning in Italy and Sweden, *International Planning Studies,* **8**(3), 181-200.

Larsson, G. (1997) *Land management, public policy, control and participation.* Stockholm: The Swedish Council for Building Research.

Merriam, S.B. (1994) *Fallstudien som forskningsmetod,* Translation by Nilsson, B. *[Original title: Case Study Research in education].* Lund:.Studentlitteratur.

Midgley, J. (2000) Exploring Alternative Methodologies to Establish the Effects of Land Area Designation in Development Control Decisions. *Planning Practice & Research*, **15**(4), 319-333.

Miller, T. (1993) *Genomföandeavtal i exploateringsprocessen [Public implementation agreements in the property development process].* Karlskrona: Boverket

Mitchell, R. K. Bradley, R.A. and Wood, D. J. (1997) Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts. *The Academy of Management Review*, **22**(4), 853-885.

Monk, S. and Whitehead, C.M.E. (1999) Evaluating the economic impact of planning controls in the United Kingdom: Some implications for housing. *Land Economics,* **75**(1), 74-94.

Olander, S. (2005) *Planprocessen, ett hinder för nyproduktion av bostäder [The planning process, an obstacle for the production of new housing].* Lund: Construction Management, Lund University.

Olander, S. (2006) *External Stakeholder Analysis in Construction Project Management.* Lund: Construction Management, Lund University.

Olander, S. (2007) Stakeholder impact analysis in construction project management, *Construction Management and Economics,* **25**(3), 277-287.

Olander, S. and Landin, A. (2005) Evaluation of stakeholder influence in the implementation of construction projects, *International Journal of Project Management,* **23**(4), 321-328.

Phillips, R. (2003) *Stakeholder Theory and Organizational Ethics*, , San Francisco, California: Berrett-Koehler Publishers Inc.

Post, J.E. Preston,L.E. and Sachs, S. (2002*) Redefining the Corporation – Stakeholder Management and Organizational Wealth*, Stanford, California: Stanford University Press.

Riksdagens revisorer [Auditors of the parliament] (2001) *Rapport 2000/01:14 Plan- och byggprocessens längd [Report 2000/01:14 The length of the planning and building process]*. Stockholm: Swedish Parliament.

Silva, A.S. (2002) Indecision Factors when Planning for Land Use Change, *European Planning Studies,* **10**(3), 335-358.

Sohtell, B. and Sundell, U. (1993) *Genomförandeavtal – inriktning mot ekonomiska regeleringar LMV rapport 1993:13 [Public implementationagreement- emphasis on ecenomic regulations LMV report 1993:13].* Gävle: Lantmäteriet.

Sternberg, E. (1997) The Defects of Stakeholder Theory. *Corporate Governance: An International Review*, **5**(1), 3-9.

Wedegren, T. (1997) *Exploateringsavtal [Property development agreements].* Stockholm: Faculty of Law, Stockholm University.

Verhage, R. (2002) *Local Policy for Housing Development, European experiences.* Aldershot: Ashgate Publishing Company.
Yin, R.K. (1994) *Case Study Research – Design and Methods,* Applied Social Research Methods Series, **5**. London: Sage Publications.

CLIENTS AS INITIATORS OF CHANGE – THE NEED FOR PROBLEM DEFINITION IN THE EARLY STAGE OF THE CONSTRUCTION PROCESS

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ABSTRACT

The construction industry has for a long time received criticism regarding relationship-related issues such as harmful conflicts and disputes, poor collaboration and lack of customer focus and end user involvement. Researchers, practitioners and, perhaps foremost, society as a whole have therefore called for various changes in attitudes, behaviour and tools and techniques used during the construction process as way of increasing the chances of project success and an improved end product. The most important actor in such changes is often argued to be the client, who should initiate and lead change efforts through suitable procurement procedures and management processes. The context for the decision process in the early stage of the construction process is called briefing. The aim of briefing is to define the operational demands and support the development of the business process. Since the early stage of the construction process defines the mission of the project, the client should therefore scrutinise the present situation in order to correct potential difficulties for the project. The results from this study show that lack of integration of the different stakeholders (customers, owners, society and construction sector) can be an obstacle for construction clients wishing to act as change agents.

1. INTRODUCTION

The construction industry has been criticized for a long time regarding relationship related issues such as harmful conflicts and disputes, poor collaboration, and lack of customer focus and end user involvement (Latham, 1994, Egan, 1998, Ericsson and Johansson, 1994). Researchers, practitioners and society as a whole therefore argue that various changes in attitudes, behaviour and procedures used during the construction process are required in order to increase the chance for project success and an improved end product (Love et al., 2000, Dubois and Gadde, 2002). Two major investigations of the Swedish construction industry pinpoint the role of the construction client as a "driver" for change in the industry (2002:115., 2002, 2000:44, 2000). This is because construction clients have a key position regarding choice of procurement methods and management processes. Clients set the basis for the governance of construction projects. According to the Swedish Planning and Building Act (PBL 1995), a construction client is:

> *"A party who carries out or assigns others to carry out construction, demolition or land work."*

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A further development of this definition is made by the Swedish Association for Construction Clients. Their definition develops the construction clients' responsibility further:

> *"The construction client is also responsible for interpreting and translating the users' needs, expectations and desires into requirements and prerequisites for the construction project based on society's need for a sustainable built environment."*

It is the construction client who is responsible for ensuring that all of the requirements from owners, customers and society are met in a construction project from concept to implementation. It is the construction client that purchases products and services from the construction sector, steers the entire construction process, and thereby also creates the conditions for the use and management of the building or facility over a long period of use.

Since construction is a complex, multi-actor business where many actors come and go in the process, initiatives from one actor may not result in changes in all other actors' behaviour and procedures. A change process, however, needs a clear definition of the present situation (problem formulation), that is shared among the participants in the process (i.e. it needs broad participation) (Borgbrant, 1990, Kotter, 1995, Tichy, 1983) in order to form visions and goals.

The construction process is carried out in a temporary organisation for practical reasons. Even if two exactly similar buildings are produced in different places, in different times and by different organisations, the construction process can become a unique process (Kadefors, 1997). This kind of project also becomes a venue for different experiences, interests, norms and ways of doing things: it becomes a scene for different organisation processes (Sahlin-Andersson, 1989).

The purpose of this paper is to investigate how construction clients handle the transformation of requirements in the early stage of the construction process in order to contribute to change in the construction process. Since the early stage of the construction process defines the mission of the project, the client should therefore scrutinise the present situation in order to correct formulate missions for the project (Ryd, 2003).

2. LITERATURE REVIEW

In this brief literature review potential relevant decision factors are examined. The literature review begins with a presentation of the main areas for the client to handle in the construction process.

2.1 Areas of need for the construction client

The decision process in the early stage of the construction process is crucial for the client. It is there that clients intentions for the project are defined (Ryd, 2003). There are four main areas: customer, owner, society and construction sector, for the client to handle throughout the construction process (Johannson and Svedinger, 1997) in order to get the best result.

The *owner* determines the *values* and *economic* demands to which the client has to relate. They can be formulated in *goals* and *visions* for the organisation that the client belongs to (Johannson and Svedinger, 1997, Ljung, 1998).

Society affects clients' decisions by virtue of *laws*, *regulations* and *opinions* (Cassel and Hjelmfeldt, 2001, Johannson and Svedinger, 1997). The restrictions and rights over the property are crucial for clients to recognise (Carn et al., 1998). Environmental regulation offers a strong opportunity for opinions to be turned into actions against construction projects.

The clients' relation to the *customer/user* concerns the knowledge of the customer/end user *needs* (both known and unknown customer/user). In order to provide sufficient requirements, the client should understand the customers/users *desire, needs* and *economic* condition (Johannson and Svedinger, 1997). The client must consider how the customer's/user's *market situation* looks like when dealing with unknown customer/user.

There are, nevertheless, limitations in customer orientation. The existing *resources*, *environmental considerations* and *technical conditions* are physical limitations on the customer orientation (Gerdemark, 2000). There is a balance between *construction*, *maintenance* and *economy* in the decision process for the client (Engwall, 2001).

The *construction sector* is concerned with the integration of all actors that are involved in the construction process. The organisations to which the different actors belong have different material and personnel resources and different values and norms. It is the organisation that the actor belongs to that creates the limits for how they think and proceed in the construction process. This influences the end result of the process (Ericsson and Johansson, 1994). Members of a temporary organisation tend to found their actions on their mother organisation's belief (Josephsson, 1994). Clients must also handle the legal relationships with the actors (Johannson and Svedinger, 1997).

2.2 The briefing process

The context for the decision process in the early stage of the construction process is called briefing. The aim of the briefing process is to define the operational demands and support the development of the business process.

A decision process is to be seen as a rational process where the decision maker has all the information needed. A rational decision making presupposes though that there are no uncertainties and indistinctness in the decision process. Uncertainty and indistinctness in decision situations create a limitation on the rationality (March, 1994, Simon, 1957). According to March (1994), decision makers normally take few alternatives into consideration and look at them sequentially rather than simultaneously.

The decision process comprises two important dimensions, the apprehension between cause/effect and preferences about conceivable outcomes (figure 1).

		Preferences about conceivable outcomes	
		Certainty	Uncertainty
Apprehension between cause/effect	Certainty	Well-structured decisions	Compromise decision
	Uncertainty	Appraisal decision	Ill-structured decisions

Figure 1. Types of decision problem (Thompson, 1967)

The difference between well-structured and ill-structured decisions is that well-structured decisions are repetitive and perfunctory. Ill-structured decisions are, on the other hand, unique and demand more scrutiny of the mapping of alternative and influencing factors (Gareth, 1995, Thompson, 1967, Simon, 1957). Well-structured decisions can be based on fact and can be proven if they are true or false. Ill-structured decisions, however, can only declare a wanted-situation (bör-läge) and lead to selection of a final objective. According to (Ekman, 1970), the well-structured decision can be characterised as an action-decision and the ill-structured decision as a goal-decision.

The briefing process is divided into two stages according to (Ryd, 2001): strategic briefing and operative briefing. The strategic briefing concerns the business related issues, the core business. The operative briefing relates to delivering the “technical project” (Yu et al., 2006). The focus lies in many cases on the operational briefing because the information processed there is more familiar to the construction professionals and so they can rely on their experience (Barrett, 1999).

The process of capturing operational needs is divided into four steps: goal formulation, operational needs, analysis of operational needs and, finally, formulation of the products portrayal (Fristedt and Ryd, 2003). The initiation of the briefing process concerns the strategic issues of the organisations and is often neglected. Depending on if the client organisation is “unitary” or “pluralistic” the briefing process must underpin more or less sophisticated processes to create common understanding of the “problem” to solve (Green, 1996). The briefing process should be seen as a social process based on iteration and learning instead of a straightforward technical process of problem-solving. According to (Katz and Kahn, 1978), a “problem” can be solved by previous knowledge of a similar problem. But if the “problem” instead has the characteristic of a “dilemma”, where all alternatives have a negative outcome, there needs to be a new formulation of the problem.

In order to handle insecurity, organisations usually create an administrative structure where the problem area divides into different areas of decisions (Axelsson, 1981, Simon, 1957). The need for information and structure increases with higher grades of non-programming in the nature of the decision (March and Simon, 1993). Organisations can also have interest in the environment that affects the organisation’s decision by exposing the organisation to information (Katz and Kahn, 1978). The information that the organisation collects is usually used to confirm decisions made already, instead of being a base for decisions to make (March, 1998). Decision makers search for information but they see what they expect to see. Individuals are especially prone to forming expectations about the future, based on known empirical connection and information about the present situation (Simon, 1957). The knowledge acquired by the client in the early stage of the construction process is more tacit than explicit and needs systems to handle it (Winch, 2002).

2.3 The role of the change agent

Managing change is important, but to lead change is crucial (Kotter, 1995). The action needed to alter behaviour requires leadership. A change process needs a clear vision and a strategy that is based on a thorough examination of the present situation. According to (Kotter, 1995), there is a difference between management and leadership – see table 1.

Table 1. The difference between management and leadership

Management	**Leadership**
Planning and budgeting	Establishing direction
Organising and staffing	Aligning people
Controlling and problem solving	Motivating and inspiring

Management creates a certain degree of predictability and order, but leadership creates an environment that supports and facilitates change (Kotter, 1995). Katz and Kahn (1978) define leadership thus:

> *"Any act of influence on a matter of organisational relevance"*

The essence of leadership has to do with influential increment which goes beyond routines. Leadership taps bases of power like reference power and expert power[13].

In order to get a specific change to occur, the new ideas must diffuse to the recipients and they have to adopt them. The social and communication structure of a system facilitates or impedes the diffusion of change in the system. Change agents usually introduce change into a recipient system. The success of the effort to secure the adoption of a wanted change is related to the change agent's effort in contacting the recipients (Rogers, 2003).

3. RESEARCH PROJECT

This research project is dealing with the transformation of requirements in the early stage of the construction process. In this stage of the process, clients must define the product. At the same time, clients need to consider all stakeholder expectations. This part of the construction process is also crucial if clients want to act as a change agent, since most of the strategic choices are made at this point.

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[13] According to Katz & Kahn (1978) reference power depends on personal liking between leader and follower. Expert power depends on the knowledge and ability of the leader.

3.1 Project description and objectives

The purpose of this paper is to investigate how the construction client handles the decision process in the early stage of the process. Since the early stage of the process defines the mission of the project, the client should therefore scrutinise the present situation in order to correctly formulate missions for the project (Ryd, 2003). The main question to be answered is: how construction clients can contribute to change in the construction process?

3.2 Research methodology

The empirical evidence in this study was collected through interviews. The interview approach was selected because the researcher was interested not only in *how* (normative decisions) decisions were made, but also *why* and *what* (descriptive decisions). The empirical material in the main study was collected through interviews with six clients within different organisations (table 2). The criteria for the selection of respondents were that they all were professional clients in the sense that they are almost constantly involved in the construction process.

Table 2. Interview sample

Typ of company	Geografical distribution	Respondent
Private	Local	Owner
Private	Local	Manager
Private	Regional	Manager
Own by public	Local	Manager
Own by public	Local	Manager
Public organisation	Regional	Manager

The interviews were conducted in three steps, with both quantitative and qualitative data (see table 3).

Table 3. Interviews

	Quantitative data	**Qualitative data**
Interview 1	Grading of most influencing factors	How the graded factors influenced the client's decision
Interview 2	Grading of first examined factors	How the graded factors influenced the client's decision
Interview 3		Basic data for decision-making regarding the six most important factors

During the interviews the respondents graded the factors from 10 = most important to 1 = least important. The area of *construction sector* was not graded by the respondents. This was covered by qualitative questions and is presented below. For each of the factors within the areas, owner, society and customer, there were several keywords representing each factor. In total, the questionnaire had 20 keywords for the respondents to grade.

In order to complete the decision process a pre-study was conducted where interviews were conducted with 12 consultants (architects, technical consultants and project managers) normally involved in the early stage of the construction process. They were selected from both large and small companies and had a local and national geographical distribution.

3.3 Results from the interviews

The result from the pre-study showed that the clients had difficulties in formulating their demands and criteria for the end result of the process. This can indicate that clients do not have a good base for decisions in the early stage of the construction process. The consultants also felt that the clients had more or less transferred the client's role to external project managers and they (the clients) were not present in the construction process.

The empirical results from the main study are shown in table 4. The graded factors from interviews 1 and 2 are weighted together.

Table 4. Graded factors

Owner	Economical demands	7,4	6,8
	Goals	6,1	
Society	Opinion	4,8	6,1
	Laws	5,9	
	Regulations	7,7	
Customer	Solvency	8,6	8,4
	Customers demands	9,0	
	Market situation	7,5	

The results show that the respondents considered the customer area as most influencing the decisions in the early stage of the construction process. Second comes the owners' perspective and, third, demands from society.

In this study, there are two main clients: private and public. Table 5 shows the difference in grading between these two groups.

Table 5. Graded factors from different organisations

Privat organisaitons

Owner	Economical demands	7,8	6,5
	Goals	5,2	
Society	Opinion	5,2	5,7
	Laws	3,2	
	Regulations	8,7	
Customer	Solvency	8,5	7,8
	Customer demands	8,2	
	Market situation	6,8	

Public organisations

Owner	Economical demands	7,0	7,0
	Goals	7,0	
Society	Opinion	6,4	7,0
	Laws	7,8	
	Regulation	6,8	
Customer	Solvency	8,6	8,9
	Customers demands	9,9	
	Market situation	8,3	

The public organisations had slightly higher grading on customer area, owner area and much higher grading of the society area, as affecting their decision. To further understand the process and how decisions are made, each of the areas is presented with the result from the qualitative interviews.

3.4 Relation to the owner

In order to confirm the economic demands from the owner, several cost estimates were used as a tool through the process. From the beginning, the cost estimates were in broad outlines and they become more detailed further down the process. Normally, the cost estimate was based on demands from the owner regarding rate and payback time. There were different approaches to how they handled the cost estimates in the organisations, depending on the uncertainty of the projects. In some cases, the respondents even used two separate consultants to calculate the cost in order to get as accurate a result as possible. What all of the respondents agreed on was that it was difficult to get the cost estimate right. This factor had a strong relation to the factor *market situation*. If the cost estimate showed too high a cost (and therefore resulted in too high rents) the projects had be re-estimated or rejected. This area has a connection to the area customer/user needs too, if the economic demands from the owner do not match the state of the market and the rent level that is possible is too low.

The owners' value was measured in this inquiry by how clear and consistent the organisations' business concepts were. There was a large discrepancy between the different organisations. It was only the private organisation with the regional geographic distribution that had a clear strategy for its action. The smaller local organisations rather saw opportunities and reacted on that. The public organisation had a more diffuse business concept (rather a description for action), but it had a higher grading for the owner's perspective in its decision.

3.5 Relation to society

The area of society represents laws and regulations concerning the construction sector. To this area belongs the factor opinion. The public organisations had a higher grading for this area. They related the area to their responsibility to society for their organisations. For the private organisations, the area was not that influential on their decisions. All of the respondents said that they always communicated with the authorities regarding building permissions and other matters related to laws and regulations, irrespective of whether or not the project needed permission. They were all very keen that their projects were correct.

There is a connection between the area of society, customer and owner. The owner's interest and the customer's/users' needs can be the opposite to what the regulations for buildings require.

3.6 Relation to the customer

This area had the highest grading in this study, for both organisations. The public organisations had, however, higher mean values for this area. All of the respondents regarded customer/user needs as important input in the early stage of the construction process. There was though a discrepancy in how they handled the confirmation of customer/user needs in the early stage of the construction process. If they had a known customer/user (a specific customer), the customer was involved in the process directly. For clients with an unknown customer/user (for example, in the building of apartments) they used their experience to decide on the concept.

The relationship with the customer is characterized by how clearly the customer was aware of what they needed. The handling of customer/users needs was problematic according to the respondents. Mostly, they felt that customers/users had difficulties in expressing their needs and they had problems to understand the way the construction process is conducted.

One question during the interviews dealt with the concept "customer" and which views they and their organisation held. The respondents viewed customers as part of two main groups: professional and unprofessional. The unprofessional customer had to be led through the process by clients asking the right questions in order to define their needs. In some cases the customers/users had too great expectations of the construction process and the cost to achieve their needs.

3.7 Relation to the construction sector

This area deals with the integration of all actors that are involved in the construction process. Throughout the interviews the respondents were asked which actors were involved in the process and what their contribution was. Normally, there were architects involved in the early stage of the process and in some cases other consultants that dealt with the cost estimate. The view from the respondents for the reason to bring in other competences was mostly a question of time: they did not have the time to do the work themselves. Mostly, the clients used their own organisation to process the necessary basic data for decision making. It was mainly in the technical area they used external competence.

In this area, the respondents discussed the market situation and the economic risk with the customers/users business. The respondents revealed that there is constraint between the customer/users need and cost for the project. Construction cost that leads to rent levels that do not match the customer/user means or the owners' economic demands would frustrate the entire process.

4. CONCLUSIONS

The purpose of this paper was to investigate how construction clients handle the transformation of requirements in the early stage of the construction process, in order to contribute to change in the construction process. The empirical evidence shows that four areas (customer, society, owner and construction sector) have different impacts on clients' decisions in the early stage of the construction process (table 6).

Table 6. The area's impact on clients' decisions

Area	**Impact on decision**	**Tension**	**Obstacle for change**
Owner	Medium graded, Large impact	Unclear value from owner, Public organisations higher grading but diffuse demands from the owner. Cost as evidence base	Focus on cost, low on goal, mission and value
Society	Low graded, High impact	Clear demands, more tension for public client (opinion)	Low impact on change
Customer	High graded, Large impact	Discrepancy in evidence base; problem to formulate needs (inexperienced customer), experience from client as evidence base	Focus on cost, low on integration of demands
Construction sector	(No grading)	Low participation; low faith of knowledge contribution	Focus on controlling and problem solving

The tensions between the different areas during the briefing stage indicate that the process has the characteristic of ill-structure decisions. The approach from the clients, however, was to treat the decision process as more well-structured. The lack of systematic inquiry in the briefing stage of the construction process decreases the possibility for clients to initiate a change process. The change process needs a clear objective and vision that is shared between the participants in the process. The lack of involvement of other participants is a barrier that clients should consider if they are to act as change agents.

The area of construction sector relates to the coordination and use of the actors in the construction process. The view from the respondents of what kind of competence the actors provide to the process differs. Mostly, they revealed that they used external competence due to lack of time in the own organisation to handle the issue. To increase the benefit of external actors' competence the clients must connect them earlier in the decision process. This also demands a clear vision and goal for the decision process in order to capture the tacit information of the different areas (i.e. customer, owner and society). Despite the different types of construction clients in this study (private and public) there where similarities regarding the decision process. The three different areas were graded in the same order. The difference though was the area of society. There, the public clients' had a higher grading, which can be an indication that their decision process is more "pluralistic".

The main question to be answered in this study is how construction clients can contribute to change in the construction process. Clients' decision processes in this study are more concerned with management (planning, budgeting, controlling and problem solving) of the process than leadership. The respondents were mostly concerned about how to manage the different factors. Frequently, they related to basic data for decisions that can be related to the operational briefing. The strategic issues for the construction process were not taken into consideration to the same extent. In order to act as a change agent, clients should act more as an integrator of the requirements from the different stakeholders (customers, owners, society and construction sector).

5. REFERENCES

2000:44, S. (2000) *Från byggsekt till byggsektor. Byggkostnadsdelegationens slutbetänkande,* Stockholm, Fritzes.

2002:115, S. (2002) *Skärpning gubbar. Byggkommissionens betänkande,* Stockholm, Fritzes.

Axelsson, R. (1981) *Rationell organisation,* Stockholm, Norstedts juridik.

Barrett, P. S. (1999) Good practice in briefing: the limits of rationality. *Automation in Construction,* **8**, 633-642.

Borgbrant, J. (1990) *Strategisk dialog 2,* Stockholm, Natur och kultur.

Carn, N., Rabianski, J., Racster, R. & Seldin, M. (1998) *Real Estate Analysis - Techniques & Applications,* Engelwood Cliffs N.J USA, Prentice Hall.

Cassel, P. & Hjelmfeldt, M. (2001) *Marknad och ledning,* Stockholm, Svensk byggtjänst.

Dubois, A. & Gadde, L.-E. (2002) The Construction Industry as a Loosely Coupled System: Implications for Productivity and Innovation. *Construction Management and Economics,* **20**, 621-632.

Egan, J. (1998) Rethinking Construction. London, Department of the Environment, Transport and the Regions, London, HMSO.

Ekman, B. (1970) *Beslutsrationalisering,* Uppsala, Almqvist & Wiksell Förlag AB.

Engwall, Å. (2001) *Dynamics in refurbishment: a study of production processes and human interactions in a commercial environment*, Institutionen för väg- och vattenbyggnad, Luleå, Luleå Tekniska Universitet

Ericsson, B. & Johansson, B. M. (1994) *Bostadsbyggandet i idé och praktik*. Lund, University of Lund.

Fristedt, S. & Ryd, N. (2003) *Ju förr desto bättre: Programmarbete i tidigt skede av byggprocessen,* Stckholm, Svenska kommunförbundet.

Gareth, R. J. (1995) *Organizational theory: text and cases,* Reading, Mass. USA, Addison-Wesley Publishing.

Gerdemark, T. (2000) *Kundorientering - oklarheter på den självklara vägen*. Institutionen för Byggd miljö. Gävle, Högskolan i Gävle.

Green, S. D. (1996) A metaphorical analysis of client organsiations and the briefing process. *Construction Management and Economics,* **14**, 155-164.

Johannson, B. & Svedinger, B. (1997) *Kompetensutveckling inom samhällsbyggnad, Byggherren i fokus*. Stockholm, Kungliga Ingenjörsvetenskapsakademien.

Josephsson, P.-E. (1994) *Orsaker till fel i byggandet: en studie om felorsaker, felkonsekvenser, samt hinder för inlärning i byggprojekt*, Department of Building Economics and Construction Management. Göteborg, Chalmers University of Technology

Kadefors, A. (1997) *Beställar- entreprenörrelationer i byggandet- samarbete, konflikt och social påverkan*. Institutionen för byggnadsekonomi och byggnadsorganisation. Göteborg, Chalmers Tekniska Högskola.
Katz, D. & Kahn, R. L. (1978) *The Social Psychology of Organisations,* USA, John Wiley & Sons, Inc.
Kotter, J. (1995) Leading Change: Why Transformation Efforts Fail. *Harvard Business Review,* **73**, 59-67.
Latham, M. (1994) *Constructing the team,* HMSO: London.
Ljung, B. (1998) *Tankar om ledning och utveckling i fastighetsföretag*. Stockholm, Byggforskningsrådet.
Love, P., Li, H., Irani, Z. & Faniran, O. (2000) Total Quality Management and the Learning Organization: A Dialogue for Change in Construction. *Construction Management and Economics,* 18, 321-331.
March, J. G. (1994) *How decisions happen,* New York, The Free Press.
March, J. G. (1998) *Decisions and organizations,* New York, Basil Blackwell Inc.
March, J. G. & Simon, H. A. (1993) *Organizations,* Cambridge, Blackwell Publishers.
Rogers, E. M. (2003) *Duffusion of innovations,* New York, Free Press.
Ryd, N. (2003) *Exploring construction briefing: from document to process*, Section for architecture, Göteborg Chalmers Tekniska Högskola.
Ryd, N. (2001) Byggnadsprogram som informationsbärare i byggprocessen. Göteborg, Chalmers tekniska högskola.
Sahlin-Andersson, K. (1989) *Oklarhetens strategi: organisering av projektsamarbete* Lund, Lund : Studentlitteratur.
Simon, H. A. (1957) *Administrative behavior: a study of decision-making processes in administrative organisations,* Stockholm, Bokförlaget Prisma.
Thompson, J. D. (1967) *Organizations in action*, McGraw-Hill.
Tichy, N. M. (1983) *Managing strategic change,* New York, John Wiley & Sons.
Winch, G. M. (2002) *Managing construction projects,* London, Blackwell Publishing.
Yu, A. T. W., Shen, G. Q. P., Kelly, J. & Hunter, K. (2006) *A How-to Guide to Value Briefing,* Hong Kong, Department of Building and Real Estate, The Hong Kong Polytechnic University.

THE SWEDISH DEVELOPER AND CONSTRUCTION CLIENT IN A HISTORICAL CONTEXT

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ABSTRACT

This paper, which is a part of doctoral studies, will give new insights into the changes in the roles and responsibilities of the actors in the building sector in general and the Swedish developer and construction client (*Byggherren*) in the 60-year period, 1945–2005, since the end of the Second World War. A very strong reason for changes in the house building sector is the connection between the legal institutional framework and the financial and the economical institutions. The word, *Byggherre*, is the Swedish legal comprehensive term for the coherent concept of responsibility in a building project. The structure in the historical context gives answers to the questions *how* and *when* the change in roles takes place and *what* influences those changes have had on roles and on management and organisation.

1. INTRODUCTION

The two words or the two roles Developer and Construction Client have only one equivalent in Swedish, the role of *Byggherren*, which in the Swedish law is a united role of responsibility. This complicates and confuses the roles for the Construction and Real Estate Sector as a whole. This paper will give insights into the structure, organisation and management during the last 60 years, 1945-2005, for the Developer and the Construction Client in the Swedish housing market.

From the end of the Second World War in 1945 until 2005 both sectors have changed in organisation and management several times. Three main changes has been observed: one was when the state finance system was introduced, the other was when the one million dwellings program were built, during the years 1965-1974, and the third was when the state finance system was abolished.

The role of *Byggherren* also changed during the period that this paper will cover. A very strong reason for the changes is the connection between the legal institutional framework and the financial and the economical institutions.

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2. THE SWEDISH HOUSE BUILDING SECTOR IN THE PERSPECTIVE OF 60 YEARS IN SOCIETY DEVELOPMENT THE INSTITUTIONAL FRAMEWORK

After the end of the Second World War the Swedish industry expanded rapidly. Sweden was a step ahead of the rest of Europe since there had been no war damages in infrastructure or buildings compared to the rest of Europe. Industrial production could start without a huge rebuilding program, but the social structure in other respects was not prepared for the industrial expansion at that time. Before the Second World War most of the inhabitants were engaged in the agriculture, and during the war more than one million Swedish men actually joined the military. At the end of the war a big structural changeover took place (Hägg, 2005).

At the end of 1920 Sweden probably had the lowest living standard of all industrial countries in Europe. After the Second World War the living standard started to rise. More families asked for a better way of living including better dwellings. More than a quarter of the dwellings had no central heating, no toilet or bath/shower. Industry and the government expanded and more buildings were needed everywhere. The buildings that existed were too bad and too small and were located in wrong places for a society with a growing industry (Eriksson, 1994).

2.1 The political institutional framework

The development of the institutional framework for the million dwelling program was started before the Second World War and the strategic ideas long before that. The political decisions were taken at the end of 1940s when housing maintenance was the responsibility of local government, even if it was directed by the central government. The most important part of the central government directive was the economic and political means that confirmed the scale of the housing program. The house finance system was steered by the Swedish Central Bank *(Riksbanken)* as well as the control system, which has been built up in the credit market. At the same time as the government steered the finance and the control system they also tried to steer and control, on one hand the building costs and on the other hand the increasing industrialization process (Gråbacke, 2002).

Full employment and the statement of economic stability have been the main goals on the political agenda and it had a huge impact on government, housing policy and the building workers union in particular. The union's point of view was very powerful in advancing the political agenda of their members. The main questions and claims was about to handle housing production, the number and types of dwellings, the choice of owners and developers or group of owners and developers (*Byggherrar*) which one who should build what and were (Gråbacke, 2002).

2.2 The financial and economical institutions

Structural and political changes in the Swedish society have greatly influenced the society as a whole, including the development of the construction and housing sectors.

Before the Second World War, the responsibility for housing provision was no obvious matter for the central government or for the local government. At that time this was the job of the employers to arrange housing for their employees, even if the state was involved in financing and loans before the Second World War. The governmental finance investigation from 1933 that was presented in 1942 was permanent in 1948 for the owner-occupied houses (SFS 1948:546). Another law in that area was a law about how to give and handle government loans but also about how to divide dwellings and houses (Law 1947:523) (Brunfeldter, 1984).

The law from 1947 (Law 1947:523) remained in effect until 1993, when it was abrogated together with the end of government loans for housing.

Government financing and loans was at the time before the Second World War a question about handling risks and elements of risks. Fälting (2001) has identified three main elements of risks in owner-occupied building, the income risk, the maintenance risk and the production risk. Local authorities handled the income and the maintenance risks, but not the production risk. The production risk was the most complicated risk to handle (Fälting, 2001).

At the end of 1950s the most effective impact on the Swedish credit market was ATP, a new financial system for Swedish pensions. The political influence on the finance market got stronger during that time. Finance from ATP had a strong impact on the housing bond market. ATP was at that time a very big buyer of housing bonds. The economic framework was a politically brilliant move if the idea was to dominate the credit market for housing bonds. Without the ATP-bond system, the fulfilment of the million dwelling program would have been very difficult (Gråbacke, 2002).

2.3 The legal institutional framework

Municipal and local government plans characterised the housing and the construction industry during the post-war period. The law from 1947 made it possible to reintroduce a municipal monopoly in the planning process. A lot of laws in planning and building were created with a doctrinaire background. As a result of the law from 1947 (BL 1947, SFS 1947:385) the new ideas were introduced which meant that all municipal planning had to be approved by the local government. In addition to this the local government had another political instrument in the form of the power to extend more land for building purposes. That instrument was the law of expropriation from 1949. The local government could, with the power of that law, decide if they wanted to use the land in the municipality for buildings or not. However a doctrine of mixed economy was used in negotiations with construction companies if they let their land be planned and developed as population centres. The economic conditions would be fulfilled in equitable or “under fair and reasonable” conditions (Brunfeldter, 1984).

The current Swedish law for Planning and Building (PBL 1987:10) was introduced in 1987, and it was a comprehensive in planning for the use of land, water and buildings. The law has pointed out that it is the responsibility for the local government to make plans for the use of land and water, and the one who has the responsibility for supervising and control is the one who in the law is defined as *Byggherren*. The law has also clauses emphasising sustainable development in the building process, today and for next coming generations. This part has, from 1998 been supported by a new environment code Miljöbalken (MB 1:7) which is applied in the administration and management of the construction and hosing sectors and in the use of buildings (Sveriges Rikes Lag, 2000).

2.4 The building sector and the investment development in housing

From 1945 to the middle of the 1960s (before the million dwelling program) there was a period when not only new houses where built but also new infrastructure and social structures. Investment in buildings increased in clear numbers and as a proportion of the GNP, from about 12% in 1950 to about 16% in 1965. The fastest rise was in the housing market, but all investments in buildings and in infrastructure was rising during this 20-year period. In both 1950 and in 1965 about half of the total investments were in new dwellings and houses, about 30 billion SEK per year in 1950 to about 80 billion SEK per year in 1965, respectively at 2002 prices. To be compared with a total investment about 65 billion SEK per year in 1950 to about 170 billion SEK per year in 1965, respectively at 2002 prices (Sveriges Byggindustrier, 2003; Sveriges Byggindustrier, 2005).

During the million dwelling program, from the middle of the 1960s to the middle of the 1970s, a large scale construction system was developed, where the actors from the building sector adapted the production system to be able to have the capacity to produce one million dwellings in ten years. The investment in buildings was raised from about 170 billion SEK per year in 1965 to about 190 billion SEK per year in 1970 and then it dropped to about 180 billion SEK annually, respectively at 2002 prices. New dwellings and houses still took about half of the investment, rising from 80 billion SEK per year in 1965 to about 90 billion SEK per year in 1970 and then dropped back to about 75 billion SEK per year in 1975, respectively at 2002 prices. The GNP numbers rose from about 16% of GNP between 1965 and 1970, and then fell back to about 12% in 1975 (Sveriges Byggindustrier, 2003; Sveriges Byggindustrier 2005).

Investments in the building sector was at about the same level during the ten-year period from 1975 to 1985 at about 170 billion SEK per year but the production of new dwellings fell sharply from 75 billion SEK per year in 1975 to about 40 billion SEK per year in 1985. The rebuilding of old dwellings rose during the same time from about 15 billion SEK per year to about 50 billion SEK per year, respectively at 2002 prices. In the ten years that followed there was a dramatic roller coaster in building investments. Total building investments are rose from about 170 billion SEK per year in 1985 to about 210 billion SEK per year in 1990 and then dropped back to about 150 billion SEK per year, respectively at 2002 prices. This was a more dramatic fluctuation than during the implementation of the million dwelling program. Investments in new dwellings doubled during this ten-year period from about 40 billion SEK per year in 1985 to about 80 billion SEK per year in 1990 but fell to 20 billion SEK per year in 1995, respectively at 2002 prices, a fluctuation that also had a great impact on rest of the economy. Investment in buildings fell not only in money terms and clear numbers but also as a fraction of GNP, from about 10% in 1985 and 1990 to about 6% of GNP in 1995, the lowest fraction ever in this measure. The state finance system abolished in 1993 at the same time as the “property bubble” burst in the group of buildings that often is identified as commercial buildings. Since then the level of investment in buildings slightly rose from about 150 billion SEK per year to about 170 billion SEK per year, respectively at 2002 prices, but as a fraction of GNP it is still about the level of 6% in 2005 (Sveriges Byggindustrier, 2003; Sveriges Byggindustrier, 2005).

3. RESEARCH PROJECT

This paper will describe and give new insights into changes in the roles and responsibilities for the Swedish Developer and Construction Client, *Byggherren*, and what happened in the 60-year period, 1945-2005, since the Second World War was ended. The research will cover changes in roles, how and when they took place and what influences these changes have had over time on management and organisation, which will result in knowledge for ideas and fresh thinking.

3.1 Project description and objectives

Since the state finance systems for house-building was abolished in 1993, the roles of *Byggherren* have been debated in the building and real estate sector in general and in the housing sector in particular. The distinction between Developer and Construction Client might perhaps solve the co-ordination problem, but this is not enough and probably not consistent with Swedish law. In 1987 the PBL-law was introduced for the building sector, which is a Planning and Building Law, that very clearly pointed out that it is the one who builds and constructs or permits building and construction who has the whole responsibility for the result is *Byggherren* and nobody else. An important part of the paper is therefore to find out if and how the roles, the responsibility and the authority for *Byggherren* has been divided or changed. To answer these questions, it is therefore necessary to place it in context from a historical perspective. The period that was representative for that investigation was the period that started at the end of the Second World War and continued until today.

3.2 Research methodology

The method of analysis is to use relevant literature from the period in question, to analyse investments in the construction sector in general and in the housing sector in particular in a triangulation from a political, from a financial as well as a from legal perspectives. The impact of *Byggherren*, the Swedish Developer and Construction Client for house-building, is then analysed.

When the roles of *Byggherren* have changed over time, different roles also have different impact on result and expenses, and from that point of view the responsibility for different roles also get different form of impact of responsibility. The case study from a Principal Agent perspective then is another triangulation, from the angle of management, from the angle of organisation and from the angle of risk and responsibility (Milgrom and Roberts, 1992).

At the end of the Second World War, in 1945, the roles of being a Swedish *Byggherre* were a composite role – a house builder and very often also a master builder or a building constructor. He controlled the whole building chain and had all the influence the developer needed taking full responsibility for the costs and the result. He was the Owner, the Real Estate Developer, the Construction Client, and the Project Developer as well as the Contractor. What he often did not have in his own control was the Subcontractor, the services of which he had to buy at this time making him a client of the subcontractor.

Over time the scale of projects expanded because of the change in the society and changes in the industrialization process in the construction industry. In the middle of the 1960s the projects expanded in scale and number. *Byggherren* played at that time several and different roles: the Owner, the Developer and the Construction Client. The rapid industrialization of the house building process made the project development to a part of the construction industry as well as vertically integrating the subcontractors with the construction industry as a whole. All sectors in the building industry grew with the government policy focused on welfare, housing programs, full employment and financial stability.

The start of the big house building program from the middle of the 1960s to the middle of 1970s, when one million modern dwellings was built, changed the meaning of the word, *Byggherre*, from being both Developer and Construction Client to be more of a Construction Client. One million dwellings are roughly a quarter of all dwellings in the country, and these dwellings were built during a period of 10 years, which had a huge impact on the society as a whole. The design and building process was standardized and regulated by the government authorities and even the land preparing was standardized, all the developer had to do was to execute the plans, follow the standardized regulations and to held the project costs. The Construction Client from now on mostly became the client for big contractors and construction companies and the client for the subcontractors will now be the mission for contractors, especially all the housing contractors. The role that has an economic influence on the building industry was not the Developer during this time but the Construction Client. The local government and the public housing companies exercised the influence on the responsibility from a holistic point of view, but the state regulations, the government administration and the political issues heavily governed them.

The Developer earlier had two roles: Real Estate Developer and Project Developer. The Real Estate Developer was during the million dwelling program a profession for the local government and the public real estate companies. The Project Developer was from this time and on a mission for the big contactors and big construction companies. Other constructors found it very difficult to be engaged. The role of the Construction Client was to purchase the project and the project development, but *Byggherren* was still the one according to Swedish law that has the responsibility for the result as a whole. From 1975 when the million dwelling program ended, and about 10 years after that until about 1985, this was also the organisation and management model for the sector as a whole.

From 1975 to 1985 the numbers of new dwellings fell dramatically. But the roles of the principal actors from the million dwelling program were still left. The building industry was still prepared to tackle new and more complicated projects. The science of civil engineering was at its peak, but from the middle of 1980s to the middle of 1990s the house-building sector and the real estate sector experienced a both quicker and more radical change than during the million dwelling program, from the middle of the 1960s to the middle of the 1970s. During 1985 to 1990 the building sector get expanded dramatically especially in new dwellings that followed by an equally and dramatic fall for both the house-building sector and the building and real estate sector as a whole. The financial sector collapsed and the Real Estate Developer was, if he was still alive, a mission for the Owners. The Construction Client becomes the one who was in the middle between on one hand the Owner and the Real Estate Developer and on the other hand the Project Developer and the Contractors. The Project Developer is now a part of the big Contractors even if some

Real Estate Companies by Consultants do the Project Development of their own. The mission for *Byggherren* was during this time the legal focus of the Real Estate Developer and The Owner the one who takes the initiative to build or construct.

At the end of the 1980s and before the state finance system was abolished in 1993 the roles of *Byggherren* are divided into three directions: the first direction handling the Real Estate Development, the second handling the part that belongs to the Construction Client and the third handling the Project Development issues. All parts are important parts, but in the Swedish law *Byggherren* is the united part of all of this directions or parts. You can as an Owner, a Landholder or a Construction Client buy the qualifications and the competence you need to build but you cannot buy the responsibility. On that point the law is crystal clear. Too many actors with too little responsibility made the finance ministry to conduct an investigation in 2002 “To pull the building sector together” (Skärpning gubbar, SOU 2002:115).

The figure below will illustrate the discussions above, how (in grey colour) the roles and responsibility for *Byggherren* have changed over the time from about 1945 until about 2005. The changes in the house-building sector has evolved from a unified mode of operating to a more split up way of operating which from a holistic point of view give insights in roles and responsibility in the sector as a whole.

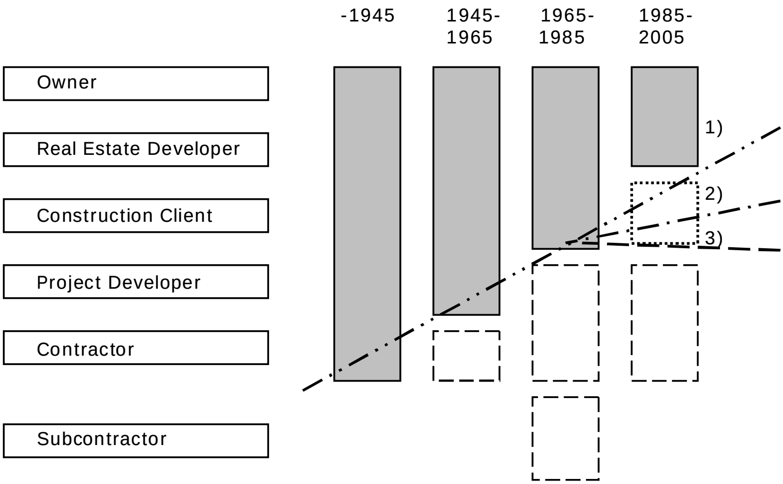

Figure 1. The development of *Byggherren* and the organisation of the roles in the house-building sector

The three directions 1) 3) of the role of *Byggherren* in the figure above will be discussed in section 4.2 below.

4. RESEARCH RESULTS AND INDUSTRIAL IMPACT

The million dwelling program was a peak in building investments and at the same time a period of dividing the roles of *Byggherren* in several ways.

- A national force of strength in building industry to catch up housing shortage
- A national force of strength to finance the million dwelling program
- The legal structure that started several years ago made the program possible

The political and governmental steering against standardization - not less than 1,000 units per project led to central government by the definition that apply to *Byggherren* today taking responsibility for the production risk by financing the housing projects using 100% state loans. It was a symbiotic relationship between the local government that have the operational responsibility to realize the project and the central government who have the functional responsibility in a form of governmental partnership. Under that scenario the role and the main mission for *Byggherren* in the public housing sector was as a Construction Client.

The next policy change that greatly impacted the building industry in general and the role of *Byggherren* in particular, was in the beginning of the 1990s a when a combination of course in action there the finance systems collapsed for commercial buildings in the real estate market and the central government redraw the finance system in housing projects. The public opinion was that Sweden at that time had completed their buildings for a long time and a liquidation of competence that no longer was needed has started. The usefulness or otherwise the role of *Byggherren* became the subject of heavy debate. Those in the role of *Byggherren* who where left and survived tried to find a new identification.

4.1 Results

The political influence is huge on the buildings that are already built as well as on those who will be built in the future. The decisions which resulted in the million dwelling program not only started more than 20 years before it was realised, it also have had a great influence on the house-building sector for more then 20 years after the program was finished. The political decisions that were taken during the depression and in the period between the wars had repercussions beyond the Second World War and before the million dwelling program. For that reason there are a clear grounds for arguing that the decisions that were taken in the 1990s about redrawing in the engagement of the society will have consequences during the beginning of the 21st century. History has clearly shown that political decisions such as these have very long lasting impact on the society as a whole.

To manage these impacts it would be good to learn from history. The legal roles of *Byggherren* will have strong measures for at least the next decade what ever you like it or not. So what have to be done in the building and real estate sector in common and for the divided role of *Byggherren* in particular? This paper will show up the historical context and give insights in the change of role of *Byggherren* and the on going licentiate thesis will be more focused on how and why the big change has take place and what we can learn from the post-war period and also what can be used from in this knowledge for management and organisation for the future.

4.2 Implementation and exploitation

In the building sector as a whole the different roles and the responsibilities that follow from those roles have to be more aligned with the way the job has to be done. The roles of *Byggherren* could, in the author's opinion, get evolved in three main directions. The numbers are from figure 1.

1. The development for *Byggherren* will continue in the same direction as from the direction in 1945 to 1975, which will means that the legal institutional framework has to be changed, and under those circumstances giving the constructor a bigger responsibility in keeping with the law.
2. The development of *Byggherren* will be kept in the same situation as shown for the period 1985 to 2005. The roles of *Byggherren* will then belong to the (Project) Owner and the Real Estate Developer. The legal institutional framework can be in the same position as today but it is necessary to make an addition where all parts have to have clarity in terms of the missions and the linguistic use of the words.
3. Development return to a situation more like the situation that was during the million dwelling program which is shown in the figure above for the years from 1965 until 1985. The steering of the state will then be needed to be stronger for housing projects and other projects than the situation is today. The legal institutional framework can be in the same position as today but it is here even necessary to ensure clarity in the content of the missions and the linguistic use of the words.

As after the Second World War in the middle of the 1940s there are in the years after 2000 a shortage of houses and dwellings in the expanding cities in Sweden. The historical scenario has repeated itself and there are still too many buildings in wrong places or too few of them where they should be needed today.

5. CONCLUSIONS

The word *Byggherre* is the Swedish legal comprehensive term for the coherent concept of responsibility in a building project. It includes the responsibility that the Owner, the Real Estate Developer, the Construction Client, the Project Developer and the Constructor have for the project. The common way to work and to point out responsibility for the result in house-building at the end of the Second World War was all these together and often in a master builder role.

When the million dwelling program was built in ten years, 1965-1974, building and housing sector underwent a big structural change in terms of management and organisation leading to a division of the roles of *Byggherren*. Next big structural change was started in the middle of the 1980s and was ended in middle of the 1990s. The role as *Byggherre* gets divided again and the role becomes a role for the Owner and the Real Estate Developer and the Construction Client becomes the client for housing projects.

In 1987 a new law was enacted for the building sector: the Plan and Building Law (PBL), that very clear pointed out that it is the one that build and construct or permit building and construction who is the one who has the whole responsibility for the result is *Byggherren* and nobody else, even if others will have the title.

The summary of the linguistic and structural conclusions are that:

- a land Owner or a house Owner is often a project Owner and *Byggherre*
- a project Owner is always a *Byggherre*
- a *Byggherre* always has the legal responsibility for the project result
- a *Byggherre* often is a Real Estate Developer and a Construction Client
- a Real Estate Developer does not necessarily have to be a *Byggherre*, and
- a Construction Client does not necessarily have to be a *Byggherre* either
- the words Developer and Construction Client which in the Swedish language has one word *Byggherre* for different roles with different responsibilities in the same organisation or in the same structure complicate and confuse the roles for both the Building and the Real Estate Sector as a whole
- if the Swedish law still wants one part to have the legal responsibility for a whole project, management, organisation and the linguistics have to be used in a more correctly way in the building and the housing sector as a whole.

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7. REFERENCES

Brunfeldter, U. (1984), *Svensk planlagstiftning i historiskt perspektiv*, Byggforskningsrådet R37:1984. Stockholm 1984.

Eriksson, O. (1994), *Byggbeställare i brytningstid*, *Bostadssektorn och statligt byggande under miljonprogramsperioden*, BFR T20:1994. Oskarshamn: Tryckeri AB Primo.

Fälting L. (2001) *Småhusfinansiering, en studie av kommunens, statens och enskilda aktörers riskhantering I Nyköping 1904-1908*. Department of Economic History, Uppsala University. Stockholm: Elanders Gotab.

Gråbacke, C. (2002), *Möten med marknaden, Tre svenska fackförbunds agerande under perioden 1945-1976.* Göteborg: Ekonomisk Historiska Institutionen, Handelshögskolan vid Göteborgs Universitet.

Hägg, G. (2005), *Välfärdsåren, Svensk Historia 1945-1986*. Stockholm: Wahlström & Widstrand.

Milgrom, P. and Roberts, J (1992), *Economics, Organisation and Management*. New Jersey: Prentice-Hall Inc.

SOU 2002:115 (2002), *Skärpning gubbar*, Stockholm Edita Nordstedts Tryckeri AB.

Sveriges Byggindustrier (2003), *Fakta om byggandet*, Stockholm: CA tryck Offset AB.

Sveriges Byggindustrier (2005), *Fakta om byggandet*, Stockholm: A-teknik Offset AB.

Sveriges Rikes Lag (2000), Uppsala: AWT Tryckeri.

AN ANALYSIS OF VALUE-BASED AWARD MECHANISMS

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ABSTRACT

At present, procurement based on lowest price is the dominant strategy of public clients in the Dutch construction industry. Tender regulation allows value-based procurement (also known as selection based on the Most Economically Advantageous Tender, MEAT), but this criterion is difficult to implement. Several value-based procurement methods have been delayed by legal claims, due to errors in the award mechanism. However, examples of successful implementation can also be found. The study presented in this paper aims to find the distinguishing features that influence acceptability and soundness, by analysing applications of the MEAT award mechanism. This paper presents the preliminary observations based on five cases where MEAT was applied.

1. INTRODUCTION

The exclusive and prolonged use of a lowest price based procurement strategy by public authorities can have a severe negative impact on the construction industry as a whole. However, public authorities continue using this method because they think it is the only way to justify the spending of tax money. In the Dutch building and construction industry – and in many other countries as well – this results in problems such as low client satisfaction, low profits, lacking innovation, high transaction costs, a troubled client-supplier relation and even corrupt behaviour, as concluded in previous studies by the authors (Dreschler and de Ridder 2006), (Dorée and de Ridder), (De Ridder et al, 2002). This paper presents a study which is ongoing.

2. PROBLEM STATEMENT

2.1 General problem statement

Several problems in the Dutch building and construction industry can be attributed to the dominance of the lowest price contract award mechanism in public procurement. In this kind of procurement, companies are forced to customize beyond the economic optimum, causing the industry to under perform. As a result of the lowest price-based procurement regime, contractors and indeed the entire supply chain have to comply with a detailed list of demands, setting up a new production system each time. In this regard, standardised components or company-specific solutions can

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only be applied with great difficulty, which means the supply chain cannot organise itself in the most economic way. Furthermore, the traditional organisation model – an architect or engineering firm producing a design for the client (Roelofs and Reinderink, 2005) – which is associated with the lowest price selection mechanism results in designs lacking constructability because design and construction knowledge and responsibilities are separated. In addition, most clients are not able to describe their requirements realistically and in detail because they lack thorough knowledge of the market. This becomes a problem with the lowest price-based selection regime and ultimately results in high preparation costs and unrealistic expectations. A combination of these factors leads to 'friction' problems such as low client satisfaction, low profits, high transaction costs, a troubled client-supplier relation and a predominantly negative image of the building and construction industry as a whole.

2.2 Advantages of value-based procurement

The problems associated with lowest price-based procurement are unrealistic customisation demands, lack of constructability in designs, and the need to "predict the unpredictable". Value-based procurement can solve these problems. Using this method, it is no longer necessary to give a detailed description of the desired solution and suppliers must assume more responsibility for the design. This also allows suppliers to apply company-specific solutions or components, which makes designs more constructible. Furthermore, the client no longer has to specify the need in great detail in advance. Hence value-based procurement can bring about improvements that clients as well as suppliers can benefit from.

2.2 Specific problem statement

Several factors threaten the adoption of value-based procurement. The main reason is that the public clients lack confidence in value-based procurement. Public clients often hesitate to formulate award criteria, because even small details of these criteria have potentially large consequences. When the public client is faced with the uncertainty of legal consequences in addition to a general lack of experience with the process, the choice for the lowest price-based selection strategy becomes obvious. Goal of the study presented in this paper is to increase the knowledge of value-based procurement. As explained in section 4, this will be accomplished by a study of implementations of the MEAT award mechanism.

3. VALUE-BASED PROCUREMENT

3.1 EU regulation – definitions

According to article 53.1 of *Directive 2004/18/EC* of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts (European Parliament, 2004) the relevant public clients have two possibilities for awarding contracts. Without prejudice to national laws, regulations or administrative provisions concerning the remuneration of certain services, the criteria on which the contracting authorities shall base the award of public contracts shall be either:

(a) when the award is made to the tender most economically advantageous from the point of view of the contracting authority, various criteria linked to the subject-matter of the public contract in question, for example, quality, price, technical merit, aesthetic and functional characteristics, environmental characteristics, running costs, cost-effectiveness, after-sales service and technical assistance, delivery date and delivery period or period of completion, or

(b) the lowest price only (European Parliament, 2004).

In article 53.1, the word 'criteria' has two different meanings. In the introduction 'criteria' is used in the sense of award mechanism. In paragraph (a) 'criteria' is used in the sense of "a property on which a performance evaluation is based". This paper uses the term 'award criterion' for the second meaning. Public clients usually use the award mechanism in the award stage where the final bids of suppliers are ordered and the best bid is selected (Figure 1). The award phase is part of an encompassing procurement strategy and usually comes after the selection phase (see [URL1] for an example of a description of the entire procurement process).

Figure 1. The award mechanism grades the bids

Figure 2 describes the lowest price award mechanism; figure 3 describes the 'Most Economically Advantageous Tender' (MEAT) award mechanism. The procurement strategy which uses the lowest price award mechanism is known as lowest price-based procurement, the strategy that uses the MEAT award mechanism is known as value-based procurement.

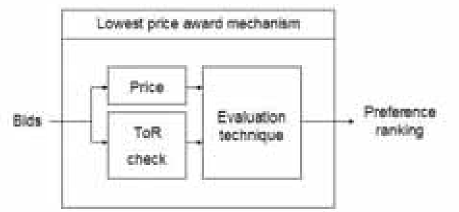

Figure 2. The award mechanism in lowest price-based procurement

The evaluation technique in the lowest price award mechanism simply consists of rejecting bids which do not comply with the Table of Requirements (ToR) and selecting the cheapest bid. In reality this rarely occurs, because bids almost never comply entirely with the Table of Requirements or other contractual provisions.

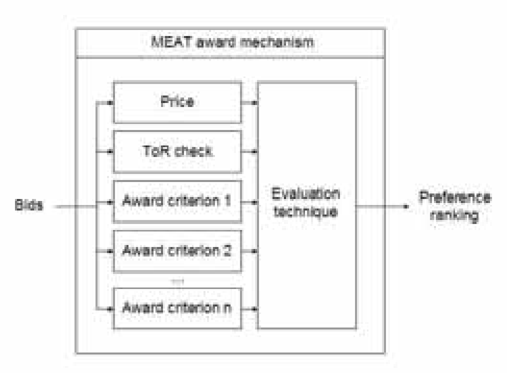

Figure 3. The award mechanism in value-based procurement

The MEAT award mechanism takes into account other criteria than price and conformance with requirements. These other criteria are known as award criteria and are used to establish the partial performances of each bid. The evaluation technique combines the performance and price information into a preference ranking. Generally, the evaluation technique uses a mathematical formula.

3.2 Legal requirements

Stipulation 46 of the directive (European Parliament, 2004) states:

> *Contracts should be awarded on the basis of objective criteria which ensure compliance with the principles of transparency, non-discrimination and equal treatment and which guarantee that tenders are assessed in conditions of effective competition. As a result, it is appropriate to allow the application of two award criteria only: 'the lowest price' and 'the most economically advantageous tender'*.

Pijnacker Hordijk et al (2004) elaborate these legal requirements. To summarise: the award criteria should be objective, transparent, non-discriminative and should be known in advance by the suppliers.

3.3 Types of evaluation techniques

Several legally acceptable possibilities for combining financial and non-financial criteria exist (Goovaerts, 2004). Until now, four types have been identified in practice or in the directive.

1. Price Correction. The performance of a bid on initially non-financial criteria is expressed in monetary terms, which is then combined with the price of the bid. The bid with the lowest price after this correction is awarded the contract.

2. Point System. The performances on financial and non-financial criteria of a bid are translated into points. The bid with the most points is awarded the contract.
3. Two Envelope System. Bids are evaluated on non-financial criteria first. Then the price envelope of the bid with the highest quality is opened and if it fits the budget, it is awarded the contract. If not then the price check is repeated for the bid with the second highest quality and so on.
4. Design Contest. Bids are evaluated on non-financial criteria only, because they all have to comply with the same budget and other contractual demands.

By choosing between these assessment-techniques and shaping the chosen option, the public client establishes the influence of financial and non-financial criteria in the assessment.

4. RESEARCH METHODOLOGY

In order to increase the confidence of public clients in value-based procurement, knowledge about this approach needs to be increased. Section 3 explained the most important element of value-based procurement, namely the MEAT award mechanism. The most distinctive elements of this mechanism are the award criteria and the evaluation technique. These elements will have to be studied in order to increase the knowledge about the MEAT award mechanism. An important methodological consideration is that information is gathered via realised applications, because this information cannot be influenced by the study. Information is gathered firstly by archive research and secondly by interviews. For the collection of information a template is used which is developed via an iterative procedure. The study is limited to cases from the Dutch building and construction industry and to award criteria only (no selection criteria). “Unsuccessful” cases are also included. The administrative procedure surrounding the award mechanism is outside the scope of this study.

5. CASE STUDIES

This investigation defines a case as a project wherein the MEAT award criterion has been adopted by a public client. In this section cases are presented individually and in aggregated form.

5.1 Case descriptions

At the moment of writing this paper, the information of the next five cases is available. Specific details have been left out for confidentiality.

Case A – Design and construction of a secondary school

Budget:	About 20 M€
Type of evaluation:	Price correction
Evaluation formula:	$\text{Price}_{\text{Base}} + \text{Price}_{\text{Maintenance}} + \text{Price}_{\text{Scenarios}} - S_{\text{Energy}} - C_{\text{Wishes}} - C_{\text{Cooperation}} - C_{\text{Value creation}}$
Award criteria:	See Table 1

Table 1. Award criteria used in case A

Award criteria	Range (€)
Energy performance	[0 – 1,800,000]
Satisfaction of wishes	[0 – 2,000,000]
Level of cooperation	[0 – 500,000]
Value creation	[0 – 1,000,000]

Case B – Design for the renovation of a large office building

Budget:	About 25.5 M€
Type of evaluation:	Point system
Evaluation formula:	$Points_{Total} = 0.3 * Points_{Price} + 0.7 * Points_{Award\ criteria}$
$Points_{Price}$:	$(2.5 * Price_{Lowest\ bid} – Price_{Bid\ x}) / (1.5 * Price_{Lowest\ bid}) * 5$ points, until a minimum of 0 points.
$Points_{Award\ criteria}$:	See Table 2. Maximum number of points to be earned with these aspects: 5 points.

Table 2. Award criteria used in case B

Award criteria	Weight	Range (points)
Aesthetics	20%	[1 – 5]
Quality of office concept	10%	[1 – 5]
Preservation of monument	10%	[1 – 5]
Quality of employees	10%	[1 – 5]
Cooperation	15%	[1 – 5]
Product quality	15%	[1 – 5]
Explanation price	20%	[1 – 5]

Case C – Design and renovation of a large office building

Budget:	About 190 M€
Type of evaluation:	Point system
Evaluation formula:	$Points_{Total} = Points_{Price} + Points_{Award\ criteria}$
$Points_{Price}$:	The lowest bid gets 100 points, the other bids get 1 point fewer per million € difference, with a minimum of 0 points.
$Points_{Award\ criteria}$:	See Table 3. Maximum number of points to be earned with these aspects: 30 points.

Table 3. Award criteria used in case C

Award criteria	Weight	Range
Visual quality	40%	Unknown
Functionality	40%	Unknown
Flexibility	20%	Unknown

Case D – Design and reconstruction of a road and several objects

Budget:	Unknown
Type of evaluation:	Point system
Evaluation formula:	$Points_{Total} = Points_{Price} + Points_{Award\ criteria}$
$Points_{Price}$:	The bid with the lowest Net Present Value gets 90 points, the other bids get 2 points fewer per percent difference.
$Points_{Award\ criteria}$:	See Table 4. Maximum number of points to be earned with these aspects: 7 points.

Table 4. Award criteria used in case D

Award criteria	**Range (points)**
Nuisance surrounding area	[-1,1]
Traffic safety	[0,3]
Aesthetics	[-3,0,3]

Case E – Design and construction of a quay wall

Budget:	About 60 M€
Type of evaluation:	Point system
Evaluation formula:	$Points_{Total} = Points_{Price} + Points_{Award\ criteria}$
$Points_{Price}$:	The lowest bid gets 120 points, the other bids get 1 point fewer per percent difference with an unknown minimum.
$Points_{Award\ criteria}$:	See Table 5. Maximum number of points to be earned with these aspects: 80 points.

Table 5. Award criteria used in case E

Award criteria	**Range (points)**
Planning	[0 – 16]
Risk	[0 – 16]
Maintenance	[0 – 16]
Innovation	[0 – 16]
Quality	[0 – 16]

5.2 Preliminary database

Table 6 presents the main characteristics of the evaluation techniques that were used. The first column states the cases. The types of evaluation techniques in the second column correspond with the types mentioned in paragraph 3.3. The column "Share award criteria" presents the possible influence on the preference that performance on award criteria has. The column "Performance determination" states how the performance on award criteria was determined. Using the relative method, knowledge of the other bids is needed, because all bids are ranked per award criterion. The absolute method uses an absolute performance standard, so using that method, knowledge of other bids is not required.

Table 6. Main characteristics of the evaluation techniques used

Case	Type of evaluation	Share award criteria	Performance determination
A, Secondary school	Price correction	18%*	Absolute
B, Office building	Point system	70%	Relative
C, Office building	Point system	23%	Relative
D, Road and objects	Point system	7%	Relative
E, Quay wall	Point system	40%	Relative

* Approximation based on cost estimate. This share depends on the price of the offers.

6. SYSTEMATIC CONSIDERATIONS

The interviewees directly and indirectly confirm the research assumptions at the problem statement. They support the idea of increasing the level of value-based procurement and stimulating supplier creativity. Even in cases where they have knowledge about setting up a value-based procurement, they are still interested in this study for several reasons: they assume it can help them doing it better and quicker next time, it can confirm they have done the right thing, it can help build up confidence with regard to juridical aspects and finally they feel it can help them explain their decisions to controlling authorities. They feel that having a thorough, structured overview of the strengths and weaknesses of the possible configuration options in MEAT award mechanisms will be a valuable addition to their “toolkit” and professional knowledge. They state that the value-based procurement strategy has lead to a higher value-price ratio than would have been likely with a traditional procurement strategy.

7. POINT SYSTEM PREFERENCES MAPPED INTO THE VALUE-PRICE MODEL

The value-price model is a model of the “value for money” notion; consumers do not only look at the price of a prospect but at what it will deliver as well. According to this theory, customers will choose the product with the highest value-price ratio. In the example in Figure 4, prospect number 2 is preferred over prospect number 1. The preference for products with the same value-price ratio is the same, as depicted by the iso-preference lines in Figure 4. For offers with the same value-price ratio the choice will have to be based on additional criteria.

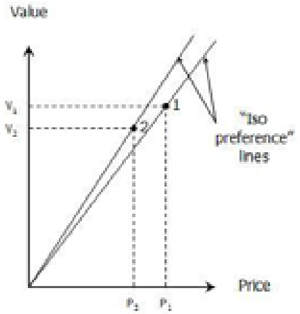

Figure 4. The value-price model and two iso-preference lines

There is a need to visualise point system preferences into the value-price model. As the value-price model has two dimensions, it can provide a more insightful picture of how the offers relate to each other than a one-dimensional point ranking. Furthermore the implications of using a point system can be explored. For this purpose the point system of Case E is combined with three fictitious offers (Table 7). In the point system, the offer with the lowest price gets 120 points, the other bids get 1 point fewer per percent price difference. Based on the performance of the offers on the award criteria, 0 to 80 points for added value can be gained. The points are then added, the offer with the most points wins the contract. In the fictive case, offer C would win the contract. In real life the difference in points is probably to close to pick a winner, but that does not matter for this example.

Table 7. Three fictitious offers

Offer	**Price (M€)**	**Points$_{\text{Award criteria}}$**	**Points$_{\text{Price}}$**	**Points$_{\text{Total}}$**	**Rank**
A	60	30	120	150	3
B	70	50	103.33	153.33	2
C	80	70	86.67	156.67	1

In order to map the point system preferences into the value price model, the following assumptions are made.

- Preference is based on value-price ratio. The offer with the highest value-price ratio wins the contract.
- The number of points corresponds with the preference because the offer with the most points wins the contract.
- The point system takes the offer with the lowest price as reference. Following this example, the price of the lowest offer is set as reference value. This implies that the iso-preference line of 120 points is set at 45° and that the steepness of the other iso-preference lines is relative to that line.

Based on these assumptions, the values of the offers are derived (Table 8) and then the offers are plotted into the value-price model (Figure 5).

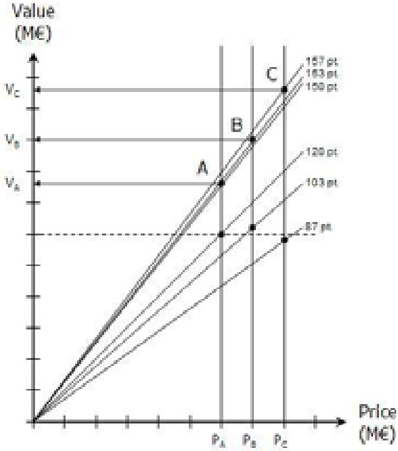

Figure 5. Offers mapped into the value-price model

During this exercise three inconsistencies are encountered. Firstly, it is notable that the extra quality or added value as defined by the performance on the award criteria is rewarded twice for offer A. At first it receives 120 points for the total value-price combination and then it gets another 30 points for a performance which was already valued in the 120 points. There are several possibilities for correcting this inconsistency in the modelling. Extra research is needed to find out what is the correct possibility. Secondly, the values of the offers without added value (the base values) are not the same. Although the difference in the calculated base values is pretty close (respectively 60, 60.3, and 57.8 for offers A, B, and C) they should be exactly the same when the logic of the value-price model is followed. Besides the error introduced by the first inconsistency, the differences are explained by the fundamental error in the way the point system awards points for the price. In the point system, the offer with the lowest price gets 120 points and the other bids get 1 point fewer per percent price difference. That means that an offer that is 120% more expensive than the cheapest would get zero points, which corresponds with a value-price ratio of zero, so that it would always have a value of zero, regardless of the quality of that offer. This inconsistency can be solved by introducing curved point depreciation instead of linear point depreciation. Remarkably, no cases with curved point depreciation have been encountered so far, although the point depreciation system of case B is a step in the good direction. The third inconsistency is the disproportionality of the added values. The 30 points of offer A are worth 15 M€, the 50 points of offer B are worth 29.2 M€ and the 70 points of offer C are worth 46.7 M€. This would imply that the value per point increases if the price increases. This is an error that obviously needs correction, because offer C would not win the contract if one point value would be used consistently.

Table 8. Calculation of values

Points	Tan α	Value	Comment
120	1	60 (Reference point)	Value of offer A without added value
150	1.25	60*1,25=75	Value of offer A
103.33	0.86	0.86*70=60.3	Value of offer B without added value
86.67	0.78	0.78*80=57.8	Value of offer C without added value
153.33	1.28	1.28*70=89.4	Value of offer B
156.67	1.31	1.31*80=104.4	Value of offer C

8. CONCLUSIONS

At present no definite conclusions can be drawn because the study is still ongoing. The number of cases is not yet statistically relevant for generalisation for the entire population, although it allows for several preliminary observations.

Interviewees have stated that selecting based on MEAT helps them to reduce their transaction costs, improve the quality of the relation with the supplier, and get more value for money. The construction industry is usually divided into residential, commercial and civil sectors. Until now, no MEAT award mechanisms have been encountered in the residential sector. The number of cases for commercial and civil sectors is about equal. Looking at the column “share award criteria” in Table 6, the possibility for influencing the preference by adding value seems a bit higher for the commercial sector than the civil sector. Based on the five cases, public clients seem to prefer point systems over price correction systems. This conflicts with the statement supported by some experts that public clients prefer price correction systems because they are more intuitive, easier to explain to controlling authorities, and easier to formulate.

Given the inconsistencies that became clear after mapping a point system into the value-price model, it is striking that that kind of point systems still can be applied successfully. If presented in court, the inconsistencies would give a judge enough ground to decide that that kind of point system does not provide reliable results. This has a potentially large industrial impact, because it will increase the probability of success for legal cases against procurement procedures using the wrong type of point systems.

9. REFERENCES

Dorée, A.G. and Ridder, H.A.J. de (2003), *Oriëntaties op de toekomst*, AVVB, Moordrecht, online at [URL2].

Dreschler, M. and Ridder, H.A.J. de (2006), *Results of an explorative research into value quantification methods*, Proceedings 6th International Postgraduate Research Conference, 588-596.

European Parliament (2004), *Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts*, online at [URL3] (overview page) and [URL4] (specific file).

Goovaerts, A., Ridder, H.A.J. de & Hombergen, L.P.I.M. (2004), *Afwegingsmethodieken – Een overzicht van bestaande methodieken*, KCBPI, Delft.

Pijnacker Hordijk, E.H., van der Bend, G.W. & van Nouhuys, J.F. (2004), *Aanbestedingsrecht – Handboek voor het Europese en het Nederlandse Aanbestedingsrecht*, Sdu Uitgevers bv, Den Haag, 366.

Ridder, H.A.J. de, Klauw, R.A. van der & Vrijhoef, R. (2002), *Het nieuwe bouwen in Nederland*, TNO, Delft.

Roelofs, B. and Reinderink, H. (2005) *Bouworganisatie- en contractvormen – Ordening, standaardisering en toepassing*, ONRI, Den Haag.

Internet sources:

URL1: http://www.ogc.gov.uk/procurement_the_bigger_picture.asp

URL2: http://www.bouwendnederland.nl/_upload/Publicaties/11_publicatie_bestand.pdf

URL3: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0018:EN:NOT

URL4: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2004/l_134/l_13420040430en01140240.pdf

ORGANIZATION CHANGE IN THE RESIDENTIAL BUILDING SECTOR

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ABSTRACT

Traditional organizational structure studies emphasize department groupings and the management style of different organizations that are often based on common tasks, products, geography and processes. In response to competitive pressure, required competence and degree of flexibility necessitated by the changing economic environment, different organization patterns could emerge when major actors in the building sector integrate or differentiate among themselves. The organization structure models presented in this paper focus on the basis of the formation of various supplier housing organization structures and then relate them to organization structures that have existed or could exist in the Swedish residential sector. As a method of general evaluation of different organizational structures, three criteria were chosen as they are in line with the transaction cost approach: flexibility and risk allocation, competition and competence.

1. INTRODUCTION

In recent decades studies in the area of industrial organization have increased dramatically. The fundamental question is why production is organized in a specific way, e.g. what is produced in-house and what is outsourced and bought on the market from external suppliers. This is however a very simplified way of describing the alternatives. Lansley (1994) argues that a construction firm can be seen as a broker of opportunities for projects and as intermediary acquiring resources to undertake building projects. From a functional aspect, Tenah (1986) defines a construction company as a group of people sharing specialized knowledge to design, estimate, bid, procure, and obtain resources to complete a construction project. These functions definitely extend beyond the boundary of a single legal entity and include an interwoven relationship with subcontractors, manufacturers, material suppliers and equipment distributors etc. (Tenah, 1986). Thus, the interaction of these entities and how they transact their services and products shapes the organizational structure of a project and ultimately determines the governance structure of the specific firm (Shirazi et al, 1996). Winch (1989) argues that the prime object of construction management research should be the firm, and the project should be seen as a temporary coalition of these firms together with the client. In line with Winch's argument, we will focus more on the possible organization patterns of the firm - or group of firms - delivering the building project rather than the project itself.

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The objective of this paper is to analyze various models of the construction organization as a whole from the transaction cost theory perspective. A more holistic approach of analyzing the housebuilding industry in relation to different possible organization patterns may enable us to understand the bearers of risk and incentives, responsibility and control mechanism, and consequently it may also shed light on construction cost determinants. The choice of this approach is motivated by the need of a study of construction organizations' structure that focuses more on the nature of the relationships among the participants in the building process, rather than archetypical studies that often are based on the department groupings and management style of different organizations. These grouping are often based on common task, products, geography, and process (Grant, 2005).

The paper starts with a brief introduction followed by the second section that presents some basic models of organization structures in the construction industry. Four major possible organization forms will be presented. In the first model (ODC), the major players of the building process are integrated and market transactions are limited or non-existent. The other three models that are basically an extension of the ODC model envisage a variety of organizational forms that could emerge when different actors in the construction sector interact and the prevailing structure is dictated by the competition and market transactions. The third section explains the theoretical approach and the criteria of evaluating different organization structures. Transaction cost theory in relation to various organization patterns and the basis of three evaluation criteria will also be discussed in this section. Section four covers the evaluation of the different organizational structures and presents stylized history of organization patterns in the Swedish residential construction sector. Opportunities and challenges facing each type of organization pattern in terms of flexibility and risk allocation, competitiveness, and competence are appraised in this section. Section five summarizes this organization patterns and it put forwards future research ideas.

2. ORGANIZATION STRUCTURE IN THE CONSTRUCTION INDUSTRY: THE BASIC MODEL

A housebuliding project is a multi-stage process where developers acquire land, consultants or in-house professionals carry out design and estimation, and (usually) contractors erect actual buildings. Other actors in the building process are subcontractors, manufactures and suppliers of materials, etc. but developers and contractors are generally the main actors in residential housing constructions and hence all other actors directly or indirectly work for them. The client might be a company that is building rental housing that they plan to let themselves, or it might be a company that is building condominiums for sale.

The following four models will be analyzed later in this paper. There are several other models that can be structured but we focus on what seem to be the forms that most often have been observed during the last 50 years. A common feature is that the client is the initial owner of the project and for simplicity; the term owner will be used in the models.

The first model represents an organization that acts as developer/owner and has the capability to construct its own building with no or very small resources from outside. This is called an Owner-Developer-Contractor (fig. 3: ODC). The firm has the human asset capabilities as well as physical assets that are essential to undertake building projects from land development to planning and design phase to construction, and all the intermediate tasks in between. In other words, the large enterprise with centralized hierarchical organization allocates all its sources, products and services internally by administrative means rather than market. A case that could fit the above characterization is a municipal company with input resource and capable to construct its building projects - a type of company that could be found in Sweden in the 1960s but has since then disappeared.

Figure 1. Model ODC: Integrated Owner-Developer-Contractor

A typical structure that also has been found on many markets is whether a separate company carries out the direct building activities. There is competition between different contractors, and the chosen contractor builds from an order decided by the Client/owner/developer. In this model it is assumed that the contractor carries out all the work with his or her own staff. One interpretation is that the building part of an integrated firm now might have been divested and competes with other firms for the job. The relation between the Owner-develop and the contractor can differ considerably depending on the specific contractual form.

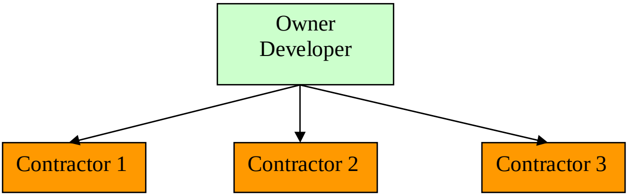


Figure 2. Model OD-C: Owner-Developer and a separate Contractor

In the next model – called OD-C-SC – the contractors in the above model have outsourced considerable parts of the work to subcontractors, who are also hired after some kind of competitive process. These subcontractors can work for anyone of the main contractors.

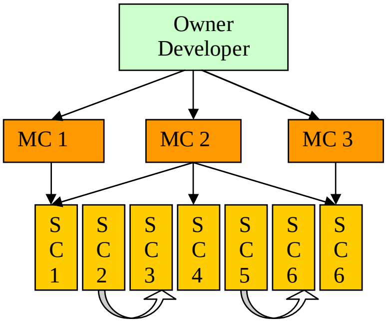
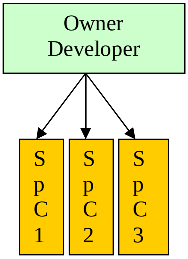


Figure 3. Model OD-C-SC (MC = Main Contractor; SC = Subcontractor)

The subcontracting firms can be active in almost any stage of the work, both as consultants involved in various types of investigations, to carrying out specific work at the construction site. The model described in Figure 3 has for a number of years been the dominating model in the Swedish residential construction sector. In reality there might be further levels of subcontracting where one subcontractor hires another for carrying out part of the work that the first firm has a contract on.

In recent years two more models have been observed. In Figure 4 the owner/developer hires the subcontractors directly instead of going through a (main) contractor, and in Figure 5 the owner/developer hires a special consultant to work with finding and coordinating the subcontractors. There is assumed to be a market for these consultants and competition between different consultancy firms. The next step is to look closer at the theoretical framework that will be used in the comparison of the models.



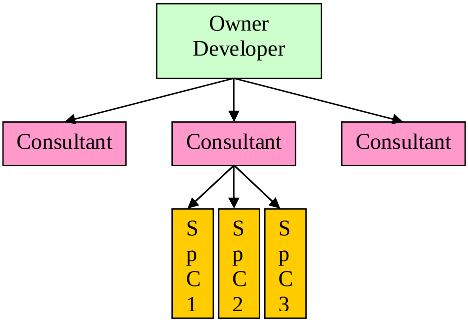


Figure 4. Model OD-SpCs Figure 5. Model OD-Cons-SpCs
(SpCs = Specialty Contractors; Cons= Consultant)

3. THEORETICAL APPROACH AND CRITERIA FOR EVALUATION

3.1 Transaction cost approach

Transaction cost analysis can be made on different levels and Robins (1987) states that the purpose can be either to explain the prevailing institutional structure of society at some point in history or to explain the adoption of specific organizational form in response to conditions faced by any individual firm. It is the second type of analysis that is made in this article and the focus is on three specific aspects: how flexible the organizational model is in situations where the external market changes, how strong competitive pressure is on the activities carried out is, and finally what kind of competence the model demands from the client. The fundamental hypotheses is that organizational change can be seen as a reaction to problems in one or more of these three dimensions, and that the new model can handle these problems better and lead to a more efficient use of resources. New circumstances will, however, sooner or later lead to problems for this model too. In this article, examples from the development of the Swedish house building industry will be used to illustrate the theoretical arguments presented.

Lansley (1994) accentuates the significance of the link between the firm and its environment and how transaction cost approach is useful in explaining issues such as subcontracting, procurement method, horizontal and vertical integration. Williamson's (1975) transaction cost theory, a development of the ideas in Coase (1937), is one of the most important tools that can be used to explain the practice of different contractual forms and procurement methods. Transaction cost approach explicitly regards efficiency as a fundamental element in determining the nature of organizations (Ouchi, 1980). In response to ever-changing business and economic conditions, construction firms adopt different type of organizational structures that influence procurement methods and best economizes on the transaction costs of carrying out building projects. Morris (1972) points out that the effectiveness of the construction process lies in the management of the dynamic interrelationship between various organizations found on a building project17. Briscoe et al (2004) note that an organization's business environment and the procurement route undertaken affect the level of supply chain integration that will affect future procurement decisions.

3.2 Criteria for evaluating organization structure

Different environments, which generate different scale of uncertainty, require varying degrees of separation of organizational units and different degrees of integration. Differentiation and integration of construction organizations in relation to other construction actors have some bearing on how risk is allocated and how organizations respond to economic environment changes (degree of flexibility). Nahapiet and Nahapiet (1985) contend that contracts represent different organizational arrangements for defining and coordinating the contribution of parties involved in the building project. Reve and Levitt (1984) also state that each organization pattern or governance structure corresponds to a particular type of contract ranging from classical contracting in market governance (contingent-claims contracts) to relational contracting in organizational governance (employment contracts). Walker (1996) refers to Lawrence and Lorsch's study (1967), which

[17] Cited in Shirazi et.al (1996)

states that there is no one best way to organize but rather that organization is a function of the nature of the task to be carried out and its environment. The level of separation and integration of the players in the construction process can present many opportunities as well as challenges for each member of the construction project coalition. Grant (2005) claims e.g. that the lack of vertically integration in the construction industry partially reflects the need for flexibility in adjusting to cyclical patterns of demand and different requirements of each project.

Child (1972) argues that environment, technology, and size provide a powerful explanation to the variation of organizational structure. He regards contextual factors as the most important determinant of structural patterns. The characteristics of the business environment in which an organization operates - such as the nature of competition - has a measurable effect on the organizational structure, job design, and upon management (Brooks, 2006). It seems to be a difficult task to provide a unified theory or approach that fully explains the basis of organization structures (Bridge and Tisdell 2004). Thus, a combination of economic theory (transaction cost) and organization theory (resource-based view) as well as contingency theory may provide some understanding of organization structure in the residential sector. As a method of general evaluation of different organizational structures, three rather broad criteria were chosen as they are in line with the transaction cost approach and as they seem to be relevant for the current issue: flexibility and risk allocation, competition, and competence. (See table 1).

1. *Flexibility and Risk Allocation:* This refers to the degree to which an organization is capable to respond to a changing economic environment and the ease with which it efficiently can utilize its resources. Uncertain factors that different parties of construction projects face can be categorized as risk (Ahmed et al, 1999) and how risks are allocated plays a major role for the final construction costs. Typical risks that contractors and owners often try to allocate or share by using various contractual conditions are delays, quality deficiencies, unit price increases, design changes, etc.
   Construction firms are often confronted with uncertainties that arise from workload fluctuations due to the general business cycle of construction activity and the amount and size of contracts rewarded. Workload dynamics may necessitate certain forms of organization structure in order to handle not only risks stemming from business cycle but also successfully bidding and managing projects with the optimal resources allocation.
2. *Competition:* Is there competitive pressure on the parties in the construction organization? In the long run, if an organizational structure leads to a situation where more units of process have to compete with others for work, then it should lead to higher efficiency. From an incentive perspective, Grant (2005) notes e.g. that vertical integration give rise to what are termed low-powered incentives due to the internal supplier-client relationship that is governed by the vertically integrated organization rather than market with its high-powered incentives.
3. *Competence:* Different organizational patterns entail various degrees of competence in order to maintain any edge over an equally competitor actor. There could be several competence issues that could emerge from the formation of different organization patterns. One of them is the kind of competence those actors in the construction project of the different organization structures, especially developers, require for carrying out their tasks efficiently. In an efficient organizational structure all actors must have the right competence and be in a situation where it is possible for them to

keep the competence updated. As an example can be mentioned that it has been argued that competence problems on the developer's side played a major role for quality problems in the late 1990s. As construction activity had been very low in the early 1990s, the developers did not have enough experience.

Table 1. Criteria for evaluating organization structure and their definitions

Criteria	**Definitions**
Flexibility and Risk allocation	Degree and ease in which major construction project parties handle uncertainties posed by changes in the economic environment and the level of demand. It measures organization's capability to adapt economic environment changes.
Competition	Degree to which each organizational unit or subunit is put under competitive pressure.
Competence	The level of competence that an organizational structure requires and the possibilities for the unit and subunits to continuously keep this competence.

4. EVALUATION OF ORGANIZATIONAL STRUCTURES

4.1 Introduction

Construction firms cannot gain a sustained competitive advantage over others because competitive pressures force firms to be more-or-less similar in efficiency (Ball et al, 2000). If that is not the case, the result might be inefficiencies that induce the emergence of new organization pattern. Integration of various actors in the building process increases different means that an organization could earn profits. Barlow and King (1992), claim that the increased use of vertical integration in the building process is an alternative solution that has enabled firms in Sweden to manipulate production costs. Integration of developer and contractor with specialist contractor might increase the competence of the integrated organization, but it may also limit the flexibility of the amalgamated organization to adapt to economic changes. Contrary, a separate developer, contractor and specialist contractor may allow these actors to adopt competitively in the prevailing economic environment and lead to a better risk allocation but the required competence of each actor may increase in order to engage contracting process efficiently and autonomously. Reliance of consultants or other form of contracting could arise in the absence of the essential competence.

Eccles (1981) notes the fundamental questions that vertically integrated firms faces are the extent to which a firm is responsible producing all the required input resources for its output and how to organize the work and manage the relationship between other firms had the firm choose to obtain inputs from these firms. Smaller organizations are characterized by centralization of power for formulation of strategy and adaptability to respond economic changes (Shirazi et al, 1996). However, due to the limited resources in the face of non-integrating, smaller organizations may become inapt to undertake large project or could face input resources shortage during high construction activity that favors large firm. At the same token, large firms with abundant resources may inevitably face the reality of economic downturns where construction activity and demand are low and many firms struggle to utilize their resources efficiently.

Since most of the construction work is obtained on the basis of tender (Gonzalez-Diaz et al, 2000) construction firms often face the daunting task of choosing the right projects that are likely to be rewarded. Firms tender a price that would not only allow them to win the specific contract but also provide them a margin of profit. Similarly, construction firms - big or small - have different capacity to undertake one or few contracts simultaneously and that itself creates a source of uncertainty. There are the times when a general contractor cannot keep a large number of labour specialists because of the great uncertainty about labour needs dictated by the time, location, and specialty (Eccles, 1981). The bulkiness of construction material affects the transportation costs and can result in regionalized market structure (Lowe, 1987) that reduces the flexibility to transfer materials where is needed the most. One of the major advantages of subcontracting is to reduce these uncertainties and pass much of the risk on the subcontractor, given that the subcontractor has other possibilities to handle these risks than the general contractor.

The potential organizational change that any of these criteria – *flexibility and risk allocation, competitiveness, and competence* – could be attributed is not the same. The need for higher flexibility and better risk allocation in an unstable economy and volatile construction activity is much more serious than addressing a higher competence requirement or competitiveness pressure. These criteria can be formulated as hypotheses about when there will be changes in the organizational structure. Such changes are likely:

- when there are other organization forms that can manage risk better;
- when there are other organizational forms that are more efficient because more units are put under competitive pressure;
- when the current organizational form need competences that are difficult to maintain in the organization compared to the situation in other organizational forms.

4.2 From ODC to OD-C model

The Owner-developer-contractor model faces many challenges as well as opportunities ranging from increased risk exposure and bureaucratic costs to improved level of competitiveness in terms of capacity and less reliance on other firms to provide the desired inputs. Uncertainties of the development and construction markets are present simultaneously in the ODC organization model as well as the risk that arises when the organization is not subcontracting. A more unstable economy also causes under-utilization of the resources amassed by this type of firm where the transferability of labour and material from a low to a high demand region is not economical.

The ODC organization type could improve the competitive position of the firm and the competence of its entities. Organizations strive to get bigger by acquiring or merging with other firms in order to benefit the economies of scale or scope. Thus, one can assume that a vertically integrated organization with capital and manpower muscle has improved its competitive advantage. However, small firms and specialty subcontractors have advantage over large firms in many small jobs and repair works (Foster, 1964). Many of the competitive advantages of large firms – wealth, superior technical knowledge, and the scope of standard procedures may become ineffective for small projects and variety of situations encountered (Foster, 1964). Thus, an organization must be large enough to compete and at the same time small enough to specialize in certain construction works.

The main problem with the ODC-organization from the competition point of view are the control problems which means that various parts of the organization might not work efficiently because they are sheltered from competition. The differentiation between owner/developer and contractor presents the developer and with an opportunity to deal with other contracts and practice market deriving procurement. Nevertheless, the separation compels the developer to acquire the necessary competence to efficiently carry out the nuts and bolts of transaction process – from design and specification stage to tendering and procurement of the final product. The OD-C model might replace the ODC model for two reasons.

1. The independent contractor can handle market fluctuation better than the integrated ODC firm.
2. The contractor is put under more competitive pressure as the developer can choose between different contractors. There could be a reduction of bureaucracy costs as result of splitting as well as efficiency due to transacting in arms-length with high-powered market incentives.

4.3 From OD-C to OD-C-SC model

The opportunity to transform fixed costs to variable costs through subcontracting practices is absent in the OD-C model. Thus, this form of organization could still be associated with lack of flexibility and ability to allocate risk. The OD-C-SC tries to rectify this. Reduction of overhead and construction costs stemming from lack of local market knowledge and the need of supervision are some of the benefits that contractors gain from subcontracting

Subcontracting to specialized firms, construction companies can avoid committing themselves to significant investment in terms of labour and other assets. Thus, subcontracting allows construction companies to secure numerical and functional flexibility (Velzen, 2005). An important but rather neglected issue is how subcontractors can handle market risk. There are several possible answers. Subcontractors can of course work for different developers, and they might also be able to work in large regions. They can also informally cooperate with other subcontractors if they have excess supply or excess demand for specialists. They might also work with maintenance projects and directly for owner-occupiers on the housing market. Finally the bankruptcy costs might be lower for a small subcontractor.

The organization model *OD-C-SCs* seem to provide greater flexibility and risk allocation of construction actors by allowing both market contracting and separation of construction activity to development and construction. There still might be a problem of lack of competition in the contractor market as in the OD-C model. If that is the case, developers face competitive pressures to:

- integrate with non-vertically integrated firms or establish a contracting section within their organization;

- protect against opportunistic market driven behaviors with painstaking contract; or
- gravitate towards direct contracting with specialty contractors.

The required competence of the developer in the first scenario is not that of importance unless the developer is permitted to procure projects externally. However, the other two scenarios demand higher developer competence in order to tender, manage, monitor and evaluate the performance of contractors.

4.4 From OD-C-SC to OD-SpCs or OD-Cons-SCs model

Developers have no direct contract with subcontractors in the previous governance forms. Though they are not the real beneficiaries of subcontracting they are still not exempted from any risk from the subcontractor's underperformance. When a frequent developers act as owners/developers of the building projects, specialty contractors and developers get the opportunity to work repeatedly and build long-term relationship. Specialty contractors are not only participants of the new projects offered by the developer but also have the opportunity to carry out repair and renovation works of the old projects owned by the same developer. Thus, it means a reduction of the transaction costs (search cost, administrative and contracting costs, monitoring costs, etc.) for both parties. Learning by doing is an old philosophy that the owner/developer can benefit from. Developers may accumulate the skills and the experience needed to carry out future projects without the employment of an outside agents.

The situation is somewhat different when the developer is not frequently developing building projects. On one hand, specialty contractors and the developer may not have fostered a good working relationship and thus trust and harmony are in short supply. The developer might also not have the skills to find the right specialty contractors and coordinate their work. On the other hand the developer might not want to use the OD-C-SC structure because of the lack of competition between the main contractors. In this situation, the hiring of project leader or consultant firm that could provide necessary skills of contracting is one possible alternative to procure the services and products of subcontractors (this procurement method is also called project management). In a competitive market at the consultant level, a good working relationship would obviously serve the best interest of both the infrequent developer and the consultant. Discontinuous developers need to utilize the expertise and resources of the consultants that frequent developers could have endowed by virtue of building regularly.

In this organization model, the owner/developer's competence and the increased use of subcontracting for risk allocation might not suffice to compete against larger vertically integrated organizations carrying out major projects. Ball et al (2000) state that banks and insurance companies may not be able to monitor contractor performance and rely on size as a proxy for competency and solvency. Thus, larger firms may have an advantage over smaller firms when it comes to financing. The competition could be even tougher in big cites or a growing region where a high concentration of large contractors is likely to be present. Often these owner/developers organization operate at the regional level and medium cities where the developer and few specialty contractors could develop a dyadic relationship rather than a market driven relationship.

4.5 The most recent development

There are probably many reasons that construction actors choose to integrate or differentiate. Turner (1997) emphasize that depressed economic situations and reduction of general housing subsidies in the private rented sector forces municipal companies to be more efficient and more businesslike in order to be able to handle a harsher economic situation. In Sweden, the number of firms that are active both as developers and contractors is not that quite high but there are couple more developers or contractors, specially medium-size firms, who joined the dominant four vertically firms.

It is not only the developers who are forced or motivated to integrate but contractors also could initiate the integration process. Contractor who wants to enter rental markets or build his own projects in order to maintain the productivity of its resources may integrate with developer or create a separate division that fulfils these objectives. A survey carried out by Warsame (2006) found that some developers in small regions of Sweden have raised concerns on large, vertically integrated contractors entering rental markets that are already experiencing lack of competition among big contractors. One of the motives of large contractors to engage in the rental market could come from their anticipation of subsidy policy changes that will restrict subsidies to only rental projects rather than to all residential building projects.

5. CONCLUSIONS

A better understanding of the various organization structure models as well as the economic and market forces that determines their efficiency could not only help to enlighten construction cost increase differences among the Swedish regions, but it could assist to predict what kind of organization structure would emerge in the coming period. Will the dominating position of the big contractors be broken by the use of consultants and specialty contractors? Will the big contractors then respond by being even more active as developers themselves?

The use of transaction cost theory as a tool for exploring different organization structures in the construction sector from an efficiency perspective makes it easier to predict how major actors in the building projects respond to economic and business challenges that are vital for their survival. It may explain why certain organization structures have dominated at some point in time. It helps to reveal forces (competitive pressure, higher level of required competence, greater flexibility etc.) that make it necessary to bring another form of organization.

Four main organization models were envisioned to prevail when major actors in the building process are allowed to integrate or separate in response to uncertainty and ever-changing construction business. The Owner-developer-contractor model faces many challenges as well as opportunities ranging from increased risk exposure and bureaucratic costs to improved level of competitiveness in terms of capacity and less reliance on other firms to provide the desired inputs. A more unstable economy also causes under-utilization of the resources amassed by this type of firm where the transferability of labour and material from a low to a high demand region is not economical.

A separate owner/developer and contractor structure with permitted subcontracting practices might provide risk reduction and greater flexibility. Risk is allocated to those who can handle it better. Actors are able to enter market arrangements that would allow them to minimize their exposure to market volatility. When major actors deal directly with specialty contractors or are subcontracting, it enables them to reduce overhead and construction costs stemming from uncertainties of workload and lack of local knowledge. The use of consultants could arise when developers infrequently undertake projects and thus lack the resources and skills necessary to successfully carry out building projects.

The organization patterns presented in this paper as well as the presumed differentiating factors (flexibility and risk allocation, competition, and competence) that instigate such organization structure changes have not been empirically tested. The author intends to carry out a semi-structure survey in Sweden and other countries with similar housing markets and policies. The study will explore the effects of exogenous environment factors namely competition and uncertainty as well as endogenous factors such as developer's required competence on the prevailing and past organization structures.

6. REFERENCES

Ahmed, S., Ahmed, R., and Saram, D. (1999), Risk management trends in the Hong Kong construction: a comparison of contractors and owners perception, Engineering, *Construction and Architectural Management*, **6**(3), 225-234.

Ball, M., Farshchi, M., and Grilli, M. (2000), Competition and the persistence of profits in the UK construction industry, *Construction Management and Economics*, **18**, 733-745.

Barlow, J. and King, A. (1992), The state, the market, and competitive strategy: the housebuilding industry in the United Kingdom, France, and Sweden, Environment and Planning A, **42**, 381-400.

Bridge, A. and Tisdell, C. (2004), The determinants of the vertical boundaries of the construction firm , *Construction Management and Economics*, **22**, 807-825.

Briscoe, G., Dainty, A., Millett, S., and Neale, R. (2004), Client-led strategies for construction supply chain improvement, *Construction Management and Economics*, **22**, 193-201.

Brooks, I. (2006), Organizational Behaviour: Individual, Groups and Organization Third Edition, London, Prentice Hall, 134-135.

Child, J. (1972), Organizational Structure, Environment and Performance: The Role of Strategic Choice, *Sociology*, **6**(1).

Coase, R. (1937), The Nature of the Firm, *Economica*, **4**(16), 386-405.

Eccles, R. (1981), Bureaucratic versus craft administration: the relationship of market structure to the construction firm, *Administrative Science Quarterly*, **26**(3), 449-469.

Foster, C. (1964), Competition and Organization in Building, *Journal of Industrial Economics*, **12**(3), 163-174.

Gonzalez-Diaz, M., Arrunada, B. and Fernandez, A. (2000) Causes of subcontracting: evidence from panel data on construction firms, *Journal of Economic Behavior & Organization*, **42**, 167–187.

Grant, R. (2005), Contemporary strategy analysis, Fifth Edition, Oxford, Blackwell Publishing, 202-204.
Lansley, P. (1994), Analysing construction organizations, *Construction Management and Economics*, **12**, 337-348.
Lawrence, P. and Lorsch, J. (1967), Organization and Environment: Managing differentiation and integration, Boston: Graduate School of Business Administration, Harvard University.
Lowe, J. (1987), Monopoly and the material supply industries of the UK, *Construction Management and Economics*, **5**, 57-71.
Morris, P. (1972), *A study of selected building projects in the context of theories of organization*, PhD Thesis, Department of Building, UMIST, Manchester.
Nahapiet, H and Nahapiet, J (1985), A comparison of contractual arrangements for building projects, *Construction Management and Economics*, **3**, 217-231.
Ouchi, W. (1980), Markets, bureaucracies, and clans, *Administrative Science Quarterly*, **25**, 129-141.
Robins, J. (1987), Organizational economics: Notes on the use of transaction theory in the study of organizations, Administrative Science Quarterly, **32**, 68-86.
Shirazi, B., Langford, D., and Rowlinson, S. (1996), Organizational structures in the construction industry, *Construction Management and Economics*, **14**, 199-212.
Tenah, K. (1986), Management level as defined and applied within a construction organization by some US contractors and engineers, *Project Management*, **4**(4), 195-204.
Velzen, M. (2005), Building on Flexibility, Training for Construction: A Comparison of Training Arrangements for Flexible Workers in the Dutch and American Construction Industries. In: I.U. Zeytinoglu (ed.), *Flexibility in Workplaces: Effects on Workers, Work Environment and the Unions*, Geneva: IIRA/ILO.
Walker, A. (1996), *Project Management in Construction*, Third Edition, Oxford Blackwell Science.
Warsame, A. (2006), *Long run relationships, Vertical Integration and International Competition: Can they contribute to explaining regional construction cost differences?* Licentiate Thesis, Department of Real Estate and Construction Management, Royal Institute of Technology (KTH).
Williamson, O. (1975), *Markets and hierarchies*, New York, Free Press.
Winch, G. (1989), The construction firm and the construction project: a transaction cost approach, *Construction Management and Economics*, **7**, 331-345.

DECISION-MAKING PRACTICE IN THE DUTCH REAL ESTATE DEVELOPMENT SECTOR

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ABSTRACT

Investment decisions are presented as strategic decisions within the real estate development sector. These decisions are about allocating financial resources to a development project and as a consequence accepting the risks that result from this commitment. As risk is a consequence of a decision, decision making and risk management are intertwined. To get a better understanding of the way real estate developers treat risk, the decision process of a Dutch real estate development organisation is analysed according to six strategic decision process characteristics. From the analysis, it is concluded that a series of risk management strategies is incorporated in the decision making process. Moreover, indications are found for the explanation of organisational risk behaviour.

1. INTRODUCTION

Managing a real estate development project is inherent to risk taking. However, from previous research (Akintoye and MacLeod, 1997; Gehner, Halman and Jonge, 2006; Lyons and Skitmore, 2004) can be concluded that in this sector risk analysis techniques are hardly used, because of lack of objective data, time constraints, and lack of confidence in the outcomes. Apparently, other methods are used to manage risks in a project successfully. In order to gain insight in these methods, a merely technocratic approach to risk management seems insufficient. The technocratic approach views risk as a probability of an event multiplied by the magnitude of loss related to that event (Raftery, 1994). However, risk should be seen in a broader, cognitive and sociological, context in which individuals perceive risk differently and their willingness to take risk varies (Sitkin and Pablo, 1992). Thus, risk must be seen in the context of choice (Stallen, 2002) or in other words, ‘risk is a consequence of a decision’ (Luhmann, 1993). This implies that the way real estate developers treat risk is expressed to a large extent in the decision-making process. A lot of research is carried out on decision-making, but not in this particular sector and not specifically from this perspective. Therefore, research on the decision-making process is needed in order to understand how risks are treated and how the risk management process could be facilitated in the real estate development sector. In this paper, a single case study of a Dutch real estate development organisation is analysed using a framework derived from the strategic decision making literature in order to obtain an understanding of how the decision making process is organised and contributes to risk management.

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2. LITERATURE REVIEW

During a real estate development process hundreds of decisions are made before a project comes to completion. In the first section one group of decisions, the so-called investment decisions, are typified as strategic decisions from the perspective of a real estate development organisation. In the second section the characteristics of strategic decision making processes are presented and related to the stages of decision making and risk management. This review results in an analysis framework for the decision making practice in real estate development.

2.1 Investment decisions in real estate development

The real estate development process is a complex and lengthy process in which a wide variety of risks is encountered. During this process a developer is responsible for all activities that range from the purchase of raw land, coordinating the design and construction process, the application of building permits, and the sale of the real estate (Peiser and Frej, 2003). The start of a process is characterized by a lot of uncertainty, while initial investments are low, and during the process uncertainty is reduced while the financial investment strongly increases correspondingly with signing some major contracts (Gehner and Jonge, 2005). By signing a contract a developer commits himself to a certain course of action and a corresponding investment or income. Taking this decision means that he agrees upon the risks coming with all commitments made and the level of influence left to manage these risks. The major contracts in a real estate development process are the land purchase contract, the cooperation agreement with a municipality, the tender and real estate contracts (rental or sale). The signing of these contracts usually announces a new phase of the process. At the gates between two phases so-called investment decisions are made to agree upon the contractual commitment. Investment decisions are considered strategic for several reasons. In the first place, a decision is strategic when the decision is 'important, in terms of the actions taken, the resources committed, or the precedents set' (Mintzberg, Raisinghani and Théorêt, 1976), or in other words 'that critically affect organisational health and survival' (Eisenhardt and Zbaracki, 1992). From the perspective of a project, the importance is obvious. But also from the perspective of the organisation the importance is high, as the financial resources committed to this kind of decisions demand a considerable amount of equity. Depending on the contractual commitments, the same amount of equity could be at risk in the worst case scenario. In the second place, a strategic decision is about 'the determination of the basic long-term goals and objectives of an enterprise' (Ghemawat, 1999). Although the investment decision is directed in the first place towards the course of action of the project itself, it also directs the goals and objectives of the organisation. The commitments in a real estate development project are made for a time period of easily 5 to 10 years. During this period the equity demand of a project restrains the organisation to acquire new projects, thus the (middle) long term strategy is set by an investment decision.

In the third place, a decision is strategic when it concerns 'those infrequent decisions made by the top leaders of an organisation' (Eisenhardt and Zbaracki, 1992). Investment decisions are not made by the project manager itself, but only 'a person in authority' (Nutt, 2005), that is someone at the strategic level of a development organisation, is empowered to make such decisions.

This analysis lead to the following definition: an investment decision is a commitment to the allocation of financial resources to a project taking in consideration the goals of the project as well as the objectives of the organisation which is made by the strategic level of a real estate development organisation as the risks involved could lead to a significant negative impact on the survival of the organisation. Still, two important remarks must be made. First, strategic decision making focuses on infrequent decisions. However, in each real estate development several investment decisions are made, which do not differ that much as for the type of decision problem. Unfamiliarity with the decision problem remains, as each project differs largely in spatial and economical context, parties involved and the program of requirements. Second, Dutch real estate development organisations are relatively small organisations with quite straightforward organisational structures. Communication lines between the operational level of the project manager and the strategic level of decision makers are shorter than usually is the case in cases described in literature on strategic decision making (e.g. Mintzberg, Raisinghani and Théorêt, 1976; Nutt, 2004; Eisenhardt and Bourgeois III, 1988).

2.2 The strategic decision making process

Decades of research on strategic decision making has shown that these processes can be described in similar general stages such as identification – development – selection (Mintzberg, Raisinghani and Théorêt, 1976), intelligence – design – choice (Simon, 1977), awareness – analysis – action (Noorderhaven, 1995), and framing – gathering intelligence – coming to conclusions – learning from feedback (Russo and Schoemaker, 2002). These stages have similarities with the stages in a risk management cycle, being objective setting – risk identification and assessment – risk response – risk control and monitoring (Association for Project Management, 2004). Thus, looking at the stages of decision making gives us at the same time insight in how the risk management steps are carried out. However, the problem with these models of decision making is that the stages are too generic to serve as a framework to analyze decision making processes. A framework for analysis needs to consist of distinguishing factors regarding both the content of the decision and the subjects carrying out the process. Fredrickson (1983) identified six major characteristics to distinguish different types of processes, being 'process initiation, role of goals, the means/ends relationship, the explanation of strategic action, the comprehensiveness of decision making, the comprehensiveness in integrating decisions'.

First, the process of initiation is related to the stage of identification and can be described in terms of how (reactive or proactive to a problem, or risks) and where (at what level of an organisation) the decision making process is initiated. Second, goals play an important role in the stage of selection: are goals conceptualized in precise or general decision criteria, and are these criteria determined on a basis of individual or organisational objectives? A third question is whether the goals are irreversible and persistent regardless of the available means. This question is addressed in the development as well as in the selection stage. Both stages of development and selection can as a fourth aspect be explained by the extent that a process is intentionally rational, the result of a social process or highly influenced by politics and power (Eisenhardt and Zbaracki, 1992). Fifthly, the cognitive perspective is used to determine the comprehensiveness of each stage in the decision making process: to what extent is a decision maker influenced by its cognitive limitations and perceptions? These questions all refer to an individual decision. Finally, the sixth characteristic is about the level of integration between individual decisions towards an overall strategy.

2.2 Decision making and risk behaviour

The six strategic decision process characteristics are used as a framework to describe the decision making practice in a Dutch real estate development company. Moreover, an analysis is made to what extent a particular characteristic contributes specifically to the management of risks. The final aim of a broader research than is presented in this paper is to explain the mechanisms that steer the decision making process and thereby the risk behaviour. Not only individual characteristics influencing risk perception and propensity (March and Shapira, 1987) are taken into account, but also organisational factors. Fredrickson (1986) already explained the relationship between the structure of an organisation and the strategic decision process, but also cultural aspects as well as the financial structure and the position on the life cycle of an organisation are assumed to influence risk behaviour.

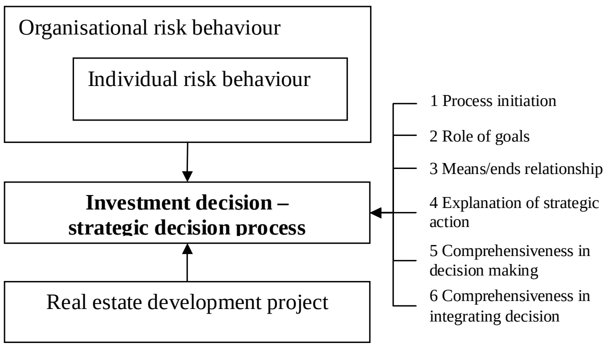

Figure 1. Case study analysis framework

3. RESEARCH PROJECT

In this paper the preliminary results are presented from a case study conducted at a Dutch real estate development organisation. This case study is part of a PhD research in which a multiple case study is carried out to explore the strategic decision making processes in the real estate development sector to analyze the risk management strategies making part of the development process and explaining the differences in risk taking behaviour from the perspective of the organisation as well as from the individual perspective.

3.1 Project description and objectives

From the previous section it can be concluded that investment decisions in real estate development can be labelled as strategic decisions which reflect the risk behaviour of an organisation. As the application of formal risk analysis techniques is often not present in real estate development organisations, the aim of this research is to get an understanding what risk management strategies – other than or next to the formal risks analysis techniques – are part of the strategic decision making process. In order to get insight the following successive research questions are asked.

- How are investment decisions made in real estate development?
- What risk management strategies are, explicitly or implicitly, incorporated in the decision making process?
- Which characteristics of the organisation as well as the individual are explanatory for the revealed risk behaviour?

The strategic decision making process is described making use of the six characteristics by Fredrickson (1983) presented in figure 1. Per characteristic it is questioned to what extent the way the decision making process is executed contributes to managing the risks in a real estate development project. Finally, some hypotheses are presented that might explain the risk behaviour a real estate development organisation. The testing of these hypotheses is a starting point for further research.

3.2 Research methodology

The objective of this research implies an in-depth, holistic analysis of the decision making process of a real estate development organisation to explore explicitly and implicitly used risk management strategies. To study such a social phenomenon, in general three research strategies can be distinguished: a survey, an experiment and a case study (Braster, 2000). A survey is well suited to research social phenomena on a large scale but only superficial. To conduct a survey it is necessary to have a well-defined conceptual model with a limited number of variables. Quantitative methods are used to analyze data, thus statistical validity of this research strategy is high, but it does not give profound insight in the studied phenomenon. An experiment is an appropriate method to gain deeper knowledge by conducting a controlled test of a hypothesis. The general procedure is one or more independent variables are manipulated to determine their effect on a dependent variable, whilst so-called antecedent or intervening variables are eliminated or controlled. Experiments are carried out by cognitive psychologists on individual decision making in game situations and by social psychologists on group decision making in the laboratory (Mintzberg, Raisinghani and Théorêt, 1976). A case study is well suited for understanding the ‘how and why?’ of phenomena in their natural settings (Yin, 1989). Multiple research methods are used to collect data on a wide variety of variables. In contrast with both a survey and an experiment a qualitative method is used to analyze the data.

To research investment decisions in real estate development we chose for a case study, in the first place because the nature of the research is exploratory and not limited to certain variables and their causal relations. Secondly, we want to research the decision making process within the real-life context of the organisation. All variables are taken into consideration and not decoupled as with an experiment.

Case selection
The case study design consists of three cases for literal replication (Yin, 1989). However, this paper only presents results of the first case study. For each case study

a real estate development organisation is selected based on its portfolio, financial independency, track record/image, and internal stability. We made a selection of Dutch real estate developers with a development portfolio all around the Netherlands and with an investment value over € 250 mln ((m^2 x rental value)/(m^2 x gross yield)). The reason for using this criterion is that those organisations are able to develop projects of a substantial size with corresponding risks. The second criterion is related to the different types of developers that are distinguished in the Netherlands: those related to a financial institution, to a contractor, to an investor, to a housing corporation, and independent developers. We selected only independent developers as the core business of these organisations is to develop real estate project in order to make a financial benefit. This aim is not contaminated with objectives of other business units. The third criterion is a good track record and entrepreneurial or risk-taking image within the building sector. This criterion is not a hard, objective criterion, but gives an idea how an organisation is perceived by other parties involved. Moreover, a good track record implies that risks are adequately managed. The final criterion is the internal stability of an organisation. Structural changes, such as a merger or take over, can strongly influence the decision making process and therefore are left out of consideration. For confidential reasons the selected real estate development organisation is put forward anonymously.

Data collection

Within the case study multiple methods are used to collect data to counter the intrinsic subjectivity of this research strategy. In the first place a total of 13 in-depth interviews are conducted with 12 representatives of each part of the organisation (Mintzberg, 1979): the operational level (4 project managers), the middle level (1 program manager), the strategic level (3 members of the board), the technostructure (2 financial analysts) and the support staff (2 secretaries). The interviews varied in length from 25 to 90 minutes. The average interview took about 60 minutes. We used semi-structured interviews based on a list of topics (table 1) for which the interviewees did not have to prepare. For each interviewee, these topics were adapted to his or her specific functional level in the development project and his or her role in the decision making process. During the interviews, notes were made and these notes were used to type the interview transcripts. Unless the interviewee objected, the interview was recorded and the recordings were used to supplement the interview transcripts.

Complementary to the interviews documents were analyzed regarding the decision making process in the broadest sense as well as for three particular projects. Those documents included strategic documents (organisational structure, annual report, code of conduct), tactical documents (project handbook, meeting schedules), and operational documents (budget request form, budget reports, project reports).
The third method to collect data was participatory observation. During the 7 weeks the case study was conducted all strategic meetings concerning investment decisions were attended. During these meetings notes were made on what issues were discussed, who brought these issues up, how they came to a conclusion, and how the decision was formulated.

Data analysis methodology

The method described here is only directed at the single case study which serves as the basis for a cross case analysis. The first step in the analysis is a description of the intentional decision process derived from the formal documents and partly from the interviews. The second step in the analysis is the description of the actual decision process observed during the strategic meetings and derived from the interviews focusing on three particular projects. The third step is to deduce risk management strategies from the strategic decision process: how does the decision process contribute to the management of risks? The final step is the comparison of these two processes and finding explanations in existing theory for differences between the actual and intentional decision process and the risk behaviour.

4. RESEARCH RESULTS AND INDUSTRIAL IMPACT

The selected case is a Dutch, independent real estate development organisation with a development portfolio of around € 1,0 - 1,5 billion per 01-01-2006 (Enk, 2006) with a mix of retail, leisure, commercial and business-to-business functions. The investment decision process is described following the characteristics (Fredrickson, 1986) presented in figure 1. Per characteristic is indicated to what extent the decision process contributes to risk management.

4.1 Results

Process initiation
In the project handbook of the organisation under study is formalized that the development process is divided into six phases – acquisition, initiative, pre-development, development, construction, management – and in between two phases an investment decision has to be made (see figure 2). The investment decision is about allocating a budget to spend on a specified set of activities in the next phase of the development process. According to the organisational structure it is the responsibility of the project manager to initiate the decision process. A project manager recognizes the need to request a new budget when he wants to start new activities for which no budget is allocated yet, or when he runs over budget while activities are not yet completed.

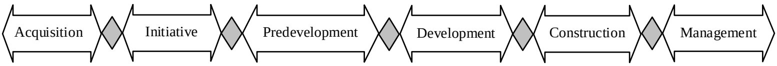

Figure 2. Phases and investment decisions of the real estate development process

The phasing of the development process – and therefore determining decision moments – as well as allocating a limited budget to each phase – thus restricting decision authority – are means of managing risk. However, budget and activities are coupled without taking the factor time in account. This means that when investments are made, but activities have no result, this could remain unrecognized. A monitoring system could be a solution to this problem, which takes away some responsibility of the project manager.

Role of goals
For each decision moment explicit decision criteria are formally determined. Those criteria are conceptualizations of organisational-level goals to the level of detail of activities in each phase of the development project. For example, at the initial stage an inventory must be done on the (anticipated) zoning plan, a program of requirements is to be formulated and a market feasibility report is required. The

criteria become more measurable in the course of the process: as for the start of construction a project must be tendered, the building permit must be in possession and over 70% of the rentable area must be leased. Next to goals related to the status quo of a project at a particular decision moment, future goals are set in terms of the expected return on investment.

Determining preliminary results for a phase as decision criteria to enter a new phase is a risk management strategy. It ensures a certain amount of certainty and limits the amount of risk to be taken in the next phase by agreeing on future financial commitments by allocating budget. The openness on goals gives the project manager the freedom to operate within clear boundaries, whereas the decision makers are forced to act according to these goals and let individuals goals not prevail. Downside of preset criteria based on profitability is that there is little room for other strategic goals to take along in the decision.

Means/ends relationship
The goals or ends mentioned in the previous section, the expected return as well as the preliminary results, are minimum criteria. An unconditional budget approval (the so-called 'go'-decision) is only possible when all criteria are met. Deviations from these criteria are not acceptable, unless (1) budget and time are limited or (2) conditions regarding the activities (an alternative strategy) is set.
Those limitations being part of the decision are measures to optimize the development strategy (allocation of means) and at the same time managing risks by (1) limiting risk by limiting expenditures or (2) reducing or transferring risk by improving a deal or financial structure. The decision makers must not become inflexible due to the set of criteria, but also act as an advisory body for the project manager.

Explanation of strategic action
As the decision criteria are not arbitrary, but explicit and familiar both to project managers and decision makers, the decision making process can be described as intentionally rational. Still, good information is necessary to make an adequate, rational choice. The project information is provided by the project manager, which is always influenced by his or her subjective perception. Therefore the decision process is organized as a two-step process. First the project is assessed merely on its content – the progress of activities – by program managers. If they approve on the budget request, the project is evaluated on its financial terms by the investment committee.

The structure of the decision process functions as a risk management method in the sense that it strives for inter-subjectivity. Dividing the decision in two parts based on different fields of interest and composing groups by experienced people with different amount of involvement in the project contribute to an objective, rational choice.

Comprehensiveness of decision making
The two-step decision process and the group composition already decreases cognitive limitations during the process of 'intelligence – design – choice' (Simon, 1977). Yet, the comprehensiveness depends to a large extent on the quality of the information provided by the project manager. The information coming along with the budget request consists of a memo and an investment budget. The memo is presented in a standardized format consisting of five categories of activities (corresponding with the decision criteria) – land, building/permits, budget, marketing, and financing – in which the status quo is described. With regard to risk

management, a qualitative description of risks is added, but no formal quantitative risk analysis is made. Supplementary is a visual presentation of the progress of activities using a spider diagram.

The decision makers prepare themselves by reading the budget request; the decision is only arrived at during a group discussion. During this discussion additional information is asked for, assumptions are questioned, and alternative scenarios (risks) and strategies (risk measures) are - unsystematically - evoked and evaluated. Finally, a decision, possibly with additional conditions or limitations, is proposed and adjusted until an unanimous decision is reached.

Comprehensiveness in integrating decisions
The standardisation of goals implies an equal contribution of each project to the overall strategy of the organisation. Still, investment decisions need to be integrated with regard to cash flow planning as the organisation has only a limited amount of equity at its disposal. Diversification in type and phases of projects is desirable to distribute cash flows evenly. Moreover, it is attempted to keep initial investments low and finance substantial investments with outside capital of private equity providers or financial institutions, thereby transferring risk in exchange for a share in the return. The bottom line for allocating budget to (new) projects is that the loss of breakdown of all projects is smaller than the organisation's equity capital, so the survival of the organisation is not endangered.

The financial structuring of a project is an important method to manage risks, especially the risk of breakdown. However, only a few persons have insight in the total cash position of the organisation, thus only those people are able to take this along in the decision. To enable others to make a comprehensive decision, a rule of thumb is set on the acceptable level of risk of breakdown.

4.2 Implementation and exploitation

The results are only still based on a first case study of a total of three case studies. All three organisations are selected as best practices, thus the results are in the first place examples to learn from. The lessons are directed at how the decision process is structured, what kind of information is used to support decision making and how information is handled, and which risk management strategies are applied. As a next step the findings should lead to recommendations on the effectiveness and efficiency of implementing decision support tools to better respond to and control risks in the real estate development process.

As suggested in figure 1, a decision does not only depend on the risk profile of the real estate development project, but also on the characteristics of the organisation and the (group of) individual decision maker(s). With regard to the behaviour of individuals a lot of research on this topic has been done, merely in the field of cognitive psychology (March and Shapira, 1987; Tversky and Kahneman, 1974; Sitkin and Pablo, 1992; Simon, Houghton and Aquino, 2000). As to the influence of the organisational structure, Fredrickson (1986) described the influence of three archetypical structures on the strategic decision process.

From this particular case study two characteristics seem to influence risk behaviour largely. The first is the culture of the organisation which in this case is strongly based on trust and entrepreneurship. Since entrepreneurship is delegated at the operational level, a lot of responsibility is given to the project managers. They act within the set of decision criteria; when making an investment proposal the decision makers rely on the sincerity and knowledge of the project manager. The second characteristic is the equity position of the organisation. In the case study the financial structuring of a project is emphasized, as the equity position is limited and therefore the risk taking capacity is limited. In further research more attention needs to be given to the influence of the organisational structure, culture and (financial) means on the risk behaviour.

5. CONCLUSIONS

Investment decisions are presented as strategic decisions within the real estate development sector. These decisions are about allocating financial resources to a development project and as a consequence accepting the risks that result from this commitment. As risk is a consequence of a decision, decision making and risk management are intertwined. To get a better understanding of the way real estate developers treat risk, the decision process of a Dutch real estate development organisation is analysed following the strategic decision process characteristics defined by Fredrickson (1983).

From the analysis can be concluded that a series of risk management strategies is, sometimes explicitly, but also implicitly, incorporated in the decision making process. In the first place at the gates between two phases of the development process a decision is made regarding the allocation of a limited budget to a new phase, thus limiting the amount of risk and knowingly taking risks. To support the decision making process a set of decision criteria is explicitly determined that guarantee a certain level of certainty and therefore a level of risk reduction. This set of criteria serves as a guideline from which one can only deviate suggesting a grounded proposal to manage risk in a different way. For example by transferring risk or taking more risk but limited to a certain point in time or to a certain amount. To respond adequately to the investment proposal and the related risk, one strives for inter-subjectivity by a two-step decision process and by composing groups of experienced people with different disciplines. During the discussion leading to a decision they weigh several scenarios, ascertain that the worst case scenario does not endanger the survival of the organisation and develop fall back strategies. Based on this unsystematic risk analysis they reach a decision.

This paper demonstrates that the approach of examining risk management by enquiring the decision making process is relevant. Although the results are only based on one case study, the research will be extended with more empirical material. The final aim is to contribute to the implementation of effective and efficient risk management strategies: not based on formal risk analysis techniques, but on the conditional requirements of organisational risk behaviour.

6. REFERENCES

Akintoye, A. S. & MacLeod, M. J. (1997) Risk analysis and management in construction. *International Journal of Project Management*, **15**(1), 31-38.
Association for Project Management (2004) *Project Risk Analysis and Management Guide*, Buckinghamshire, APM Publishing Limited.

Braster, J. F. A. (2000) *De kern van casestudy's*, Assen, Van Gorcum.
Eisenhardt, K. M. & Bourgeois III, L. J. (1988) Politics of strategic decision making in high-velocity environments: toward a midrange theory. *Academy of Management Journal*, **31**(4), 737-770.
Eisenhardt, K. M. & Zbaracki, M. J. (1992) Strategic decision making. *Strategic Management Journal*, **13**, 17-37.
Enk, W. v. (2006) Top-101 Ontwikkelaars. *PropertyNL Magazine*, **6**(17), 49-67.
Fredrickson, J. W. (1983) Strategic process research: questions and recommendations. *Academy of management review*, **8**(4), 565-575.
Fredrickson, J. W. (1986) The strategic decision process and organizational structure. *Academy of Management Review*, **11**(2), 280-297.
Gehner, E., Halman, J. I. M. & Jonge, H. d. (2006) Risk management in the Dutch real estate development sector: a survey. In Amaratunga, D., et al. (Eds.) *6th International Postgraduate Research Conference*. Delft University of Technology, University of Salford, 541-552.
Gehner, E. & Jonge, H. d. (2005) A cognitive perspective on risk management in real estate development. In Wang, Y., et al. (Eds.) *International Conference on Construction and Real Estate Management*. Penang, China Architecture & Building Press, 739-744.
Ghemawat, P. (1999) *Strategy and the Business Landscape*, Reading, Addison-Wesley.
Luhmann, N. (1993) Risk: a sociological theory, Berlin, Walter de Gruyter.
Lyons, T. & Skitmore, M. (2004) Project risk management in the Queensland engineering construction industry: a survey. *International Journal of Project Management*, **22**(1), 51-61.
March, J. G. & Shapira, Z. (1987) Managerial perspectives on risk and risk taking. *Management science*, **33**(11), 1404-1418.
Mintzberg, H. (1979) *The structuring of organizations: a synthesis of the research*, Englewood Cliffs, N.J., Prentice-Hall.
Mintzberg, H., Raisinghani, D. & Théorêt, A. (1976) The structure of 'unstructured' decision processes. *Administrative Science Quarterly*, **21**, 246-275.
Noorderhaven, N. G. (1995) *Strategic decision making*, Wokingham, Addison-Wesley.
Nutt, P. C. (2004) Averting decision debacles. *Technological Forecasting and Social Change*, **71**(3), 239-265.
Nutt, P. C. (2005) Search during decision making. *European Journal of Operational Research*, **160**(3), 851-876.
Peiser, R. B. & Frej, A. B. (2003) *Professional Real Estate Development; The ULI Guide to the Business*, Washington, Urban Land Institute.
Raftery, J. (1994) *Risk analysis in project management*, Londen, E. & F.N.Spon.
Russo, J. E. & Schoemaker, P. H. (2002) *Effectieve besluitvorming: toepassingen, oplossingen en technieken van kritisch denken en goede besluitvorming*, Amsterdam, Uitgeverij Nieuwezijds.
Schmidt, J. B. & Calantone, R. J. (2002) Escalation of commitment during new product development. *Journal of the academy of marketing science*, **30**(2), 103-118.
Simon, H. A. (1977) *The new science of management decision*, New Jersey, Prentice-Hall.
Simon, M., Houghton, S. M. & Aquino, K. (2000) Cognitive biases, risk perception, and venture formation: How individuals decide to start companies. *Journal of Business Venturing*, **15**(2), 113-134.
Sitkin, S. B. & Pablo, A. L. (1992) Reconceptualizing the determinants of risk behavior. *Academy of management review*, **17**(1), 9-38.

Stallen, P. J. M. (2002) Risico is bias; en het kan ook niet anders. *Bedrijfskunde*, **74**(3), 14-20.
Tversky, A. & Kahneman, D. (1974) Judgment under uncertainty : heuristics and biases. *Science*, **185**, 1124-1131.
Weick, K. E. & Sutcliffe, K. M. (2001) *Managing the unexpected; Assuring high performance in an age of complexity*, San Francisco, Jossey-Bass.
Yin, R. K. (1989) *Case Study Research: Design and Methods*, London, Sage.

WHAT MAKES IT SLOW? A QUESTIONNAIRE SURVEY OF ENVIRONMENTAL ATTITUDES, MANAGEMENT AND PERFORMANCE

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ABSTRACT

Over the last two decades the Swedish building industry has made much effort to develop green building practices. Researchers within the field have provided theoretical knowledge on how to design green buildings and analytical environmental management tools have been developed to guide practitioners. Information campaigns have raised the general environmental awareness among building practitioners. In spite of these efforts, mainstream building practices do not seem to have undergone any marked changes. This raises the question of how environmental issues actually are dealt with in the building industry. Has the development stagnated and, if so, why? What causes green innovation inertia in the Swedish building industry? What makes it slow? This paper provides some answers to these questions by empirically examining environmental attitudes, management and performance in the industry. The paper is based on a structured questionnaire survey directed to environmental managers at all companies in Sweden with at least 50 employees within technical consultants, building constructors, and property owners and managers and companies with at least 20 employees within architecture. The response rate was 45.4% which corresponds to 246 respondents. The study detects possible causes to deficiencies and creates larger understanding as to why the development, despite much effort, sometimes does not go in the direction as intended by top management. Focusing on relations between the definition of environmental challenge, measures adopted and results from measures, the paper identifies trends and institutionalising processes that hinder sustainable development within the building industry.

1. INTRODUCTION

Over the last two decades the Swedish building industry has made much effort to develop green building practices. Researchers within the field have provided theoretical knowledge on how to design green buildings and analytical environmental management tools have been developed to guide the practitioners. Information campaigns have raised the general environmental awareness among building practitioners. In spite of these efforts, mainstream building practices do not seem to have undergone any marked changes (Gluch, 2005; Femenías, 2004). This raises the

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questions: why is it so difficult to incorporate environmental issues into mainstream building business? How are environmental issues actually dealt with in the building industry? Has the development stagnated? What causes green innovation inertia in the Swedish building industry? What makes it slow?

This paper aims to provide some answers to this question by empirically examine environmental attitudes, management and performance in the Swedish building industry. The paper is based on a questionnaire survey carried out in autumn 2006 which is an almost identical replication of the survey carried out in 2002 (Baumann, et al., 2003).

The questionnaires were directed to environmental managers or alike at all companies with at least 50 employees within technical consultants, building constructors, and property owners and managers and at least 20 employees within architecture firms. This covered 542 firms and the response rate on the questionnaire was 45.4%. The structure of the surveys covers the industry's definition of its environmental challenge, attitudes towards this challenge, and the response and performance from environmental measures taken. The questionnaire contains a total of 55 questions.

Results from 2002 years study showed that many firms at that time were working with environmental issues. However, the study showed that their work mainly focused on a few targeted subjects e.g. toxic substances and waste management, which departed from what they perceived as the industry's main challenge, i.e. energy-savings. Firms also on one hand mainly laid effort into top-controlled governing environmental management activities, e.g. EMS, while implementation of technical environmental measures on the other hand met large resistance. Striking was also that much focus was laid on pre-planning activities while feed-back and self-assessment were neglected. This caused an asymmetric communication within the firm with the consequence that many environmental managers lacked information of their firms' environmental performance. By repeating the survey it is possible to identify trends and institutionalising processes that contribute as well as hinder sustainable development within the building industry. In this paper we point at some possible explanation to why the development although much effort sometimes does not go in the direction as intended by top management.

2. RESEARCH PROJECT

The Environmental barometer for the Building sector is a questionnaire study with the objective to survey environmental attitudes, management and performance within the Swedish building and real estate industry. The structure, as schematically illustrated in Figure 1, has been developed from the questionnaire used by the International Business Environmental Barometer (IBEB) which has measured the state of environmental management in industry since 1993. Terminology and wordings in IBEBs standardised questionnaire has been adjusted into more sector-oriented terminology and words in order to suit the building sector.

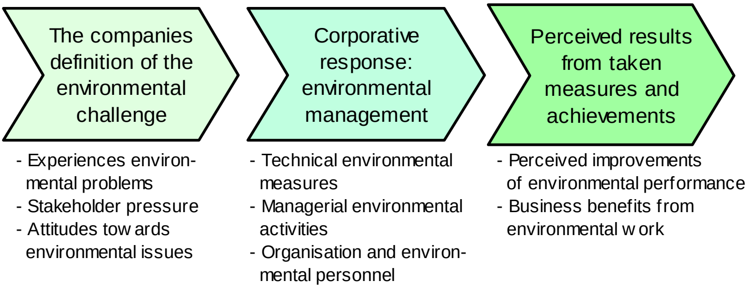

Figure 1. General structure of the survey

The structure of the survey covers the industry's definition of its environmental challenge, attitudes towards this challenge, and the response and performance from environmental measures taken. The questionnaire contains a total of 55 questions.

2.1 Preparation of the questionnaire

The questionnaire used in 2002 years study has only slightly been changed. Keeping the questionnaire as intact as possible has been a deliberate move in order to be able to make comparisons over time. Due to its actuality a section concerning energy declarations directed to real estate firms was added. However, since this section only was directed to real estate firms it is not presented in this paper.

2.2 Statistical population

The survey covers all companies in Sweden with at least 50 employees within technical consultants, building constructors, and property owners and managers and to companies with at least 20 employees within architecture. According to the Swedish Statistical Office, 620 companies have a core business that falls into one of these categories. However several of these, especially among the technical consultants, do not belong to the building industry, for example IT consultants and energy suppliers. After a correction the final population, which the questionnaire was sent to, consist of 542 companies and/or organisations. The questionnaires were directed at environmental managers or alike. 246 companies of 542 answered on the questionnaire which corresponds to a response rate of 45.4%.

Table 1. Total number of companies, response frequencies and response rates

	Total number of companies	Rate per cent	Responses	Rate per cent	Percentage of answers
Construction companies	300	55,4%	123	50,0%	41,0%
Property owners and managers	151	27,8%	78	31,7%	51,7%
Architects	36	6,6%	20	8,1 %	55,6%
Technical consultancies	55	10,2%	25	10,2%	45,5%
Total	**542**	**100%**	**246**	**100%**	**45,4 %**

2.2 Organisation of survey

The questionnaire, together with an introductory letter, was sent out to each company in the statistical population in September 2006. Addresses were obtained from the Swedish Statistical Office's company register. Three reminders were sent out, the first in the beginning of October, the second in the end of October and the third, which contained a copy of the questionnaire, in the beginning of November. Responses were collected until the end of December.

In addition and with the purpose of investigating dropout reasons an e-mail was sent to environmental managers in companies that had not answered the questionnaire after the second reminder.

The data has been stored in and analysed by using the statistical data programme SPSS. In order to secure reliability and validity of the study a statistician has been consulted both during data collection and analysis.

3. RESULTS FROM THE SURVEY

3.1 The environmental challenge as perceived by the companies

The environmental challenge is defined by how the companies see themselves contribute to environmental problems and how they experience environmental pressure from stakeholders.

3.1.1 Environmental problems

Most companies see use of non-renewable resources, use of energy and water as their most serious environmental problem. Three areas were a majority of the respondents perceive that they have lowered their impact and sees as their least serious problem is within contaminated soil, risk of environmental accidents, waste management use of toxic substances (see Figure 2).

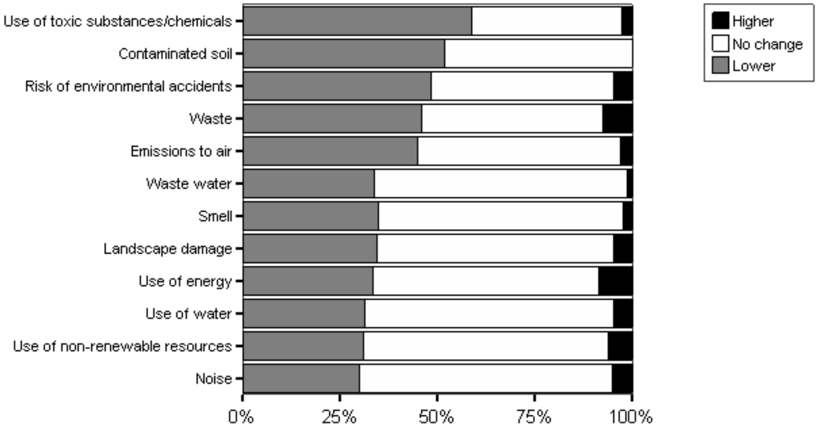

Figure 2. Companies' rating of their contribution to various environmental problems relative the industry average

Energy aspects, global climate change and waste are the three top issues the respondents put forward as the building sector's major challenge now and in the future.

3.1.2 Stakeholder pressure

Clients together with managers are the environmentally most influential stakeholders in most companies (see Figure 3). Also the final customer is considered as an important stakeholder as well as the employees and owner/shareholders of the company. Seen out of an environmental research as well as environmental information perspective it is noticeable how low influence on the companies environmental work that researchers, environmental organizations, mass media and politicians are assumed to have. Neither financial actors, such as banks, insurance companies and financial analytics nor controlling instances such as accountants are perceived as influential on the companies' environmental work.

There are some differences between different actors groups within the building sector, although the client is placed as top stakeholder by them all construction companies and technical consultancies rank them higher than property owner/managers and architects. Property owners set managers and environmental authorities high.

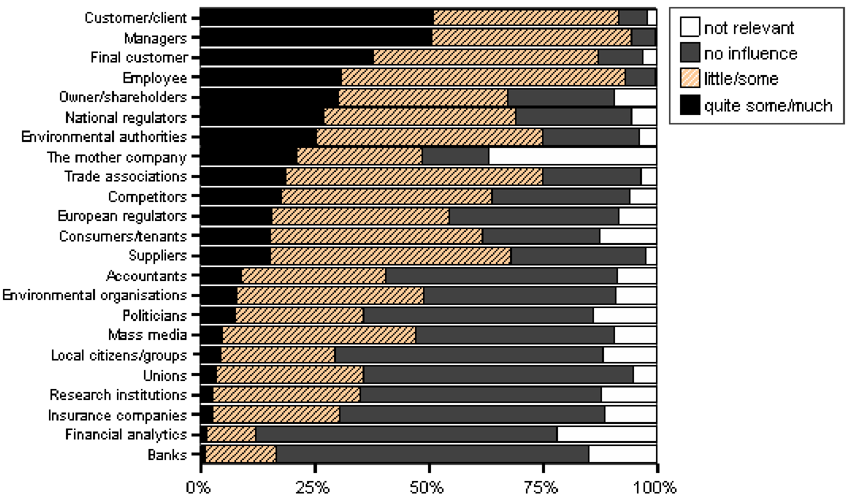

Figure 2. Companies' rating of their contribution to various environmental problems relative to the industry average

3.2 The companies' response to the environmental challenge

The companies' response towards their environmental challenge can take different expressions; employing personnel and create environmental working groups, cooperation with stakeholders, technical measures as well as managerial measures are some examples.

3.2.1 Staffing and environmental personnel

A majority of the companies have some kind of personnel that handles environmental issues within the company (81%) although the share that does not (19%), is comparing to manufacturing industry comparatively high (10% in 2001, Nilsson and Hellström, 2001). Many of the personnel that work with environmental issues do this on part time, i.e. the person has other tasks besides the environmental work. Most respondents answer that the number of environmental personnel has been the same during the last four year period (see Figure 4). In 2002 (Baumann et al., 2003) the number of environmental personnel was still increasing fairly or much in the companies which indicates that the environmental personnel in the companies have stabilised to a level of approximately one person per company.

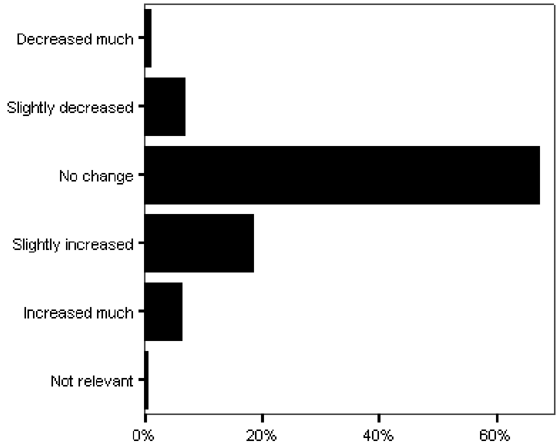

Figure 4. Changes in number of environmental personnel during the last four year period

How influential the environmental work is in the company are partly connected to which formal position the environmental manager has in the company. The study shows that a majority of the environmental managers (66%) are not members of the board which is a decrease comparing to 2002 when 56% did. This differs between the actors were it is more usual that the environmental managers sits on the board in construction companies (44%) than in real estate companies (21%).

A majority of the respondents think they have, at least partly, enough knowledge in order to influence practice (85%) as well as strategic decisions (85%). On the other hand a relatively large share of the respondents (appr. 25%) is not in a position that they have authority to stop environmentally damaging processes and/or influence strategic decisions. This reveals a certain discrepancy between knowledge to influence and actual authority to do so.

3.2.2 Managerial measures

The environmental work in many of the companies within the building sector work in accordance with an environmental management system (73%). This is a large increase since 2002 when 46% had an EMS.

Together with the companies that are under an implementation phase or that are considering to implement an EMS in their organisation it adds up to 90% which mirrors the pervasive force EMS has. Figure 5 also show that the managerial activities that are carried out in the companies largely are related to the EMS. For example have 93% of the companies set up an written environmental policy, implemented routines to secure the observance of environmental laws (82%), established an order of accountability (83%), and formed environmental goals as part of continuous improvements (80%) as well as measurable goals (76%).

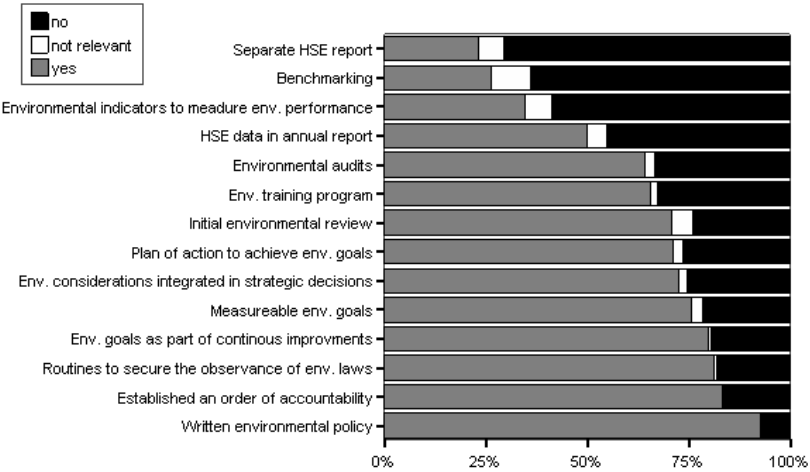

Figure 5. Environmental management activities related to the EMS

Considering that an overwhelming majority of the companies say the set measurable environmental goals relatively few perform activities that in turn measure the environmental performance (see Figure 5).

Besides activities related to the EMS the companies foremost carry out activities that aim at transfer environmental information and demands between actors that takes part in the supply chain (see Figure 6). Another communicative move is to develop checklists and guidelines.

Considering that the clients and customers have been put forward as the main stakeholder, it is surprising that marketing measures such as green marketing and eco-labeling is so rare activities among the companies. In a “relay”-business were the so many actors are dependent on each other throughout the whole building process, from planning to administration, it is also surprising that so few are involved in cooperative activities and even more amazing that one fifth consider it as not relevant.

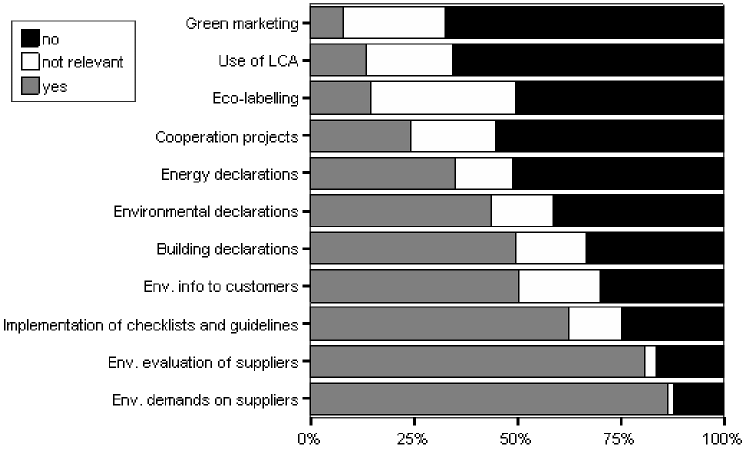

Figure 6. Environmental management activities related to purchasing and market

The environmental work in companies within the building sector is just as in 2002 not an integrated activity within the companies. Figure 7 shows that several areas, such as R&D, accounting, marketing and staff policy, according to the respondents has no relation to the environmental work performed within the company.

Environmental work has mostly been integrated with quality and health and safety work which probably are a consequence from that many companies have organisationally structured these areas together, for example assigned personnel with these multiple tasks.

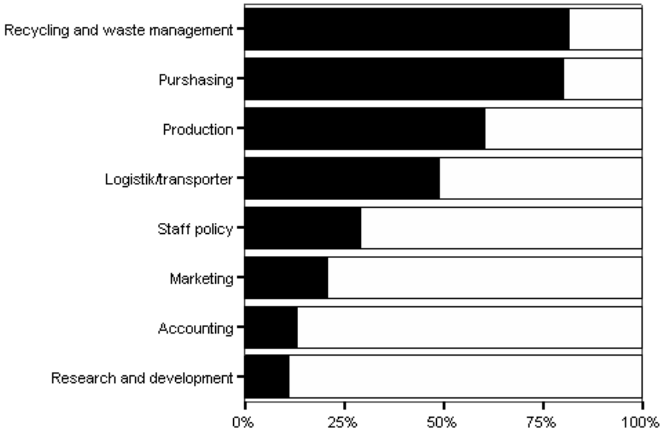

Figure 7. Business areas were environmental measures are taken

3.2.3 Technical measures

Waste separation is by far the most common measure to reduce environmental impact in Swedish building industry (see Figure 8). Also, other waste management activities and substitution of hazardous substances/chemicals is common measures within the building sector. Although much effort has been made to reduce waste several of the respondents sets it as one of the major environmental problems the sector is facing. Figure 8 also shows that more companies still are more devoted to handling of already generated waste instead of performing waste minimising measures. In spite that many of the respondents emphasise energy as a major problem for the sector to hand there is only 39% that during this latest four year period actively has acted to substitute non-renewable energy sources. This is surprising given the importance of energy issues in the building industry.

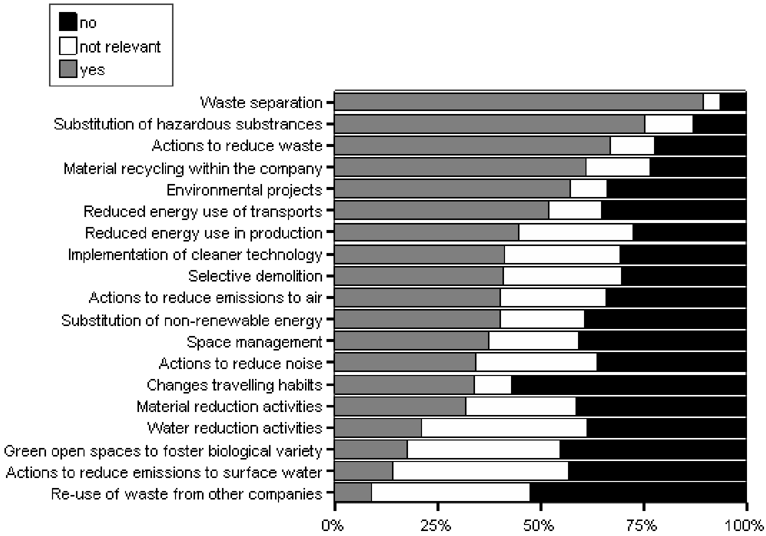

Figure 8. Environmental activities of a technical nature in the companies

3.3 Results from the companies' environmental activities

An indication of the success of the environmental work is obtained by looking at what extent environmental activities have had on environmental performance and business.

3.3.1 Environmental improvements

Environmental activities have had most impact on waste, use of hazardous substances, use of non-renewable materials and energy use (see Figure 9). Apart from energy use, the results are in line with Figure 8 which shows that waste management and substitution of hazardous substances are common activities in the industry. For several problem areas the companies however state that there has been no effect or that they have no information of it.

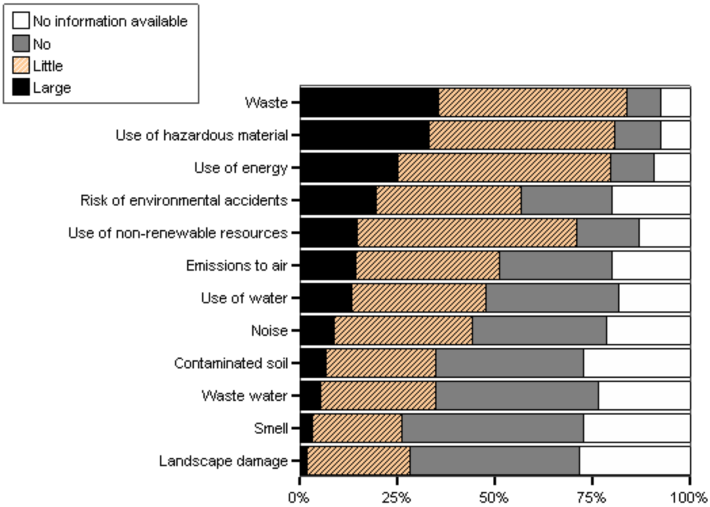

Figure 9. Effect of environmental activities on environmental problems

3.3.2 Business effects

Similar to the results from 2002 years study (Baumann et al., 2003) as well as to other industry sectors (Nilsson and Hellström, 2001), companies in the building sector consider that environmental activities mostly bring long-term benefits to business or benefits for the principal stakeholders, such as staff, management and owners/shareholders. Figure 10 shows that a majority of the companies answered that environmental activities has had a positive impact on especially company image, whereas environmental activities have had a negative on profits, cost savings and productivity.

Moreover, Figure 10 shows that environmental measures taken for most of the companies have had no effect on several business areas. The lack of effect on market aspects such as creation of new markets and increasing market shares is especially noticeable. This apprehension of an absence of market can explain the low interest into making efforts within R&D and development of new technology, such as clean tech.

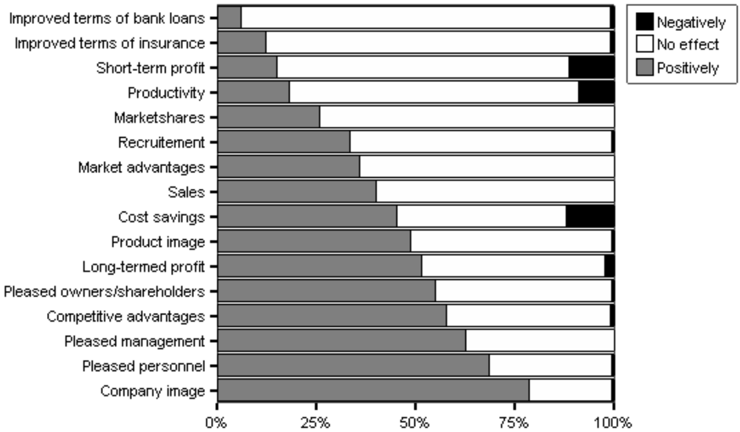

Figure 10. Effect of environmental activities on business

3.3.3 Obstacles for effective environmental work

Obstacles for carrying out an effective environmental work can be divided into internal and external obstacles, where the external are out of the company's immediate control and the internal are easier for the company to have an effect on. External obstacles that companies experience as hampering is foremost lack of market incentives (see Figure 11). This perception has since 2002 rose, which may be a result from the respondents experiencing problems entering the green products/services market.

An internal obstacle that many companies emphasize is that environmental work is too costly. Also lack of educated personnel is mentioned as an obstacle for effective environmental work.

On an overall level, the building industry experiences that obstacles except for regulation are more pronounced (between 5 and 10% more) now than four years ago. In comparison with other sectors in Sweden (Nilsson and Hellström, 2001) the building sector to a higher degree also speak for regulation as a solution to their environmental problem.

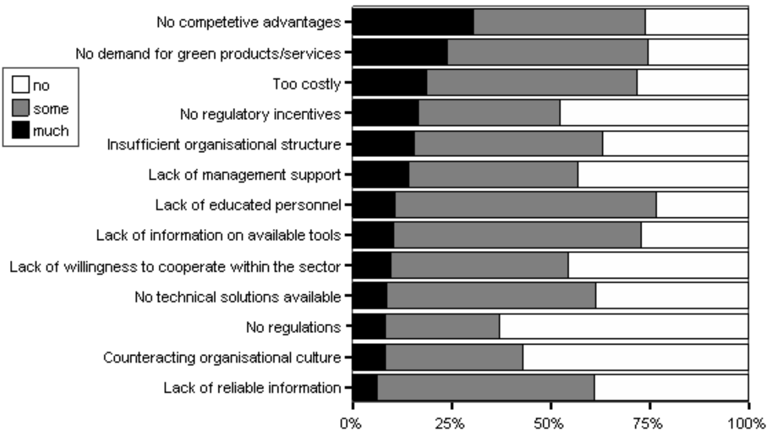

Figure 11. The extent which obstacles have influenced environmental activities in the companies

4. DISCUSSION AND CONCLUSIONS

We started this paper by asking; what makes it slow? Firstly we can conclude that there is an environmental inertia within the Swedish building sector, i.e. it is slow. The sector is still struggling with energy aspects and use of non-renewable resources, the companies continue to have a preference for waste management and environmental activities of a managerial kind and they, like 2002 (Baumann et al., 2003), perceive that they have accomplished most results concerning use of toxic substances/chemicals and waste separation. Companies within the building sector have especially put much effort into measures related to Environmental Management Systems.

So why is that? The study reveals five possible reasons to this inertia. First, the notion that the market for green products and services are dysfunctional does not stimulate innovation and new approaches. Second, the lack of cooperative actions between actors involved in the building process limits the possibility to view the products and services out of a holistic perspective. Third, for goals and goal setting to have a motivating effect it is important to provide information of whether one has achieved the goals or not (Locke and Latham, 1984). Although many companies say they has set environmental goals the lack of follow-up activities and environmental performance measurements has the consequence that the motivating effect do not take place. Fourth, the perception that banks and other financial institutions have little or no effect on the environmental work hinder that the issues are considered on the business agenda. Last but not least, little or no cooperation with R&D departments or institutes creates poor foundation and stimuli for the development and creation of pioneering green ideas, innovative green technique and new green business opportunities.

There is always a risk in surveys that intend to measure peoples' attitudes and values that the respondents may answer as they believe they should answer and/or tries to place themselves and their companies in a favourable light. It is therefore important to acknowledge that this survey do not present an objective truth about the companies environmental work but rather measure what the respondent perceive as their environmental challenge, problems and so forth. There is also a risk, since the survey, is directed to environmental managers, that they in general have a larger interest in environmental aspects and therefore is not representative for the overall values within the company.

Moreover, it may also be so that the companies that pay more attention to environmental management are more benign to answer which might lead to that the results are not representative for the whole building sector. The importance of this discussion is that the reader acknowledges these possible biases when interpreting the results. Moreover, this paper only present basic frequency analysis the database permits more advanced and detailed analysis which will strengthen the study's validity.

5. ACKNOWLEDGEMENT

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6. REFERENCES

Baumann H., Brunklaus B., Gluch P., Kadefors A., Stenberg A.-C. and Thuvander L. 2003. *Byggsektorns miljöbarometer 2002*. CMB-report, ESA Report 2003:2. Chalmers, Sweden.

Femenías P., 2004. *Demonstration Projects for Sustainable Building: Towards a strategy for Sustainable Development in the Building Sector based on Swedish and Dutch experience*. Dissertation thesis, Chalmers University of Technology.

Gluch P., 2005. *Building Green – Perspectives on Environmental Management in Construction*. Dissertation thesis, Chalmers University of Technology.

Locke, E.A. and Latham, G.P., 1984. *Goal setting: A Motivational Technique That Works*. Prentice Hall: Englewood Cliffs, NJ.

Nilsson A. and Hellström D., 2001. *Miljöbarometern 2001*. HandelsConsulting AB, Göteborg, Sweden. Internal report of the Swedish Business Environmental Barometer 2001.

HUMAN BEINGS – THE MISSING LINK IN INDUSTRIAL CHANGE CONCEPTS

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ABSTRACT

Several investigations have been carried out concerning problems in the Swedish construction sector. The criticism can roughly be summarized as poor adjustment to clients' interests and lack of social responsibility. Simultaneously, while adjusting to the critique, diminishing subsidies and a low level rate of interest together with increasing competition in the home market, force construction related companies to raise their effectiveness. The chosen path mainly consists of three lines of action – Partnering, Off-site manufacturing and Lean Construction. The paper questions if these efforts will lead to the expected results referring, first, to Koskela's critical analysis of Womack and Jones on *Lean Thinking* and, second, to the human factor that these authors, as well as the sector in general, seem to disregard. Implementing new techniques and working methods, creating client value and changing behaviour, are deeply connected to human factors on the individual, group, and organisational levels. The paper claims that neglect in the organisational design of human factors will never reach what is potentially possible when it comes to value creation. The authors have, in an earlier analysis of counterproductive behaviour, proposed a methodology for value creating collaboration. The paper suggests that this is to be enhanced with the role of an interventionist/facilitator, I/F. The I/F is introduced as an important prerequisite to assist a group through the process of changing its working routines into a value creating process.

1. INTRODUCTION

An inventory of current problems in the construction sector presented in different inquires/reports was made by Sunding (2006). The problems mentioned are functional errors, delays, runaway costs, unethical business methods etc., see e.g. (SOU 2002:115). All these together may jeopardize the demand on the home market and may deteriorate the competitiveness of Swedish companies on the global market. A growing insight can be noticed, which Swedish companies earlier have been able to evade due to limited competition, subventions, and lately considerable reduction of rates of interest. But what to do now that the seriousness of the situation is understood? The three tracks the sector seems to have chosen are Partnering, Off-site manufacturing and Lean Construction. Lots of legitimate questions can, and have been asked about these approaches, their application, their implementation and their effectiveness. For instance Koskela (2004) makes a critical review of Womack's and Jones's (1996) book Lean Thinking, generally, and with respect to the construction sector specifically. He concentrates on the five main principles[22] that are stated in the book, and he criticises the authors claim for generality: “Let us assume a one-of-a-kind production with temporary location and temporary organization. Construction is the classic example of this. We realize that practically all the principles are in great trouble.” His conclusions are not surprising when comparing the complexity of the construction sector to the simplicity in the five principles, which according to Koskela ”seem to have led to misplaced views on Lean Thinking in many circles. It has been understood that the five principles provide an exhaustive, mature foundation for the transformation of any productive activity.” Although Koskela convincingly points at some deficiencies of Lean Thinking, LT, he also admits that Womack’s and Jones’ book has reached an admirable distribution and that it for many people has served as an inspiring introduction to LT. Koskela’s questioning is legitimate and relevant, but there are more relevant questions that he abandons. Koskela seems to share Womack’s and Jones’ basic view that industrial enterprise is about experts defining the “truth” which then in some magic way clients, collaborators, and employees automatically will happily adjust to fulfil. Even though Koskela touches another dimension in some of his questions and viewpoints he does not finish the work:

- ”What is the meaning of continuous improvement when the production system will anyway be dismantled, the organization disintegrated, and any improvement will be swept away like dust by the wind?
- “How can we specify value, if it is something happening between the customer and the product?”
- “The book [Womack & Jones, 1996] rightly mentions transparency as one of the most important spurs to perfection.”
- “But there is a more profound problem. […]. It has been argued that even some types of physical production, such as construction, can better be seen as a complex adaptive system […]. *Lean thinking* does not address this kind of phenomenon, which obviously requires different managerial approaches.”

What Koskela and a lot of other actors trying to develop the effectiveness and value creating capacity of the construction sector forget is the living human being; man as client, as entrepreneur, as bearer of needs and demands, as problem formulator/ solver etc. In some way all conceivable system variables are scrutinised except the human being. The concepts of meaning, value, spur, and adaptive in the quotations above all imply human involvement. How do Womack, Jones, Koskela and others imagine efficient implementation to be carried out without taking explicit consideration to the function of the human mind? There must be some implicit ideas which are not unveiled. Koskela cites Womack and Jones: ”Lean thinking also provides a way to make work more satisfying by providing immediate feedback on efforts to convert muda [=waste] into value.” Koskela’s comment is logical and legitimate: “This suggests that value can be maximized through minimizing waste”. It opens up for a question about the human dimension of the concept of value. But Koskela confines himself by pointing out that: ”A product with a wonderful value may be produced in the most wasteful process” and vice versa. According to the argumentation above we will make two additional comments. At first, Womack and

[22]
1. Precisely specify value by specific product.
2. Identify value stream for each product.
3. Make value flow without interruptions.
4. Let the customer pull value from the producer.
5. Pursue perfection.

Jones claim that feed-back automatically will bring satisfaction which we find questionable. Secondly, Koskela refrains from pointing at the relations between satisfaction and value, and between satisfaction and muda. We argue that these relations might be at least as fruitful as the one between value and muda.

To sum up, it can be maintained that the Swedish construction sector seems to have taken notice to the critique and furthermore begun a change process, yet a legitimate question is what the chances are for the chosen approaches to prevail; will they work all the way through to implementation in the sector? Unfortunately, there is a lot speaking against that. Koskela points out the deficiencies of Lean Thinking, one of the corner stones of the selected actions.

Perhaps the dilemma between lack of time and the complexity of the situation can explain why the sector now, more or less hazardously, chooses to make a large-scale venture. An unfamiliarity to manage change and an unwillingness to accept the full complexity of the problem might follow from an earlier habit to put the market forces out of the running. The future will probably look different. The price for failure, i.e. if the efforts do not lead to the expected effectiveness, can be fatal. The question raised here is if it is possible to get further with value creation, implementation, and industrial change without acknowledging the human's role and the way human action is designed. These factors must be considered just as thorough as the structural aspects of the process. When these matters occasionally are explicitly dealt with, the measures taken are often in conflict with what is considered as established knowledge in those scientific areas dealing with change and development of individuals, groups and organisations.

This paper has the following four objectives, to:

1. Briefly present an inventory of problems that the Swedish construction sector faces, as found in some recent reports.
2. Present some new perspectives on joint value creation and briefly discuss some new prerequisites that these will give rise to.
3. Introduce the idea of an interventionist/facilitator and motives why.
4. Briefly present planned future research.

2. LITERATURE REVIEW

In his licentiate thesis, Sunding (2006) made a literature review which included some recent inquires/reports where the construction sector's problems are looked at from different viewpoints. Questions about problem solving and the functionality of human beings were avoided in these reports, in a similar way that is significant for construction sector practitioners. The thesis also studied theories of problem solving and human functions, practical methods for development of individuals, groups and organisations, and existential and philosophic aspects of joint value creation, e.g. the concepts of value and responsibility.

2.1 The constructions sectors complex of problems.

The thesis' analysis of the construction sector's problems was based on the following publications: SOU 2000:44; SOU 2002:115; Fi 2004:115; SBIKom (2002);

Josephson et al (1998); Ericson & Johansson (1994), and Grange (2005). In addition to that, the sector's problems have also been the central theme in the empirical endeavour of the project – byggkrAft - where some ten experienced actors from different parts of the construction process have thoroughly discussed and reflected upon the problems.

One quotation from SOU 2002:115 may stand as a symbol for the paradoxical circumstances that come to expression in the different publications: "A lasting impression from the work in the commission is also that the vast majority of the actors [in the sector] agree with the problem descriptions but consistently do not see themselves as having anything to do with neither the emergence nor the remedy of the problems." [Auth. translation]

2.2 Problem and problem solving

Problem and problem solving have been scientifically studied within the technical/systems theoretical tradition and the cognitive psychological tradition. With the intention to cover the structural as well as the organic (i.e. human related) aspects of problem handling the following publications have been studied: Checkland (1981); Ekholm (1987) and (2003); Senge (1990); Axelrod (1984); Kollock (1998); and Jonassen (2000). A special interest has been directed towards different kinds of dilemmas (especially social dilemmas). What stands clear is that problem definition and formulation is an essential part of problem handling. Regarding what is mentioned initially there seems to be a reason to question the sector actors' way of defining and formulating their problems. An inappropriate problem formulation might lead to remaining trouble although the problem is considered successfully solved. This seems to be a feature that the Swedish construction sector suffers from – large amount of resources are spent without getting rid of persistent troubles.

2.3 Human function and joint problem solving

The issues that have been in focus in this work are the human being and the way human action is designed. One reason is that technicians, even after university studies, practically never have had contact with these issues at all. Throughout their education, human psychology is handled with unreflecting omission at the same time as failures paradoxically enough are often blamed on (other) human beings' mistakes. Mans' psychological defence and different mechanisms in human perception tend to distort information about how the world is constituted, information we need to solve problems effectively.

The surveyed literature in (Sunding 2006) was selected from its ability to explain different reasons why people act counterproductively, i.e. create unwanted results. The different reasons were divided into four groups – do not *understand*, do not *want to, do not dare to*, and *can not.* These conceptions can roughly be related to the corresponding scientific concepts or areas – consciousness (understand), motivation (want), fear (dare), and learning (cannot). The review has identified central publications within each area, see Table 1.

Table 1. Reasons for counterproductive action, related scientific concepts, and main publications

Do not understand	Consciousness	Sjöbäck (1984); McWilliams (2001); Argyris (1985)
Do not want to	Motivation/Drivers	Maslow (1958); Madsen (1969); Pritchard (2003); Festinger (1956); Rendahl (1992)
Do not dare to	Fear/Anxiety	Dozier (2000); Sjöbäck (1984); McWilliams (2001)
cannot	Knowledge, ability[23]	Kolb (1984); Schön (1983); Argyris (1985)

2.4 Value and responsibility

The two concepts, value and responsibility, are most relevant to the concept of joint value creation. Especially the concept of value has been frequently used in different contexts, but without making its meaning explicit. This is also noticed by Koskela (2004) in his review of (Womack and Jones 1996). A common actual use of the word value is in the conception "customer value", which almost has become a mantra in the industrial context. Here, this routine-like use of the word is questioned with reference to the Argentinean philosopher Mario Bunge, who means that the concept of value is intimately coupled to human needs: "No organisms, no needs, hence no values" (Bunge 1989:11). Thus, values are not things, the state of things or ongoing processes in things. These entities can only be bearer of values in relation to an evaluating organism. To be able to define value one must in consequence know something about peoples needs, i.e. the needs of clients, the need of the company owners, the need of the management, the need of the workers and so on.

Furthermore, the difference between problem solving and value creation needs to be explained. Value creation demands that the sum of the actions carried out leads to a higher degree of value than existed before the endeavour started (Sunding 2006). From the actions' positive effects the negative effects must be drawn. That kind of explicit quality aspect is usually missing in common problem solving although such can be implicit in the situation. This theoretical reasoning will of course lead to difficulties in practice, but will also induce new questions for science to investigate: E.g. how may all effects from an action be determined? How can you give expression to needs? How can needs be measured? One more practical question is how to relate to these aspects more explicitly.

Also the concept of responsibility has been considered from a philosophical viewpoint. Normally, the words' legal or moral aspects are referred to. It is also habitual to try to deal with ones' own blunders by blaming others' (*cp* the quotation from SOU 2002:115 above). The activities in the construction sector are often compared to the card-game "The Old Maid" where the aim is to avoid sitting alone with the old maid at the end, which should be understood as to avoid the responsibility at the end of the project. This might be seen as productive behaviour on the micro level, but it is obvious that it will draw attention and resources from value creation at the macro level. A more existential interpretation is accounted for in (Sunding, 2006), by using what he calls "inverted argumentation". In a common

[23] Here even structural features and resources are included.

thesaurus[24] the meaning of the word responsibility is explained as: "obligation to make a certain enterprise function or take the consequences if this is not the case" [auth. translation]. Conversely, this means that those who have to take the consequences are also responsible. This fact can be handled in two ways, either you see to it that the damage never happens or you try to avoid the consequences when the damage is a fact, as is described above. But as member of the community you cannot avoid all negative effects since every fault will pollute the environment you are a part of. This effect will be worse when everybody is using the same idea. In this way one is doomed to take responsibility for own and others action. Creating an insight of this fact might promote a more preventive behaviour than otherwise.

2.5 Practical methods

Since the objective of the current research project is to develop a methodology that in practice can promote value creation in working groups by helping them extract "their own best", different existing practical methods have been studied, see Table 2. The studied methods have contributed to development of the scientific approach as well as the method the work is aiming at. The methods are shown to be identical with the exception for the demand for scientific documentation.

Table 2. Methods for value creation, literature and scope

Action Science	Argyris (1985)	Practical and scientific method for promoting change from model-I to model-II behaviour[25].
krAft	Norbäck et al (2006)	A Swedish national program for the development of small and middle sized enterprises (SME).
Fyrklövern[26]	Palm Beskow et al (2001)	For cognitive psycho-therapy and consciousness development.
SMfTUP[27]	Checkland (1988)	Systems theoretical method for solving complex problems.

3. RESEARCH PROJECT

The first phase of the research project was carried out between April 2002 and December 2005, when the licentiate thesis Sunding (2006) was examined. The work in this paper is part of the start for the second phase which is aiming for a PhD-thesis in 2008. This second part of the project is part of the joint Swedish-Danish EraBuild project "Developing values and delivering customer value in an industrialised context".

3.1 Project description and objectives

The present project is called "Method for value-creating collaboration in the construction sector." It has emerged from an understanding that the daily work as well as most organisational change and development endeavours in the construction

[24] Norsteds svenska ordbok
[25] See below
[26] In English – "The four leaf clover"
[27] Systems Methodology for Tackling Unstructured Problems.

sector categorically omit to take into account the function of human beings. This is illogical seen from a systems theoretical point of view, which should be obvious to engineers operating in the sector. Some engineers claim that they will treat the human system as a “black box”, but to be able to do so properly you have to know the relation between input and output of the black box. Here is maintained that this is not the case. The omission is remarkable and should be closer investigated.

Different questions that have been raised in the early phase of the project are, for example:

- How can professionals omit such a fundamental fact while they honestly are trying to reach competitive advantages?
- Why do people take part in obviously counter productive activities?
- How do people design their actions?
- What is value?
- What can be done to promote a higher degree of value creation?

The project designation and the questions above mirror the aspiration to create a method to help working groups be more efficient in their problem solving/value creating efforts. The strategy is to furnish with new perspectives on their ingrained opinions and operations often hidden behind their own psychological defence operating at the individual level as well as at the group level. Sunding (2006) makes an inventory of different plausible explanations to the omission and discusses different features that should be part of a method for promoting value creating collaboration. In this particular paper we have chosen to discuss one feature which is supposed to be of vital importance – the interventionist/facilitator. This important feature may be implicit, and not appropriately treated in Sunding (2006) which this paper attempts to remedy.

3.2 Research methodology

The work will best be described as an iterative search process with the aim to identify what Argyris (1985) calls an “optimal incompleteness”, which means to identify relevant parts of reality and ignore others. According to Argyris this is a critical component of practitioners’ efficiency. Development of the models and the method has been carried out in a cyclic, successively refined process of experience – theoretical studies – model/method design – model/method test (*cp* experience based learning according to Kolb, 1984).

An extensive theory survey of different areas that might affect ‘joint value creation’ has been carried out (see section 2 above). New knowledge has contributed to the refinement of the models and to more detailed research questions as well as ideas of appropriate features being part of a methodology for efficient joint value creation in the construction sector. Both models and methodology have been tested in what could best be described as action research with active intervention in a setting with a group of experienced actors from the construction sector – byggkrAft.

4. RESEARCH RESULTS AND INDUSTRIAL IMPACT

Sunding (2006) identifies some individual related phenomena that tend to obstruct the working group from extracting its full problem solving capacity. The sectors' effectiveness could be assumed to be less than it could be if this inherent capacity was extracted to a higher degree. The concept of value is introduced as a quality aspect of both the working process and of its results. One initial hypothesis is that the sectors' way of defining its task might cause the problems. A confusion of the concepts of problem = "trouble" and problem = "task" is the assumed reason. This will lead to inefficient problem solving in the way that not even a seemingly successful problem solution will make the trouble disappear or that new trouble will arise as a direct consequence of the "problem solving" process. This hypothesis found some support in the action-research like pilot study "byggkrAft". A number of different models illuminating different aspects of problem solving and value creation were developed and shown in more detail in (Sunding, 2006) and briefly in (Sunding and Ekholm, 2007). One model concerns theoretical demands on problem solving including *what* shall be achieved, *how* it shall be done, and *that* the requisite actions are executed. These matters are often considered to be so obvious that they need not be object for neither reflection, problemizing nor discussion. Another model describes the problem solving system – the group and the situation surrounding it. A new problem formulation which takes the difference between "trouble" and "task" into consideration was suggested.

Supported by the models and by knowledge about problem-solving and human function, different causes to counterproductive behaviour can be classified as is mentioned above as: do not *understand*, do not *want* to, do not *dare* to, and *cannot* act contra-counterproductively[28]. Combinations of the models and explanations lead to a tool for diagnosis to be used in a working group context to track down conceivable and potential obstacles that might hinder the group from extracting "its own best."

The project has so far came to the conclusion that different phenomena on individual, group, and organizational levels contribute to what is nearest to be described as self-deception which has its roots in psychological defence (Sjöbäck 1984), McWilliams (2001), and Argyris (1985). This insight has somewhat led to a changed direction for the project. What initially was a structural approach aiming to put together material and distribute it via Internet turned into a more organic approach. Instead of supporting groups in developing their problem solving/value creating ability by themselves, the work was directed towards helping groups deal with their own psychological defence. Instead of normatively describing what people should do to raise their problem solving capacity based on structural theories, the work is now directed towards how they shall release their inherent capacity based on more organic theories. The reason is the psychological defence that a group hardly can deal with by themselves. With this kind of strategy, where the psychological defence is handled properly, learning of a higher order can take place at the same time as conditions for problem solving and motivation will improve.

[28] The term contra-counterproductively is used instead of the positive form productively due to the latter expressions frequent use in different contexts which may lead the thought in a wrong direction.

4.1 The need for an interventionist/facilitator

Since individuals as well as groups have a tendency to deceive themselves in matters that tend to be threatening or awkward, the group must be helped to pass by this behaviour (Argyris, 1985, 1996, 1999). Further, the help must be designed so that the defensive behaviour is not directed towards the helping assistant – here called the interventionist or facilitator, I/F. There might be a theoretical chance for well developed groups to handle their own defensive behaviour, in the same way as a well trained individual might be able to get more insightful. Anyhow, one could claim that a mentor or sounding board will be required in almost every practical case. It is almost impossible to discern ones own defensive behaviour, which is well known by psychotherapists. Argyris (ibid) has made similar findings in his experiments. He shows that practically 100% of not particularly trained persons conduct what he calls a model-I behaviour i.e. unconsciously do not practice as they preach (see below). The reason for model-I behaviour is to be found in the basic way of framing oneself in relation to the world and other people, Argyris presents four governing variables (1996:93):

1. Define goals and try to achieve them;
2. Maximize winning and minimize loosing;
3. Minimize generating or expressing negative feelings and;
4. Be rational.

Argyris shows that this behaviour contains inescapable contradictions that have to be hidden for those who e.g. will avoid “negative feelings”. The result is a distortion of information that is needed for “maximizing the winning and minimizing the loss.” The alternative to model-I behaviour according to Argyris is model-II behaviour which builds upon another set of governing variables (1996:118):

1. Valid information;
2. Free and informed choice, and;
3. Internal commitment to the choice and constant monitoring of its implementation.

The way from model-I into model-II behaviour is “double-loop-learning”, which in difference to single-loop-learning allows new information to challenge current values and conceptions.

Also Womack’s and Jones’s (1996) experiences from an industrial context show that several large and well-known organisations have been forced to engage some special Japanese change agents to facilitate the implementation of the new ideas which without them seemed to be almost impossible.

4.2 Important features on I/F and his/her working method.

Based on Sunding (2006) some conclusions concerning important features of the I/F and his/her working method can be made. The I/F’s task is to help the group extract “their own best”. The situation for the intervention is the group’s daily work and there are several reasons for this. One important reason is that working with “real” tasks seems to be more motivating. This is probably because it is experienced more meaningful to develop the joint work with others in a real context instead of manufactured exercises. It might also reduce stress to see that ones own work is progressing while training. In similar ways the conditions for learning will improve when you get help to look at your own problems from a new view-point.

In contrast with a lot of other practical methods that often concentrate on just one or two aspects of collaborative work, e.g. communication, motivation, values, or training, the basic idea of the model here is that all these aspects are present simultaneously in practical situations, which an effective method must deal with. Thus, the starting-point for the method is a comprehensive view. This means new problems since the variations of conditions for different groups are infinite why an attempt to describe every single situation will either be fragmentary and incomplete or so extensive that one will be lost in complexity. For that reason a practical method must approach the situation step by step. First, the groups' specific situation, circumstances and potential obstacles should be diagnosed. Then, the group shall be stimulated to form its own process of double-loop-learning, and to solve the problems lying ahead. Any obstacle to this, whether it depends on lack of understanding, willingness, or courage has to be dealt with in one and the same process. The difference between problem solving and value creating will raise additional demands on the value creating process. The I/F's task is therefore to:

1. Create an appropriate working climate;
2. Motivate to active participation;
3. Deal with the psychological defence;
4. Stimulate learning and provide good conditions for that;
5. Help the group formulate its problem and solve it and;
6. In case of value creation look after that the result is representing increased value.

4.3 Proceeding research

The research question that the proceeding work will deal with can be formulated: "What can/should an I/F do to facilitate a group to overcome its own obstacles for value creating collaboration?"

The development of theory based models and methods concerning value creating activities of a group and the I/F's role will continue. When Sunding (2006) mainly has dealt with individual related obstacles, the proceeding work will focus on obstacles at the group- and organizational levels and how they can/should be handled by the I/F. When the models and methodology have been "finally" formulated they will be compared to change processes in real working organisations. How have the different aspects of the models/methods been handled? Was the result the expected? Is it possible to show a relationship between successful change processes with different aspects of the models? Are some of the aspects especially important? If some aspects of the model have mistakenly not been considered, could this have been foreseen with the use of the model? A possible further exploration of the models and the method is to test them by using them in an action research experiment in a genuine construction project.

5. CONCLUSIONS

The Swedish construction sector has several incentives for developing its value creating ability. A great deal of effort is now spent by introducing industrial concepts e.g. partnering, off-site manufacturing and lean thinking. There is a substantial risk that this is going too fast and that the expected delivery will fail. Koskela (2004) alerts that these concepts, at least those which build from Lean Thinking, might be grounded on a misunderstanding. Sunding (2006) alerts for a similar risk based on the fact that none of the adopted concepts consider the function of the human being in a serious way. Finally it is here claimed that neglect of the function of the human being in organisational design will never led to what is potentially possible when it comes to value creation.

6. REFERENCES

Argyris, C., Putnam, R. & McLaine Smith, D. (1985). *Action Science*. San Francisco: Jossey-Bass.

Argyris, C. & Schön D. A. (1996). *Organizational learning II* – Theory, Method, and Practice. USA: Addison-Wesley.

Argyris, C. (1999). *On Organizational learning* (Second Edition). Oxford, Blackwell Publishing.

Axelrod, R. (1987). *Från konflikt till samverkan*. Kristianstad: SNS Förlag.

Bunge, M. (1989). Etics: *The good and the right*. Treatise on Basic Philosophy. **8**, Dordrecht: D. Reidel Publishing.

Checkland, P. (1981). *Systems thinking, systems practice*. London: Wiley & Sons.

Dozier, R.W. (2000). *Rädsla.* Stockholm: Wahlström & Widstrand.

Ekholm, A. (1987). *Systemet människa – byggnadsverk – Ett ontologiskt perspektiv*. Doktorsavhandling Stockholm: Byggforskningsrådet.

Ekholm, A. (2003). Design as problem handling – outline of a framework. In R. Amor (Ed.), Construction IT Bridging the Distance, proceedings of the *CIB W78's 20th International conference on Information Technology in Construction*, New Zeeland, 23-25 April 2003. CIB Report: Publication 284.

Ericson, B. & Johansson, B-M. (1994). *Bostadsbyggandet i idé och praktik – om kunskap och föreställningar inom byggsektorn.* Doktorsavhandling Lund: Lund University Press.

Fi 2004:115. *Uppbyggnad och samordning av ett utvecklingsprogram för samhälls-byggnadssektorn – Delredovisning 1.* Statens offentliga utredningar Byggkommittén.

Grange, C. (2005). *Arkitekterna och byggbranschen . om vikten av att upprätta ett kollektivt självförtroende*. Doktorsavhandling, inst. för arkitektur vid Chalmers tekniska högskola.

Jonassen, D.H. (2000). Toward a design theory of problem solving. *Educational Technology: Research & Development,* **48**(4), 63-85.

Josephson, P-E., Wallström U. & Hammarlund, Y. (1998). *Produktionsledning i förändring – Del II: Problem och behov i byggföretag.* Göteborg: Byggmästarföreningen Väst/FoU Väst.

Kollock, P. (1998). Social dilemmas: The Anatomy of Cooperation. *Annual Review of Sociology*, **24**, 183-214.

Kolb, D. A. (1984). *Experiential learning. Experience as the source of learning and development*. Engelwood Cliffs, New Jersey: Prentice Hall.

Koskela, L. (2004). Moving-on – beyond lean thinking. *Lean Construction Journal* **1**(1), 24-37

Madsen, K.B. (1969). *Motivation – drivkrafterna bakom våra handlingar*. Stockholm: Wahlström & Widstrand.

Maslow, A. (1954). *Motivation and personality*. New York: Harper.

McWilliams, N. (2001). *Psykoanalytiskt diagnostik – Att förstå personlighetsstruktur*. Wahlström & Widstrand.

Norbäck, L-E., Olsson, L-E. & Odenrick, P. (2006*). Homo pracademicus. Om att lära om – om sig själv och sin verksamhet.* Stockholm: Bilda förlag.

Norstedts svenska ordbok, digital utgåva genom *Wordfinder* – Lexikon på PC Professional version 7.0.1.

Pritchard, R. D. & Payne, S. (2003). Performance management practices and motivation. In Holman, D., Wall, T. D., Clegg, C. W., Sparrow, P. & Howard, A., (Eds.) *The New Workplace: People, Technology and Organisation: A Handbook and Guide to the Human Impact of Modern Working Practices.* John Wiley, 219-244.

SBIkom, (2002). Svensk Byggindustris Byggkommissions rapport - *Byggsektorns struktur och utvecklingsbehov.*

Senge, P. M. (1990). *The Fifth Discipline - The art & practice of the learning organization*. New York: Currency Doubleday.

Sjöbeck, H. (1984). *Psykoanalytisk försvarsteori* – Andra utökade upplagan. Lund: Studentlitteratur.

Sunding, L. (2006). *Gemensamt problemlösande och värdeskapande i byggprojekt.* Licentiatavhandling. LTH, Lund.

Sunding L. & Ekholm A. (2007). Human based value creating cooperation in construction projects. Forthcoming in proceedings of *CIB World Building Congress 2007* in Cape Town.

SOU 2000:44 *Från byggsekt till byggsektor*. Stockholm: Fritzes

SOU 2002:115 *Skärpning gubbar! – om konkurrensen, kvaliteten och kompetensen i byggsektorn*. Stockholm: Fritzes

Womack, J. & Jones, D. (1996*). Lean thinking – Banish waste and create wealth in your corporation.* New York: Free Press.

LOGISTICAL APPROACH TO OPTIMISING SUPPLY AND DISPOSAL PROCESSES ON CONSTRUCTION SITES

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ABSTRACT

This paper provides an overview of the logistic approach to optimising supply and disposal processes on construction sites. The aim of the research undertaken at the Fraunhofer IML is to develop a holistic system for construction logistics based on a performance measurement system for logistic key data, technical solutions like barcode or Radio Frequency Identification (RFID) and optimisation tools. Logistic key data, well known in other industries, are not used systematically in the construction sector. Construction companies, even civil engineers, work with their own instruments to plan and calculate construction site logistics, most of the time without specific software programs or standardised databases. At the same time new software programs (4 or even 5 dimensional planning) provide site managers with highly sophisticated data about the finished building and necessary resources. Fraunhofer IML is working on a logistic approach to bring these two realities closer together.

1. INTRODUCTION

The right product, to the right time, at the right place…. What sounds like a nursery rhyme to some is the fundamental idea of logistics and a difficult task to fulfil on construction sites. Since the importance of a steady flow of goods in our globalising world is increasing more and more, the ideas of logistic science become more complex and the solutions in the industry more technical.

The construction industry is picking up some ideas of the “world of logistics” but a strategic method as it has been used in the automotive industry is missing. The construction logistics is mostly on the first level of a four-level-system for logistic development. Furthermore, an important question that most construction companies cannot answer is: how expensive is my logistics?

This paper does not repeat the model of supply chain management, since the construction industry is far from this level. The ambition of the authors is to develop a logistics calculation and controlling model to give the discussion a solid base to start from.

2. LITERATURE REVIEW

Since the early 90s publications are dealing specifically with different aspects of construction logistics. Two different types of publications can be distinguished for construction logistics: Publications dealing with logistic problems on specific construction sites, (bottom-up research) [Olsson, 2000; Salazar et al., 2006] and papers and dissertations about a management approach with a top-down background [Ala-Risku et al.,2004; Bronsted et al., 2003; Jang, et al., 2003, O'Brein, 2002;Salagnac et al., 1999; Veiseth et al., 2003; Zou et al., 2006].
Both have their strength and weaknesses. The project orientated approach on the one hand often presents specific solutions that cannot be transferred to other projects easily. On the other hand the impact of the management solutions on construction sites is seldom shown. What is missing is a kind of "middleware" to connect both worlds and enable the construction industry to take the next steps. In this paper two publications are presented, that are dealing with the cost calculation and controlling of logistic systems in general and which have a bearing on this paper.

2.1 Logistic cost calculation

In Weber's publication [Weber, 2002] dealing with logistics cost calculation he developed a model [Fig.1], which describes the typical development of logistics systems with two parameters: level of logistics knowledge and chronological development. In his opinion, several upgrades are necessary to achieve a complex logistic system and it is not possible to skip one step.

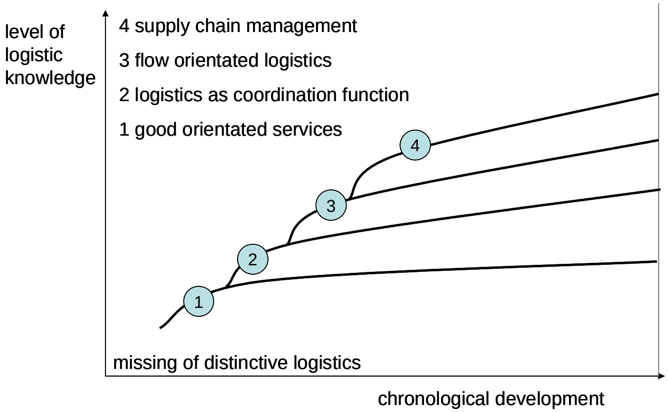

Figure 1. Model of logistics development (Weber, 2002)

As mentioned in the introduction, companies of the construction sector often are on the first level. Bigger companies, active in international projects, sometimes hold a department for logistics planning and could be seen as second level. Documented examples for the third or even fourth step in construction are unknown to the authors. The general work of Weber concentrates on the cost effect of logistics systems and offers a wide spectrum of points that could be transferred into the construction sector to make logistics processes transparent for the calculation and controlling of a company. Weber describes typical logistics cost indicators and combines them with his 4-level-model. Interestingly, most of the indicators of the first level are not used or even known in the construction sector.

2.2 Controlling with logistics indicators

Reichmann [Reichmann, 1995] is another expert for controlling in Germany. He has published a fundamental work about the use of indicators in controlling and for management reports. One chapter of his book is dealing with logistics controlling and instruments that can be used effectively. Some ideas have found their way into this paper and will be referred to later on.

2.3 Supply chain management for construction logistics

As shown above, most authors publishing about construction logistics use management approaches. They often refer to the supply chain management, sometimes to lean management or Goldratts “theory of contraints”. In most of these publications the impacts documented must be described as quite small compared to the dimension of the theory. A reason might be, that most actions on construction sites are “managed” by workers who prefer a pragmatic solution. The management overhead is quite small compared to other industries. The real power on site is someone solving technical problems (engineers) or saving money (business people). This paper is mainly intended for the last group, since it finds applicable ideas for its daily controlling.

3. RESEARCH PROJECT

First of all we want to present an overview on the logistics system we are talking about. Every author comes up with slightly different names and descriptions, so we see it as evidently that the wording is defined.

Starting from a sound preparation of work, different working fields can be identified for the performance of construction logistics. In the case of big projects, it will be useful to plan these topics in the preliminary stages to get maximum use out of the logistics concepts. Planning parallel to the constructing period – which is still practised in Germany – is insufficient from a logistic point of view and therefore should be avoided. As for all planning services in construction it is also true that the project outcome can be influenced most easily at an early stage. Increased planning effort and surplus costs connected on the side of the client are balanced with a higher reliability in view of costs, time and quality in the construction realization. Logistics concepts can be divided roughly into supply logistics to the construction site, site logistics and disposal logistics [Fig.2].

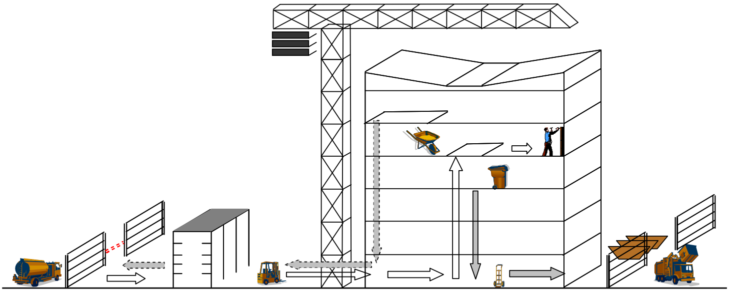

Figure 2. System of construction logistics

Supply logistics: The trouble-free supply of the construction site with construction materials and building machinery is a central prerequisite for continuous working processes. Knowledge of the supply chains is essential, for which customer service level and supply conditions are important factors. Each trade has a specific organisation of supply which is mostly coordinated by the trade itself. Since all construction companies are using common resources on the construction site coordinating is indispensable. It starts with traffic control in the surroundings of the construction site – especially in inner-city areas – to warrant the supply within the supply of goods in time. In case of cramped space within the supply zone, regulations for approach are able to prevent unnecessary delays. A JIT concept for certain products requires a trouble-free process at the receipt of goods. The application of modern I&C technologies has proved to be a helpful means. So-called on-board units provide both suppliers and dispatchers with data in time. A known problem on big construction sites is the organisation of the receipt of goods. Different places and persons being recipient can be a reason for considerable delay in the transfer of goods. Automated transfer systems operated according to the principle of vending machines provide new opportunities for the transfer process organization.

Site logistics: Correct storage of the materials on construction site is very important to prevent the material from being contaminated or damaged due to the rough conditions on site. Prepared storage areas can be situated centrally in the goods receipt area or also on floors or in construction sectors. Cranes and lifts serve for vertical transport and have to be sufficiently dimensioned to provide the required capacity as primary transport means. Distance transports are of great importance because a manual handling is combined with high costs for personnel. Lean supply processes require the knowledge of the stock on the construction site. However, on construction sites systems for inventory management are scarcely found.

Disposal logistics: The disposal from construction sites is an important cost factor, especially when construction is taking place in an area with existing buildings. The German construction industry is already making 60% of its turnover in this sector. Disposal has to be done in accordance with legal regulations, which must be considered when devising disposal alternatives. Besides pure disposal fees, expenditure on logistics makes a difference to the overall cost. The fact is that low disposal fees can be realized only with increased effort in logistics. It is therefore necessary to find the optimum balance between effort and waste fractioning. To determine the waste quantities to be expected is a complex task due to the individuality of the construction sites being of considerable influence to the combinations of waste and the time of occurrence. The selection of suitable transport and collection systems is decisive for the functionality of a concept which – in too many cases – fails due to missing acceptance by the personnel.

Planning, controlling and monitoring are indispensable components of realizing construction logistics because only this way the effectiveness of measures can be warranted. This task can be supported by using indicators. Until now, however, indicators have not been determined in standardized form.

3.1 Project description and objectives

The challenge for construction logistics is the transparency of logistics cost. To develop a method of indicators for construction logistics is the objective of our research.

Indicators serve for demonstrating quantitatively comprehensible facts of business administration in a concentrated form. They can refer to the entire enterprise (e.g. balance indicators) or they can be applied for single departments and divisions (e.g. production or logistic indicators). The most important elements of an indicator are its informative character, its ability to be quantified and the specific form of its information. The latter referring to complicated structures and processes are shown in simplified form to allow a rapid and complex overview especially for leading authorities.

3.2 Research methodology

Our objective is to develop a system of indicators for construction logistics to make logistics cost transparent. The system will be developed in four steps. The first step is the development of a data structure (What key data do I need?), second the extraction of logistics planning data from bidding documents or CAD into a database (Which logistics information are in my bidding documents/CAD-model?), thirdly the analyses of real time processes (Which way does the resource take to the construction site?) and finally the optimisation of construction material and logistics resources (What can be improved? How can it be improved?). To achieve this we start with the first step and define what data we need and how they are structured. Therefore, first of all we take a look at the methodology of indicators.

Indicators have to fulfil criteria determined for practical use covering inquiry, controlling and recipient. The inquiry of indicators has to be based on available data. They should be recorded with little effort, use-orientated and for the long term. For the controlling it has to be considered that they are target-related, relevant for controlling, influenceable, resistant against manipulation and incentive-orientated. Last but not least, they have to be understandable, definite and interpretable for the recipient so that they can be used as database in process control.

Indicators are versatile instruments which can be used for both internal and external purposes. They are a central instrument of control. Indicator contents are orientating on the respective analysis targets as e.g. target/actual analyses or productivity analyses. They are applied as auxiliary means in the entire process of operative planning and control – starting with target operationalisation up to demonstration of target/actual deviations for single service sectors.

The informative value of single indicators is limited. On the one hand their quality depends on the features of the information system they are based on. On the other hand, mistakes made in the design of the indicators can lead to insufficient results. The possible insufficiencies in the evaluation with single indicators cause the necessity of integrating the indicators into a system.
These indicator systems help eliminating ambiguities in the interpretation and to include relations of dependence between the system elements.

Indicator systems are usually understood as a collection of quantitative variables where the single indicators stay in a relevant useful relation to each other. They supplement or explain each other and in total are orientated on a superordinate system. The relations can be of systematic, mathematical or empirical nature. Generally logistics serves the following enterprise target [Fig.3].

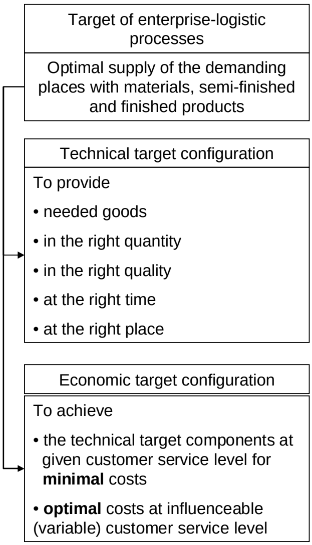

Figure 3. Logistics targets in general

An indicator system for logistics has to be orientating on this. The following example of a typical logistics indicator should demonstrate the way it works [Fig.4]:

Customer service level
$\dfrac{\text{Number of requests delivered in time}}{\text{Total number of requests}} \cdot 100$

Figure 4. Customer service level as an example for a logistics indicator

The customer service level is defined according to the above formula and provides a quantified statement on the quality of a logistics service. The customer service level is often fixed as a quantity between 50% and 100% by the enterprises for which the fulfilment of the 100% customer service level causing high effort and costs for logistics. On the other hand, it can be assumed that stock-out cost will arise due to the imperfect logistics service. When setting these two values into a relation a target function results, having a minimum and thus an optimal solution [Fig.5]. Logistics cost are represented here in simplified form by the inventory costs.

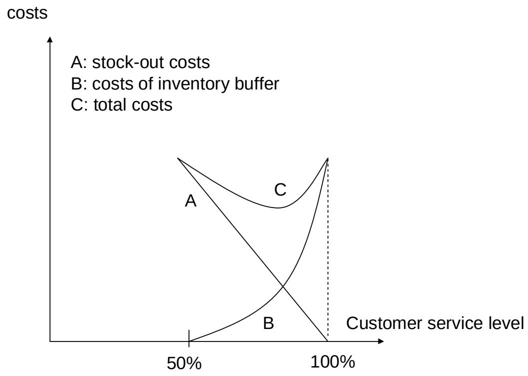

Figure 5. Connection between customer service level and costs

For further logistics indicators and their application see the references. The objective of the use of indicators is the optimisation of the profit ratio, economic efficiency and productivity.

4. RESEARCH RESULTS AND INDUSTRIAL IMPACT

4.1 Tentative Results

A number of logistics indicators can be transferred to construction logistics without further adjustment. But in several fields considerable differences become obvious. The deviation is especially obvious in the sector of distribution logistics. Due to the immobility of the product, this field is completely inapplicable in construction logistics. Its place, with limitations, is taken by disposal logistics which has direct influence on the logistics processes on the construction site. However, the structure of the indicators in this sector is deviating from the systems of supply and construction site logistics so that only a few indicators can be applied for the superordinated indicator system.

Which indicators are served particularly depends on the organisation of the construction site. The basic structure is shown by [Fig.6].

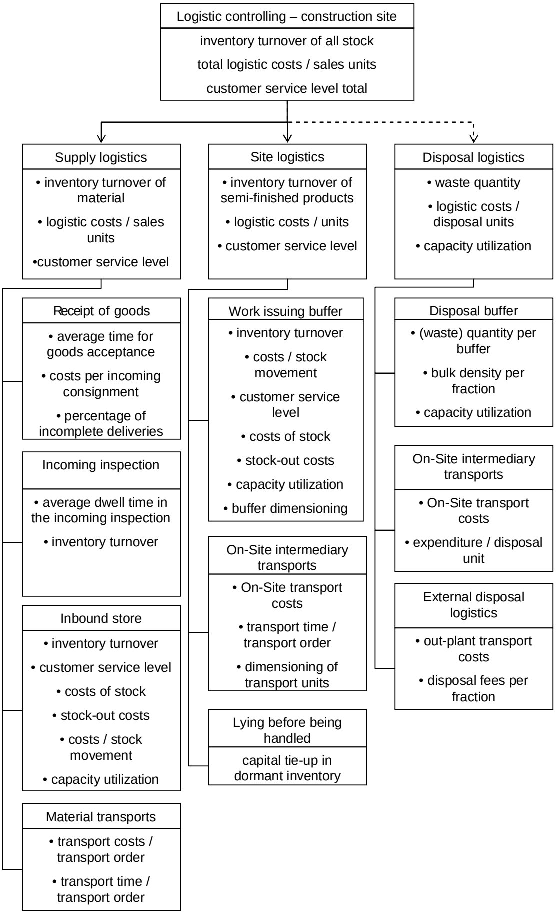

Figure 6. General approach of an indicator system for construction logistics

Within the planning phase there are different information sources available for the determination of indicators. Applications of CAD (Computer Aided Design) and AVA (Ausschreibung, Vergabe, Abrechnung – application of tenders, allocation, invoicing) are of special importance for data processing in the construction sector. These systems contain a great deal of information which – with an appropriate classification – provides clues about the logistics needs on the building site. In the planning process the data are already used for dimensioning transport and storage capacities. However, the evaluation is done mostly manually and without a planning or controlling system. A documented controlling and performance calculation is not at hand why further sources for the determination of indicators are not available.

In logistics, therefore, technologies, such as barcodes and RFID for identification, are decisive for a continuous data flow. In the end they should comprise the entire logistic process. The necessary databases for storage are so-called WMS and ERP systems. A realization of the process optimisation for several suppliers up to the final customer is therefore called supply chain management. So the target is to establish these technologies, systems and management approaches and to link them with already existing planning programs to simplify the planning and control of the logistics service.

4.2 Implementation and exploitation

The result will allow site managers to obtain logistics information during the planning and building process. Due to this information they have the possibility to e.g. plan the traffic situation in the streets around the construction site to handle procurement. They are also able to work with adapted warehouse management systems to lower inventory stocks or to manage storage space. Transport capacities on the site like the crane, in most construction projects a logistic bottleneck, are easily simulated and optimised. In general, data based analysis and real time information with the focus on logistics key data provide information for further logistics concepts on construction sites and the whole supply chain.

To meet the requirements of the criteria for the use of indicators the automation of the recording at construction sites is indispensable. Special need for research lies in the low-effort identification of the items and the continuous availability of the data. Here, technologies like barcodes and RFID tags as well as software applications from the group of WMS/ERP are of special importance. For those responsible at the construction site their application has to be realized without any problem and with low effort. In consequence, communicating control measures and incentive systems will become understandable for the recipient and clearly representable with the aid of the indicators.

5. CONCLUSIONS

The application of indicators is widely spread in logistics control of the stationary industry. The advantages provided by this approach can also be transferred to the construction industry. Also, in a construction enterprise the targets are the optimization of the profit ratio, of the economic effectiveness and of the productivity. For this objective, however, the development of a logistics indicator system is necessary to fulfil the requirements of a construction site on the one hand. On the other hand, the data recording and data management has to be automated to be able to care for the system easily and user-friendly. Currently the efforts supporting this step for the construction industry become obvious from the side of the WMS and ERP providers.

6. REFERENCES

Ala-Risku, T. & Kärkkäinen, M. (2004) Material delivery problems in construction projects: A possible solution, *International Journal of production economics* <http:// lib.tkk.fi/Diss/2005/isbn9512277654/article5.pdf> Rev. 2006-06-25

Bronsted, J., Walloe, P. & Bindslev, K. (2003) Object oriented information modelling for use in lean construction, *Proceedings International Group of Lean Construction, 11th Annual Conference*, July 22-24, 2003, Virginia Tech, Blacksburg, Virginia.

Jang, H., Russell, J.S. & Yi, J.S., (2003) A project manager's level of satisfaction in construction logistics, *Canadian Journal of Civil Engineering*, **30**.

O'Brien, W. J., London, K. & Vrijhoef, R. (2002) Construction Supply Chain Modeling: A research review and interdisciplinary research agenda, *Proceedings IGLC-10*, Aug. 2002, Gramado, Brazil.

Olsson, F. (2000) *Supply Chain Management in the Construction Industry*, Licentiate Dissertation, Department of Design Sciences, Logistics, Lund University, Sweden.

Reichmann, T. (1995) *Controlling mit Kennzahlen und Managementberichten*, 4. Auflage, Verlag Franz Vahlen, München, Germany.

Salagnac, J.-L., Yacine, M. (1999) Logistics: A step towards lean construction, *Proceedings of Seventh Annual Conference of the International Group for Lean Construction (IGLC-7)*, Berkeley, California, USA, 26-28 July 1999.

Salazar, G., Mokbel, H. Aboulezz, M. & Kearney, W. (2006) *The use of the building information model in construction logistics and progress tracking in the Worcester Trail Courthouse*. <http://www.icccbexi.ca/program/Abstracts/tp154.pdf> Rev. 2006-06-25

Veiseth, M., Rostad, C.C. & Andersen, B. (2003) Productivity and logistics in the construction industry, Proceedings *Nordnet 2003, Project Management: Dreams, Nightmares and Realities*, Oslo, Norway September 24-26.

Weber, J. (2002) *Logistikkostenrechnung*, 2. Auflage Springer- Verlag, Berlin Heidelberg, Germany.

Zou, P.X.W. & Seo, Y., (2006) Effective applications of e-commerce technologies in construction supply chain: Current Practice and future improvement, In Proceedings ITcon, **11**, 127-147.

ADDRESSING UNCERTAINTIES ABOUT TIMBER HOUSING BY WHOLE LIFE COSTING

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ABSTRACT

Increased cost and declining quality has resulted in a growing interest in industrialised construction. During the last twelve years around 20000 apartments have been built in Sweden using industrialized timber housing techniques. Still, potential clients and building owners are uncertain of long-term financial costs and functional performance of timber houses. The idea in this paper is to investigate if the use of whole life costing calculations might become a tool for addressing these uncertainties. For this purpose, a pilot interview study has been performed to obtain uncertainties expressed by Swedish building owners connected to multi-dwelling timber frame houses. In general, the results show that a tool must be able to handle not only economical factors but concurrently the effects of economical, technical, functional, cultural and human factors.

1. INTRODUCTION

In recent years, industrialization of construction is put forward as an aid to decrease the building costs. The challenge for the sector is to understand what industrialization implies in terms of management, actors' roles etc. Industrialization of construction is also debated in literature (e.g. London and Kenley, 2001). Multi-family timber frame housing has been pointed out as an area for industrialized process development in Sweden. However, uncertainties are expressed by clients and building owners concerning long-term financial costs, technical performance and management of prefabricated timber frame houses (Höök, 2005). The construction industry is to a high extent project oriented and construction is therefore, at times, criticized to lack a systematic and strategic approach to change because of the project nature (Saad et al., 2002). Since the project orientation/culture is so strong, a method that incorporates uncertainties caused by e.g. housing industrialization must be able to work on a project level and at the same time capture long-term behaviour of the facility. The aim of this paper is to identify uncertainties about timber housing and investigate if whole life costing can be used to address the uncertainties. In the context of this paper, timber housing is the industrialized production of multi-storey, multi-dwelling timber frame houses.

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2. BACKGROUND

Among Swedish contractors there is currently a specialization trend towards an increased use of prefabrication and industrialisation in housing construction. The Swedish regulations adopted in 1995 a functional view that allows timber in multi-storey buildings. Of a special interest for this research is therefore the development of timber housing.

Timber volume element (TVE) prefabrication is examined since it displays several of the attributes that are important in the industrialization approach. The TVE's are prefabricated as "ready-to-use" housing volumes complete with electrical installations, flooring, cabinets, and finishing etc. TVE prefabrication is competitive on the Swedish detached house market but much less on the multi-storey market (≤ 10 % market share). The basis for this low acceptance of the TVE prefabrication was examined by Höök (2005). The attitudes of 35 building owners' organisations were:

- *Historical prejudice:* TVE prefabrication was connected to barracks and simple movable houses and hence to a historical prejudice about poor performance and low quality.
- *Lack of required technical information:* Technical solutions of TVE's and timber in itself were not believed to be able to fulfil all code based functional demands such as adequate sound insulation etc.
- *Low long-term economical performance:* The TVE building system and their manufacturers' capacity and intention to fulfil long-time quality and life-cycle costs were questioned.
- *Organizational or project management change:* The TVE management is more related to process than traditional project management. This necessitates new co-operative patterns between the client and the manufacturer.

Hence, the presumed beneficial effects of industrialisation seem to be limited for TVE prefabrication due to two combined effects. Firstly, organizational and technological changes seem to outmode the traditional construction management practices and place greater demands on the coordination between different organizations. The client has to take a more active role in coordinating the industrialised process and he/she apparently lacks knowledge or trust if the TVE system leads to an optimal life cycle design. Secondly, in the eyes of the clients, there are too few actors to make the TVE system reliable comparable to other building techniques.

3. LITERATURE REVIEW

The research in this paper considers the basis and implications for the perceived uncertainties regarding timber housing. Literature on transaction costs is reviewed to address uncertainties, and literature on whole life costing (WLC) and whole life appraisal (WLA) is considered for life cycle design definitions and applications. The purpose is to give an explicit, not a comprehensive, literature review to explain the empirical results.

3.1 Definition of uncertainty

Uncertainty is viewed in this paper as "*a business risk which cannot be measured and whose outcome cannot be predicted or insured against*". Uncertainty cannot be measured. However, two central contributors to uncertainty in a product development context are defined technology novelty/complexity and project complexity (Tatikonda and Rosenthal, 2000). Project complexity increases the degree of uncertainty as for a construction project with, e.g. new frame material, new actors or new type of co-operation. Technology novelty is, in a product development context, defined as *"the newness, to the development organisation, of the technologies employed"* (Tatikonda and Rosenthal, 2000). This opens the definition of technological novelty/complexity in construction e.g. to a broad range of attributes in industrialized timber housing. Knowledge about a new or altered production process and product design is needed as potential adopters' assumption of risk taking decreases with increased knowledge (Frambach, 1993).

Uncertainty has also been addressed in terms of the difficulties of task performance (e.g. Baccarini, 1996). Summing up, uncertainty is defined as "*the difference between the amount of information required to perform the task and the amount of information already possessed by the organization*" (Tatikonda and Rosenthal, 2000).The more uncertain the task, the greater the quantity and quality of information is needed to generate the knowledge necessary to complete the task.

3.2 Rationale for uncertainty

Transaction cost theory (TCT) was developed from transaction cost reasoning known through Oliver Williamson's *Transaction Cost Economics* (1975). The unit of analysis is the transaction, which "*occurs when a good or service is transferred across a technologically separate interface*" (Williamson 1985:1).

Two human and three environmental factors lead to transaction costs arising (Williamson, 1985:1). The two human/behavioural factors are:

- *Bounded rationality:* Humans are unlikely to have the abilities or resources to consider every state-contingent outcome associated with a transaction.
- *Opportunism:* Humans will act to further their own self-interests.

The three environmental factors are:

- *Uncertainty:* Uncertainty aggravates the problems that arise because of bounded rationality and opportunism.
- *Small numbers trading*: If only a small number of players exist in a market-place, there is little or no possibility of withdrawal and use of alternative players in the marketplace.
- *Asset specificity:* The value of an asset may be attached to a particular transaction that it supports. The possibility (threat) of a party acting opportunistically leads to a so-called "hold-up" problem. It refers to the extent to which a party is "tied in" a business relationship.

It is not until the human factors are combined with the environmental factors that problems arise (Williamson, 1975). Bounded rationality is a problem only when it is combined with situations perceived uncertain or complex for the party involved. As asset specificity and uncertainty increase, the risk of opportunism increases. Furthermore, human inclination for opportunism increases at a market with a small number of players, since opportunism brings its own punishment at a market with a large number of players (Williamson, 1975).

Transactions between organisations are controlled through contracts. This is especially true in construction since control of construction projects is based on firm contractual arrangements. However, the bounded rationality makes it impossible to regulate every matter within a contract, a phenomenon Williamson (1985:2) describes as contracts being unavoidably incomplete. In the relation between supplier and customer, trust will both facilitate the co-operation and prevent conflicts between the parties (Berggren and Lindkvist, 2005) and contracts can function both as a substitute and complement of trust (Klein Woolthuis et al., 2005). Prior experiences also play an important role in determining if and to what extent a partner can be trusted. Without long-term experiences it may not even be possible to submit the risk that one who is trusted may fail (Nooteboom, 2002).

3.3 Whole life concept

Traditionally, focus in construction is on minimising the initial building cost. It has, however, since the 1930s become obvious that it is unfavourable to base the choice between alternatives solely on the initial cost alone (Kishk et al., 2003). This philosophy is today globally denominated whole life appraisal (WLA) (Flanagan and Jewell, 2005). Several definitions of the WLA technique exist, of which many can be found in Flanagan and Jewell (2005), and the one we have chosen to use is: *"WLA is the total cost of a facility/asset over its operating life including initial acquisition costs and subsequent running costs"*. The terms whole life costing (WLC) and life cycle costing are differentiated by ISO (2004) defining WLC as a broader term including within it life cycle costing. The standard defines the term life cycle costing as more frequently used to describe a limited analysis of a few of the components within a constructed asset, rather than the whole building (ISO, 2004). We employ the above definition of WLC/WLA. The authors' comprehension of the whole life concept[30], including cost categories and cost variables, is illustrated in figure 1. In Sweden, taxes constitute approximately 50 % of the initial acquisition cost of a project and have to be accounted for, although the cost for taxes has not been included in figure 1.

For input to the WLC calculation, future costs are converted to their current equivalent by using a suitable discount rate. A period of analysis is chosen and an appropriate investment appraisal technique is applied, of which the most employed in literature is the net present value method (Kishk et al., 2003). As WLC, by definition, deals with the future and the future is unknown (Flanagan et al., 1989), a risk analysis should be carried out after the performed calculation.

A review of different mathematical WLC models revealed that most of the models use the same basic equation. However, what separates them is the breakdown of cost elements. Concerning the suitability for the construction sector, each of the models seemed to have some specific advantages and some specific disadvantages (Kishk et al., 2003).

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[30] A term mounted and used by the authors as an umbrella term for both of the terms WLC and WLA.

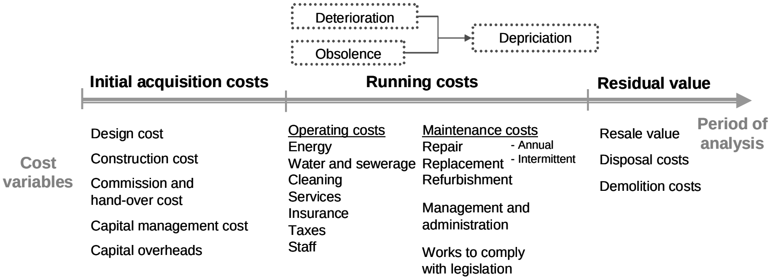

Figure 1. The authors' understanding of the whole life concept for buildings

The quality of decision-making derived from the use of WLA is constrained by the availability of appropriate and accurate data, which Flanagan and Jewell (2005) refers to as the "data problem". Additionally, the transition from understanding the theory of WLC to practising it is not easy (Flanagan et al, 1989). In many cases, the intangibles (such as aesthetics) are in conflict with the results from WLC calculations (Kishk et al., 2003), also contributing to the difficulties facing the usefulness of the technique. To conjoin these objective techniques with more subjective ones, Flanagan et al. (1989) suggest using weighted evaluation matrices to handle the intangible costs and benefits. Despite the above mentioned attempt, Öberg (2005) states that the majority of the tools, such as WLC, durability of materials and environmental assessment (LCA), are limited to their specific purpose and cannot provide a holistic view of the issue. A general and holistic model combining different tools for an optimal life cycle design has been denoted *integrated life cycle design,* Sarja (2002). The model, with methodology and methods linked to it, makes it possible to handle the multiple needs desired by the owners, users and society in an optimised way during the entire life cycle of the building. The main aspects included in the model are displayed in figure 2. The model might be able to address several facets of uncertainties, going beyond a traditional WLC model. Notable, and important, is that WLC calculations are included in this model.

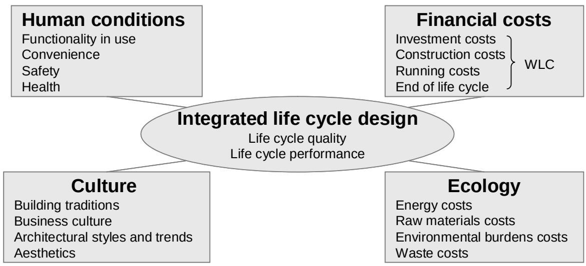

Figure 2. Main aspects of integrated life cycle design (after Sarja (2002))

4. RESEARCH QUESTIONS AND METHODOLOGY

The incentive to this study, aroused by the interview study by Höök (2005), is to deepen the understanding of the uncertainties and lack of trust expressed by building owners associated to timber housing. According to a market analysis presented by a Swedish commission, Industrifakta[31], clients are foreseen to receive increased power and a different role in a future industrialized building process in Sweden. A key factor for the clients is knowledge regarding long-term performance of the building systems. With a profound comprehension of the rationale for the uncertainties and lack of trust, the authors wish to investigate if and to what extent the uncertainties can be addressed by WLC/WLA considerations.

In this pilot study, we therefore formulated the following research questions:

- What are the uncertainties expressed by Swedish building owners related to timber housing and what are their rationale.
- If and to what extent can aspects in integrated life cycle design be used to address the uncertainties.

4.1 Research methodology

Considering the research questions, the investigation was designed as an exploratory study with a qualitative research approach. In-depth interviews are especially suitable when the problem is complex since the interviewer can rephrase the questions as well as pose related questions to penetrate the problem (Wiedersheim-Paul and Eriksson, 1989). With the possible difficulty involved concerning how to express uncertainties in mind, personal in-depth interviews were conducted. The possibility to adjust the questions to each individual was important in this case to reach the bottom of the viewpoints. The same questions, but from different angles, were asked thereby also reaching triangulation. In total, a number of seven in-depth interviews with five Swedish building owners were conducted. The interviews were held as semi-structured face to face-interviews.

The participating rental apartment building owners were selected from the features: geographical location of flats, size, type of ownership and whether they have experience of timber housing or not, see table 1.

Table 1. Characteristics of the participating companies

Location	**No of rented flats**	**Ownership**	**Experience of timber housing**
Luleå/Piteå	1100	Private-owned	Yes
Stockholm	5000	Cooperative economic association	No
Luleå	11500	Public-owned	No
All over Sweden	29000	Private-owned	Yes
Stockholm	43000	Public-owned	Yes

The interview data was analysed through *categorization*, taking into consideration the instructions by Dey (1993). Affinity diagram (Foster, 2004) was used for grouping the data and the aspects in Sarja (2002) to combine the groups.

[31] In Swedish: Industrifakta, 2006: Konsekvenser av industrialiserat byggande.

5. RESULTS AND ANALYSIS

A number of clusters of uncertainties were distinguished. Assorting the different groups of uncertainties under headlines constituted by the main aspects in of *integrated life cycle design* resulted in a number of groups falling outside the model by Sarja. These could, instead, be clustered under the headline technical solutions, identified by Höök (2005). The result of the categorization is displayed in table 2.

Table 2. The expressed uncertainties grouped and categorized

Financial costs	**Technical solutions**	**Human conditions**	**Culture**	**Ecology**
Energy consumption*	Motions*/Stability*	Sound insulation*/ perceived sound level*	Co-operation with partners*	Natural and sustainable materials
Long-term performance*	Risk of fire*	Security/ safety	Experience, history, tradition*	
Water damage, piping, installations*	Fulfilment of functional demands on actual location*	Comfort, well-being	Dry building process*	
Maintenance of wooden facades*	Timber as frame material*	Architecture, aesthetics		
Initial construction cost	Adaptability to new regulations and change			
Management- and life cycle economy*				
Stairwells and wooden staircases*				
Maintenance of: facades, roofs and windows				
Serviceability, accessability				
Wear				

The table shows the groups sorted under five headlines and divided into three levels. The groups in black squares are of highest importance as they are mentioned by four or more of the respondents. The groups on the second level, with grey filling, were mentioned by three or less and the third, the white, by one or two of the respondents. Notable is, no uncertainties were mentioned by four or more respondents under the headlines *culture* and *ecology*. The groups marked with an asterisk are uncertainties, or concerns, expressed especially about timber housing.

The most frequently mentioned uncertainties regarding *financial costs* are energy consumption, long-term performance and water damages. The respondents expressed a belief of higher energy consumption with a timber frame than for a traditional (concrete) frame, questions about the length of the building's physical life and particular concerns about the consequences of a water leakage in a timber frame house. All building owners, except one, expressed perceptions about motions (a technical solution) in the wooden frames causing, for example, cracks in wall paper. All respondents expressed doubts that the sound insulation, found under *human* *conditions*, is not good enough for timber housing. Their impression was that the living environment would be disturbed by noise making the building less attractive.

Most of the uncertainties are about financial costs. This finding clearly, and maybe not surprisingly, indicates that the long-term financial cost is the most crucial uncertainty to address. Furthermore, a salient observation from the interviews is that cost is the decisive factor in design decisions, but with shifting focus on short-term and long-term costs among the respondents. A difference could be discerned between private and public building owners. Consequently, many of the uncertainties of highest importance can be addressed by WLC calculations, although not all.

A conclusion drawn from table 2 is that the main grounds for the uncertainties about *technical solutions* originate from the TVE houses being a new product offer, a new frame material, with a novel construction method (industrialized production), all of which can be referred to as *technology novelty*. The technology novelty added with the facts that construction encompass high project complexity and that buildings incorporate a high degree of asset specificity and are of high economic value for the client makes it evident that human bounded rationality will influence the client's understanding of the transaction. Uncertainties concerning the technical solutions must therefore be addressed for the product to be trusted.

A building is a complex product delivered long after the contract has been signed. Due to this project complexity, the human bounded rationality is high in this type of transaction making trust an essential ingredient in the choice of contractor. No prior experience of the contractor will lead to an even higher perception of risk-taking from the client. Even more, if the client in addition has no prior experiences of either industrialised production or timber housing, there will be poor trust for all three inherent components in the choice of timber housing and little motivation to take the risk. The small number of manufacturers on the timber housing market further increases the perception of risk-taking. This can be explained by the increased inclination for opportunistic behaviour by the contractor, inevitably making the contractor perceived as less trust-worthy. Thus, creating distrust for the product and uncertainty about the delivery since the client has no possibility of withdrawal when there are no alternative contractors to engage.

To sum up, one can clearly derive many of the grounds for the expressed uncertainties related to timber housing, especially for the ones under the headlines *financial costs* and *culture* from Sarja (2002) and *technical solutions* coined by Höök (2005). Visible is, however, that most of the uncertainties can be embodied in the main aspects in *integrated life cycle design* by Sarja (2002). Though, with diverse weight given to the aspects since this study takes into consideration solely the perspective of the client resulting in the high importance given to the economical aspect and insignificant consideration of ecology. However, to address *all* uncertainties requires augmenting Sarja's model with the aspect *technical solutions*.

6. CONCLUSIONS

The most important features of timber housing, as a new product on the construction market produced with a new production process by relatively small and unknown manufacturers, generate uncertainties and scepticism among the potential clients and building owners. The grounds for the uncertainties related to timber housing are shown to a large extent to be found in the transaction cost theory and in the notions of technology novelty and project complexity. Knowledge of the rationale behind the perceived uncertainties makes it possible to address them. The study does, however, not reveal how this should be achieved since it was outside the scope of this paper.

The interviews in this pilot study show that uncertainties related to financial costs constitute the great majority of the uncertainties emphasized by building owners. Hence, a conclusion drawn is that WLC calculations will be able to address a large number of the perceived uncertainties about timber housing. Although, for the calculations to be applicable and accepted, the model must be broadened to include all aspects in integrated life cycle design. The characteristics of timber housing make it crucial to address the uncertainties about its technical solutions for the new product to be trusted by the clients.

Further research will be directed towards finding methods to meet the concerns related to timber housing. Since uncertainties about financial costs and long-term performance represent the majority of uncertainties mentioned, the research will focus on addressing these by applying WLC methods. However, the long-term objective is to tackle this subject with a holistic approach, creating a tool for addressing uncertainties related to new construction products from a general point of view and to facilitate the use of integrated life cycle design models.

7. ACKNOWLEDGEMENT

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8. REFERENCES

Baccarini, D. (1996), The concept of project complexity – a review. *International Journal of Project Management*, **14**, 201-201.

Berggren, C. and Lindkvist, L. (2005), *Projekt - Organisation för målorientering och lärande*. Lund: Studentlitteratur.

Dey, I. (1993), *Qualitative data analysis – a user-friendly guide for social sciences*. London: Routledge.

Flanagan, R. and Jewell, C. (2005), *Whole life appraisal for construction*. Oxford: Blackwell Publishing.

Flanagan, R., Norman, G., Meadows, J. and Robinson, G. (1989), *Life cycle costing – theory and practice*. Oxford: BSP Professional Books.

Frambach, R.T. (1993), An Integrated Model of Organizational Adoption and Diffusion of Innovations. *European Journal of Marketing*, **27**(5), 22-41

Foster, S. T. (2004), *Managing quality – an integrative approach*. Upper Saddle River, N.J.: Prentice Hall.

Höök, M. (2005), *Timber Volume Element Prefabrication - Production and market aspects*. Licentiate thesis 2005:65, Luleå University of Technology. Division of Structural Engineering – Timber Structures.

ISO/DIS 15686-5 (2004), *Buildings and constructed assets – Service life planning. Parts 5: Whole life costing*. International organization for standardization, Geneva.

Kishk, M., Al-Hajj, A., Pollock, R., Aouad, G., Bakis, N. and Sun, M. (2003) *Whole life costing in construction – A state of the art review*. Research paper. London: RICS Foundation.
Klein Woolthuis, Woolthuis R., Hillebrand B. and Nooteboom B. (2005), Trust contract and relationship development. *Organizational studies*, **26**, 813-840.
London, K. and Kenley, R. (2001), An industrial organization's economic supply chain approach for the construction industry. *Construction Management and Economics*, **18**, 777-788.
Nooteboom, B. (2002), *Trust: Forms, foundations, functions & failures*, Cheltenham: E. Elgar.
Saad, M., Jones, M. and James, P. (2002), A review of the progress towards the adoption of supply chain management (SCM) relationships in construction. *European Journal of Purchasing and Supply Management*, 179-183.
Sarja, A. (2002), *Integrated life cycle design of structures*. London: Spon Press.
Tatikonda, M. V. and Rosenthal, S. R. (2000), Technology novelty, project complexity and product development project execution success: a deeper look at task uncertainty in product innovation. *IEEE Transactions on Engineering Management*, 47.
Williamson, O.E. (1975), *Markets and hierarchies – analysis and antitrust implications*. USA: The Free Press.
Williamson, O.E. (1985:1), *The economic institutions of capitalism*. USA: The Free Press.
Williamson, O.E. (1985:2), Reflections on the New Institutional Economics, *Journal of Institutional and Theoretical Economics*, **141**(1), 187-95.
Wiedersheim-Paul, F. and Eriksson, L. T. (1989), Att utreda och rapportera. Malmö: Liber.
Öberg, M. (2005), *Integrated life cycle design – application to Swedish concrete multi-dwelling buildings.* Doctoral thesis, Lund Institute of Technology, Lund University, Department of Building Materials.

RISK MANAGEMENT ON SMALL PROJECTS

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ABSTRACT

The Swedish construction sector has for some time struggled with problems that result in increased costs, delays and faults. To sort out and analyse these problems, the government appointed a commission which culminated in the report *Skärpning gubbar* (2002). The report highlights that, despite ongoing work with quality management and internal quality surveillance, improvements are still lacking. Risk management is about thinking ahead and preventing things from going wrong and about stimulating and searching for better solutions. Small projects rely on few individuals, yet are significant in number in the sector representing 83% of the projects between 1-15 MSEK (in 2003). This dominance highlights the importance of working efficiently with risk management in order to address the concerns and problems identified in *Skärpning gubbar*. The research is focused on small projects and how risk management, including the tools and techniques employed, is undertaken. This paper presents results from an interview-based survey of risk management at the site level. 28 interviews were conducted on 10 different projects in Sweden. The respondents occupied key positions on those projects, representing the contractor as well as the client. The results show that there is a low to non-existent level of education in risk management amongst the respondents. The use of formal risk management is low and there is a lack of a systematic approach. The paper concludes that the risk management system applied on small projects is rather poor. Project staff rely on their own intuition, experience and personal judgments to control the projects. Control is mainly performed in a traditional way through schedules and detailed work plans and not through management systems.

1. INTRODUCTION

The construction sector in Sweden has for some time suffered from poor performance and a lack of control in various stages of the process. Due to the sector's problems with numerous faults and the increased cost of building, the Swedish government initiated the Building Commission, whose assignment was to focus on where the problems were and how to increase effectiveness instead of costs. They found, amongst other things, problems with cost and faults related to construction. Risks and other uncertainties can cause losses that lead to increased costs, time delays and lack of quality during the progression of projects and at their end. The Commission also found that quality management systems according to the ISO standard 9000 have not been enough to decrease problems in the sector (SOU 2002:115, 2002).

In the Swedish construction sector, the most common project is less than 15 MSEK (roughly €1.65m). According to Sveriges Byggindustrier (Hultén, 2004), as much as 83% of all projects range from 1 MSEK to 15 MSEK (in 2003). At NCC, a similar figure (68%) is found from the company's internal cost control system. This figure is probably comparable over the years.

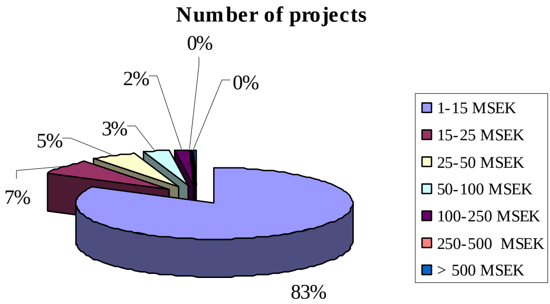

Figure 1. Number of projects divided into segments in relation to their size (Sveriges byggindustrier, statistics from 2003, Hultén, 2004)

The distribution of projects in each segment, sorted by monetary value, instead of the number of projects is also interesting. For the Swedish construction sector, the figure would then be 21% (Hultén, 2004) and 24% for NCC. Clearly, a large portion of the work done in the construction sector concerns the small-scale projects environment. The projects in the range 1-15 MSEK are not as dominant, but still represent measurable economic volumes. Projects up to 50 MSEK represent half of sector turnover. The smaller projects, regardless of their precise limit, represent measurable volumes in both numbers and monetary value. There is, however, no clear understanding of whether small projects lose money or not. This study presupposes that there is a connection between the control of the project and their result. If there is a lack of system to control projects, the assumption is that there is also a connection to the result. Projects with systematic control lose less money or gain more than they otherwise would have.

The aim of this paper is to answer the following research questions:

- Which methods and tools for risk management are used in small projects?
- How are these methods and tools used?

This paper consists of a summary of the literature review that has been performed in the study, followed by a description of the used research method. The results from the study are presented as a summary of answers from the interviews complemented with quotas to illustrate the respondents' answers. Finally the conclusions are drawn from the answers of the research questions.

2. LITERATURE REVIEW

2.1 Previous research

Previous studies in the field of risk management in construction tend to cover large-scale projects, often with many different participants (Ahlenius, 1999; Staffan Hintze, 1994; Hintze et al., 2003; Jaafari, 2001). The risks cover a spectrum of events from financial, political and legal to technical, often related to complex constructions. There are also studies that focus on the use of risk management in construction from both the client and contractor perspective, but with a top-down approach.

In a questionnaire survey in the UK (Akintoye & MacLeod, 1997), the perception of risk was closely connected to the objectives of the projects, i.e. time, cost and quality. Their perception of risk was the occurrence of something unforeseen that would have adversely affected the successful completion of the project. The connection to probability and consequence is concealed and other matters settle the perception of risk.

In another study, the relation to knowledge management is highlighted, as a means to go beyond the traditional approach, with its logical structure based on identification, assessment and response. The motivation for this is the conclusion that the traditional way to manage risks does not produce the sought after results in construction projects (Tah & Carr, 2001).

The attitudes and use of risk management systems in construction have been examined frequently between 1987 to 2004 (Lyons & Skitmore, 2004; Mills, 2001). Lyons and Skitmore have used four surveys from various papers between 1994 and 2001 (Akintoye & MacLeod, 1997; Baker et al., 1999; Raz & Michael, 2001; Uher & Toakley, 1999), when conducting their survey in the Queensland engineering construction industry 2002. Lyons and Skitmore compared the different surveys and made some conclusions about the use and development of risk management in construction.

1. Risk management in the execution and planning stages of the project life cycle is higher than in the conceptual or termination phase. This contrasts with the view that the application of risk management in the conceptual phase is the most important.

2. Risk identification and risk assessment are the most often used risk management elements, ahead of risk response and risk documentation.

3. Brainstorming is the most common risk identification technique used. Consistent with previous survey findings, intuition, judgement and experience are the most frequently used assessment techniques. That no single risk assessment technique is best for all cases may in part be why the respondents have opted for the simplest approach.

4. Qualitative methods of risk assessment are used most frequently, ahead of quantitative and semi-quantitative methods.

5. Project teams are the most frequent group to be used for risk analysis, ahead of in-house specialists and consultants. The level of training in risk management techniques is low to moderate.

These conclusions are from a survey sample covering senior managers in the Queensland construction industry comprising owners, property developers, consultants and contractors. The response rate was, all-in-all, 22% and for the group of contractors almost 18%.

Another study has been performed in UK and has come to similar results as presented in this study. It was based on a survey amongst staff in various projects within UK construction industry (Edum-Fotwe & Azinim, 2006). That study was carried out in parallel with the study presented in this paper.

2.2 Risk definitions

Project risk is defined as a "combination of probability of an event occurring and its consequences for project objectives", according to the international standard IEC 62198:2001. This is a rather technical definition of a matter that is quite individual and also somewhat philosophical. To set the scene for the risk definition chosen in this paper the different approaches to risk and uncertainty are presented.

According to the Project Management Institute, PMI (PMBOK, 2000), a definition of risk should consider both the positive and negative effects of a project objective. This is a broad view in terms of threats and opportunities and how they are connected to an event, a condition or a specific circumstance. This is the definition that works in theory but fails in practice. Despite the enlightened definition, opportunity is neglected when it comes to practical use. According to PMI, risk includes upside effects, the opportunities, but traditionally focuses on the downside, i.e. the negative effects.

Risk in this study is defined as something that occurs and which is foreseen neither in the project description nor in the contract, often being caused by lack of knowledge of one or many of the parties involved. These risks could be dynamic or static, aleatory or epistemic, and could be an event that occurs during the project (Simu, 2006). It could also be something known from the beginning that makes the project unique, i.e. makes it different from the standard procedure. This definition is well in line with results from a questionnaire study in the UK carried out by Akintoye and MacLeod (Akintoye & MacLeod, 1997). They found that general contractors' perception of risk is closely connected to the objectives of the projects in terms of cost, time and quality.

2.3 Risk processes

Risk management systems literature has different ways to relate to the risk management process. There is no common definition on the scope of risk analysis, risk management or the risk process in the literature, since each one has its own twist (Chapman & Ward, 2003; Flanagan & Norman, 1993; IEC62198:2001, 2001; Ingvarsson & Roos, 2003; Smith et al., 1999). It is therefore essential to say what risk management process has been chosen for this study; it is, in fact, the simplest approach. The risk process consists of risk analysis followed by risk response. Risk analysis refers to the inclusion of identification and assessment (see Figure 2).

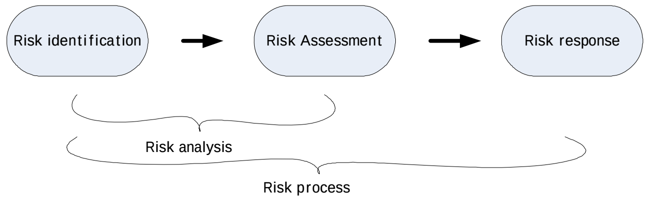

Figure 2. The simplest approach to the risk management process

3. RESEARCH PROJECT

3.1 Objective

This research project has focused on small construction projects and their approach to risk management. In the research, the aim has been to find the status of risk management on small projects and to compare that with theories as well as with the ambitions in the companies investigated. There has also been focus on obstacles and drivers for risk management on the small projects.

For this paper, the aim has been to present parts of the research project namely the status of risk management on small projects, focusing on the site level. If one is able to find out where the starting point is, at what level or to what degree systems are applied today, one is able to progress with further applications or improvements as the next step. This paper will provide the first step in this development.

3.2 Delimitations

In the study, projects in the range of 1 MSEK to 15 MSEK were chosen. The characteristics of a small sized project were subsequently discussed and agreed upon within this study's reference group[32]. The resulting description is enough to distinguish these projects from very small projects that are more of continuous business operations and from larger projects at the other end of the scale. The characteristics of small sized projects agreed upon in the reference group, for the purpose of this study, are:

- contract value between 1 MSEK to 15 MSEK
- a site manager responsible for a maximum of two projects simultaneously

[32] A reference group is made up of representatives from the construction-related industries in Sweden with sufficient knowledge about construction and risk management.

- limited construction time, maximum 12 months
- established technique, no development work
- project environment is independent
- personnel involved are more generalist than specialist

Projects in the range of 0-1 MSEK were excluded because they are less interesting from a project risk management perspective. The upper limit at 15 MSEK was chosen in accordance with the other parameters for a small sized project. When a project increases in volume, the organisation also increases. However, the absolute number for this is not defined, since it is related to the rest of the project context. To have a set number for obtaining statistical data, the size limit of 15 MSEK was chosen.

4. RESEARCH METHODOLOGY

The research design was decided with help from the suggestion that the research style is dependent on the formulation of the research question (Yin, 1994): see Table 1.

Table 1. Relevant situations for different research strategies (Yin, 1994)

Strategy	**Form of research question**	**Requires control of behavioural events**	**Focus on contemporary events**
Experiment	how, why?	Yes	Yes
Survey	who, what, where, how many, how much?	No	Yes
Archival analysis	who, what, where, how many how much?	No	Yes/No
History	how, why?	No	No
Case study	how, why?	No	Yes

The two research questions in this study are a ‘how’ and a ‘what’. According to Yin’s theory illustrated in Table 1, the best way to answer these questions would be with a survey and a case study. The alternative of experiments for this kind of research question fails due to the complexity of undertaking experiments with people and it is people and not materials that are performing the risk management on the project site. To choose an archival or historical study fails due to lack of documentation on small projects: there would not be sufficient amounts of data.

The method left, and also chosen for this study, is an interview survey, with influences from the case study strategy according to Yin (1994). The choice of an interview survey then ending up with qualitative data is also a strategic choice. Common knowledge about risk management and its terminology is limited on construction projects, especially at the site level. To avoid any misinterpretations, having a dialogue about risk management issues rather than filling in inquiries has been important. By using semi-structured open-ended interviews, the respondents were free to add additional information and the researcher was free to adjust the interview questions for each situation and over time.

This study focuses on the site level of construction projects. To ascertain where the information about risk management in these projects is kept, discussions were held with the reference group for the study. In accordance with the theories, the best way to get information was to talk with those involved in the projects. Triangulation in research is all about finding multiple sources of evidence (Yin, 1994) and in this study, different sources of information were used to collect data, such as documents and interviews. The interviews were held with three individuals having different roles in each project.

The key role individuals to be interviewed were to be the site manager, the project's manager from the construction company and the project manager from the client. As a complement to the interviews, some documentation about each project was studied. A chart of the basic information in the projects is shown in Figure 3.

It was decided that a sufficient number of projects would be about ten, since ten would be enough to achieve information saturation, but still few enough to collect the sought after information through interviews and document studies. Data collection would thus be based on approximately 30 interviews. At the end, 28 interviews were conducted, since two of the project managers were responsible for two projects each.

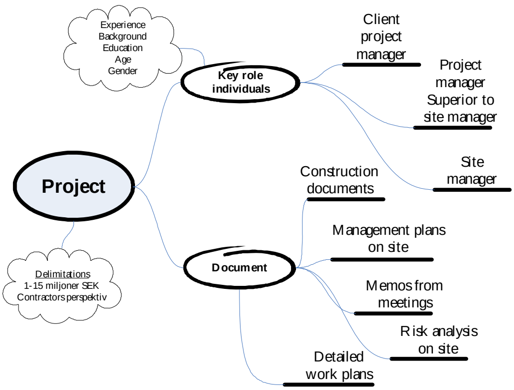

Figure 3. Where the interesting information in the project is kept

5. RESEARCH RESULTS AND INDUSTRIAL IMPACT

5.1 Results

There are some very clear results from this study and one of these is that most managers rely on their own gut-feeling and traditional ways of controlling the project rather than on established risk management systems. The largest group of respondents 17(28) with similar approach to risk management is especially interesting, since they represent such a large proportion of the total group and their way of controlling the projects could be found in the other groups as well, but not so clearly. The following two quotes illustrate this phenomenon.

> *"The actual assessment is based on experience and very much in my head"*

> *"These risk checklists are filled in, but the real meetings and the shared thoughts are done during coffee breaks or over the phone..."*

In some sense, this is the traditional way to control projects in construction – see figure 4. The traditional control process starts with the unstructured allocation of risk money in the tender. The money is allocated with a 'gut-feeling' rather than in a systematic manner. Two of the respondents put it this way:

> *"I do not document the risk assessment I do; I put in some extra money in the tender. Sometimes I allocate the money specifically for a certain risk, but not too often"*

> *"Sometimes we allocate money in the tender for the site manager to see. The money is a combination of money allocated to prevent failures and as a measure to handle thing that go wrong, but mainly for measures if things go wrong."*

Controlling the project continues with high reliance on schedules that are based on resources and activities. Quality assurance is where the quality of critical events is documented, if it is documented at all. The background for this comes from the legal document PBL and judgments from the site manager and the project managers. A common way to control issues in the quality assurance plan is to do detailed work plans, either verbal or through documents. Finally, controlling the project is done through construction meetings where time, money and contractual conditions are handled. These steps are found in most of the projects involved in this study. The steps, however, are not necessarily kept together and a system is lacking.

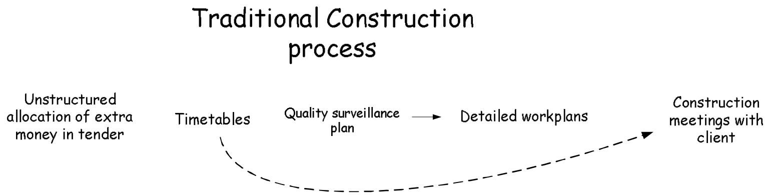

Figure 4. Traditional process to control the construction project

Another result is that there is a lack of training and education of risk management in the projects. More than half of the respondents have not received any training or education in risk management and the rest have received it as a minor part in other education.

The role of the client in the projects risk management is also rather passive. The clients place demands on the constructor to perform risk management, but do not contribute with any themselves. The clients rely on the construction documents to be sufficient. Any information about the project prior to the construction is not shared with the constructor of the project. One of the clients described it in this way:

> *"We have requirements in our management system to manage project risks, but so far we have only stated that the contractors should do this. This is a new way of working and so far it has only been applied in one project and not in this one that we are talking about."*

Another client said almost the same thing about their way of handling project risks:

> *"We do require that the contractors have management systems for quality and environment, but we do not have our own system in use as it is. We are working on the development of such systems."*

The identification and assessment of risks are formalised only in a few of the projects. Most often these steps in the risk process are done on blank pieces of paper based on the individuals' personal judgements and gut-feeling. The use of the systems is neither obvious nor a matter of course.

Instead of using the management system and the risk management tool, site managers control their projects through schedules. Planning is a key issue for the project to succeed according to those site managers. Schedules consist of activities and resources for the different parts of the project. One of the respondents made the following remark about the importance of planning.

> *"Good planning is a key to effective risk responses. If there is a shortage in any way it is my lack of planning that causes it. The system is a good help if I only have the time to use it as a tool in my planning."*

6. IMPLEMENTATION AND EXPLOITATION

Those results could well be used to put focus on the gap between the systems supplied by companies and the use of same in the organisations. It also puts focus on the lack of education in these matters. With more education in risk management there would be an increased understanding of the nature of risk thinking. If one understands why risk management is important and how it can be applied in each and every project, it is more likely that the available tools are used more and also developed further to fit the needs from the project site level.

7. CONCLUSIONS

The research questions addressed the issues of which methods and tools are used on small construction projects and how they are used. The short and simple answer to these questions is that small projects lack systematic risk management. However, in a business where the core value is to handle continuously arising uncertainties, there must be some way to deal with this issue.

This paper concludes that the theoretical framework does not fit; small projects rely on the experience and personal judgements of individuals to do their risk management continuously throughout the project life. Schedules, quality assurance and detailed work plans are commonly used methods. Tools are either checklists or blank pieces of paper. This way of controlling risks and uncertainties is not to be regarded as evidence of systematic risk management. The reliance on the ability of managers is the key to how the risks in these projects are handled. The individuals' risk attitude and risk perception are much more important than the available system, as supplied by the company.

To be able to take risk management to the next step it is probably necessary to start focusing on each and every individual's contribution to the process and the influence of the organisations in which the individuals are situated.

8. ACKNOWLEDGEMENTS

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9. REFERENCES

Ahlenius, E. (1999). Om lönsam och effektiv riskhantering. *Väg- och Vattenbyggaren*, (1), 26-29.

Akintoye, A. S. & MacLeod, M. J. (1997). Risk analysis and management in construction. *International Journal of Project Management*, **15**(1), 31.

Baker, S., Ponniah, D. & Smith, S. (1999). Survey of risk management in major UK Companies. *Journal of Professional Issues in Engineering Education and Practice*, **125**(3), 94.

Chapman, C. & Ward, S. (2003). *Project risk management: Processes, techniques and insights* (Second edn.). Chichester: Wiley.

Edum-Fotwe, F. T. & Azinim, M. (2006, 18-20 October). Risk management practices of construction project staff: Preliminary lessons. Paper presented at the *Construction in the XXI Century – Local and global challenges*, Rome.

Flanagan, R. & Norman, G. (1993). *Risk management and construction*. Oxford: Blackwell Scientific Publications.

Hintze, S. (1994). *Risk analysis in foundation engineering with application to piling in loose friction soils in urban situations*. Royal Institute of Technology, Stockholm.

Hintze, S., Olsson, L. & Täljsten, B. (2003). Risk och riskhantering i arbete i jord och berg. *Bygg och teknik* (1), 12-14, 16-17.

Hultén, V. (2004). Stockholm: Sveriges Byggindustrier.

IEC62198:2001. (2001). *International standard IEC 62198:2001*: International Electrotechnical Commission.

Ingvarsson, J. & Roos, A. (2003). *Riskanalys:Metodbeskrivning för beställare-utförare-granskare*. Stockholm: Svenska brandförsvarsföreningen.

Jaafari, A. (2001). Management of risks, uncertainties and opportunities on projects: Time for a fundamental shift. *International Journal of Project Management*, **19**(2), 89-101.

Lyons, T. & Skitmore, M. (2004). Project risk management in the Queensland engineering construction industry: a survey. *International Journal of Project Management*, **22**, 51-61.

Mills, A. (2001). A systematic approach to risk management for construction. *Structural Survey*, **19**(5), 245-252.

PMBOK. (2000). A *guide to the project management body of knowledge*. Newton Square: Project Management Institute.

Raz, T. & Michael, E. (2001). Use and benefits of tools for project risk management. *International Journal of Project Management*, **19**(1), 9.

Simu, K. (2006). *Risk management in small construction projects*: Licentiate dissertation, Department of Civil and Environmental Engineering, Luleå: LTU.

Smith, N. J., Merna, T. & Jobling, P. (1999). *Managing risk in construction projects*. Oxford: Blackwell Science.

SOU 2002:115. (2002). *Skärpning gubbar! Om konkurrensen, kvaliteten, kostnaderna och kompetensen i byggsektorn*. Byggkommissionens betänkande. In B. Stockholm (Ed.): Norstedts.

Tah, J. H. M. & Carr, V. (2001). Knowledge based approach to construction project risk management. *Journal of Computing in Civil Engineering*, **15**(3), 170-177.

Uher, T. E. & Toakley, A. R. (1999). Risk management in the conceptual phase of a project. *International Journal of Project Management*, **17**(3), 161.
Yin, R. K. (1994). *Case study research, design and methods*, Second edition, 5. Thousand Oaks: Sage Publications, Inc.

QUANTITATIVE RISK MANAGEMENT FOR CONSTRUCTION – MODEL OF ELEMENTS FOR WORKABLE SOLUTIONS

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ABSTRACT

The quantitative risk management approach can provide a somewhat explicit linking from risks towards business or performance elements of construction, for example cost estimate, budget, schedule and resource use plan. These obvious merits are diminished by difficulties construction professionals have when experimenting with quantitative risk analyses. Typical difficulties are inappropriate level of detail, thinking probabilities and credibility of resultant estimates. This paper presents and discusses a set of key elements that seem to form the basis for workable solutions of quantitative risk management for construction. Three case studies are presented as sources for findings. In those projects, risk management procedures and related tools have been implemented for use in live construction projects. The author has developed a software tool for project risk management. This software tool, the *Temper System*, has been used as a research platform for experiments within the company cases.

1. INTRODUCTION

Risk management can be understood as a viewpoint for decision making and other managerial actions. What is its role, relative importance or practical implications in our work are kind of questions we are still often facing regarding risk management. In general terms, the field of risk management may easily look rather confusing and difficult to understand.

First, the mentioned difficulties of risk management seem to be originating from a characteristic of practical risk management that means highly situation specific solutions. "There are numerous moving parts to an enterprise-wide frameworks for operational risk management" (Hofman, 2002) and "Risk management must be tailored to each project - one size does not fit all" (Conrow, 2003) are practical statements that are indicating how multi-dimensional and challenging the practical applications can be. Classical business process development approach targeting standardised procedures can only produce limited solutions that can turn out to be disappointments in live projects and business.

Second, when we are approaching risk management it inevitably leads to the need to combine probabilistic views with current business practices that are usually highly deterministic of their nature. Our daily business practice is composed of deterministic objectives, such budget items, mile stones and quality requirements, whereas in the world of risks we are facing spectrum of potential outcomes that may or may not happen. Risk management solutions seem to be failing often here that results in isolated risk analyses which are then usually omitted and do not have any impact on the actual decision making and business performance. The required integration of probabilistic and deterministic worlds has proved to be a challenging task.

Third, it is a leading thinking model that risk management is understood as a separate function in conjunction with other business or project functions; look for example (PMI, 2004 & IPMA, 2006). It is often mentioned that risk management is a continuous process, which is next explained to include four core tasks: risk identification, analysis, response development and control. Continuity for the process is achieved with the cyclic use of the named core tasks. Carrying out these core tasks successfully requires a thinking model that is a different one compared with other project planning or management tasks. Underlying concepts (risk, opportunity, probability) and various required judgements based on those form a specific field of reasoning.

The second explained aspect, that is the need for integration, can be seen as a force that is trying to present risk management procedures together with other standard business functions. On the other hand the third aspect, risk management as a separate function due to specific characteristic of risk management, is a force that is pulling risk management apart from other business functions. These two contradictory forces together with the explained first aspect, that the solutions are highly situation specific, need to be acknowledged as fundamental characteristics of risk management.

It is target of this paper to present and discuss a set of key elements that seem to form basis for workable solutions of quantitative risk management for construction. The discussion above provides a background model of main aspects that were considered as ones to be taken into account in a well-balanced manner. In an unbalanced approach one or more key aspects are omitted and the functionality of resultant solution is not satisfactory.

2. LITERATURE REVIEW

2.1 Traditional risk management paradigm

Our thinking, its rationale or lack of it originates from scientific paradigms that have capacity to present concepts, to structure the part of the world in question and to explain its behaviour. A paradigm can be understood as a cluster of beliefs. In the terms of research certain paradigms are guiding scientists what should be studied, how research should be done and how results should be interpreted (Bryman, 1988). It is of importance that researchers try to understand and increase their awareness of various paradigms that are affecting their work.

In the field of risk management it is too easy to anchor your mind and thinking to the basic model that the core of risk management means "a cyclic process of risk identification, risk analysis, risk response and risk control". After the described choice, whether a popular action research methodology shall be applied this shall likely result in an improvement to the current core model, for example by restructuring its content or by presenting a new element to it. Such efforts are here termed as explorations according traditional risk management paradigm.

Varieties of efforts having traditional risk management paradigm as a starting point have been documented widely in scientific periodicals and text books, for example (Boehm, 1991; Cooper et al, 2005; PMI, 2004; IPMA, 2006; Chapman & Ward, 2002; ISO, 2003; Smith, 1999; Nicholas, 2004). It would be unfair to judge all these sources and work behind them as promoters traditional risk management paradigm since many of them surely goes beyond this. However, dominantly in most sources the starting point and basic principle for explaining the content of risk management is the core of risk management according to the traditional paradigm.

2.2 New emerging risk management paradigm

Quite different views over project risk management are provided by DMO (2006), Pryke & Smyth (2006) and Goldratt (1997). These are examples how daily project risk management can be understood as a fully embedded dimension within managerial practice, and, not as a separate function. Grey (1998) is explaining this as a need to consider risk management in all aspects of project management. It is considered that risk management permeating through all project management is a different paradigm compared with the traditional paradigm having a focus of separate risk management functions.

Paradigm shifts tend to be most dramatic in sciences that appear to be stable and mature, as in physics at the beginning of the 20th century. At that time, physics seemed to be a discipline that was merely providing last few details of a largely worked-out system of Newtonian mechanics. In 1900, Lord Kelvin famously stated, "There is nothing new to be discovered in physics now. All that remains is more and more precise measurement." Five years later, Albert Einstein published his paper on special relativity. That paper challenged successfully the scientific principles and rules describing force and motion that had been the dictating theory (and paradigm) for over three hundred years.

It might be good for risk management research to have a paradigm shift from the traditional paradigm towards new ones. Research and development in risk management have been clearly dominated by one leading paradigm that is the traditional one. Competing paradigms can provide ground for fruitful debates and have profound effects on research design (Bryman & Bell, 2003). The problems and challenges of risk management discussed in the introduction chapter are fundamental ones and the plain traditional risk management paradigm is too shallow for providing grounds for successful solutions.

3. RESEARCH ON QUANTITATIVE RISK MANAGEMENT FOR CONSTRUCTION

3.1 Project description and objectives

This paper is based on numerous case studies where project risk management procedures and relating tools have been implemented for the use in live construction projects. The author has developed a software tool for project risk management. This software tool called Temper System (http://cic.vtt.fi/eds/temper.htm) has been used as a research platform for the experiments within the mentioned company installations.

The main objective of the research and development was to gain improved understanding over possible developments when applying a more holistic paradigm compared with the traditional risk management paradigm.

3.2 Research methodology

The applied research methodology can be characterised as constructive action research where the main body of research included three company installations of resultant risk management system and analysis of gained results. The company cases are the following ones:

1. Elevator and escalator system supplier. This is an internationally operating company that is carrying out deliveries and installations of large scale elevator and escalator system supplies for high rise office and residential buildings.
2. Internationally operating project management consultancy company. For the clients from heavy industry this company is providing project management services for the whole life-cycle of clients' capital investment projects.
3. Risk management organization of a major industrial construction project. This organization had a challenge to analyze potential problems, their scenarios, back-up plans and provide useful information about those to decision making.

Quantitative risk analysis was a common solution development approach for the company cases. Compared with simple qualitative risk estimates it was considered that quantitative risk estimates could provide credible linking towards business or performance elements of construction, for example cost estimate, budget, schedule or resource usage plan. Despite of this almost self-evident benefit the use of quantitative risk analysis has been very limited in live projects and company environments. It seemed that one main cause for this situation is the unbalance between the amount of information available and the level of detail of estimates. In other words, the accuracy of approximations and reporting needs to match with the overall understanding of the project and its details.

For each case, the research included the following phases (i) Specification of needs and requirements, (ii) Adjustments to Temper System accordingly, (iii) Early testing, feedback and additional adjustments, (iv) Main test use in live project situation, feedback and its documentation.

4. RESEARCH RESULTS AND INDUSTRIAL IMPACT

The earlier discussions of the risk management aspects and paradigms present the background reasoning forming the main body of research path. This was aiming to have a more comprehensive coverage over the various challenges of risk management than one purely originating from the traditional risk management paradigm. Having different risk management aspects and relating challenges as a starting point a set of elements were formed for providing grounds for workable risk management solution. These elements are as follows.

1. *Situational applicability*. Flexibility of the solution along the various needs of project life-cycle.
2. *Conformity with related project management culture and its processes*. Company practice, its taxonomy and concepts, unspoken rules need to be incorporated in the solution.
3. *Scope of risk management tasks*. Changes presented to the project conditions and continuity of risk management need to be the main targets here.
4. *Levels of details in risk modelling*. Basically the solution needs to provide several levels of details for risk modelling. This is the basis for balancing the accuracy of estimating with the amount of information available.
5. *Interfaces for accessing risk models*. These interfaces are composed of two components: (i) user interfaces and (ii) system interfaces. User interfaces make risk management procedures effective and easy to apply. System interfaces integrate risk management with other company operations. and
6. *Communicativeness*. Characteristics of risk communication need to be understood and incorporated in the solutions.

In general, these elements form a top-down framework for addressing and understanding various key aspects for practical installations of quantitative risk management applications. Within this paper it is possible to have a closer look at the fifth element (Interfaces for accessing risk models). On the following this shall be addressed by presenting the resultant solution and experiences from its use from the viewpoint of the fifth element.

4.1 Results

4.1.1 Life-cycle aspects of risk management in modern building construction

Resultant solution. Building construction has been conventionally understood to comprise several phases from early draft until building commissioning. Additionally it is often assumed that the previous phase is fully completed before the next phase is started. This can be sometimes the case still nowadays, for example in public construction, but in most cases the different project phases are highly overlapping and the process as whole is very dynamic including parallel design and construction, incomplete or changing user requirements, and, networked contracting. Additionally, the whole process can often include several contractual options that can break the whole project into several granular supplies. The nature of these supplies is conditional where the realisation of next supply depends of the earlier one (Figure 1).

Utilization in live projects. Traditionally, the main milestones of the project have formed natural steps for carrying out specific risk analyses and relating procedures. In addition to this we should acknowledge the granular nature of modern construction. Granularity means increasing dynamics where new parties are appearing continuously, and their contractual obligations and activities can easily produce surprises. This would mean changes in the risk profile of the project: some earlier identified risks may fade away, whereas the severity of some other can go up and new risks may appear. The described situations is seemingly producing a situation where there risk profile of the project can be changing all the time, and, all possible risk factors affecting it need to be monitored all the time.

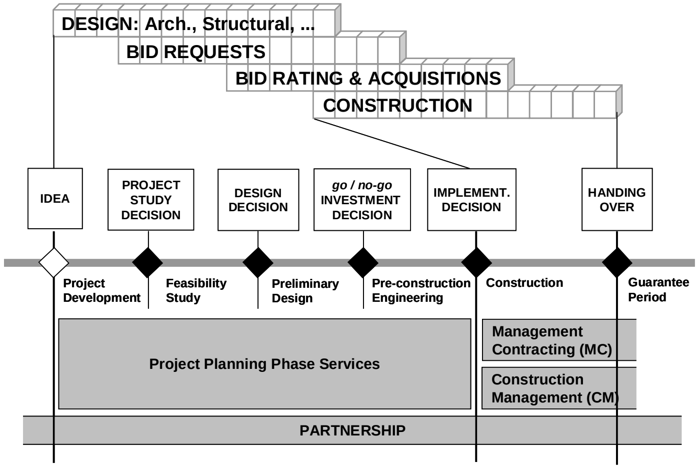

Figure 1. Granularity of modern construction process with typical decision points as milestones for specific risk analyses

4.1.2 Levels of abstraction

Resultant solution. Different levels of abstraction can be an important means for facilitating different task that are present in risk management, such as identification of risk titles, various further studies over the identified risks and risk status reviewing. The structure of these levels provides a framework for this purpose (Figure 2). Level of abstraction is high in the terms of qualitative risk knowledge where risk titles are approached via qualitative descriptions of experiences from past projects. When moving to other levels the titles and methods get gradually more detailed. The most detailed analyses cover responsive actions, their impacts over different severe risks and relating cost/benefit analyses (Figure 3).

Utilization in live projects. In all cases it was discovered that the main target of users was to gain understanding of the overall picture of risks in the project. Thus, having project risk map completed turn out to be the level that is most often reached and the users go further on towards more detailed levels only in the situations where there was particular needs e.g. for additional finances out of current budget (Figure 4).

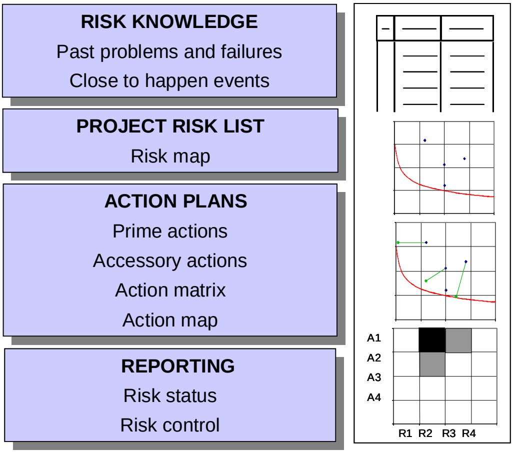

Figure 2. Different levels of abstraction from general risk knowledge descriptions to detailed risk reporting

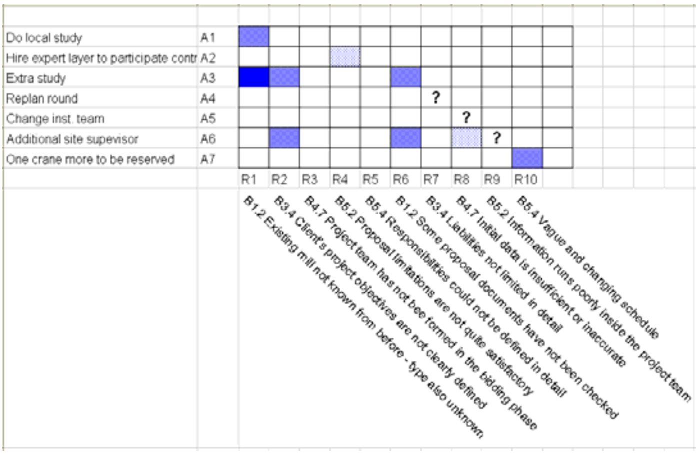

Figure 3. Visualisation of links between responsive actions and risks

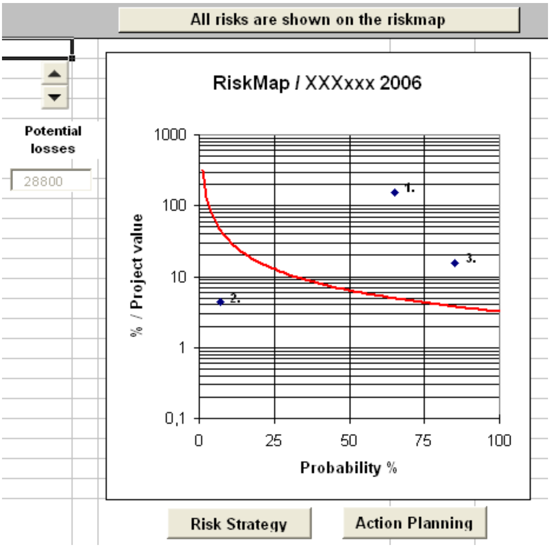

Figure 4. The resultant risk map visualises the details of individual risk estimates

4.1.3 Quantitative estimates

Resultant solution. Preparation of probability estimates has particularly been a problematic area for quantitative risk management. One of the main results from long term risk perception studies is that cognitive structuring of risk using qualitative terming is similar across nations irrespective of cultural background (Boholm, 1998). These provided grounds for using natural language expressions for approaching quantitative probability ranges (Figure 5). Rather than using natural language expressions as such they need to be clearly associated with certain probability ranges (Hillson, 2005).

Utilization in live projects. All received feedback was very positive. It was considered that the proposed model provided an effective and easy to use way for estimating probabilities. Additionally, the users find it useful that the interface enables more detailed estimates if appropriate (Figure 6).

Probability range	**Probability value used for calculations**	**Natural language expression**	**Numeric score**
1% through 14%	7%	Extremely unlikely	1
15% through 27%	21%	Low	2
28% through 42%	35%	Probably not	3
43% through 57%	50%	50-50	4
58% through 72%	65%	Probably	5
73% through 86%	79%	High likelihood	7
87% through 99%	93%	Almost certainly	9
100%	100%	Problem already	10

Figure 5. Qualitative risk terms with corresponding quantitative ranges

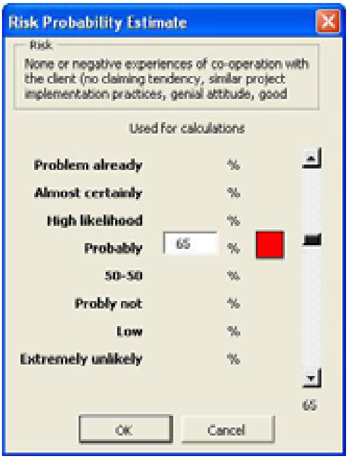

Figure 6. Dialogue for inputting probability estimates

4.1.4 Relevance of risk analysis

Resultant solution. One of the main lessons learned from early phases form each company cases is the need for impacts from risk management to the actual decision making and managerial actions. The quantitative estimates are here linked to strategic thinking using categorisation that present relative importance to the "figures" that form the risk map (Figure 7). This is based on risk isobar which is used to classify the data that are shown on the risk map. Definition: the risk taking level is same in each point along the risk isobar.

Utilization in live projects. In the completed company cases, the described method for linking individual risk estimates and risk strategy provided a means to discuss further on the severities of risks in the terms of current market and business conditions. It was felt that quantitative risk estimates are not "just figures" but they have meaning in the context of the company or project in question. Completing this successfully provides perhaps the most valuable result that can be only reached via quantitative risk estimates.

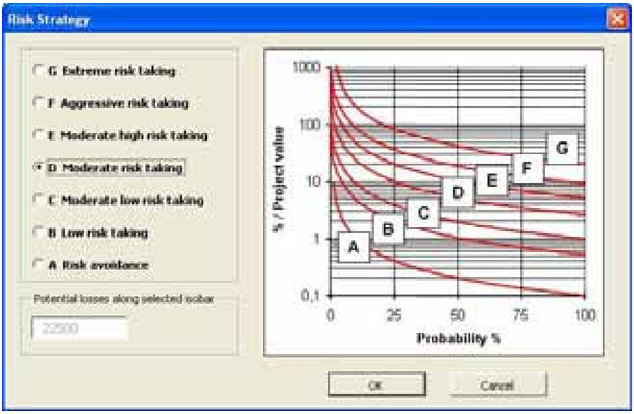

Figure 7. Dialogue for the selection of risk strategy

4.2 Implementation and exploitation

Temper System risk management software tool developed by author is behind of the action research and its company cases described in this paper. The first version of this tool was first time presented in Kähkönen & Huovila (1995). Since then the tool has been developed via numerous industrial case studies and implementations. Due to this kind of history and long term development the basic Temper System package can be considered as a rather matured software tool which can be implemented for the needs of certain project or company. From year 2006 Temper System has been available via Vergo corporation.

For research purposes Temper System has provided a platform for exploring potential models that can advance the use of risk management in companies. This was also the research approach of the work presented in this paper. The needs and specifications obtained from companies were used as a basis for forming the elemental grounds of proposed solutions, adjustments to Temper System and, finally, their testing.

All named companies and organizations have started to use the developed solutions by themselves as a part of their operations.

5. CONCLUSIONS

Rather than having risk management as a separate function it needs to be developed towards solutions that are increasingly integrated or even embedded within other management. This requires elemental understanding of the content of situation specific risk management. The work presented in this paper is along this research and development path. The elements explaining various dimensions of quantitative risk management have provided additional understanding for successful implementations.

Quantitative risk management has clear merits over simple qualitative risk estimates. This is particularly due to possible links to actual business content. The implementations of quantitative risk management in three case situations can all be considered as successful ones. The elemental structuring of dimensions of quantitative risk management contributed clearly to this outcome. Through careful implementation, quantitative risk management can have a wider and more important role in project risk management than is assumed at the moment.

6. REFERENCES

APM, (2004) *Project Risk Analysis and Management Guide*. High Wycombe: APM Publishing Limited.

Boehm, B.W. (1991) Software risk management: principles and practices. IEEE Software, **8**, 32-41.

Boholm, Å. (1998). Comparative Studies of Risk Perception: A Review of Twenty Years of Research. *Journal of Risk Research.* **1**(2), 135-163.

Bryman, A. (1988) *Quantity and Quality in Social Research*. London: Routledge.

Bryman, A. and Bell, E. (2003) *Business Research Methods*, Oxford: Oxford University Press.

DMO (2006) *Competency Standard for Complex Project Managers* version 2.0. Commonwealth of Australia: Department of Defence, Defence Material Organisation.

Chapman, C. and Ward, S. (2002) *Managing Project Risk and Uncertainty*. Chichester: John Wiley & Sons Ltd.

Conrow, E.H. (2003) *Effective Risk Management: Some Keys to Success*. Reston: American Institute of Aeronautics and Astronautics.

Cooper, D., Grey, S., Raymond, G. and Walker, P. (2005) *Managing Risk in Larger Projects and Complex Procurements*, Chichester: John Wiley & Sons.

Einhorn, H.J. and Hogarth, R.M. (1999) Decision Making, *Managing Uncertainty,* Boston: Harvard Business Review Paperback.
Goldratt, E. M. (1997) *Critical Chain*, Great Barrington: The North River Press.
Grey, S. (1998) *Practical Risk Assessment for Project Management*. Chichester: Wiley Series in Software Engineering Practice.
Hillson, D.A. (2005) Describing probability: The limitations of natural language. Edinburgh: *Proceedings of the PMI Global Congress 2005 EMEA*.
Hoffman, D. (2002) *Managing operational risk*. New York: John Wiley & Sons.
IPMA (2006) IPMA Competence Baseline. Nijkert: International Project Management Association.
ISO (2003) ISO 10006 *Quality management systems - Guidelines for quality management in projects*. Geneva: International Organisation for Standardisation.
Kähkönen, K. and Huovila, P. (1995) Risk Management of Construction Projects in Russia, Proceeding of IPMA Symposium St. Petersburg, Russia, 14-16 September 1995, The Russian Project Management Association SOVNET, 237-241.
Kerzner, H. (2004) *Advanced Project Management*. New Jersey: John Wiley & Sons.
Nicholas, J.M. (2004) *Project Management for Business and Engineering*. Burlington: Elsevier Butterworth-Heinemann.
PMI (2004) *A guide to the project management body of knowledge*. Newtown Square: Project Management Institute.
Pryke, S. and Smyth, H. (2006) *The Management of Complex Projects*. Oxford: Blackwell Publishing Ltd.
Smith, N.J. (1999), *Managing Risk in Construction Projects*. Oxford: Blackwell Science Ltd.

LIFE CYCLE COST OPTIMISATION IN THE BUILDING PROCESS – APPLICATION OF INDOOR CLIMATE SYSTEMS

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ABSTRACT

When it comes to realising a building, the client or users must often compromise between the cost of the building and the function it can provide. In a given building, the design can vary in terms of building physics and building services, which means that different systems can be used to fulfil indoor climate requirements. System choices often seem to be based on initial costs, if not on habit. This paper refers to doctoral research that has produced a model for life cycle cost (LCC) analyses for indoor climate systems in dwellings and commercial premises. Literature, technique, results and problems with implementation are discussed. If a life cycle cost perspective is used, there will be an approach taking the future into account. Even if factors other than life cycle cost are used as a decision-making criterion, life cycle cost contributes more realistic information about the building.

1. INTRODUCTION

Buildings are constructed with the purpose of fulfilling the needs of the client or building users in providing, amongst other things, a shelter from the outdoor climate. When it comes to realising a building, the client or users must often compromise between the cost of the building and the function it can provide. In a given building, the design can vary in terms of building physics and building services, which means that different systems can be used to fulfil indoor climate requirements. System choices often seem to be based on initial costs, if not on habit. As long as the aim of the client is to get a building as cheap as possible over the life cycle, the life cycle cost (LCC) would be a better base for choosing the building construction and systems.

The purpose of this paper is to summarize a thesis regarding life cycle costing of indoor climate systems (Johansson, 2005). In this thesis, a model is presented for life cycle cost analyses of indoor climate systems, comprising of heating, ventilation and cooling systems, for premises and dwellings. The length of this paper to give all theories and details behind the model but emphasizes some problems with implementing the life cycle cost approach in the building industry. Optimisation means that one or more parameters are chosen so that the life cycle cost becomes as low as possible based on given conditions. In a practical situation, more than life cycle costing will form the base of the design criteria, but here, focus is on life cycle costs.

2. LITERATURE REVIEW

Life cycle costing is a well known application, which has its techniques and simplification. It is used in many industries, and particularly in industries without an interest of profit dealing with equipment with a long expected life time, such as road work and transformers, it seems like it has been used most. The following references point out the need for models for calculating LCC for indoor climate systems and buildings as whole.

2.1 Life cycle costing in other industries

LCC analysis methodologies were analyzed by Durairaj et al. (2002). They did not discuss buildings in particular and state that there is a need for several LCC models for different application areas. Often, constant maintenance and repair costs are assumed in LCC analyses. Karyagina et al. (1998) stated that these assumptions often lead to over-simplifications in the LCC analysis and incorrect results. They used statistical methods to specify the system failure and LCC for a number of Computer Numerically Controlled (CNC) machines.

The LCC for semiconductor circuits was discussed by Riedel et al. (1998). They differentiated simpler semiconductor circuits from more complex semiconductor circuits. For the simpler, the reliability can be high enough to cover the lifetime of the system. For the more complex, there can be need for a lot of maintenance.

A PC programme that performs LCC analysis was presented by Ruegg and Petersen (1985). This programme calculates the LCC and a number of other economic factors. However, since it does not focus on indoor climate systems, it requires a problem definition and a definition of the alternatives by the user. Fan system design in agricultural buildings was discussed by Christianson and Fehr (1983). Both physiological and economical considerations were discussed. Malinowski (2004) discussed the LCC of electrical motors and their drives. He pointed out the benefit with adjustable speed drives regarding energy and motor life time. Motor bearing lubrication methods and their impact on the LCC was evaluated by Hodowanec (1999). The over-sizing of pumps and the influence on the LCC was discussed by Wheatley (2002). Measures used in the UK for better pump design was given.

2.2 Life cycle costing in the building industry

Öfverholm (1998) did a broad analysis of the life cycle costing for buildings. He presented methods and problems with that approach although he never focused on indoor climate systems or building services. He found a need for more input data with a good structure regarding costs. He also referred to a model used for the procurement of transformers in the electric power industry. This model has apparently increased the energy performance of transformers and has made these transformers more profitable for the manufacturers.

Lewald and Karlsson (1988) examined the LCC for electrically heated houses to determine if it would make sense to change to a hydronic system. Lutz et al. (2005) discussed LCC analysis of residential furnaces and boilers. They showed that a reduction of LCC was possible with more efficient products.

Arditi (1996) conducted a survey that showed that 40% of the municipalities in the US used LCC analyses to some extent in construction projects including more than buildings. The reasons given for not using these analyses were the absence of guidelines and the difficulty of estimating future costs. Sterner (2000) showed that 66% of clients used LCC analyses to some extent in projects in Sweden in 1999 but rarely in all phases of their building projects. A significant reason for this low rate of use was the lack of tools and knowledge.

A number of different economic techniques, regarding LCC for insulation materials depending on thickness, were discussed by Al-Hammad and Fahd (1992). One of the preferred techniques was the net present value method. The researchers did not discuss either how to calculate the energy demand or the effects of different indoor climate systems. Optimal insulation thickness for building envelopes was derived by Hasan (1999) taking into account heat transmission and insulation costs. Hens et al. (2002) investigated the optimal insulation thickness of a building with regards to the fact that the users of a building adjust indoor temperatures according to their energy bills. The real savings from additional insulation decreased, since people increased the indoor temperature when their energy costs decreased. Anger and Nilsson (2004) analysed measures to lower the energy use in buildings. It was shown that energy saving measures were profitable if they are applied to new houses.

2.3 Life cycle costing of indoor climate systems

Vik (2003) looked at the life cycle costs for hybrid ventilation systems while Johansson (2005) focused on mechanical systems. They incorporated the building in a higher extent than mechanical systems. He compared different solutions, also with a typical mechanically ventilated building, and described a method to calculate LCC. Since the building structure and envelope is a part of the ventilation, he discusses cost allocation a lot. The result showed no large difference between mechanical and hybrid ventilation systems.

A number of LCC models are available for indoor climate systems. However, many of them handle only a part or some parts of the indoor climate system. In Sweden, a popular model for do an LCC analyses on a routine basis is called Energy Efficient Procurement, ENEU 94 (Sveriges Verkstadsindustrier, 1996), which has been updated to a web-based version called “LCC Energi” (Sveriges Verkstadsindustrier, 2001). This is a form-based guideline, in which the contractors have to calculate the LCC in a procurement situation. If many contractors attend to the procurement, a ventilation system with a low LCC is likely to be found, but this is not always the case. “LCC Energi” handles a number of details in the air handling unit, such as heat recovery unit efficiency and a correction term for freezing in the heat recovery unit. Still, external programmes for calculating the initial costs of the system, the energy demand, and pressure drops are needed.

Using ideas from ENEU 94, an EU-supported project has drawn up similar guidelines. This SAVE project, known as “LCC-based Guidelines on Procurement of Energy Intensive Equipment in Industries” (Eurovent, 2001), adopts the manufacturer’s point of view instead of that of the client or building owner. One problem with both sets of guidelines is the lack of options for modelling either the entire indoor climate system or different control strategies.

James and Phillips (1992) presented a spreadsheet application for the purpose of separating the HVAC system from the building, but it does not calculate the energy demands or different HVAC systems.

3. RESEARCH PROJECT

3.1 Project description and objectives

Due to the lack of models for LCC taking the entire indoor climate system into account, the objective was to make a model to do LCC calculations on indoor climate systems early in the building design process. The LCC should basically be done in the context of the building owner. The model handles different systems that are common in Sweden and different control strategies for these systems. The buildings that are taken into account are residential buildings, office buildings and school buildings. All indoor climate systems must fulfil general requirements to get an appropriate indoor climate. Johansson (2005) presents the model in detail and questions about input data and indoor climate system design are addressed in seven appended papers.

3.2 Research methodology

The referred LCC model was based on a theoretical approach using empirical data for components that are put together to form different indoor climate systems. By this approach, parameters such as outdoor climate can be handled by the simulation. It was also possible to simulate non-existing systems. An alternative approach would be to use measured data from empirical objects, which means real buildings. That would provide realistic data, but it would be difficult and most likely impossible to find enough valid or reliable objects with traceable costs for each part of the indoor climate systems to obtain significant results for different indoor climate systems.

4. RESEARCH RESULTS AND INDUSTRIAL IMPACT

4.1 LCC – definition and boundaries

The LCC is herein defined as the total cost that an entity incurs for a product or function over its entire life span. Entity needs to be clearly defined; it can be a company, a manufacturer, the government or, as in this case, the owner of a building. The product or function, as well as the life span, need to be defined. For example it can be “somewhere to live under reasonable conditions for 40 years”, a statement that might be made by an end-user. In a situation of procurement, it could be up to the market to provide that function at the lowest total cost.

The product or function is defined by a boundary. It can be difficult to define the boundary. If an individual has a car and a bike in a garage and the roof caves in during a storm, should the cost of the roof be added to the LCC of the car or the bike? The total cost usually consists of an initial cost, such as the price of a new car, and running costs, such as petrol, maintenance, insurance and repairs. At the end of the operational lifetime, there is a demolition cost or scrap value. With our economic system, the value of a cost is not constant over time. Usually, tomorrow’s costs are less valuable than today's. The future costs need to be discounted to today's value or to any other day, which needs to be defined.

Usually, in LCC analyses, today is used as the reference. The literature covers the techniques (Bull, 1993; Flanagan et al., 1989; Beacom, 1984), which consist of only two factors: total cost and discounting over time by an interest rate or a change in price. The common techniques for LCC analyses are the payback method, with or without compensation for money changing value over time, the net present value method and the annuity method. Since the annuity method requires equal annual costs, the net present value method is preferable and used by Johansson (2005), just as it is in the "LCC Energi" and the "LCC guidelines" (Sveriges Verkstads-industrier, 2001; Eurovent, 2001). Jorgensen (2000) also preferred the net present value method.

4.2 LCC – technique

The net present value method uses a discount rate of interest to discount the value of money over a period of time. The discount rate has to be determined. The nominal rate of interest, $r_{n,n}$, is the annual interest an individual will get if he or she has money in the bank year n. The inflation rate, $r_{f,n}$, is the annual value loss of money over time on general expenditures in a country for year n. Not all expenditures change their value with the inflation rate. Every expenditure can have its own nominal change rate over time, $r_{ci,n}$. The index i is there to demonstrate that these change rates can be unequal for different costs. The real rate of interest, $r_{r,n}$, and the real price change rate, $r_{pi,n}$, are based on the inflation rate, the nominal rate of interest and the nominal price change rate.

The amount of money we need to set aside today is called the net present value of the future cost. The discount interest rate, $r_{di,n}$, for the net present value method can be defined according to Equation 1. The number of years before the expenditure occurs can be denoted n. Equation 2 gives the net present value, $NPV_{i,n}$, of a cost, $C_{i,n}$. The right part of Equation 5 is the commonly used part where it is assumed that r_{di} is constant over time (Nelson and Schwert, 1977).

$$1+r_{di,n}=\left(\frac{1+r_{n,n}}{1+r_{ci,n}}\right)=\left(\frac{1+r_{r,n}}{1+r_{pi,n}}\right) \qquad (1)$$

$$NPV_{i,n}=\frac{C_{i,n}}{(1+r_{di,1})(1+r_{di,2})\cdots(1+r_{di,n})}=\frac{C_{i,n}}{(1+r_{di})^{n}} \qquad (2)$$

To arrive at the total net present value for one kind of cost, the costs for all years during the life span, N, have to be added together. The LCC is equal to the sum of the net present values for all types of costs.

4.3 LCC – problems

In conclusion, it is possible to discount a cost to the value of today. The question is how to decide the change rates in order to be able to predict the future, which is the purpose of LCC analyses. It seems to be impossible to say anything about all change rates 50 years into the future. This interest rate problem is depending on human behaviour. It is, from the positivistic perspective, not possible to predict human activities with certainty. A person's real rate of interest is more likely to be known for a shorter life span than for a longer one. The fact that future costs are less important also leads to a lower impact of errors as long as the discount rate is positive. Sensitivity analysis can help the user to see what will happen if data change from those that were assumed or estimated. In two hypotheses, Jensen (1986) stated that it is always possible to find a real price change rate that makes a measure profitable and it is always possible to find a real price change rate that does not. This is apparently true if the initial costs and the running costs are acting towards each other.

The user also needs to handle possible investment costs. In the case of comparison of two alternatives with approximately the same absolute life cycle cost, the influence from different investment costs should be small but if the life cycle costing is used for evaluating, for example energy saving measures, the investment cost should be taken into account.

The life span, *N*, can also be denoted life cycle time, lifetime or operational lifetime. All these terms refer to the number of years a product or function will last, whether the end of the lifetime depends on the final breakdown of the product or whether the user finds the product old-fashioned and replaces it before it actually breaks down. The time the user actually wants to use the product is often denoted as operational lifetime or life cycle. There can be a number of reasons for a lower operational lifetime (Dahlblom, 1999; Dahlblom, 2001).

The discount rate can vary over the life span if the nominal price change or inflation varies. For constant annual costs, both the order of variation and the average determine the net present value. Johansson (2005) analysed this error.

In theory, a daily interest could be used instead of an annual to obtain better time resolution, but it is not generally used in LCC analyses. If recurring constant costs occur monthly or daily instead of annually, which was assumed, the value loss of money over time (if the discount rate is positive) will decrease. Figure 1 shows the relative error of the net present value depending on the constant discount rate, r_{di}.

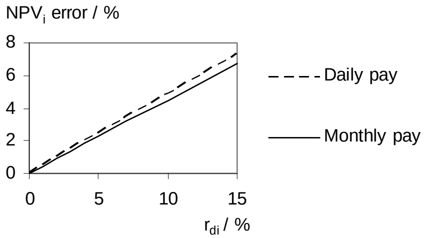

Figure 1. The relative error of the net present value, NPV_i, of a recurring constant cost due to the fact that LCC calculations are made annually and the money flow occurs monthly or daily as a function of the discount rare, r_{di}.

4.4 LCC – optimisation

To optimise a system, the LCC can be differentiated with respect to the optimisation variable. If the derivative is equal to zero and the second derivative is positive, a minimum is found. There is a risk for more than one minimum. Many parameters are discrete and therefore impossible to minimise with this method. Instead, a numerical optimisation can be done on each calculated system, or each system must be designed according to a previously performed optimisation. The limits of the parameters must be clear. For example, it is not an option to set the airflow rate of a ventilation system to zero even if it most likely would be optimal.

4.5 LCC – application

It can be questioned why LCC analyses is not used extensively. Despite several uncertain and hermeneutic parameters that reduces the accuracy, the LCC analyses adds relevant information about for example the building that will be built or the car that will be bought. Anyway, people tend to not use LCC analyses. Three main problem areas can be pointed out.

Different actors in the building industry are interested in different things. It can be suspected that actors have a greater interest in their profit than in the LCC of the client or end user. An example is the choice of indoor temperature in multi family dwellings where the building owner pays the heat but never value the benefit from a good indoor climate. A way to decrease the amount of heat that the owner has to pay is to raise the internal load indoors by, for example, installing towel dryer that use more expensive electricity but paid by the user instead of the owner, or buying white goods that are not energy efficient. Another example is the quality of a car which seems to be optimized more from a profit perspective than from a user perspective.

That leads to the second reason for not applying LCC analyses. The customers in the form of clients or end users do not demand LCC analyses. Either, they do not understand that there is a future, there is not enough competition to be able to find a supplier that can deliver an LCC analysis or based on an LCC analysis, or they have analyzed the situation comprehensively and found out that the risk with saving money for the future is too high to take it. The common problem in building industry as well as in other consumer product industries seems to be the lack of competition. People do not have the choice to take the apartment with energy efficient white goods or the car that lasts longer and is easy to repair with standard spare parts. At many places in Sweden, these days, you have to be glad if you find somewhere to live, which does not really open for an LCC discussion. The question is if research can solve these problems. Demands on warranties and quality of the end product could help.

The third reason for the low interest of LCC analyses is lack of knowledge, models and input data. The quality of a lot of hermeneutic input data is unknown even if energy calculations are physics and cost calculations are adding and multiplying in particular lists of costs based on components on the market. For example, it is interesting to compare a demand controlled ventilation airflow rate with a constant airflow rate ventilation system. The demand controlled system decreases the cost for energy but increases the initial cost for control components, maintenance and repair.

In that case, the occupancy level is crucial for determining the pay back time for the more complicated system. The lack of data on occupancy levels is a problem.

4.6 LCC for indoor climate systems – example

Based on Johansson (2005), Figure 2 gives an example of an LCC analysis of the indoor climate system of a typical office building over a 40 year life span with the assumptions that the salary cost is 200 SEK/h and that the benefit from higher airflow rate follows the current research regarding work productivity and sick leave levels in relation to airflow rate. A constant airflow rate ventilation system with radiator heating and chilled beams was assumed. In Figure 2, it is assumed that the cost of decreased work productivity and increased sick leave due to decreased airflow rate is zero at 80 l/person.

Other findings regarding indoor climate systems are that:

- heat recovery is always profitable;
- the initial cost is a significant part of the life cycle cost, particularly for offices;
- since the initial cost is a significant part of the life cycle cost both for parts of the indoor climate system and for the whole, the life cycle cost optimisation is a blunt tool for decreasing the energy use in the built environment; and
- if work productivity, sick leave, health and comfort are influenced according to recent studies, it can have a large impact on the life cycle cost.

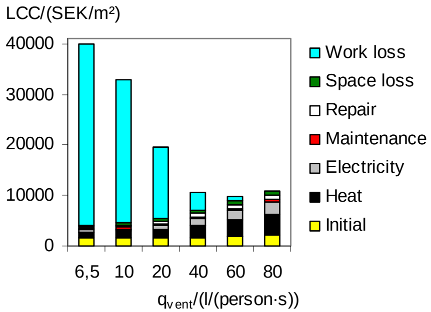

Figure 2. The life cycle cost excluding VAT for the office in Figure 3 if the work productivity increases and the sick leave level decreases by use of higher airflow rate according to existing studies. The airflow rate q_{vent} refers to the airflow rate per person. 1 SEK ≈ 0.14 USD ≈ 0.11 EMU 2007-02-15.

5. CONCLUSIONS

According to the referred thesis, a model now exists for doing life cycle costs analyses on indoor climate systems in common buildings. Even if the results of the model depend on the input data that are not positivistic, an estimate of the LCC will be better with the model than without. Therefore, this LCC model should be helpful for calculations as well as understanding the life cycle cost for indoor climate systems. The problem is to get different actors interested, and particularly the clients need more knowledge. Over time, when new building regulations, requirements and the EU directive of energy performance of buildings is incorporated to the building sector, perhaps more care will be taken regarding both life cycle costs and energy use.

Future research could be able to provide a model that includes the entire building into the life cycle cost. More research will hopefully address the need for occupancy data and user behaviour of buildings but there are still data that are difficult to estimate like future economics and life spans. With more knowledge regarding how to build good, inexpensive, sustainable and easy to use indoor climate systems in energy efficient buildings, there will hopefully be better and more developed components on the market with that purpose.

6. REFERENCES

Al-Hammad, A.M. & Fahd, K. (1992), An overview of life cycle cost models used in the assessment of building insulation materials, *Housing Science*, **16**(2), 123-136.

Anger, Y., Ohlsson, H. (2004), *Sänkta boendekostnader genom energieffektivisering*, Building Services, Lund University, Lund, Sweden, Report TVIT—04/5002, in Swedish.

Arditi, D.A. (1996), Life-cycle costing in municipal construction projects, *Journal of Infrastructure Systems*, **2**(1), 5-14

Beacom, V.A. (1984), Life-cycle costing for HVAC, and more, *Specifying engineer*, **51**(1), 68-71.

Bull, J.W. (1993), *Life Cycle Costing for Construction*, London: Blackie Academic & Professional, London.

Christianson, L.L., Fehr, R.L. (1983), *Ventilation – Energy and Economics*, ASAE Monograph, **6**, 333-349.

Dahlblom, M. (1999), *Installationer ur ett livscykelperspektiv – En litteraturstudie*, of Building Services, Lund University, Sweden, Report TABK—99/3058, in Swedish.

Dahlblom, M. (2001), *Orsaker till byte av VVS-installationer – En intervjuundersökning*, Building Services, Lund University, Sweden, Report TABK—01/1020 in Swedish

Durairaj, S.K., Ong, S.K., Nee, A.Y.C. & Tan, R.B.H. (2002), Evaluation of Life Cycle Cost Analysis Methodologies, *Corporate Environmental Strategy*, **9**(1).

Eurovent (2001), *Life Cycle Cost*, Review, ed. Becirspahic, S., May 2001.

Flanagan, R., Norman, G., Meadows, J. & Robinson, G. (1989), *Life Cycle Costing – Theory and Practice*, BSP Professional Books, Oxford.

Hasan, A. (1999), Optimizing insulation thickness for buildings using life cycle cost, *Applied Energy*, **63**, 115-124.

Hens, H.L.S.C., Mohamed, F.A. & Verbeeck, G. (2002), Using Energy Life Cycle Costs as an Instrument for Optimisation, Proceedings of *the Sustainable Building Conference* in Oslo, 400.

Hodowanec, M.M. (1999), Evaluation of Antifriction Bearing Lubrication Methods on Motor Life-Cycle Cost, *IEEE Transactions on Industry Applications*, **35**, (6).

James, N., Phillips, P.E. (1992), Spreadsheet application for HVAC operation cost comparisons, *Energy Engineering*, **89**(1).

Jensen, L. (1986), *Energibesparingsekonomi*, Building services, Lund University, Sweden, Report BKL1986:24 in Swedish
Johansson, D. (2005), *Modelling life cycle cost for indoor climate systems*, Report TVBH—05/1014, Building Physics, Lund University, Lund, Sweden available at: http://www.byfy.lth.se/Publikationer/1000pdf/TVBH-1014_web.pdf
Jorgensen, M, (2000), Faldgruber i investeringsanalyser, *Dansk VVS/VVB*, 3-2000, Denmark, in Danish.
Karyagina, M., Wong, W. & Vlacic, L. (1998), Life cycle cost modelling using marked point processes, *Reliability Engineering and System Safety*, **59**, 291-298
Lewald, A., Karlsson, B.G. (1988), *Evalutation model for optimal LCC in existing electric heated houses*, International council for building research studies and documentation CIB report **107**, 175-183.
Lutz, J., Lekov, A., Chan, P., Dunham-Whitehead, C., Meyers, S. & McMahon J. (2005), Life-cycle cost analysis of energy efficiency design options for residential furnaces and boilers, *Energy*, **31**, 311-329.
Malinowski, J. (2004), Energy-efficient Motors and Drives, *AHRAE Journal*, **46**(1), 30-32.
Nelson, C.R. & Schwert, G.W. (1977), Short-term interest rates as predictors of inflation: On testing the hypothesis that the real rate of interest is constant, *The American Economic Review*, **67**, **pp**478-486.
Riedel, T., Tiemann, N., Wahl, M.G. & Ambler, T. (1998), LCCA – Life cycle cost analysis, *IEEE AUTOTESTCON Proceedings – IEEE Systems Readiness Technology Conference*, 43-47.
Ruegg, R.T. & Petersen, S.R. (1985), New software aids life cycle costing of energy conservation projects, *Heating-Piping-Air-Conditioning*, **57**(9), 79-87.
Sterner, E. (2000), Life cycle costing and its use in the Swedish building sector, *Building research and information*, **28**, 368-375.
Sveriges Verkstadsindustrier (2001), *Kalkylera med LCC energi*, Industrilitteratur, Stockholm, Sweden, in Swedish.
Sveriges Verkstadsindustrier (1996), *ENEU 94*, Stockholm: Sveriges Verkstadsindustrier, Sweden, in Swedish.
Vik, T. A. (2003), Life Cycle Cost Assessment of Natural Ventilation Systems, Norwegian University of Science and Technology, Trondheim, Norway, Doctoral thesis 2003:14.
Wheatley, G. (2002), Oversized and underachieving, *World Pumps*, **430**, 38-41.
Öfverholm, I. (1998), *Livscykelkostnader i den tidiga projekteringsfasen – cybernetiska betraktelsesätt*, Institutionen för Arkitektur och stadsbyggnad, KTH, Stockholm, Sweden, Doctoral thesis, TRITA-ARK 1998:2, in Swedish.

PARTICIPATIVE DESIGN TOOL TO SUPPORT THE START-UP OF INNER CITY REDEVELOPMENT PROCESSES

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ABSTRACT

Inner city redevelopments tend to be long and laborious processes. The cause of these problems lies primarily in the initiative phase of these processes, when objectives tend to be piled on top of each other on the road to ambitious, yet unrealistic, plans. At the start of these redevelopment processes, adequate knowledge and experience in dealing with the design commission are lacking. This leads to an unsteady course of actions and lowers the chances of enriching the design result. This research provides a new approach consisting of two parts to overcome these problems. One is a participative modelling exercise from which the participants learn about their own position in relation to the others in terms of how they value the redevelopment and the extent to which their ambitions are being shared. The second is a participative design exercise that challenges the participants to communicate their wishes and ideas and to negotiate their objectives and willingness to invest. The method was tested in practice and the participants evaluated the method as useful.

1. INTRODUCTION

Inner city redevelopment processes are complex. They deal with both a physical as well as a functional transformation of a conjoint part of the city. It's about the construction of new real estate, infrastructure and public space while the area as a whole stays very much in use. Development and construction of these projects takes a long time and can't be done by one entity on its own. In short, the complexity of inner city redevelopment processes arises from the spatial context as well as from the organisational context. Ambitions to turn these areas into multifunctional hotspots within the city are high, while the transformation itself asks for dealing with numerous stakeholders, restricting environmental legislation and ensuring the continuation of transfer functions. In practice, we observe two starting points of these redevelopment initiatives. Initiators either start by commissioning the design of an alternative for the location, or they start with an extended stakeholders' analysis. Actors in the initiative phase tend to cling far too long to one or the other approach. This brings about problems. On the one hand, the design approach leads to a process of reacting to sketches never arriving at a complete overview of the

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stakeholders' demands and wishes. The stakeholders' analysis approach, on the other hand, may well lead to a non-realisable pile of ambitions. Both approaches result in an unsteady course of actions and lower the chances of enriching the design solution.

The authors propose a third way (Peek 2006) which combines both approaches of design and stakeholders' analysis within a participative design tool in order to intervene in the initiative phase of the redevelopment process and contribute to a smoother process and the quality of the end result. The second section of this paper provides an overview of the literature on which both approaches are based and the background of the dynamic approach combining both approaches. In the third section the design of the participative design tool and the testing of the tool are described. The fourth section deals with the results of the testing. The paper ends with conclusions in the fifth section.

2. LITERATURE REVIEW

Both approaches – design and stakeholders' analysis – of the initiative phase of inner city redevelopment processes stem from two mayor schools of policy analysis. Traditionally these processes are viewed as a succession of phases. In the early phases emphasis is on variation, after which in later phases final choices are made. Mintzberg (1976) and Kingdon (1995) state that within the variation the most (implicit) selection takes place. One can only select what is already designed or at least devised. This led to viewing these processes as 'garbage cans' (Cohen, March and Olsen 1972). Variation and selection take place at the same time and are results of a chaotic and accidental process. The normative structured view of a process in phases is replaced by descriptive representations as the streams model (Kingdon 1995) and the rounds model (Teisman 1992, 2000).

In this research we are looking for a combination of both schools of thought accepting the chaotic and accidental character of practice, but in the same time realizing that we need to structure the process in order to get things done. In the initiative phase, when little is structured yet, the view of Kingdon's model of streams is adopted. The actual problem becomes clear when we confront this view with the dilemma of Collingridge (1980), which he observed in the introduction of new technologies and we find applicable to the initiative phase of inner city redevelopment processes. As literature basis for our solution we turn to Corner, Buchanan and Henig (2001) who have developed a conceptualization of decision problem structuring which synthesizes a number of models and approaches cited in the decision-making literature in general and the multi-criteria literature in particular.

2.1 Kingdon's model of streams

Kingdon (1995) envisions possibilities for policy change (agenda-setting) when three, to a large extend independent, streams get coupled. Combined actions between these streams – *problems*, denoting which issues are recognised as significant social problems; *policy* or – in our case – *alternatives*, referring to which advice is regarded as 'good advice'; and *political environment* characterised by elections, changes in government and changes in public opinion – and the importance of chance, captured by the concept of *policy windows*, make policy change possible. Policy windows occur when there is an opening for new views and provide the opportunity to have alternative issues and solutions considered seriously. In short, critical factors in this model of agenda-setting are timing, chance and external influence. Problems and solutions may disappear or float to the top of the streams in a somewhat random manner, which means that important decisions can be taken in various places and with varying interest in relevant alternatives. However, the role of external influences also indicates that alternatives that are circulated within policy networks may have a significant impact when it chances to address an emerging issue at the right time and place. Bruil (2004: 272-276) found the concept of streams applicable to inner city redevelopment processes.

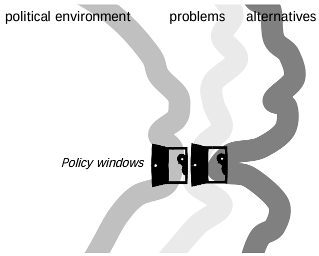

Figure 1. Kingdon's model of streams

2.2 Collingridge's dilemma

The dilemma of Collingridge hampers the occurrence of policy windows and makes using them difficult. Collingridge observed this problem in the early phases of technology development and we thought it applicable to the start of complex inner city redevelopment processes. He formulates it as follows: 'Attempting to control a technology is difficult, and not rarely impossible, because during its early stages, when it can be controlled, not enough can be known about its harmful social consequences to warrant controlling its development; but by the time these consequences are apparent, control has become costly and slow' (Collingridge 1980: 19). While the alternatives possible are numerous, potential stakeholders – for this same reason – find it hard to imagine their effects. This results in a low level of participation by potential stakeholders in the beginning of inner city redevelopment processes, especially those who could potentially benefit from it, while at this time the development of alternatives – although still abstract – is very much open and controllable (Van Eijk 2003: 199).

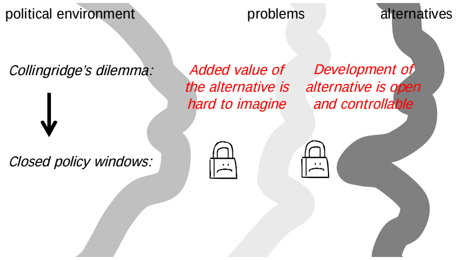

Figure 2. Confrontation of Kingdon's model of streams with Collingridge's dilemma

In figure 2, Kingdon's model of streams and Collingridge's dilemma are confronted. Because stakeholders find it hard to imagine alternatives, they see little relation between possible alternative solutions to the problem and their values. Policy windows stay shut, while the alternatives are very open to change and in response there are many opportunities for aligning the three streams.

Kingdon learns that it is essential to the starting phase of inner city redevelopment processes to study not only the spatial problem itself, but also to take account of the stakes of potential stakeholders – political environment – as well as the possible alternatives. Collingridge makes clear that, although stakes and possible alternatives are related, it is hard to establish this link in practice: there are so many directions alternatives could develop in that participants can not picture the possible effects of the redevelopment and find it hard to formulate their stakes.

2.3 Corner's dynamic approach

The problems stemming from the confrontation of Kingdon's model of streams and Collingridge's dilemma are not new to the world of decision making, especially when dealing with so called ill-structured or multi-criteria problems (Rosenhead and Mingers 2001: 4-5, with reference to Ackoff 1979; Rittel and Webber 1973; Schon 1987). Corner, Buchanan and Henig (2001: 131, with reference to Keeney and Raiffa 1976; Saaty 1980) point out that most decision models are built up out of criteria and alternatives: "Criteria reflect the values of a decision-maker and are the means by which alternatives can be discriminated. Alternatives are courses of action which can be pursued and which will have outcomes measured in terms of the criteria. Henig and Buchanan (1996) and Buchanan, Henig and Henig (1998) present a conceptualization of the multi-criteria decision problem structure in terms of criteria and alternatives, with attributes as the bridge between them. More precisely, they state that attributes are the objectively measurable features of the alternatives. Therefore, the decision problem is structured so as to separate the subjective components (criteria, values, preferences) from the objective components (alternatives and attributes), with a view to improving the decision process."

When considering inner city redevelopment processes as multi-criteria decision problems, two approaches in structuring can be taken. First, criteria are identified first in the decision making process, then alternatives are creatively determined in light of such criteria and choice is then made. ‘Known as value-focused thinking (VFT), this has been advocated as a prescriptive, proactive approach. Here, the explicit consideration of values is offered as a starting point to the structuring process, and leads to the creation of opportunities, rather than the need to solve “problems”’ (Corner, Buchanan and Henig 2001: 132). Second, following March’s (1988) view that values and criteria are formed out of experience with alternatives and suggesting decision simulations as a way to discover hidden values and, subsequently, promising alternatives, ‘the process of first specifying alternatives in the problem structuring process, and then applying value and preference information to them in order to make a choice, is commonly referred to as alternative-focussed thinking (AFT). It is clear from the descriptive decision-making literature that AFT is easily the more common procedure (for example, Nutt, 1993; Corner, Buchanan and Henig 2001: 132).

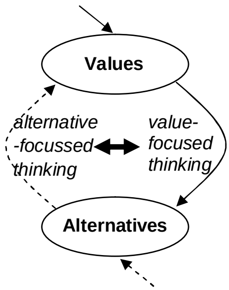

Figure 3. The alternative-focussed and value-focussed approach to multi-criteria decision problems

Figure 3 shows both approaches. The distinction between them is not just academic. ‘It is difficult to determine which does or should come first – criteria or alternatives – since both are vitally important to the decision problem structuring process. However, we argue that the starting point is not the issue. What is important is that the decision-maker learns about one (criteria or alternatives) from working with the other. In a good structuring process, criteria and alternatives both do and probably should generate each other interactively’ (Corner, Buchanan and Henig 2001: 132). The authors advocate a dynamic approach recognising the different starting points inherent in VFT and AFT. More importantly, the approach reflects the interactive nature of criteria and alternatives, and suggests movement from one to the other. ‘This interactive and dynamic approach for problem structuring implies that thinking about alternatives helps generate criteria, and vice versa. That is, neither of these two structuring elements can be thought of alone, independent of the other’ (Corner, Buchanan and Henig 2001: 132-133). Corner, Buchanan and Henig (2001: 135-138, with reference to Nutt 1993, 2001) show that best results are generated by combining approaches based on alternative focused thinking as well as on value focused thinking.

3. RESEARCH PROJECT

As we find a shortage of knowledge and experience in dealing with the design commission at the start of complex inner city redevelopment processes, a participative design tool is aimed at creating coherence by the collaboration of long-term committed shareholders in the initiative phase of the redevelopment process. Point of departure is a new way of dealing with the objectives of the actors involved. These objectives should be 'knotted' rather than piled up. 'Knotting' encompasses a process for the initial actor and other shareholders with a long-term commitment to the location to develop a shared view of the transformation based on a joint orientation on possible synergies offered by the location. The participative design tool serves at least the following objectives/criteria:

- the creation of mutual understanding by developing a shared language;
- the recognition of mutual coherence and added value by analysing of objective–means relationships in day-to-day use of the location;
- the search for 'win-win' situations by redefining individual ambitions into shared objectives;
- the trade and adjustment of objectives by negotiation and compromise; leading to
- the formulation of collaborative paths for exploiting synergy opportunities.

3.1 Project description and objectives

The research project aims at adopting the dynamic approach for problem structuring to the initiative phases of inner city redevelopment processes. This method should facilitate a shared commissioning by actors who (jointly) have at their disposal a large share of the (financial) means required for the redevelopment. A focus on synergy is essential here, as it links the possibilities of the location and the objectives of the actor with a long-term commitment to the location. By this, a focus on synergy is a focus on quality in all its diverse aspects. Such is the view underlying the study. In this paper we focus on the method developed and not so much on the concept of synergy.

The participative design tool was developed and tested in September 2005 by an experimental implementation in the initiative phase of the redevelopment process of Smakkelaarsveld, part of the station area of the city of Utrecht, being the fourth largest city of the Netherlands by inhabitants. The station is a mayor junction in the Dutch railway network. The master plan of the station area foresees Smakkelaarsveld as gateway to the old city centre and aims for a multi-functional brief including public functions, housing and a parking garage (Projectorganisatie Stationsgebied 2003: 20). This ambition asks for the participation of a number of actors of which figure 4 lists the ones who participated in the test of the participative design tool.

Long-term stakeholder	Interest
Project Organisation Station area (POS) (municipality)	Progress of redevelopment
Bouwfonds MAB (developer)	Development opportunities
Kantoren Fonds Nederland (KFN) (investor)	Owner office building 'Smakkelaarsburcht'
FGH Bank (user – investor)	Owner-user office building 'Leidseveer'
Rabo Vastgoed** (developer)	Owner office space in shopping mall 'Hoog Catherijne'
Chamber of Commerce Utrecht (CCU)	Promotion commercial interest inner city and regional economy
NS Vastgoed* ** (developer)	Adjoining development

Figure 4. Participants test participative design tool: * no mind map ** did not attend workshop

3.2 Design methodology

In order to develop the participative design tool, developing inner city locations is viewed as an organizational process as well as a design process. In the design ambitions these processes are joined. The ambitions stem from the wishes of the actors involved, based on their objectives and means, and are bordered by the possibilities provided by engineering techniques. From a pluralist paradigm participants need to find their common interests by participating in a design process. Participation begs a common language consisting of notions dealing with elements of the location as a designer would use, with objectives of the shareholders involved and with the relationships between these elements and objectives. Systems theory offers the possibility of developing such a language by observing the inner city location as a system. In the light of the interweavement of stakeholder interests and design enrichment a central role is given to the synergic relationships between the elements and objectives. In systems theory these ill-structured problems are dealt with by participative problem structuring methods.

Participative problem structuring methods are directed at mutual learning; among actors involved in relation to the problem at hand. The essence of the method is a structured confrontation between the actors' images of the problem and possible alternative solutions. De Geus (1988: 71) views decision making as 'a learning process, because people change their own mental models and build up a joint model as they talk'. 'Learning takes place when people discover for themselves contradictions between observed behaviour and their perceptions of how the "world" should operate. So, managers must experiment with models, try their own what-ifs, and use simulations to trigger wide-ranging discussion' (Morecroft 1992: 9). Mental models are 'networks of facts and concepts that mimic reality and from which executives [and indeed all people] derive their opinions of strategic issues, options, courses of action and likely outcomes' (Morecroft 1988: 313). Mental models are constructed and constantly tested by people's daily dealings with reality. For this mental models are responsive to change. In time mental models are implicit. They are within one's mind and are not directly available for discussion and analysis (Geurts and Vennix 1989: 57).

The participative design tool is based on a dynamic approach to decision making problems: an approach based on interests or values and an approach founded on solutions or alternatives to the problem are alternated. The value oriented approach is represented by participative modelling through an exercise of mind mapping by which the mental models actors involved are made explicit. The alternative oriented approach by participative design through an exercise of working with a design table by which participants in small groups start of with designing a possible alternative. Next, these alternatives are confronted in order to get a common understanding about what the actors all agree upon and what are the mayor differences.

The result of this first sequence of subsequently viewing the redevelopment issue from the point of view of values and alternatives is not so much a design, as well as a basis for a joint design commission that is able to foster coherence in the design and a long-term collaboration of committed shareholders.

4. TEST RESULTS AND INDUSTRIAL IMPACT

The test of the participative design tool consists of an individual interview and a joint workshop. During the interviews the mind mapping is introduced and the participants are asked to point out the most important factor for success and failure of the redevelopment of Smakkelaarsveld. Next, the participants have a week to make their personal mind map and submit it by the internet. At a plenary workshop, a few weeks later, the joint model based on individual maps are presented and discussed and the participants work with the design table.

4.1 Results

The individual mind maps are constructed as follows. The participant starts of with setting out all values that are influenced by the redevelopment, like return-on-investment, architectural quality and safety. Next, he adds attributes – features of the future location – and relates them to the values. In the last step he scores the relation between attributes and values from -9 (the attribute has a very negative effect on the value) to 9 (the attribute has a very positive effect on the value).
The individual mind maps are integrated to a collective model showing how each value is valued by all participants and how they value the attributes influencing these values.

During the workshop an analysis of the collective model is presented and discussed. Figure 5 shows that the Project Organisation Station area represents most values (6), followed by the FGH-Bank and developer Bouwfonds MAB (5). The value ‘return’ and ‘spatial and functional quality’ are shared by most participants (4). The same values ‘return’ (12) and ‘spatial and functional quality’ (9) and the value ‘operations’ (8), referring to the phase of use, are influenced by most attributes. Attributes ‘architecture’, ‘development urban quality’ and ‘routing pedestrians’ influence most values (5). Through this and other analyses participants get an idea of the level of commonness of their vision on the location. The presentation leads to interaction between the participants: they talk about the view they have from each other’s position in the process and they are able to adjust their perceptions.

→	Actor	←	Value	→	Attribute	←
6	POS	4	Return	12	Architecture	5
5	FGH Bank	4	Spatial and functional quality	9	Development urban quality	5
5	Bouwfonds MAB	3	Continuity	5	Routing pedestrians	5
4	KFN	2	Operations	8	Parking space	4
3	CC Utrecht	2	Image and appearance	5	Development risks and opportunities	3
3	Rabo Vastgoed	2	Liveliness	5	Dwellings	3
		2	Accessibility	3	Functional mix	3
		2	Liveableness	2	Use off space	3
		1	Relations with surroundings	3	Accessibility (by car)	3
		1	Add-value to city as a whole	2	Public space	3
		1	Multiple use of space	2	Buildings	2
		1	Parking	1	Urban plan	2
		1	Development	0	Commerce	2
					Amenities	2
					Green space	2
					Shops	2
					Added value to company	2
					Public transport	2
					management of urban quality	1
					Image of the area	1
					Double use of parking space	1
					Sustainability	1

Figure 5. Connectivity of actors' values and attributes in the collective model of Smakkelaarsveld where:

1. '→ actor' shows the number of values the actor has mentioned;
2. '← value' shows the number of actors that has mentioned the value;
3. 'value →' shows the number of attributes that influences the value;
4. 'attributes ←' shows the number of values that are under influence of the attribute.

After the participative modelling exercise the participants start designing by using a design table (based on the strategy table as used by Geurts and Weggeman 1992) in order to come up with alternative solutions. In the design table the area's most important attributes are set out, based on the factors for success and failure as mentioned by the participants in the individual interviews, followed by concrete solutions presented as options. The participants work in two small groups choosing one option for each attribute. In this way, an alternative for the location are developed that consists of the succession of the chosen options. Next, the alternatives are tested for consistency and the level to which it takes an integral view-point. Subsequently, the participants give their alternatives a catchy label. Figure 6 shows both of the alternatives designed and although the text is small and in Dutch the reader should get an impression of the structure of the table as explained. Both alternatives are pictured as series of circled options connected by the continuous (group 1) and the dotted (group 2) lines.

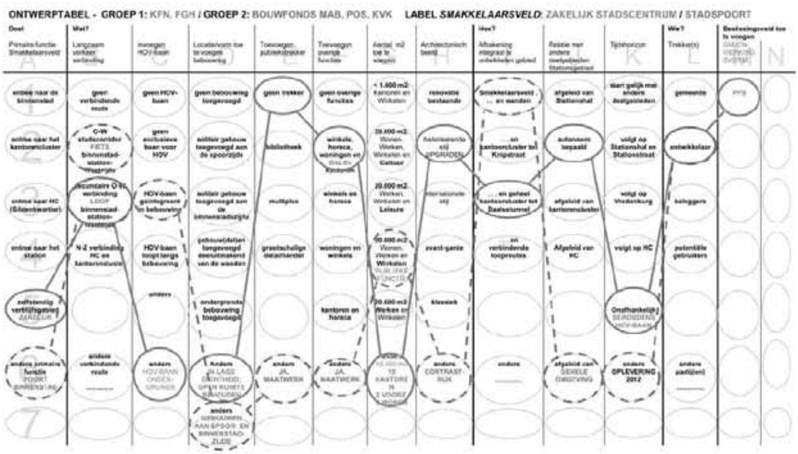

Figure 6. Design tables Smakkelaarsveld of group 1 (-) and 2 (- -)

Working with the design table forces participants to communicate their wishes and ideas and to negotiate regarding their objectives and willingness to contribute assets and means. The table offers them a window on the location's opportunities. As a final step, the different alternatives are compared. This provides insight into the similarities and differences of these alternatives and by doing so, gives directions for further steps that have to be taken.

In a SWOT-evaluation the participants wrote down that the participative design tool provided insight into the similarities and differences of their interests and generated a shared vision for the location efficiently and effectively. Moreover, it led to a discussion on the important design features and on negotiating stakes and assets. The method enabled the participants, despite the early stage in the process, to start searching for added-value opportunities collaboratively. The end-result of the design-workshop subsequently could serve as a basis for the design brief when commissioning an urban designer or architect.

4.2 Implementation and exploitation

The participative design tool should contribute to a smoother and faster redevelopment process by coupling the objectives of actors involved by means of the location synergy concept and by doing so this will lead to ambitious, yet realizable plans that create added-value in the phase of use of the location. Critical to this is the collaboration of actors who combine a long-term interest in the location with sufficiently adequate means for realisation of the plans.

These long-term committed actors should not be sought only among those already involved with the location. Although in many cases, present landowners and users do not have long-term stakes as they will leave the location and will not return after redevelopment. We should therefore also search for actors with long-term interests matching those of the initiators and/or the location's potential. These actors should become involved in the redevelopment in its earliest stages. The role of real estate developers is an interesting one. Although developers are not committed for the long term, their prime objective and conceptual and financial expertise equip them for the role of catalyst within these processes and, furthermore, position them as particularly committed to progress.

Actors lacking a long-term commitment to the location who already play a central role in the policy arena crowding these processes should be stimulated to widen their time-horizons. Next to this, shaping the plans' substance creates opportunities for stimulating long-term commitment. All these actions contribute to the formation of a group of actors that are able to benefit from a mutual steering focused on mutual added value.

5. CONCLUSIONS

Once the long-term shareholders have found each other, the next step is to get them collaborating in order to *together* develop a coherent plan that will generate added value in the phase of use. This research shows that an iteration of value-focused thinking and alternative-focused thinking is a solid basis for such collaboration and strengthens the chances for successful redevelopment. In practice in the initiative phase actors tend to cling to one or the other approach for too long.

The participative design tool offers the participants a mirror for viewing their own images of the future location and comparing these with the images of others. Moreover, the method provides a window on the location's potential and helps the actors communicate their images and views on the location's potential. Finally, the method functions as a marketplace for negotiation to arrive at a consensus and commitment regarding the approach to the location. Still, the method does not guarantee a smooth and fast process or synergy-rich result.

The participative design tool should not only result in the necessary conditions for the redevelopment, but the participative way of working should also contribute to the critical success factors of such processes. The method plays on the participants' expertise and professionalism. In the final analysis, these attributes prevail over those connected to formal positions or culture, thus establishing a dialogue even in cases of mutual distrust. Situations of great urgency, when earlier attempts have failed, create the context for such breakthroughs. Once influential representatives of the actors involved are willing to commit themselves, the power of a participative way of working becomes apparent. In the participative design tool this power is combined with the strength of designing. This combination explains why redevelopments can take off despite unfavourable prospects based on scientific analysis of the background variables. A design-based intervention by a group of inspired and courageous people has the potential for changing it all.

This research provides us with starting-points for developing further the field of inner city redevelopment. The participative design tool contributes to a more professional commissioning by the public and private actors involved. The method challenges actors to look beyond their personal interests and means by appealing to their expertise and professionalism: aren't we all in the trade of realising outstanding projects?

6. REFERENCES

Ackoff, R.L. (1979), The future of operational research is past. *Journal of Operational Research Society*, **30**, 93-104.

Bruil, A.W. (2004), Sturing en procesmanagement. In: Bruil, A.W., F.A.M. Hobma, G.J. Peek and G. Wigmans (red.) *Integrale gebiedsontwikkeling. Het stationsgebied 's-Hertogenbosch*. Amsterdam: sun, 259-279.

Buchanan, J.T., E.J. Henig and M.I. Henig (1998), Objectivity and subjectivity in the decision-making process. *Annals of Operations Research*, **80**(0), 333-345.

Cohen, M.D., J.G. March and J.P. Olsen (1972), A garbage can model of organizational choice. *Administrative Science Quarterly*, **17**, 1-25

Collingridge, D. (1980), *The social control of technology*. New York: St. Martin's Press.

Corner, J., J. Buchanan and M. Henig (2001), Dynamic decision problem structuring. *Journal of Multi-Criteria Decision Analysis*, **10**(3), 112-141.

De Geus, A.P. (1988), Planning as learning. *Harvard Business Review*, **66**(2), 70-74.

Geurts, J.L.A. and J.A.M. Vennix (red.) (1989), *Verkenningen in beleidsanalyse, theorie en praktijk van modelbouw en simulatie*. Zeist: Kerckebosch.

Geurts, J.L.A. and M.P. Weggeman (1992), Strategische beslissingsanalyse voor r&d-projecten. *Bedrijfskunde*, **64**(1), 68-80.

Henig, M., and J. Buchanan (1996), Solving mcdm problems. Process concepts. *Journal of Multi-Criteria Decision Analysis*, **5**(1), 3-21.

Keeney, R., and H. Raiffa (1976), *Decisions with multiple objectives*. New York: Wiley.

Kingdon, J.W. (1995), *Agendas, alternatives, and public policies*. New York: Harper Collins College Publishers.

Mintzberg, H. (1976), The structure of 'unstructured' decision processes. *Administrative Science Quarterly*, **21**(2), 246-275.

Morecroft, J.D.W. (1988), Systems dynamics and microworlds for policymakers. *European Journal of Operational Research*, **35**(3), 301-320.

Morecroft, J.D.W. (1992), Executive knowledge, models and learning. *European Journal of Operational Research*, **59**(1), 9-27.

Nutt, P. (1993), The formulation processes and tactics used in organizational decision-making. *Organization Science*, **4**(2), 226-251.

Nutt, P. (2001), A taxonomy of strategic decisions and tactics for uncovering alternatives. European Journal of Operational Research, **132**(3), 505-527

Peek, G.J. (2006), 'Locatiesynergie: Een participatieve start van de herontwikkeling van binnenstedelijke stationslocaties', Delft: Eburon Academic Publishers.

Projectorganisatie Stationsgebied (2003), *Masterplan Stationsgebied Utrecht*. Gemeente Utrecht

Rittel, H.W.J., and M.M. Webber (1973), Dilemmas in a general theory of planning. *Policy Science*, **4**(2), 155-169.

Rosenhead, J., and J. Mingers (2001), Rational analysis for a problematic world revisited. Problem structuring methods for complexity, uncertainty and conflict. Chichester: John Wiley & Sons.

Saaty, T.L. (1980), *The analytic hierarchy process*. New York: McGraw-Hill.

Schon, D.A. (1987), *Educating the reflective practioner.Toward a new design for teaching and learning in the professions*. San Francisco: Jossey-Bass.

Teisman, G.R. (1992), *Complexe besluitvorming. Een pluricentrisch perspectief op besluitvorming over ruimtelijke investeringen*. Dissertatie, 's-Gravenhage: vuga.

Teisman, G.R. (2000), Models for research into decision-making processes. On phases, streams and decision-making rounds. *Public Administration*, 78 (4), 937-956.
Van Eijk, P.J. (2003), *Vernieuwen mét water: Een participatieve strategie voor de gebouwde omgeving*. Dissertatie, Delft: Eburon Academic Publishers.

RISK MANAGEMENT IN THE DIFFERENT PHASES OF A CONSTRUCTION PROJECT – A STUDY OF ACTORS' INVOLVEMENT

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ABSTRACT

The results from a questionnaire survey of risk management in the different phases of a construction project are presented. The participants of the study were clients, contractors and consultants working in Sweden. We analysed the involvement of these actors in the project phases, their roles in the risk management process in particular and their influence on risk management. We show that the planning and production phases of a construction project are the most important for risk management, wherein risk identification, assessment and response take place. Moreover, collaboration in terms of risk management between the actors is most intensive in these phases. Contractors participate more actively in the risk management process in comparison with other actors and have the largest influence on project risk management. Despite the recognised importance of the early phases in the project, our study shows a very low degree of risk management activity in the programme phase.

1. INTRODUCTION

Construction projects are usually characterised by many varying risks. Being able to manage risks throughout the construction process is an important and central element preventing unwanted consequences. Risk management is also decisive for achieving a good final result with secure economy. Many different actors are involved in a construction project and often they have no or limited experience of earlier collaboration with each other. In many projects there is an attempt by actors to try to avoid risks as far as possible and let somebody else in the value chain deal with them. Considering the effects that risk management and risk sharing have on project goals in the form of both quality and economy, these processes ought to take place in an open and conscious way. In each phase of a construction project, namely programme, planning, procurement and production, the management of a specific risk should be allocated to the party that has the best corresponding qualifications.

One of the problems identified in the reports of Swedish Construction Cost Delegation and Construction Commission (SOU, 2000; SOU, 2002) is that many actors are involved only in some of the project's phases. They often focus on short-term economic results and protect their own interests rather than the project overall. This leads to a less effective risk management process. Little attention in the

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research community so far is paid to identifying the roles of individual actors in risk management through the project's different phases.

The objective of the paper is to analyse the risk management process in a construction project from the perspective of the client, the contractor and the consultant. In particular, we examine the ways and extent to which the actors are involved in risk management through the different phases of the project. The study is based on a literature review and the results of a questionnaire survey of construction project actors.

The paper is organised as follows. In section 2 we overview relevant literature. In section 3 the research methodology of the study is described. Section 4 presents the result of the questionnaire survey and analyses risk management process in the projects' different phases. Discussion and directions for future work are presented in section 5. The concluding remarks follow in section 6.

2. REVIEW OF RELATED LITERATURE

2.1. Risk and risk management in construction

There are several definitions of the project risk in the literature (e.g. IEC, 2001, PMI, 2000, Baloi and Price, 2003, Barber, 2005). A formal definition is given in the international standard IEC 62198 as a combination of the probability of an event occurring and its consequences for project objectives. Ward and Chapman (2003) discuss the concept of risk in greater detail and suggest using the more general concept of *uncertainty.* A questionnaire survey conducted by Akintoye and MacLeod (1997) shows that the majority of project actors perceive risk as a negative event. More detailed literature review on risks in construction is presented in Osipova and Apleberger (2007).

Project risk management is a formal process directed to identification, assessment and response to project risks. The process is defined differently in research literature (e.g. Flanagan and Norman, 1993; Uher and Toakley, 1999; PMI, 2000; Chapman and Ward, 2003). However, all definitions agree that the aim of project risk management is to maximise opportunities and minimise the consequences of a risk event in the construction project. The Guide to the Project Management Body of Knowledge (PMI, 2000) identifies four main steps in the risk management process: risk identification, risk assessment, development of risk response and management of risk response. Several authors develop more detailed models. Baloi and Price (2003) use the model of seven steps: risk management planning, risk identification, risk assessment, risk analysis, risk response, risk monitoring and risk communication. Chapman and Ward (2003) introduce the SHAMPU model, which consists of nine phases. Del Cano and de la Cruz (2002) present a generic project risk management process of eleven phases, which can be used in large and complex projects. For the purpose of this research we use a simplified risk management process of three main steps: risk identification, risk assessment and risk response. The reason for the simplification is that this model is well-known for the project actors and frequently used in practice.

The goal of the risk identification process is to decide on potential risks that may affect the project. There are several approaches for classifying project risks and risk sources (Leung *et al.*, 1998; Tah and Carr, 2000; Baloi and Price, 2003; Li *et al.*, 2005). The main categories are financial, economic, managerial, legal, construction, design and environmental risks. During the risk assessment the identified risks are evaluated and ranked. The goal is to prioritise risks for management. Baccarini and Archer (2001) describe a methodology for the risk ranking of projects, which allows for an effective and efficient allocation of the resources for management of project risks. The JRAP model proposed by Öztas and Ökmen (2005) is a pessimistic risk analysis methodology, which is effective in uncertain conditions in construction projects. The risk response process is directed to identifying a way of dealing with the project risks.

Several surveys conducted among the construction industry actors (Akintoye and MacLeod, 1997; Uher and Toakley, 1999; Lyons and Skitmore, 2004) show that checklists and brainstorming are the most usable techniques in risk identification; subjective judgment, intuition and experience are used mostly in risk assessment; and transfer, reduction and avoidance are the most applied methods for risk response.

2.2 The roles of the project's different phases in risk management

Traditionally, a construction process is divided into four main phases: programme, planning, procurement and production. In the programme phase the client has an idea about the project and analyses conditions for its execution. During the planning phase the architects produce construction drawings according to the client's requirements. In the procurement phase the parties sign the contract. Finally, the contractor executes the job in the production phase.

Since it is impossible to foresee all project risks in the programme phase and due to the tendency of the identified risks to change during project implementation, joint and consistent risk management is required throughout all project's phases (Rahman and Kumaraswamy, 2004). Motawa *et al.* (2006) propose a model, which helps in determining potential changes in the project based on available information in the early stages of the project. Baccarini and Archer (2001) introduce a methodology for a risk rating process in the procurement phase, which allows the effective and efficient allocation of resources for project risk management.

Several authors highlighted the importance of the early phases in project risk management since the decisions taken in these phases often have a significant impact on the final result (Kähkönen, 2001). However, according to Uher and Toakley (1999), the actual usage of risk management techniques in the early phase is very low.

Lyons and Skitmore (2004) conducted a survey where one of the aspects was the use of risk management in each of the project phases. The results showed that risk management in the planning and production phases was higher than in the programme phase. Risk identification and risk assessment were more often performed in the risk management processes than risk response.

3. RESEARCH METHODOLOGY

The study involves nine construction projects recently performed in Sweden (Table 1). In order to obtain an accurate picture, the projects included in the study satisfy the following requirements:

- the projects are located in large and small cities;
- they use different forms of contract and collaboration, i.e. performance-based contracts, design-build contracts and partnering;
- the types of the projects are building and civil engineering;
- all projects are medium-sized (between 5 and 100 MSEK).

Table 1. Characteristics of construction projects included in the study

Nr.	Location	Type of the project	Form of contract/collaboration	Contract amount (MSEK)
1	Norrbotten	Building	Design-build	41
2	Norrbotten	Building	Performance-based	18
3	Norrbotten	Civil Engineering	Design-build	53
4	Norrbotten	Road	Performance-based	20
5	Norrbotten	Road	Performance-based	5
6	Stockholm	Building	Design-build	81
7	Stockholm	Building	Design-build	48
8	Stockholm	Civil Engineering	Performance-based	95
9	Stockholm	Building	Partnering	15

As the objective of the study is to get a picture of the risk management process from different actors' perspectives, a questionnaire survey was chosen as the most appropriate research method. The survey sample comprised clients, contractors and consultants. Within each group we identified those persons who worked with risk management in a particular project. The respondents from the client's side are the representative signing the contract and project manager. From the contractor's side the respondents are the representative signing the contract, site manager and estimator. Finally, the respondent from the consultant's side is the architect or design manager.

A draft questionnaire was developed consisting of five sections. The first section contained general questions about the respondent. In the second section, the aspects of the risk management process through the different phases of the project were covered. The third section investigated relationships between the actors in the project. The fourth section focused on software management systems, which the company uses in the risk management process. The fifth section was a concluding one for miscellaneous comments regarding the risk management process in the project.

We organised two workshops where we met about 50% of prospective respondents and presented the research project and the objectives of the survey. The workshop participants were given an opportunity to answer the draft questionnaire and give their comments on the content. Following the workshop, the final version of the questionnaire was developed and sent in the electronic form to the respondents. After the questionnaires were completed, the answers were analysed using the statistical processing software, SPSS, and Microsoft Excel.

4. RESULTS OF THE SURVEY

In total, 54 questionnaires were sent and 43 responses were received, resulting in a response rate of 80%. From the received responses, 36 were completed questionnaires and seven respondents explained the reasons for non participation. A response rate of 100% was for those people who attended the workshop. This shows that the respondents who were aware of the survey objectives were more interested in taking part in the project. The sample composition aggregated according to actors' roles in the project is shown in Figure 1.

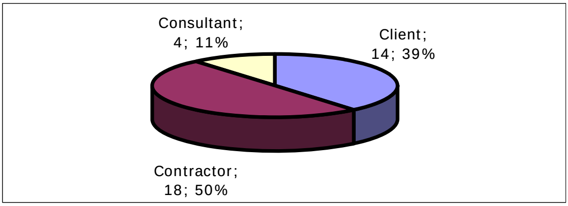

Figure 1. Sample composition

4.1 Respondents

Analysis of gender distribution confirms that the Swedish construction industry is traditionally male-dominated sector. 34 survey participants are men and two participants are women. The age distribution shows that 89% are over 41 years old. Most of the respondents (92%) have more than ten years experience in construction industry, and 64% have more than 20 years of experience. 44% of survey respondents have a university degree in construction, 53% finished upper secondary school, and only one person has vocational training only. 33% respondents participated in risk management or project management courses within their organisations or during the period of university studies.

Despite a relatively high education level and large experience, the majority of the respondents (75%) estimate their knowledge of risk management as fair. Table 2 summarises the risk management knowledge within each group of actors.

Table 2. Knowledge of risk management

	Role in the project			
	Client	**Contractor**	**Consultant**	Total
Low	1	0	1	2
Fair	10	14	3	27
Advanced	2	3	0	5

4.2 Risk management in the different phases of the project

Figure 2 shows that the majority of the respondents (32) participated in the production phase. For the contractors it is quite natural because they are always involved in the production phase and very seldom in the programme phase. Therefore contractors' participation increases as the project goes forward: one contractor participated in the programme phase and 16 in the production phase. It was quite unexpected that only seven clients participated in the programme phase compared to 14 clients in the production phase. This may be partially explained by the types of the projects. Often there is no programme phase in civil engineering projects. Therefore, most of the respondents from this group answered that they did not participate in that phase. All four consultants participated in the planning phase and two of them followed into the production phase.

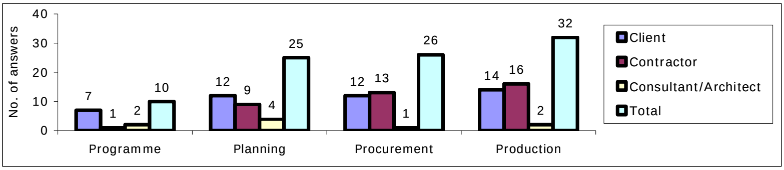

Figure 2. Participation in the project phases

When the respondents were asked to estimate[35] the importance of risk management in every phase of the construction project (Figure 3), the estimates were similar in both the client and contractor groups. The production and planning phases were identified as the most important for the management of risks. Then the procurement and programme phases follow. Consultants' estimates differ from those of clients and contractors. Overall, we observe that they underestimate the importance of all phases compared with the other actors. However, the planning and production phases are identified by consultants as the most important. From this distribution we can conclude that many actors link risks to the production phase.

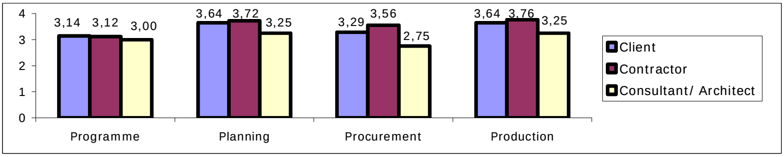

Figure 3. Importance of risk management in the different phases

Figure 4 illustrates how many actors carried out risk management processes systematically in their projects. The most active group is contractors, where all respondents identified and assessed project risks and 94% performed risk response systematically. In the client group 86% identified risks, 71% assessed them and only 57% systematically responded to project risks. The explanation of low risk response rate may be that the clients let other actors in the value chain deal with identified

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[35] Scale is between 1 and 4, where 1 is unimportant, 2 – not so important, 3 – fairly important, 4 – very important

risks. Consultants are the most passive actors when it comes to project risk management. Among consultants only 33% identified risks and responded systematically, and none assessed project risks.

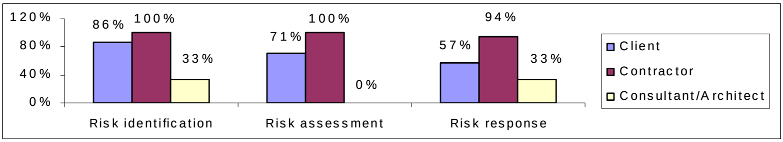

Figure 4. The risk management processes systematically performed in the project

4.2.1 Risk identification process

Risk identification (Figure 5) was mostly performed in the planning and production phases. The earlier risks are identified, the less is the probability that they occur. Despite this only seven respondents answered that risk identification was performed in the programme phase. Most of the clients indicate that risk identification was carried out in the planning phase, whereas contractors mostly identify risks in the production phase.

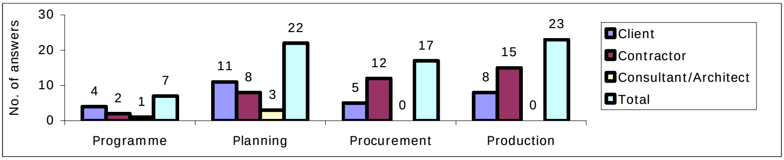

Figure 5. Risk identification in the different phases

In the programme phase 75% of the respondents answered that risks were identified by the client. In the planning phase 39% responded that risks identification was performed jointly by all actors and 25% responded it was performed by the client and the consultant. In the procurement phase the contractor plays the most important role in risk identification (52%). In the production phase risks were identified by the contractor (39%) or jointly by all actors (39%).

4.2.2 Risk assessment process

Figure 6 shows that risk assessment has a similar tendency as the risk identification process: the majority of the respondents perform it in the production phase. However, the procurement phase is more important for the risk assessment process than for risk identification and risk response. This is because the risk premium is calculated in the procurement phase and therefore it is important to assess earlier identified risks.

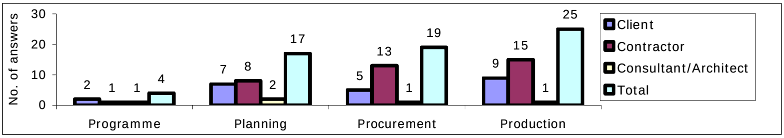

Figure 6. Risk assessment in the different phases

Similarly to the risk identification process, the risk assessment in the programme phase is performed mostly by the client, in the planning phase jointly by all actors or by the client and consultant. However, the contractor's involvement in the risk assessment in the planning phase was higher than in the risk identification. The procurement and production phases do not differ much from the risk identification process: in both phases the contractor plays the most important role.

4.2.3 Risk response process

Risk response (Figure 7) is also associated with the production phase. Both the clients and the contractors mostly manage risks in this phase. This is due to the traditional approach in the construction industry: contractors do not put enough effort into preventing problems and solve them as they appear in the project.

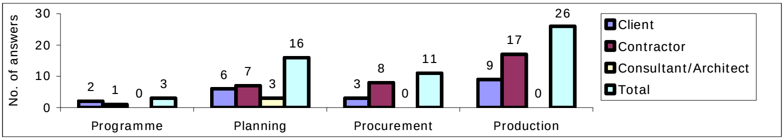

Figure 7. Risk response in the different phases

In the programme phase, similarly to the risk identification and assessment processes, risk response is performed by the client. In the planning phase the client together with the consultant responded to the project risks. In the procurement phase risk response is performed mainly by the contractor. In the production phase the role of the contractor is large and the degree of joint risk management is high.

4.3 Collaboration in managing risk and actors' influence on the risk management process

In the questionnaire we define the term *collaboration* as joint work in risk management process. Almost all respondents had collaboration in risk management with other actors in the project: 11 clients, 13 contractors and three consultants. Seven respondents (three clients, three contractors and one consultant) answered that no collaboration in risk management existed in the project. Evaluations[36] of collaboration (Table 3) vary from "fairly good" to "very good".

[36] Scale is between 1 and 4, where 1 – very bad, 2 – fairly bad, 3 – fairly good, 4 – very good.

Table 3. Evaluation of collaboration in risk management

Role in project	Evaluation
Client	3.55
Contractor	3.38
Consultant/ Architect	3.33

The degrees[37] of communication of known risks and opportunities between actors in the procurement phase are presented in Table 4. Overall evaluations are not high and vary between "little detailed" and "fairly detailed". The contractors answered that the client communicated known risks moderately (2.06). On the contrary, the clients state that their communication of known risks is higher (2.73).

Table 4. Degree of communication of known risks and opportunities between actors in the procurement phase

	Clients' communication	Contractors' communication
Client	2.73	2.69
Contractor	2.06	2.39
Consultant/ Architect	3.00	3.00
Total	2.36	2.53

Figure 8 presents the respondents' judgement[38] of their own and other actors influence on risk management in the project. The results show that the contractor has the largest influence on risk management from the perspective of all actors. It is interesting that even the clients estimate the contractors' influence to be larger than their own. This can be linked to the Figure 3, where the actors connect risk management to the production phase. The influence of the consultant is surprisingly low despite the fact that the planning phase is considered to be very important by all actors.

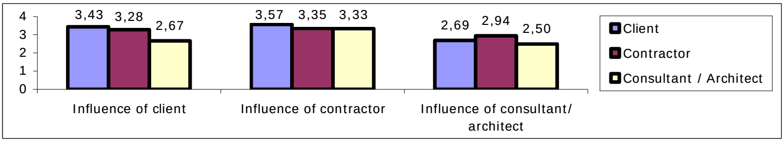

Figure 8. Influence of the actors on the risk management process in the project

The existence of collaboration in risk identification, risk assessment and risk response is shown in Figure 9. Risk identification (RI) is the process where collaboration existed according to most of the actors: 82% of clients, 92% of contractors and 67% of consultants answered that they collaborated identifying the project's risks. During the risk assessment process (RA) both the clients and the contractors collaborated with each other, while only 33% of consultants answered that collaboration existed. The risk response process (RR) has a lower degree of

[37] Scale is between 1 and 4, where 1 – not at all, 2 – little detailed, 3 – fairly detailed, 4 – very detailed.
[38] Scale is between 1 and 4, where 1 – very small, 2 – fairly small, 3 – fairly large, 4 – very large.

collaboration according to the contractors: 62% of them had collaborated in taking care of risks.

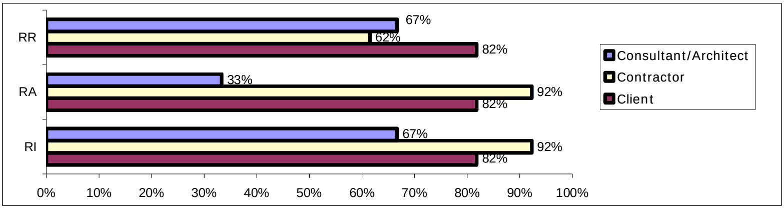

Figure 9. Existence of collaboration in risk management processes

The existence of collaboration in the projects' different phases is presented in Figure 10. It shows that in the programme phase there was minimum collaboration in risk management. Only 14% of clients, the most active participants of the programme phase, answered that collaboration existed in the phase. In the planning phase 70% of clients, 75% of contractors and 100% of consultants collaborated in risk management. This result can be linked to the importance of risk management in that phase, which was ranked high by the actors. In the procurement phase the collaboration between the clients and the contractors in risk management existed in half of the projects. In the production phase the collaboration between the actors is the most intensive because many risks appear in this phase and should be eliminated to achieve a good final result.

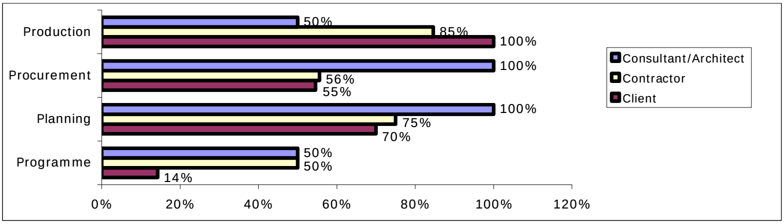

Figure 10. Existence of collaboration in risk management in the project's phases

5. DISCUSSION AND FUTURE WORK

In the previous section we presented the results of the questionnaire survey. In particular we focused on the following issues: the actors' participation in the project phases, importance of risk management in different phases, risk identification, analysis and response through the phases, collaboration in managing risks and influence of the actors on the risk management process. This section aims at discussing the results and developing directions for future research.

We found that participation in the different phases of a project was governed by the actors' roles in the construction process. In particular all contractors participated in the production phase and all consultants participated in the planning phase.

Production was the phase where the majority of respondents participated, while the participation in the programme phase was very low. Neither contractors nor clients were sufficiently involved in the programme phase. The planning and production phases were identified by all actors as the most important for risk management. In these phases risk identification, risk assessment and risk response were mostly performed. An important question to investigate further is: what the actors can gain by participating in all phases of the project? We foresee that participation of the actor in all phases of the construction process leads to more effective risk management through more intensive information and knowledge exchange and earlier identification and assessment of potential project risks.

The results of the survey show that the roles of the actors in risk management processes are strongly connected to their participation in the project's phases. Thus risk identification, risk assessment and risk response were mostly performed: in the programme phase by the client; in the planning phase jointly by the client and the consultant; in the procurement and production phases mostly by the contractor. The planning and production phases are those where joint risk management was mainly used by the actors. We suggest that the procurement phase should play a more important role in joint risk management. The risk management in the project should be based on the actors shared view of what the risks are and who should carry them. One model might be that the client prepares its view on the risk aspects of the project and the tendering contractor responds with its respective risk analysis. The total picture of the client's and the contractor's risk analyses and a shared insight will then form the basis of a conscious risk management process and risk allocation in the contract. There is a clear indication that collaboration through all phases of the project increases the probability that a specific risk is managed by the actor who has the best corresponding qualification.

Collaboration in risk management was evaluated high by all actors and was most intensive in the production phase. On the contrary, evaluations of actors' communication of known risks in the procurement phase are low. In particular the contractors state that the client communicates the risks on a low level. Collaboration between actors was very strong in the risk identification and risk assessment processes. In the risk response process the degree of collaboration decreases significantly according to the contractors' opinion. This indicates that the project's actors protect own interests and try to transfer the identified risks to other actors.

According to our studies contractors were most active in performing risk identification, assessment and response systematically in the project. Moreover, they had the largest influence on risk management in the project from the perspective of all actors. Consultants had very low influence on project risk management. They were not familiar with risk identification, risk assessment and risk response. However, it is difficult to generalise the results because the consultant group is very small in the sample. We suggest that the consultants should be involved more in risk management because design is a very significant risk source in a construction project.

In our future work we will perform a series of interviews with the construction project actors. The goal of the interviews is to investigate deeper the possible changes in a traditional construction process, where risk management is performed in late phases. Finally, it is important to understand the factors, which determine whether or not the actors consider an open discussion on risk management and risk sharing as beneficial.

6. CONCLUSIONS

Considering the effects that risk management has on a project's goals in the form of quality and cost, it should be an open and conscious process through all phases of the project. The aim of the paper was to examine the ways and extent to which the actors are involved in risk management through the different phases of the project. For this purpose we conducted a questionnaire survey of clients, contractors and consultants. The overall conclusion is that, according to project actors, risk management is strongly linked to the production phase. Most of risk processes are performed in that phase and contractors tend to be the most active group with a large influence on the risk management process. These findings confirm some results of previously conducted surveys. Despite of the recognised importance of the programme phase, this study showed that this phase does not play an important role in the risk management process.

7. ACKNOWLEDGEMENT

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8. REFERENCES

Akintoye, A. S. & Macleod, M. J. (1997), Risk analysis and management in construction. *International Journal of Project Management*, **15**(1), 31-38.

Baccarini, D. & Archer, R. (2001), The risk ranking of projects: a methodology. *International Journal of Project Management*, **19**(3), 139-145.

Baloi, D. & Price, A. D. F. (2003), Modelling global risk factors affecting construction cost performance. *International Journal of Project Management*, **21**(4), 261-269.

Barber, R. B. (2005), Understanding internally generated risks in projects. *International Journal of Project Management*, **23**(8), 584-590.

Del Cano, A. & De La Cruz, M. (2002), Integrated methodology for project risk management. *Journal of Construction Engineering and Management,* **128**(6), 473-485.

Flanagan, R. & Norman, G. (1993), *Risk management and construction*. Oxford: Blackwell Scientific Publications.

IEC 62198:2001 (2001), *Project risk management – Application guidelines*, International Standard. Genéve: IEC.

Kähkönen, K. (2001), Integration of risk and opportunity thinking in projects. 4th European Project Management Conference, PMI Europe 2001. London, UK.

Leung, H.M., Chuah, K.B. & Rao Tummala, V.M. (1998), A knowledge-based system for identifying potential project risks. *Omega*, **26**, 623-638.

Li, B., Akintoye, A., Edwards, P. J. and Hardcastle, C. (2005), The allocation of risk in PPP/PFI construction projects in the UK. *International Journal of Project Management*, **23**(1), 25-35.

Lyons, T. & Skitmore, M. (2004), Project risk management in the Queensland engineering construction industry: a survey. *International Journal of Project Management*, **22**(1), 51-61.

Motawa, I. A., Anumba, C. J. & El-Hamalawi, A. (2006), A fuzzy system for evaluating the risk of change in construction projects. *Advances in Engineering Software*, **37**(9), 583-591.

Osipova, E. & Apleberger, L. (2007), Risk management in different forms of contract and collaboration - case of Sweden. *CIB World Building Congress 2007*. 14-18 May 2007, Cape Town.

PMI, Standard Committee. (2000), *A guide to the project management body of knowledge*, Newton Square, PA.

Rahman, M. & Kumaraswamy, M. (2004), Contracting relationship trends and transitions. *Journal of Management in Engineerin*g, **20**, 147-161.

SOU 2000:44 (2000), Från Byggsekt till byggsektor. Reflection from Construction Cost Delegation (in Swedish).

SOU 2002:115 (2002), *Skärpning gubbar!* About competition, quality, costs and competence in construction sector. Stockholm: Construction commission (in Swedish).

Tah, J. H. M. and Carr, V. (2000), A proposal for construction project risk assessment using fuzzy logic. *Construction Management & Economics,* **18**(4), 491-500.

Uher, T. E. & Toakley, A. R. (1999), Risk management in the conceptual phase of a project. *International Journal of Project Management*, **17**(3), 161-169.

Ward, S. & Chapman, C. (2003), Transforming project risk management into project uncertainty management. *International Journal of Project Management*, **21**(2), 97-105.

Öztas, A. and Ökmen, O. (2005), Judgmental risk analysis process development in construction projects. *Building and Environment*, **40**(9), 1244-1254.

LIFE CYCLE COST CALCULATION MODELS FOR BUILDINGS

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ABSTRACT

Most commonly, production cost is the main cost factor in construction and is often set to the minimum, which does not necessarily improve the lifetime performance of buildings. However, a higher production cost might decrease total life cycle cost (LCC). It is important, therefore, to show the construction client in the early design phase the relationship between design choices and the resulting lifetime cost. Today, LCC calculation is used extensively for industrial products to minimise production cost and increase profit. Clearly, there are significant differences between an industrial product and a building from the life cycle perspective. The main differences are the life of a building and the lack of industrialisation in the building process, especially during construction. These factors make calculating LCC for a building difficult early in the design process. This paper presents a state of the art analysis in the area of LCC for construction. It offers a structural overview of theoretical economic methods for LCC analyses and their restrictions as described in the literature. The paper also reveals the primary data which are required to carry out a LCC analysis and discusses limitations in the application of life cycle costing from the client's perspective.

1. INTRODUCTION

According to Ozsariyildiz and Tolman (1998), the construction industry is facing increased demands from society. Construction clients ask for high quality building, lower cost and shorter lead-time. The clients, who have to pay the bill, have actually very little influence over time, cost and quality (Ozsariyildiz and Tolman, 1998). Buildings represent a large and long-lasting investment in financial terms as well as in other resources (Öberg, 2005).

In cold climate regions we spend a large amount of our time in buildings. The indoor environment of a building is therefore very important to us as it affects our well-being and health. Improvements of lifetime quality and cost effectiveness of buildings is consequently of common interest for the owner, the user and society. Life cycle cost (LCC) for buildings is therefore an important tool for involving the construction client better in early stage design decisions. However, regardless of its importance, life cycle costing has found limited application so far (Bakis et al., 2003).

An office building will consume about three times its initial capital cost over a 25 year period, but still far more attention is paid to the initial capital cost (Flanagan and

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Jewell, 2005). It should be considered that higher production costs can decrease the total LCC for a building. As stated by Kotaji et al. (2003) it is particularly important to show the relation between the design choices and the resulting lifetime cost (i.e. energy, maintenance, and operation cleaning) (Kotaji et al., 2003).

This paper presents a state of the art review in the area of LCC in construction. The aim is to describe the different advantages and disadvantages of the main theoretical economic evaluation methods for LCC calculation and show what relevant data and main sources are needed. Furthermore, the limited application of life cycle costing in the construction sector from the clients' perspective is discussed. The paper is structured as follows. First, the different definitions for LCC are discussed. In section 2.2 the different economic evaluation methods for LCC are presented and their different advantages and disadvantages are described. Section 2.3 presents the main data and data groups for life cycle costing. In Section 2.4 the main data sources are discussed. Section 2.5 refers to clients' limited request for life cycle costing so far. The research method is described in section 3. Results, implementation and exploitation are discussed in section 4. In section 5, the conclusions are presented.

2. LIFE CYCLE COSTING IN PERSPECTIVE

2.1. Definition of WLC, WLA and LCC

There are different terms used in the literature today like, "cost in use", "life cycle costs" (LCC), "whole life costing" (WLC) and "whole life appraisal" (WLA). Where (Flanagan and Jewell, 2005) defined that the terminology has changed over the years from "cost in use" to "life cycle costing" and further to "whole life costing". They defined the new term "whole life appraisal" which is globally used today and which contains consideration of the cost benefits and performance of the facility/ asset over its lifetime.

The draft of the ISO Standard 15686-5 (ISO, 2005) instead makes a difference between the expressions WLC and LCC. Their contention is that WLC is equivalent to LCC plus external cost. Even there it is admitted that sometimes all terms are used interchangeably, but the ISO Standard does try to interpret those terms more narrowly. The Standard states that LCC should be used to describe a limited analysis of a few components where instead "life cycle costing" should be understand as the cost calculations themselves and WLC should seen as a broader term, which covers a wide range of analysis. The Norwegian Standard 3454 (Ns, 2000) defined LCC as including both original costs and cost incurred throughout the whole functional lifetime including demolition.

Discussions about wording bring a lot of confusion in this field. In this article, LCC is used equivalent to WLC. LCC analysis is, in this context, to be understood as an analysis over the whole life cycle of a building. The term LCC is chosen as it is still the better known term today in practice.

2.2 Evaluation of LCC methods

The literature shows a broad variation of economic evaluation methods for LCC analysis. They all have their advantages and disadvantages. The methods have been formed for different purposes and the user should be aware of their limitations. The reviewed literature is structured in table 1. The table illustrates the six main economic evaluation methods for LCC, their advantages and disadvantages and for what purposes they can be used. The literature shows that the most suitable approach for LCC in the construction industry is the net present value (NPV) method. Existing mathematical LCC models, which are based on NPV, have various advantages and disadvantages, as they differ in the breakdown costs elements. The model from the American Society for Testing Materials (eqn. 1) for example, distinguishes between energy and other running cost, which is useful in adopting different discount rates for different cost items.

$$NPV = C + R - S + A + M + E \qquad \ldots (1)$$

C = investment costs
R = replacement costs
S = the resale value at the end of study period
A = annually recurring operating, maintenance and repair costs (except energy costs)
M = non-annually recurring operating, maintenance and repair cost (except energy costs)
E = energy costs

2.3 Data required for life cycle cost calculation

The data requirements according to the reviewed literature for carrying out LCC analysis are categorised in figure 1. These different data influence the LCC in different stages of the life cycle.

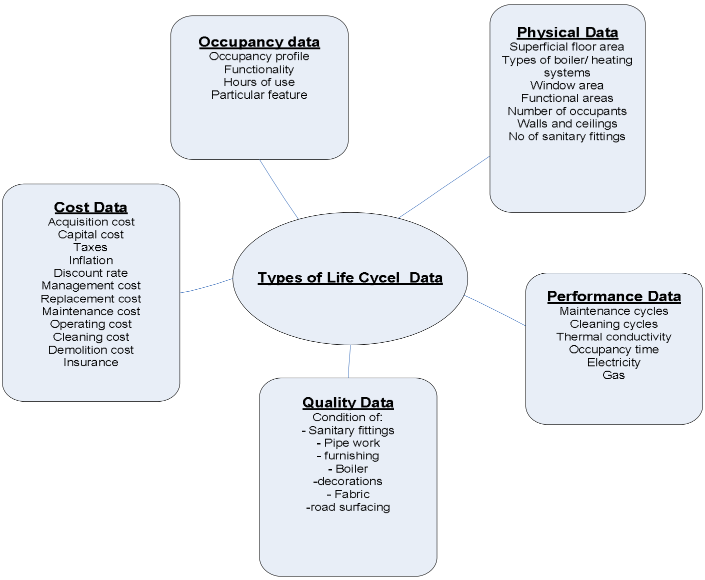

Figure 1. The required data categories for a life cycle cost analysis

Table 1. The advantages and disadvantages of economic evaluation methods for LCC

Method	What does it calculate	Advantage	Disadvantage	Usable for
Simple payback	Calculate the time required to return the initial investment. The investment with the shortest pay-back time is the most profitable one (Flanagan et al., 1989).	Quick and easy calculation. Result easy to interpret (Flanagan et al., 1989).	Does not take inflation, interest or cash flow into account (Öberg, 2005, Flanagan et al., 1989).	Rough estimation if the investment is profitable (Flanagan et al., 1989).
Discount payback method (DPP)	Basically the same as the simple payback method, it just takes the time value into account (Flanagan et al., 1989).	Takes the time value of money into account (Flanagan et al., 1989).	Ignores all cash flow outside the payback period (Flanagan et al., 1989)	Should be only used as a screening devise not as a decision advice (Flanagan et al., 1989).
Net present value (NPV)	NPV is the result of the application of discount factors, based on a required rate of return to each years projected cash flow, both in and out, so that the cash flows are discounted to present value. In general if the NPV is positive it is worth while investing (Smullen and Hand, 2005). But as in LCC the focuses is one cost rather than on income the usual practice is to treat cost as positive and income as negative. Consequently the best choice between tow competing alternatives is the one with minimum NPV (Kishk et al., 2003).	Takes the time value of money into account. Generates the return equal to the market rate of interest. It use all available data (Flanagan et al., 1989).	Not usable when the comparing alternatives have different life length. Not easy to interpret (Kishk et al., 2003).	Most LCC models utilize the NPV method (Kishk et al., 2003). Not usable if the alternatives have different life length (Flanagan et al., 1989).
Equivalent annual cost (ECA)	This method express the one time NPV of an alternative as a uniform equivalent annual cost, for that it take the factor present worth of annuity into account (Kishk et al., 2003).	Different alternatives with different lifes length can be compared (ISO, 2004).	Just gives an average number. It does not indicate the actual coast during each year of the LCC (ISO, 2004).	Comparing different alternatives with different life's length (ISO, 2004).
Internal rate of return (IRR)	The IRR is a discounted cash flow criterion which determines an average rate of return by reference to the condition that the values be reduced to zero at the initial point of time (Moles and Terry, 1997). It is possible to calculate the test discount rate that will generate an NPV of zero. The alternative with the highest IRR is the best alternative (ISO, 2004)	Result get presented in percent which gives an obvious interpretation (Flanagan et al., 1989).	Calculations need a trail and error procedure. IRR can be just calculated if the investments will generate an income (Flanagan et al., 1989).	Can be only use if the investments will generate an income which is not always the case in the construction industry(Kishk et al., 2003).
Net saving (NS)	The NS is calculated as the difference between the present worth of the income generated by an investment and the amounted invested. The alternative with the highest net saving is the best (Kishk et al., 2003).	Easily understood investment appraisal technique (Kishk et al., 2003).	NS can be only use if the investment generates an income (Kishk et al., 2003).	Can be used to compare investment options (ISO, 2004). But just if the investment generates an income (Kishk et al., 2003).

The occupancy and physical data could be seen as the key factors in the early design stage. LCC estimation in this stage depends on data such as floor area and the requirements for the building. Flanagan et al (1989) stressed the importance of occupancy data as other key factors, especially for public buildings. Performance and quality data are rather influenced by policy decisions such as how well it should be maintained and the degree of cleanliness demanded (Kishk et al., 2003). Quality data are highly subjective and less readily accountable than cost data (Flanagan et al., 1989). In the more detailed design stage, life cycle cost estimation is based more on performance and cost data of a building (Bakis et al., 2003). Cost data are most essential for LCC research. However, cost data that are not complemented by other data types would be almost meaningless (Flanagan et al., 1989). These data need to be seen in the context of other data categories to obtain a correct interpretation of them (Kishk et al., 2003).

It should be considered that LCC is a decision making tool in the sense that it could be used to select among alternative projects, designs or building components. Consequently LCC data should be presented in a way that enables such comparison. For that reason the cost breakdown structure is an important concept for LCC (Bakis et al., 2003).

There are several different standards (ISO 15686-5/ NS3454/ ASTM/ Australian/ New Zealand-Standard) available to guide a LCC analysis. All have different cost categories and slightly different cost breakdown structures.

2.4 Main sources of data

There are three main sources for data for LCC purposes.

- from the manufacturers, suppliers, contractors and testing specialists;
- historical data; and
- data from modelling techniques.

Data from manufacturers, suppliers, contractors and testing specialists can often be seen as a best guess. They may have a detailed knowledge of the performance and characteristics of their material and components, but do not have knowledge of the ways in which facilities are used (Flanagan and Jewell, 2005). However, extensive knowledge and experience of specialist manufacturers and suppliers are a valuable source for life cycle information. If the required data are not available, modelling techniques can be used. Mathematical models can be developed for analysing costs. Statistical techniques can be incorporated to address the uncertainties (Flanagan and Jewell, 2005). Data from existing buildings are used as historical data. Some of them are published as the BMI (Building Maintenance Information) occupancy cost. Other sources include clients' and surveyors' records, and journal papers (Flanagan et al., 1989).

Thus, data collection brings difficulties; however, LCC analysis is only accurate if the collected data are reliable (Emblemsvåg, 2003). Existing databases have their limitation, they do not record all necessary context information about the data being fed into them (Kishk et al., 2003). The data are usually expressed as units of cost which limits them to local use.

2.5 Construction client

An office building will consume about three times its initial cost over a 25-year period (Flanagan and Jewell, 2005). Therefore, it can be essential for the construction client to use LCC as a decision making tool among alternative projects, designs or building components to reduce building running costs over the long term. Despite its importance, LCC has found limited application so far in the construction sector (Bakis et al., 2003).

LCC needs time and effort. For that reason, there has to be a clear output motive to use LCC techniques if it would a worthwhile effort for the construction client (Raymond and Sterner, 2000). The availability of LCC data are today rather limited. One reason is the lack of any framework for collecting and storing data (Bakis et al., 2003). Construction clients often give a low priority to LCC as they are not aware of the benefits from it (Raymond and Sterner, 2000).

Raymond and Stern (2000) point out that for the construction client the initial cost can be determined easily and reliably but maintenance and operational costs are less predictable as they extend in the future. For that reason, initial cost is used as the main base for decision making today.

3. RESEARCH PROJECT

3.1 Project description and objectives

This project is part of the research project InPro (Information and Processes) which links the name to the main focus of the research work. The InPro research project includes 20 European partners representing both industry and research. The idea of the InPro Project is to introduce 3D design and Building Information Models in the European construction sector; moreover, to develop strategies and business models for new building design processes which consider the building's whole life cycle. The main idea is to improve the involvement of the end-user in the early design phase to have more satisfied customers in the construction sector.

This research project aims to explore and indicate the different parameters which are needed to optimise LCC for buildings and to provide the construction client with a better tool for decision in the early design/planning process. The objective of this research project is to provide the construction client with a more holistic picture of the lifetime cost for the planned building, specifically:

- to provide a better understanding of the long term consequences of the decisions in the early design phase to the construction client/end-user and to the planning team;
- to investigate the extent to which LCC estimation is used in the construction industry today.
- to examine ways of improving existing models to form better holistic LCC models that can influence planning in the early stage of design.

This paper aims at exploring the different data that are needed to analyse life cycle costs for buildings. The first objective aims at a structural overview of existing theoretical economic methods for LCC analyses and their advantages and disadvantages. The second objective is to point out the main data which are required to carry out a LCC analysis. The last objective is to move away from the limited application of LCC to a position where LCC can properly inform the early stage of design decision making.

3.2 Research methodology

The literature review started with the focus on life cycle cost models and required data for an LCC analysis. The key words have been life cycle cost (LCC) and life cycle costing. The field of life cycle cost is wide and to be able to keep focus on the construction sector all words have been combined with construction or building. This has narrowed the field. While reading the first literature it came clear that often terms like whole life cost (WLC) and whole life costing been used in the literature, even whole life appraisal (WLA). These words been added to the list of key words. The main sources for the literature research were databases, such as Environmental sciences, Emerald, Elsevier Science Direct, Compendix, web of science and Google Scholar. The search for articles was complemented with systematic search within libraries in Sweden through Libris.

4. RESEARCH RESULTS

4.1 Initial results

Several cost-based LCC calculation methods are available for the construction sector. They all have their different advantages and disadvantages. According to the reviewed literature, the most suitable approach for life cycle cost in the construction industries are the NPV method or, in the case of comparing alternative schemes with different lifetimes, the ECA. The NPV method is mainly used in existing LCC tools today. The user should bear in mind that different methods have been formed for different purposes. For example, in the case of a rough estimate, to distinguish if the investment is profitable, or not, the payback method would be most suitable. Consequently, other measures shown in table 1 can be used if the proper purposes are considered.

The data can be divided into five main groups: occupancy data, physical data, performance data, quality data and cost data. All of them have to be taken into account for a LCC calculation. The importance of the different data depends upon on the stage of planning in which the calculation is undertaken. LCC is a decision making tool to select among alternative projects, design, or building components. Consequently, the LCC data should be presented in a way that enables such a comparison. The cost breakdown structure is in this case an important aspect.

Sources of data are manufacturers, suppliers, contractors and testing specialist's data, historical data and data from modelling techniques. However, all of them have limited use today according to the literature.

The reviewed literature indicates that LCC calculations need to be considered worthwhile for the construction client. Therefore, data access needs to be facilitated and, consequently, less time and money consuming.

4.2 Implementation and exploitation

The collection of the data according to the reviewed literature is the main difficulty for calculating the LCC for a building. This process can involve much time and money. To build databases seems to be a good alternative, and would save time and offer easier access to data. The limitations of databases have, however, to be recognised. First, there is the local limitation and, second, there is often a need to normalize the data before adding to the database. Even so, building local databases would be a solution so long as there is regularly updating.

5. CONCLUSIONS

The choice of the right calculation method for LCC is easy and obvious if the advantages and disadvantages are appreciated. The calculation of LCC is not difficult and for structuring the main data, which need to be collected, help is available in the form of different standards such as ISO or the Norwegian standard. Nonetheless, data collection causes difficulties. Data need to be predictable if the LCC analysis is to be reliable. Regional databases are seldom available or usable. To collect data by hand, takes much time and money. This is worthwhile if the project is big enough. When historical data are collected and updated over time, their use can become more reliable and the LCC analysis more trustworthy.

Data should be shared to avoid the duplicated effort of collecting them. If more clients demand LCC information and a proper check of the information against performance is done in the future, improvement in accuracy and reliability could be expected. When LCC is used more frequently, the construction client could judge LCC in the same manner as they do with estimated capital costs today. The construction client, and the end-user, could save much money in the long run, if LCC is adopted as a decision making tool. The lifetime quality and the cost effectiveness of buildings would improve by using LCC in the early stage design.

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7. REFERENCES

Bakis, N., Kagiouglou, M., Aouad, G., Amaratunga, D., Kishk, M. & Al-Hajj, A., (2003), An Integrated Environment for Life Cycle Costing in Construction.

Emblemsvåg, J. (2003), *Life-cycle costing: Using activity-based costing and Monte Carlo methods to manage future costs and risks.* New Jersey: John Wiley& Sohns, Inc, Hoboken.

Flanagan, R. & Jewell, C. (2005), *Whole Life Appraisal for construction.* Oxford: Blackwall Publishing Ltd.

Flanagan, R., Norman, G., Meadows, J. & Robinson, G. (1989), *Life Cycle Costing Theory and Practice.* Oxford: BSP Professional Books.

ISO, (2004), ISO/DIS 15686-5 Buildings and constructed assets-service life planning, International Organization for Standardization.

Kishk, M., Al-Hajj, A., Pollock, R., Aouad, G., Bakis, N. & Sun, M. (2003) Whole life costing in construction: a state of the art review. RICS Foundation.

Kotaji, S., Schuurmans, A. & Edwards, S. (2003), *Life cycle assessment in building and Construction.* Denver: Society of Environmental Toxicology and Chemistry.

Moles, P. & Terry, N. (1997). *The handbook of International Financial Terms,* Oxford University Press. http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t181.e4104. Date accessed: 01.03.2007

NS, (2000), NS3454 Life cycle costs for building and civil engineering work - principles and classification, Oslo, S., Standard Norge.

Ozsariyildiz, S. & Tolman, F. (1998) IT support for the very early design of buildings and civil engineering works. *Digital library of construction informatics and information technology in civil engineering and construction*

Raymond, J. C. & Sterner, E., (2000), Reconciling theory and practice of life cycle costing, *Building research & Information,* **28,** 368-375.

Smullen, J. & Hand, N. (2005). *A Dictionary of Finance and Banking,* Oxford University Press. http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t20.e2493. Date accessed: 28.02.2007

Öberg, M. (2005) *Integrated Life Cycle Design - applied to concrete multi-dwelling buildings.* Lund University, Division of Building Materials. Lund, Lund University.

A MULTINATIONAL COMPARISON OF CONCENTRATION RATIOS IN THE CONSTRUCTION MARKET

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ABSTRACT

Barriers to entry are discussed in this paper with particular emphasis on market concentration ratios in construction. The analysis of three different sized national markets (Sweden, Italy and the USA) suggests that the concentration ratio is inversely proportional to market size. Within the US construction market there are sectors whose entry require significant capital investments and/or know-how resources. These sectors are likely to have higher concentration ratios.

1. INTRODUCTION

The market concentration ratio impacts the degree of oligopoly and the ability to exercise market power. This paper addresses competitiveness in the construction industry, with a focus on the aggregate and market concentration ratio.
Starting with the market structure theory, the first part introduces the concepts of concentration ratio and competitive markets and the results of previous studies of construction market. By analysing the relationship between concentration ratio and market size, three market size categories have been defined: small, medium, and large. Sweden, Italy and the USA were selected as the respective representative of the above listed categories The analysis builds upon homogeneous data in order to make consistent the comparison among different countries. The issue of subcontracting is considered to underline that a construction market may be characterized by an apparent concentration (few main contractors) and, at the same time, fragmentation for the presence of many subcontractors. In the last part of the paper the concentration ratio of US specialist trade contractors is investigated to understand the relation between concentration ratio and barriers to entry.

2. LITERATURE REVIEW

2.1 Market structure models and competitiveness

"The characteristics of a perfectly competitive industry are many small firms with no control over price, producing the same product under conditions of perfect information and no barriers to entry" (de Valence, 2006). Perfect competition means

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that no producer or consumer has the market power to influence prices. In perfectly competitive markets, participants have no market power. Perfect competition requires five indispensable parameters to make possible that prices would normally move instantaneously to economic equilibrium: atomicity, homogeneity, perfect and complete information, equal access and free entry (Cabral, 2000).

According to the Pareto's efficiency, perfect competition would lead to a completely efficient use of available resources. Agriculture with numerous suppliers, and almost perfectly substitutable products, is an approximation of the perfect competition model. This may has been true in some places at certain times, but in modern times this assertion is hard to prove, due to the complex nature of modern economies: differentiated products, public policies, wealth distribution etc.

Differently a monopoly, where a single firm is the only producer, is the opposite neoclassical model. A firm with such a market power has the ability to individually affect either the total quantity or the prevailing price of a product in the market. Different theories have been produced since 1900s to classify existing markets that generally are neither perfect nor monopolistic.

The theory of monopolistic competition pertains to markets with many firms with limited control over price that produce differentiated products and are supported by brand names and marketing with some (often important) barriers to entry. A monopolistically competitive firm acts like a monopolist in that the firm is able to influence the market price of its product by altering its production rate or vice versa (as for monopolists), but it is anyway subject to the competition of similar (alternative) products. Differently from perfect competition, monopolistic competitive firms produce products that are not perfect substitutes (Chamberlin, 1933). An oligopoly is created when few large firms producing identical or differentiated products operate in a market with significant barriers to entry. Oligopolistic markets are characterized by interactivity: the decisions of one firm influence and are influenced by the decisions of other firms. The strategic planning by oligopolists always involves taking into account the likely responses of other market participants. This puts oligopolistic markets and industries at the highest risk for collusion. The extent of entry barriers is important for defining any market structure model. According to de Valence (2003) these barriers are defined as none, few, significant and very high for perfect competition, monopolistic competition, oligopoly and monopoly respectively. Barriers to entry could play a relevant role in understanding a market structure and its competitiveness. A market with stronger barriers to entry tends to be less competitive because it contains fewer players, and hence is more concentrated in structural form (Chiang et Al, 2001). Different definitions have been proposed over the years. Bain (1956) defined an entry barrier as the set of technology or product conditions that allow incumbent firms to earn economic profits in the long run. Bain stressed three factors which could prevent the entry of a firm: economies of scale, product differentiation and the absolute cost advantages of established firms. Stigler (1968) offered an alternative definition of entry barrier: a cost of producing which must be borne by an entrant, but not by an incumbent. «In the analysis of entry conditions and barriers to entry, a greater emphasis was initially placed on structural entry conditions, e.g., economies of scale or incumbent cost advantages. Barriers to entry allow us to understand market structure as [...] central to market structure is concentration (McCloughan, 2004).

2.2 Entry barriers in the construction market

In economics, the market concentration is a function of the number of firms and their respective shares of total production (alternatively total employees) in a market. The ratio is a useful economic tool because it reflects the degree of competition in the market. Alternatively, the ratio expresses the degree of monopoly power exercised by the largest firms. Bain's original concern was based on the intuitive relationship between high concentration and collusion (Tirole, 1988). The concentration ratio is also used as an indicator of the relative size of firms in relation to the industry as a whole. This may also assist in determining the market form of the industry under consideration. The concentration ratio is expressed in the terms Cx, which stands for the percentage of the market sector controlled by the biggest x firms. A disadvantage of this ratio is that it does not indicate the total number of firms that may be operating and competing in an industry. As stated before, market forms could be classified according to their concentration ratio (perfect competition with very low ratio; monopolistic competition and oligopoly- intermediate, monopoly with very high ratio).

In manufacturing a C5 higher than 60% usually means a high concentrated market while a C5 lower than 10% shows a very fragmented one. In the UK manufacturing C5 is about 20%; this is evidence of a “correct market”. (McCloughan, 2004).
The construction market certainly is not a perfect one. Due to the large number of firms, construction is generally considered as a highly competitive market and its structure appears to be that of monopolistic competition. However it is difficult to classify it in this way. In the case of a Design/Build competition, for example, proposals (design and construction) differ and this difference suggests the existence of a perfect competitive market. In some way, the construction market seems to be close to the definition of monopolistic competition. Product homogeneity needs also to be addressed. In the single-product perfect-competition market, firms belonging to the same industry produce a single identical product, which is sold in the same market and the relationship among firms, industry and markets is relatively straightforward. In this context the industry and market are identical because each has the same group of firms as producers. However, this identity does not exist in the construction industry/market, as large firms produce a range of products (many of which are not close substitutes) that are sold in more than one market (de Valence, 2006). In addressing this issue, Gruneberg and Ive (2000) have argued that the construction industry does not produce buildings of different type and its output is not the building itself, but the service for building management. In this case services are obviously homogeneous.

The construction industry is divided into many specialized trade sectors that differ in terms of barriers to entry. If companies specialized in tunnelling are considered, high barriers exist in terms of required capital for machinery or of know-how. Differently, it is easy to start a painting business.

When protected by entry barriers, firms tend to set their profit margins at higher level and create tacit market collusion in order to keep prices and margins high (Gruneberg and Ive, 2000). These two authors have identified six barriers to entry in the construction market.

- **Economies of scale**. These are the costs associated with the minimum efficient scale of production, below which competition with existing firms would be uneconomical.

- **Supply chains**. This entry barrier is generally low in construction, but becomes more relevant when it is necessary to manage the activity of different existing firms.
- **Incumbents cost advantages**. This notion is not directly applicable to construction. Differently, in manufacturing or distribution new entrants plan to seize a share of a constant total market from existing suppliers. The entry of a new firm, however, leaves the total demand unchanged. In construction new suppliers plan to poach resources from those firms already in the market.
- **Private information**. This is the most powerful barriers to entry. Existing producers may take advantage of information not known by entrant firms. Sometimes this knowledge is available, but its use is protected by copyright or patent.
- **Contestable markets**. Existing firms modify their behaviour in order to deter increased competition from potential new entrants. Markets are contestable if there are no sunk costs and entry is perfectly reversible, so that any firm could leave the market recouping the cost of entry.
- **Client imposed entry barriers to construction contract markets**. This barrier is based on the view of contractor growth as a series of steps of increasing project size and complexity. In this way only few firms can demonstrate past experience on a given project.

Local laws could also be significant barriers to entry. Firms which plan to entry the public works market in Italy, for example, are required to be SOA (Società Organismo di Attestazione) certified. This is a required condition for participating in public project tendering. To be SOA certified, a firm has to demonstrate specific similar work experiences.

3. CONCENTRATION RATIO AND MARKET SIZE: A MULTINATIONAL COMPARISON

3.1 Project description and objectives

The construction market appears to be a high competitive market with weak entry barriers. Competitiveness depends on market structure and its concentration ratio. This paper analyses the competitiveness in the construction industry through a multinational comparison based on three different market sizes.

3.2 Research methodology

By considering the relationship between the concentration ratio and market size, three market size categories have been defined and investigated: small (up to €50 billions), medium (up to €300 billions) and large (more than €500 billions). Sweden (small), Italy (medium) and the USA (large) have been selected as a representative of the above listed categories. For each country the market concentration ratio is conventionally measured by using the 5-firm (C5) and the 50-firm (C50) ratio respectively.

3.3 Research data

The analysis has required 2 different types of data: national industry turnover and the top 5 and 50-firm turnover. National industry turnover data have been drawn from the European and national census sources (EUROSTAT, Statistika Centralbyran, ISTAT, US Census). The top 5 and 50-firm turnover data have been obtained from national construction bodies or journals (Sverige Byggin Industrier for Sweden; Fillea – Cerved Business Information analysis – for Italy, ENR-Engineering News Record for the USA). A major limitation has been the availability of homogeneous and comparable sources: 2004 data have been used for Sweden and Italy, while 2005 data have been used for the USA. When possible, the C5 and C50 calculations have been performed on the basis of different data source and also on sector and firm employees.

4. A MULTINATIONAL CONCENTRATION RATIO COMPARISON

Table 1 shows the main data for the considered countries.

Table 1: Multinational comparison approach: C5, C50 values

Swedish Construction Industry	**Production value 2004 (Millions of €)**	**Employees 2004**
Source: Statistika Centralbyran	30.882,31	187.341
Source: Eurostat	30.969,00	240.502
Source: Statistika Centralbyran		
C5 (%)	24,91	**16,96**
C50 (%)	31,26	n.a
Source: EUROSTAT		
C5 (%)	24,84	**13,21**
C50 (%)	31,17	n.a
Italian Construction Industry	**Production value 2004 (Millions of €)**	**Employees 2004**
data from Istat-Ance	131.893,00	n.a
data from Eurostat	186.353,00	1.833.000
Source:ISTAT-ANCE		
C5 (%)	3,21	n.a
C50 (%)	9,16	n.a
Source: EUROSTAT		
C5 (%)	2,27	**0,87**
C50 (%)	6,48	**2,44**
USA Construction Industry	**Production value 2005 (Millions of $)**	**Employees 2005**
Source: US Census	1.143.655,00	
Source: ENR		
C5 (%)	4,74	n.a
C50 (%)	11,99	n.a
Source: Costruire, Cerverd, EUROSTAT, ISTAT, Statistika Centralbyran, Sverige Byggin Industrier, US Census, ENR.		

4.1 Results

Swedish market

Sweden has a relatively small construction industry. Even if it is the Scandinavian biggest construction market, it still remains a small one in comparison to that of EU countries (France, Germany, UK, Spain, and Italy). The C5 (employment based) is about 25% and higher if compared to that of Italy and USA. The top 5 Swedish contactors operate also in international markets, but the data collected reflect only national production. Data collected from different sources, show similar values (24.84% against 24.91%). The C5 employment based is lower than the C5 turnover based. This pattern suggests that the top5 firms sub-contract part of their work.

Italian market

Several data sources were used for the Italian market. European (EUROSTAT) and national census (ISTAT) data show different values, probably generated by different surveying methods. Sectorial reports for the top 100 firms have been investigated. Another used source was the 2004 Fillea Report (Italian Construction Labor Union). This study provides the gross and national turnover for the top 50 firms, based on the financial audit by Cerved Business Information. Direct employees number data are drawn from Costruire's report 2004. The value of C5 (turnover based) is 2.27-3.21% and it suggests a very highly fragmented market. Figures, especially those related to employment, show low concentration. There are no firms dominating the market. The value of the C50 (turnover based) concentration ratio vary significantly (4.98% against 9,16%), depending on the two different data sources. The value is lower (2,44%) if employment is considered. Similarly to the Sweden case, the data suggest that the Italian top firms are likely to use a large number of subcontractors.

US market

The US Census contains the most complete database for the purpose of this analysis. It provides essential information for government, business, industry, and the general public. The report of ENR provided the turnover information for the top 5 and 50 firms, but no employment data. The US construction is the largest investigated market and the values of C5 and C50 suggest a perfect market, if compared to the previous ones. Data comparison suggests the low concentration ratio of construction markets. Smaller markets seem to generate higher concentration ratios and consequently more market power.

McCloughan's analysis of construction ratios has showed that aggregate concentration is low in the British construction industry, where the largest 100 private contractors account for 20 per cent of activity and 15 per cent of employment. In the same study the market concentration ratio for specialist trades is also studied. Some categories, such as scaffolding (C5, 56%) were characterized by high concentration ratio. Other studies of the market share by the largest contractors for different countries include Australia (de Valence 2003), South Korea (Yoon and Kang 2003), Japan (Woddall 1996) and Hong Kong (Chiang et. al. 2001). This paper has shown that the employment based concentration ratio is lower than that based on turnover (e.g. for Italy C5 employment based is 0.87% against 2.27%). This pattern suggests that very large contractors subcontract a significant portion of their work. The concentration ratio appears to decrease as the market size increases. The understanding of the relationship between market size and concentration ratio requires a further investigation according to the concentration ratios within the various sub-markets of construction.

4.2 Concentration ratio in the US construction sectors

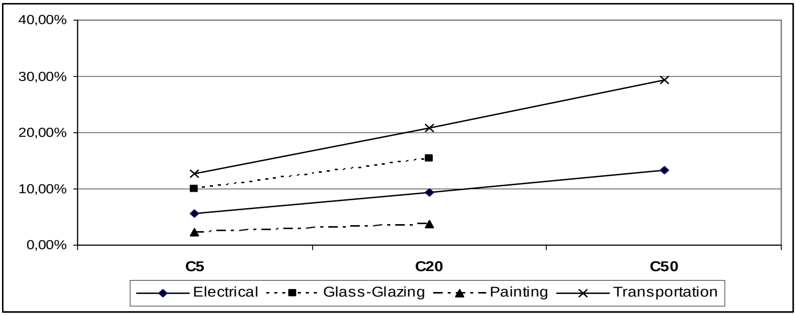
Due to the lack of homogeneous construction outputs, the relationship between the concentration ratio and nature of a specific sector was investigated to show the effect of the entry barriers in a given market sector. The results are shown in table 2. Four different US construction market sectors were considered as representative of market outputs according to required know-how, initial capital investment, supply chain, and labour cost. The considered sectors were electrical services, glass-glazing (curtain walls), painting and transportation (bridges and highways). The values of C5, C20 and C50 indexes have been calculated when data were available.

Table 2: C5, C20, C50 in US construction sectors

Construction Sector	Electrical	Glass-Glazing	Painting	Transportation
Production value 2002(millions of $)	$. 83.377,00	$6.398,00	$16.958,00	$83.355,00
C5	5,65%	9,97%	2,32%	12,69%
C20	9,38%	15,35%	3,69%	20,74%
C50	13,36%	n.a.	n.a.	29,37%
Cost of materials, components, supplies and fuels against value of business	**32,11%**	**41,09%**	**22,97%**	**33,67%**
Cost of employees against value of business	**35,46%**	**27,48%**	**35,47%**	**18,78%**
Source: US Census, ENR.				

According to the initial assumptions, high entry barriers (in terms of capital investment) lead to higher C5 indexes, as in the case glass-glazing and transportation. A more concentrated market entails relatively higher expenses for acquiring the goods necessary for production. This pattern suggests that if the final output of a given sector results more from off-site than site production operations its concentration ratio increases for the required use of machinery.

Table 3: C5, C20, C50 in the US construction sectors



Concentration ratios follow a linear distribution and increase proportionally as the number of firms grows.

5. CONCLUSIONS

This paper has addressed the economic characteristics of construction markets with emphasis on barriers to entry. In this last regard, several theories have been outlined. The market concentration ratio of three differently sized construction markets – Sweden, Italy and the USA – has been calculated. The value of the ratios seems to decrease as market size increases. The study, in addition, addressed some of the sectors that make up the US construction industry. Data show that specialty sectors, such as transportation and curtain wall markets, have relatively higher concentration ratios. It is argued that these two sectors have higher entry barriers because of their requirements in terms of capital investments and know how resources. Future studies based on a larger sample of national data should verify these preliminary findings, namely the inverse relationship between market size and concentration ratio, as well as the relationship between type of market sub-sector and concentration ratio.

6. REFERENCES

Bain, J. (1956). *Barriers to New Competition*. Cambridge, MA: Harvard Univ. Press.

Cabral. L. (2000), *Introduction to Industrial Organisation*, Massachusetts Institute of Technology Press, 84-85.

Cabral, L. (Revised December 2006), *Barriers to Entry*, forthcoming in Steven N. Durlauf and Lawrence E. Blume (Eds), *The New Palgrave Dictionary of Economics*, 2nd edition, Palgrave Macmillan, Basingstoke and New York.

Chamberlin, E.(1933), *Theory of monopolistic Competition*. Harvard University Press.

Chiang, Y.H., Tang, B.S. and Leung, W.Y. (2001). Market Structure of the Construction Industry in Hong Kong, *Construction Management and Economics*, **19**. 675-87.

De Valence, G. 2003. Market Structure, Barriers to Entry and Competition in Construction Markets, in *Proceedings* of *Joint CIB W55/W65/W107 International Symposium Knowledge Construction*, 819-28.

De Valence, G. (2006), Competition and the Characteristics of Construction Markets in *Proceedings* of *Construction in the XXI century: Local and global challenges, Joint 2006 CIB W065/W055/W086 Working - Commissions International Symposium* 68-69.

ENR (2005), *2005 Top* contractors, 6-26 & 40-57.

Graziani. A. (2005). Osservatorio Fillea - *Grandi Imprese e Lavoro. Andamento economico-produttivo e prospettive di sviluppo delle prime 50 imprese di costruzione in Italia*. FILLEA CGIL

Gruneberg, S.L. Ive, G.J. (2000), *The Economics of the Modern Construction Firm*, Macmillan, London.

Il Sole 24 ore, (2003, 2004, 2005), *Speciale Classifiche. Le Prime cinquanta società italiane*. *Novembre 2003-2004-2005*

Khemani, R.S. and Shapiro, D. M. (1993). *Glossary of Industrial Organisation Economics and Competition Law*, Directorate for Financial, Fiscal and Enterprise Affairs, OECD.

McCloughan, P. (2004). Construction Sector Concentration: Evidence from Britain, *Construction Management and Economics*, **22**. 979-90.
O'Neill, P. (1996), The trend of aggregate concentration in the USA, problem of scope and measurement, *The American Journal of Economics and Sociology*, **55**(2).
Stigler, G. (1968). *Barriers to entry, economies of scale, and firm size*. In Stigler, G. (ed.) *The Organization of Industry, Richard D. Irwin*, Homewood, IL.
Tirole, J. (1988). *The Theory of Industrial Organization*. Cambridge, Mass. MIT Press.
US Census, (October 2005). *Industry General Summary: 2002 Report census.*

THE IMPACT OF LABOUR PRODUCTIVITY ON THE SWEDISH CONSTRUCTION INDUSTRIES

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ABSTRACT

There have been debates concerning what can be done about the current low labour productivity in the Swedish construction industries. High production cost in the construction industries has been a burning issue for a long time. On the other hand, process industries and organisations have taken the advantage of labour productivity measurement to reduce their production cost and eliminate non value-added activities. The purpose of this paper is to examine, why and how the process industries and organisations have taken action to measure labour productivity and to suggest ways of improving labour productivity. Case studies have been performed for six different companies and organisations, and these are discussed. The results show that increases in global competition have led industries and organisations to reduce production cost by improving labour productivity. To improve the construction project process, beside profit maximization, labour productivity measurement is essential. Furthermore, there is a need for measuring labour productivity in order to reduce production cost.

1. INTRODUCTION

During the last decade, the Swedish government has initiated three investigations in order to identify major problems in the construction industries. SOU 2002:115 (2002) focused on general problems, SOU 2000:44 (2000) has focused on the high production costs and SOU 1997:177 (1997) focused on general quality-related problems. But unfortunately none of these investigations has investigated the level of labour productivity or waste, even though there have been debates about the measures to reduce the cost within the construction industries in Sweden.

Labour productivity within the construction industries has improved by only 1.7% per year during the period 1963 to 1998, whereas manufacturing industries have succeeded in improving their labour productivity by 2.9% per year during the same period (Lutz and Gabrielsson, 2002). Lutz and Gabrielsson explain low labour productivity as a result of low competition existing in the Swedish construction industries, which is highly dominated by three major companies. According to Borgbrant (2000), the Swedish construction industries have no experience of taking lessons from prior projects. Detailed documentation of performance from prior projects is confirmed to be very low (Forsberg, 2007).

Production cost in the Swedish construction industries has increased faster than the consumer price index (SCB, 2005). Production costs for multi-storey building in

Sweden have risen by 65% between the years 1995 and 2001 (SCB[41], 2005). Production cost includes client's cost, cost for acquisition of land, building permit and contractor's cost. The contractor's cost is claimed to be 61% of the total production cost. According to SCB, 36% of total contractor's cost goes to cover employee wages. Wages within the construction sector have risen more than for other industries' workers. As wages have increased higher in construction, it is important to produce more per hour to reduce the total cost. Byggkommissionen[42] has criticized the Swedish construction industries and states that the branch structure within building construction exerts very low pressure on competition due to factors like high concentration, vertical integration and weak competition in the field of imports and entrance barriers to the market (Bygg-kommissionen, 2002). These factors cause high prices, poor quality and low productivity within the industries. It can be mentioned that there is hardly any other branch that has been so scrutinised by the government of Sweden (Jonsson, 2005).

Production cost in construction industries has run away compared to the consumer price index (Jonsson, 2005). Borgbrant (2003) explains the phenomenon as lack of customer adjustment. The Swedish government has been worried about the productivity development in the Swedish construction sector over the years. Many reports show that there is a major need to improve efficiency in the construction industries (Jonsson, 2005). Furthermore, non value-activities are high and cause correspondingly high production cost. According to Josefsson and Saukkoriipi (2005), between 30-35% of a project's production cost is caused by waste.

Waste and rework has an effect on total cost. How the craftsmen uses their working hours and convey value added work flow has a connection to labour productivity (Josefsson & Saukkoriipi, 2005). Their study was divided into three:

1. Direct value added work – work process that brings added value to production is about 17.5% of a craftsmen's working time
2. Preparation – activities that are necessary for production that consumes 45.5% of the total production time
3. Pure waste – unnecessary activities that can be eliminated and can save 33.4% of the total cost.

Another study has been done by Alwi (2002) in the Indonesian construction industry. However his measurements of waste were limited to labour, machines and materials. There are other examples of waste such as material waste (Lindhe, 1996; Bossnik & Brouwers, 1996; Garas et al., 2001; Formoso et al, 2002) waste in labour time (Agbulos & AbouRizk, 2003) and poor quality costs (Burati et al, 1992).

Loss of productivity is caused by management of machines, wrong material, delayed material delivery, high reserve stock and ineffective distribution of workforce and material costs. On the other hand non value-added (waste) activities can cause low labour productivity. Contractors often aim to short-term high revenue, "*It is important to remember that productivity is often more of a marathon, not a one hundred yard dash!*" (Adrian, 1995).

Substandard working organization is a possible cause of this low labour productivity (Lutz, et al, 2002) and the conclusion can drawn that labour productivity is very low

[41] Swedish statistics
[42] Autonomous commission appointed by the Swedish Construction Industries

and can jeopardize competition within the industry. Productivity or lack of it is a major challenge in the construction industry (Adrian, 1999). Construction is a labour-intensive process and labour is the only productive resource in construction (Jerges et al., 2000). Time used by a construction worker on productive activities averages about 30% of the total time available (Alinaitwe et al., 2005). Hammarlund and Rydén (1998) performed a study in the field of services installations (HVAC) and found that a worker in this field works effectively only for 3.5 hours of his 8 hours shift. Strandberg and Josefsson (2005) have shown that workers spent less than 20% of their time on directly value-adding activities. Personnel costs in Swedish are 16% (SCB) of the total production cost and 36% of total contractor's cost. Up to 5% of personnel costs could be saved by improving labour productivity (Reliegh, 2004).

The purpose of this paper is to find out how and why other industries perform labour productivity measurement. This paper will also highlight the importance of labour productivity in the Swedish construction industries in order to reduce production cost.

2. RESEARCH METHODOLOGY

Case studies have been undertaken in six different companies to study labour productivity performance. Yin (1994) has discussed six sources of evidence for a case study and explains the strength and weakness of these six sources. "Interview", "direct observation" and "documentation" have been selected as the source of evidence and the companies in question have been visited (except Fritidsresor). Information about Fritidsresor has been collected from the proceedings of the Lean Forum Congress in Gothenburg. The respective plant managers and project managers have been interviewed at their working places and the production plant has also been visited by the author in the role of a direct observer to get a better idea of the companies' production process. A questionnaire was sent prior to interview to all the respondents and the questionnaire was then complemented by questions that arose during interview. To minimize misunderstanding and to get better accuracy due to poor recall (Yin 2004), all the interviews were recorded with the permission of the respondents and a copy of the interview summary was sent to the respective respondent for their comments in order to secure a better validity of the investigation.

3. RESEARCH PROJECT

Six companies are chosen to examine why and how they perform labour productivity. These companies are from different branches, but faced a great deal of competition from similar types of companies. Production type differs from company to company (see table 1). Some companies use prefabricated products in their production. Others build an entire house in an indoor plant and then move to the production site for assembling. NLL[43] and Fritidsresor are included in this investigation to get an idea of how the service sector performs its labour productivity measurement in order to improve client satisfaction.

[43] Norrbotten County Council

Table 1. Companies and organisations covered by the case studies

Company	Branch	Type of product	Type of process
Saab	Automobile	Car	Highly automated
NLL	Service	Health care	
Lindbäcks Bygg	Construction	Multi-storey house	Semi automated
Älvsbyhus	Construction	Single house	Semi automated
Tomokuhus	Manufacturing	Single house frame	Highly automated
Fritidsresor	Tourism	Charter	

A short description of the company background is followed by the summary of the interviews and knowledge obtained by direct observation is presented in this part of the paper. Company descriptions are partly taken from the company home page and completed by the information gathered from the interviews.

3.1 Saab automobile

Saab Automobile (the company was founded in 1937 in Sweden and started its production by hand-building prototypes of its car (model 92001) in Trollhättan) is now owned by the American corporation General Motors. The production plant faced lay-offs because of low productivity and loss of market share. Saab in Trollhättan introduced the Japanese lean production philosophy to improve its production process as well as labour productivity measurement after being taking over by GM. Today, Saab Automobile in Trollhättan is the most successful car manufacturing plant within the GM concern (Sveide, 2006).

Saab makes three types of car (model 9-3, 9-5 and Cadillac) in Trollhättan on the same production line. Labour productivity measurement is performed regularly to improve production results. Quality control is done in every part of production process, so that a mistake does not appear at the end of production.

> *It's the customer who decides the productivity/quality, build right from the beginning and come across waste"* (Production manager at Trollhättan)

The company has chosen the unit of measurement as the number of cars/employee/year, according to their company policy. They have increased their productivity considerably (see table 2).

Table 2. Labour productivity

Year	No. of employee	Total no. of car produced	Labour productivity Cars/employee/year
1992	4538	72 762	16
2003	3721	114 120	37
2005	2481	103 494	41.7
2006	2022	125 755	62.7

In 1992, the plant produced 16 cars per employee and today (2006) they are making 62.7 cars per employee. Employee means all the employees within the company. It takes 32.5 hours to build a car, but that includes all other jobs such as administration, planning, purchase of raw material etc. The company would take only 3.9 hours to build a car if they did not take into consideration the above-mentioned process. GM has increased its number of sold cars all over the world and in Sweden sold 2167 cars in the month of April, 2006 which is close to 8.4% of the total purchase of new cars in Sweden.

> *"Just now everything goes our way"* (Bengt Nilemo, CEO for Saab Automobile in Sweden (www.saab.se, 2007))

3.2 NLL

NLL (Norrbotten County Council) is an autonomous organization that takes care of public health. It has faced a great deal of criticism and is still facing it for its long waiting list for visiting a doctor or getting surgery done. A project called "Bra mottagning" (good reception) in cooperation with the northern county and municipalities has started to create a better atmosphere and a healthy relationship between the patients and NLL. To solve the problem, the project group started an inventory of all the problems within the problem area.

Unlike manufacturing companies, NLL has a much fluctuating flow of patients and number of surgeries to be held over the year. These uncertainties cause trouble for the planning of personnel in order to face the up and down stream of patients. Furthermore, hospitals have trouble in recruiting physicians because of the geographical position of the hospital (Niva, 2007).

NLL has started measuring productivity as:

- availability of information,
- time taken to a surgery,
- number of patient taken care by a doctor
- opening hours
- number of patients on the waiting list.

> *"We have enough resource to face the problem, in consideration of the problem of recruitment of skilled physician"* (Project manager, Ann-Mari Niva)

Project members have evaluated all the problems and developed a better process in order to face the criticism. Reception hours have increased by 25% and generated 100 new opportunities over the year. They have reduced number of patients in the waiting list from 1652 (2006) to 868 (2005) in the orthopaedic department. They have carried out 6491 magnet x-rays, in the field of Resonance Tomography which is 42% higher than the year before without providing extra resources. Access to x-ray examination has increased by 25% (2143 patients to 2604 patients) between 2005 and 2006.

3.3 Lindbäcks Bygg AB

Lindbäcks Bygg was founded in the year 1942 by Frans Lindbäck. Its vision is to become the leader in prefabricated multi-storeyed (two to five storey) house building in Sweden. Its aim is to deliver flawless house in right time to create satisfied customers. To reach the goal, they work continuously to improve work processes. They have raised their turnover by 15% per year and today the company has a turnover of about 160 MSEK, of which 3% is invested in research and development. The company has the goal of achieving 5% profit per year.

The production plant has a semi-automated production system. An entire house is built as an indoor production plant and then assembled at the production site. Production speed is 125 m^2 house area per day and 2,000 houses per year.

> *"It is important to take good care of personnel to achieve a better and effective job atmosphere"* (Plant manager)

The plant manager works continuously to minimize unnecessary rework and to create a value chain to achieve good productivity. According to the plant manager, productivity is the unit of fulfilment for the company's targets.

Lindbäcks Bygg has plant/fabric based production and it is easier to work towards value added processes. Lindbäcks Bygg performs productivity measurement and the decision is made by all the employees, "*otherwise it wouldn't have any affect"* says the plant manager. Employee wages are based on the fulfilment of targets and the idea is proposed by the employees. The company sets production targets every week and it is important to fulfil the target. Due to the bonus system, every craftsman in the company strives to reach the target.

Their unit of measurement is:

- produced volume/hour
- produced unit/hour
- produced unit/week.

Knowledge of this measurement makes it easy for the purchasing department to plan for the required material for a certain project. Besides, it gets easier for the worker to summarize the production result after a couple of days and then to adjust the production speed to meet the target. Employees receive a bonus if they produce more than the target value. After every project, the bar is raised a little bit and a new target is set. The company sets a handicap system with a margin for their new project because of its uniqueness. The plant manager explains that they have only a few units of measurement, because it gives them better control of production and a better basis for statistics. Quality control is very important to fulfil customers' demands. Labour productivity has been fluctuated in the past, but in recent years it has increased.

> *"It is important for me to follow the branch and adjust the production process as well as productivity along with it" (*Plant manager)

3.4 Tomokuhus

Japanese owned house-component manufacturer Tomokuhus was founded in 1991 in Insjön, Sweden. They build 45,000 windows and about 1,800 timber house frames per year. Whereas Swedish construction companies are facing competition from the low-wage companies in the Baltic States, Tomokuhus has created an example of reducing production cost by improving labour productivity. The plant manager explains the choice of the production plant in Sweden as good availability of skilled workers and access to raw materials.

The production process is highly automated and all the employees on the production floor are basically operators. Tomokuhus measures labour productivity regularly and takes advantage of the measurement for future projects.

Their unit of measurements are:

- number of components produced per day
- number of containers shipped per day
- number of units produced per day.

They have improved labour productivity by 6% in 2006. They have not raised their selling price by a single cent over 15 years despite high rises in wages and rises in the price of raw materials. The company produces components of a timber house that sells only in Japan. Components of an entire house fit in a container, designed by an architect, and shipped to Japan. Tomokuhus has a proposal box where every employee can contribute innovative ideas and be rewarded for proposals accepted. The plant manager works on constructing new machines to improve production processes to optimize and to improve product quality. The production plant has hardly any waste of material and continuous of improvement is everything, says the plant manager (Pettersson, 2006).

3.5 Älvsbyhus

Älvsbyhus was founded in 1944 and since 1960 they are producing timber houses and have sold more than 27,000 houses in Sweden, Finland and Norway (www.alvsbyhus.se, 2007). The company has raised turnover from 789 MSEK (2001) to 1,154 MSEK (2005). Revenue has gone up to 30% of their turnover, which is much more than any other house builder in Sweden.

Älvsbyhus builds timber houses in an indoor production plant and is one of the most effective manufacturers in Europe (www.alvsbyhus.se, 2007) and leads the list of timber house builder in Sweden (Blomgren, 2007). The production plant is semi automated and because of their rational transport and assembly system, they have become very competitive in the house builders' market.

The company's vision is to become the most successful single unit timber house builder in Sweden, to produce a quality product to a minimum price. Today, they are making 1,700 houses per year. The company measures labour productivity in monetary terms, for example production cost per built house. The company has worked with its production strategy for more than 45 years and has reached a good level of quality production. The personnel manager explains the motivation for their unit of measurement as an effective tool to find the cost effective production system. Company has a target to reduce production cost by 3% per year. *"Personnel cost is between 15 to 20 percent of the total production cost and that's why it is important to work effectively"* says the personnel manager.

The company's salary system is a bit different from most of the other house builders in Sweden. Craftsmen's salary is based on performance. Because of this system every craftsman is engaged and motivated. Production is very much customer oriented but their production is limited to a few house models. Every employee has an opportunity to come up with ideas to make production more effective and productive and gets rewarded for each accepted proposal.

3.6 Fritidsresor

Fritidsresor, a Nordic concern in tourism business was established in 1961. Since 2000, Fritidsresor is a part of TUI (Tourism Union International) and represented in 16 European countries. The company portfolio consists of 284 hotels with 160,000 beds over 29 countries. The company's main goal is to have the most satisfied customers and best profitability in the business.

Like other charter companies, Fritidsresor was struck by the Tsunami disaster in Thailand and by the impact of 9/11. During 2002-2003, the company posted negative results. In recent years, the company has introduced a modified version of the Japanese philosophy "lean" in its way of thinking and have called it "Blue Lean".

It is the customer who makes them successful. To achieve the goal, company started collecting information about their customers. They asked questions like:

- What does the customer want?
- When do they want service?
- How do they want their service?
- What is their high priority during a vacation?

Then, they looked thoroughly into their value added flow to find out the area that must be improved to achieve better customer satisfaction and to reduce costs. To reach the goal they changed their theme from "wrong from start to the end" to "right from the very beginning" (Segertorp, et al, 2006). They have changed their process flow, reduced process time by 50% and increased telephone hours to create better availability. They have even changed their IT system to create a more effective invoice system between the branches over the world. The results create better customer satisfaction and increased revenue.

3.7 Analysis of the results

Unlike other branches Swedish construction industries have not been exposed to international competition. On the other hand manufacturing industries are facing competition all the time. They are competing constantly with the companies in order to secure market share. This is one of the reasons manufacturing industries are giving importance to improve labour productivity. The other reason is to cut down production cost. To survive in this competitive world, it is important to create a better value added work flow that can reduce production cost and, at the same time, make a better quality product to create customer satisfaction. Companies in the service branch (NLL) are facing criticism because of their long waiting list. The project "God Mottagning" (Good reception) has improved their queue system and showed a great improvement in their process management to deal with the fluctuated patient flow and better patient satisfaction.

Saab Automobile and Tomokuhus have reduced waste and production cost by improving labour productivity. The Swedish construction sector is blaming high production costs on the rise of materials, but Tomokuhus has succeeded in keeping the selling price to a constant over 16 years by improving quality and labour productivity. Saab Automobile in Trollhättan has improved labour productivity from 16 cars/employee/year (1992) to 62.7 cars/employee/year (2006) by reducing waste and eliminating unnecessary work.

Älvsbyhus has raised turnover by 365 MSEK between 2001 and 2005 (about a 46 % increase) and has increased revenue by 30% of turnover per year. Their rate of profit is way over other construction industries in Sweden. Due to their unique process thinking they can cut down their production cost by 3% per year. Because of the salary system which is based on labour performance, they have succeeded in motivating their worker's and have secured a better market share.

4. CONCLUSIONS

Swedish construction industries are facing criticism for low productivity and high production cost. Labour wages and raw material prices are rising because of the high demand of construction work due to the strong economic growth in the Swedish economy. It is therefore important to produce more with the same input. As labour wages are high, labour productivity can be improved by raising human performance and by reducing non value-added activities.

To create dynamic competition between the supplier and clients, it is important that customers look for contractors who offer the best product for a reasonable price, which is unfortunately not possible due to high economic growth in the country. But international competition can change this scenario. Production cost can be reduced by improving labour productivity. In order to create a better market share the Swedish construction industry should take action to improve labour productivity to reduce production cost and enable better competition within the construction industries.

The Swedish construction industries need to change their way of thinking. A continuous process of labour productivity measurement and an effective analysis of measurement results are important. Furthermore, these results should be used to improve productivity. An improvement of labour productivity will automatically upgrade the level of value added activities and thereby reduce waste and cut down production cost. The Swedish construction industries have an old and traditional organisation structure and need updating. Every change in an organisation causes some consequences. Better knowledge and strong support from the management of the construction industries is therefore essential.

5. REFERENCES

Agbulos, A. and AbuRizk, S. M. (2003), An application of lean concepts and simulation for drainage operations maintenance crews, *Proceedings of the 2003 Winter Simulation Conference*, Edited by Chick, S., Sánchez, P. J., Ferrin, D. and Morris, D. J., 1534-1540.

Alinaitwe, H., Mwakali, J. and Hansson, B. (2005), Labor productivity in the building construction, Proceedings *of CIB 2006, W065/W055/W086 – Construction in the XXI Century: Local and global challenges*, October 2006, Rome, Italy.
Alwi, S. (2002), *Non value-adding activities in the Indonesian construction industry: variables and causes*, Doctoral thesis, Queensland University of Technology, Brisbane, Australia.
Borgbrant, J. (2000), *Byggprocessen i ett strategisk perspektiv*, Byggkommissionen, Sweden, November, 2003.
Bossnik, B. A. G., and Brouwers, H. J. H. (1996), Construction waste: Quantification and Source Evaluation, *Journal of Construction and Engineering and management*, **122**(1), 55-60.
Burati, J. L., Farrington, J. J. and Ledbetter, W. B. (1992), Causes of Quality Deviations in Design and Construction, *Journal of Construction Engineering and Management*, **118**(1), 34-49.
Forsberg, A. (2007), *Produktivitetsmätningar som förändringsarbete* (an ongoing licentiate thesis), Luleå University of Technology, Luleå, Sweden.
Formoso, C. T., Soibelman, L., De Cesare, C. and Isatto, E. L. (2002), Material waste in Building Industry: main causes and prevention, *Journal of Construction Engineering and Management*, **128**(4), 316-325.
Garas, G. L., Anis, A. R. and El Gammal, A. (2001), Material waste in the Egyptian construction industry, *Proceedings of IGLC-9*, August 2001, Singapore.
Hammarlund, Y. and Rydén R. (1998), *Effektiviteten i VVS – Branschen arbetstidsutnyttjande*, SBUF. Stockholm, Sweden.
Jonsson, J. (2005), *Förstudie om produktivitetsfrågor*, Luleå University of technology, Luleå, Sweden.
Jergeas, G. F., Chisti, M. S. and Leitner, M. J. (2000), Construction productivity: A survey of industry practices, *AACE International Transaction*.
Josefsson, P-E. and Saukkoriipi, L. (2005), *Slöseri I byggprojekt – Behov av förändrat synsätt*, FoU-Väst, report 49, Gothenburg, Sweden.
Lindhe, N. (1996), *Effektivare materialanvändning på byggarbetsplatsen*. En studie av materialspill, FoU-Väst report 9603, Gothenburg, Sweden.
Lutz, J. and Gabrielsson, E. (2002), *Byggsektorns struktur and utvecklingsbehov*, Byggkommissionen, March, Stockholm, Sweden.
Releigh, N. C. (2004), *53% See Construction Productivity as Flat or Declining*, Contractormag.com, December, 2004.
Strandberg, J. and Josefsson, P.-E. (2005), What do construction workers do? Direct observations in the housing projects, *Proceedings of CIB 2006, W065/W055/W065 – Construction in the XXI Century: Local and global challenges*, October 2006, Rome, Italy.
Segertorp, Å and Söderlund, T. (2006), *Fritidsresor*, Lean Forum Conference, Gothenburg, Sweden, October, 2006.
SOU 2002:115, Byggkommissionen (2002), *Skärpning gubbar! Om konkurrensen, kvaliteten, kostnaderna, och kompetensen i byggsektorn*, Stockholm, Sweden.
SOU 2000:44, Byggkostnadsdeligationen (2000), *Från byggsekt till byggsektor*, Stockholm, Sweden.
SOU 1997:177, Byggkvalitetesutredning (1997), *Byggkvalitet för framtiden*, Stockholm, Sweden.
Yin, K. R., (1994), *Case Study Research, Design and methods*, 5, SAGE Publication, Thousand Oaks, London, New Delhi.

5.1 Interviews

Ann-Mari Niva, Project Manager, NLL, Luleå, Sweden, 22/01/2007.
Erik Sveide, Production Manager, Saab Automobile, Trollhättan, Sweden, 09/06/2006.
Eva Sjölund, Development Manager, Department of Surgery, Sunderbyn sjukhus, Luleå, Sweden, 22/01/2007.
Mats Blomgren, Personnel Manager (Former plant manager), Älvsbyhus, Älvsbyn, Sweden, 08/02/2007.
Mats-Åke Pettersson, Plant Manager, Tomokuhus, Insjön, Sweden, 27/09/2006.
Stefan Lindbäck, Plant Manager, Lindbäcks Bygg AB, Piteå, Sweden, 16/01/2007.

5.2 Home pages

www.alvsbyhus.se (03/07/2007)
www.fritidsresor.se (08/01/2007)
www.lindbacksbygg.se (13/02/2007)
www.nll.se (20/02/2007)
www.saab.se (05/02/2007)
www.scb.se (2003 and 2005)
www.tomokuhus.se (05/01/2007)

BOUNDARY OBJECTS AS A TRANSLATION INSTRUMENT IN DESIGN

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ABSTRACT

In the design of new offices, the process of implementing the clients' needs and expectations is of great interest. The process is heterogeneous, with several actors involved such as architects, engineers, interior designers and clients. The different viewpoints imply a need for cooperation. The tension that arises needs to be managed. Based on a current study, we present some instruments which can facilitate the negotiations and the translation process between the clients on the demand side and the architects and the designers on the supply side. In order to analyze how the collective action is managed across these social worlds, we have chosen a theoretical framework from the field of science, technology and society (STS). We focus on a useful concept defined as boundary objects, which are flexible structured objects, such as analytical concepts, techniques and artefacts establishing a better and a common understanding.

1. INTRODUCTION

During the last fifteen years the attention to space and the physical environment in office solutions has increased. New ideas about management and how to lead knowledge at work, as well as new technologies, have led to a shift in how we think about these workplaces. The context of work is changing, places and times of work and the way people interact is changing. The demand for highly flexible office space is increasing. Collocating staff, focusing on spaces for interaction and getting an invigorated and stimulating workplace culture (Vos *et al.*, 1997), these new ways of working are fostering teamwork, which add value to their business and even brand the companies.

Changes have also led to a shift in the role of the architect in the building design process. The former master builder with the responsibility for the totality has been reduced to an actor among others in the briefing and design phases of a complex project, but still the architects have a larger influence on the crucial conceptual design decisions during the building design process. However, such concepts as 'team-work' and 'collaboration' as collective terms for every interaction with other people are not sufficiently precise to enable the designers to translate in the clients'

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views for a successful spatial solution. Hence, it is important how architects and designers manage the supply side, and the translation process from 'business language' to 'architectural language.' There is a chain of translations, where choices and decisions have to be made. The question is, can the translation process can be facilitated by some instruments that help the process go more easily and give the participants a better and shared understanding?

Based on a current case-study[45] we will explore some instruments used in the translation process between the clients on the demand side and the architects and the interior designers on the supply side. In order to analyze how the collective action is managed across these social worlds, we have chosen a theoretical framework from the field of the Science, Technology & Society (STS). We focus on the concept called 'boundary objects,' which is useful to achieve sufficient agreement between the stakeholders involved, to get decisions intersected and work done. The concept can be used to gain new methodological insight into the process of briefing and design (Kjølle *et al.*, 2005).

2. LITERATURE REVIEW

A building is a social and material construction, where the order of space is the purpose. Buildings often become an object of cultural discourse, which complicates the relation between usability and social meaning, and which implies that they are set apart from other objects and artefacts (Hillier and Hanson, 1984). Insofar as the building object creates and orders the empty volumes of space into a pattern, the building is also a 'black box'[46] for the users, representing the designers' and architects', as well as the engineers', associations and viewpoints.

During the work presented in his book *Science in Action* (1987), the French sociologist Bruno Latour limited the term 'black box' to be just when it acts as one. He concluded that "understanding what facts and machines are, is the same task as understanding who the people are." He presented an actor-network theory[47] (ANT), an approach to the development of facts and artefacts as a result of negotiations, interpretations and implementations of the actors' interests. During the process, the actors are changed and developed as well. This approach can be useful to gain more knowledge about the nature of alliances of interests, the relation between society and architecture, as well as technology and society (Latour, 1987; Latour, 1999).

2.1 Boundary objects as a means of communication and translation

The actor-network theory is concerned with which associations are stronger or weaker in the translation process, seen from one actor's view and position in order to

[45] This case-study is a part of a doctoral research project which is related to the Norwegian multidisciplinary R&D-project "The KUNNE workplace" (KWP). The R&D-project KWP is a research initiative on new office solutions and new ways of working in knowledge-intensive organizations, within the KUNNE network, a portfolio of research projects with focus on knowledge and learning.

[46] "Black box" is a term cyberneticians used when a piece of machinery or a set of commands was too complex.

[47] The origin of the approach of the actor-network theory (ANT) can be found in the work of Latour and his colleague Michel Callon in 1981.

stabilize fact (*ibid.*). Meanwhile, a problem occurs when the worlds of these stakeholders cross. The development of facts and artefacts depends on the communication between the participants, as well as the task of reconciling. This is the feature of the concept called 'boundary object' developed some years ago by researchers such as Susan Leigh Star, James R. Griesemer, Adele Clarke, and Joan Fujimura. All of them are associated with the symbolic interactionism, wherein the concept of social worlds has an important role. The social world is a unit of discourse limited not by geography but by communication.

Contrary to the ANT, the focal point is the collective work across different communities of practice, with divergent agendas and viewpoints. In other words, the focus of this concept is the multiple transactions needed and the equality between actors with divergent associations and agendas. The development of the concept boundary objects was made by Star and Griesemer (1989), through a study of different groups of actors crafting an easy and clear concept of problem-solving, which made the groups intersect and work successfully together. They describe the boundary objects as "common enough to more than one world to make them recognisable" and define the concept as "a means of translation" (1989). As interfaces between multiple social worlds, boundary objects are the means by which interaction and communication is affected at the places "where people meet," described as a media of communication between the communities represented. They can be abstract or concrete objects that arise over time from durable cooperation, understood or misunderstood in equality between the participants. They are working arrangements, encouraging translation for the purpose of winning allies, which include allowing others to resist translation and to construct other facts. Creating and managing boundary objects are key processes in developing and maintaining coherence across different communities of practice and social worlds. Star and Griesemer identify some criteria of the concept as follows (*ibid.*).

- "BO is an analytical concept of those scientific objects which both inhabit several intersecting social worlds and satisfy the informational requirements of each of them."
- "BOs are both plastic enough to adapt local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites."
- "BOs are weakly structured in common use and become strongly structured in individual-site use."

According to Joan Fujimura, boundary objects are defined as entities at least apparently common to several actors' discourses, enabling them to discuss an issue and perceive a shared interest. She claims that boundary objects are an analytical concept "that both inhabit several agreements at various times to get work done and produce relatively and temporarily stable facts" (1992). Furthermore, Fujimura points out that boundary objects "facilitate a flow of resources" such as concepts, skills, materials, techniques and instruments among several different lines of work (*Ibid.*). In their book *The Right Tools for the Job*, she and Clarke define the boundary objects to include "things, tools, artefacts and techniques," in addition to ideas, stories and memories – "objects that all are treated as consequential by community members" (Clarke and Fujimura, 1992).

In the Norwegian R&D project KUNNE[48] the concept of boundary objects has been used in order to describe “objects that become shared foci for the attention and explorative activities of people with initially different interests, expertise and language” (Carlsen *et al*., 2004: 229). The importance of the loosely-structured nature of the objects has been highlighted, allowing participation in development and construction of the boundary object.

2.2 Other aspects

How communication processes and organisational design react and work in virtual and global organisations or companies, are aspects which have a large influence on the communication between the demand side and the supply side in the translation process in briefing and design.

Research has shown that communications become more task-oriented with clearer role expectations when problem-solving between actors is computer mediated, while face-to-face communications are more cohesive and personal. A cluster analysis of communication patterns showed that as computer-mediated group interactions progressed, the group decisions and the general problem-solving processes were more closely related. By contrast, the study showed that face-to-face group interactions often followed sequences of interactions, because the participants reflected more on perspectives and courses of action in reaching their decisions. One finding in the study was that actors who solved problems through virtual meetings, were more satisfied and believed there was a greater quality in the problem-solving process (Jonassen and Kwon, 2001).

3. RESEARCH PROJECT

The study presented in this paper is exploratory, aiming to define the boundary objects used in the design process as a means of translation needs into design. The boundary objects discussed are primarily used by interior designers and architects on the supply side.

3.1 Project description and objectives

The study was conducted between October 2006 and March 2007 at the head office of Office Design,[49] an international office design and architecture company. The organisation has offices in Europe, North America, and Australia. It was founded in Europe in the 1970s and had approximately 250 staff worldwide at the time of the study. Some sixty staff were based in the office that was observed.

The company’s profile is to demonstrate business values through efficiency (reducing costs), effectiveness (impacting productivity) and expression (impacting brand value). Over the years, the company has developed a solid reputation for developing

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[48] The conception of knowledge in the KUNNE is grounded on a humanistic tradition. Knowledge results from the interaction between people, and between people and technology.
[49] To protect the identity of the company and the respondents, Office Design is used as name. The company is not operating under this name.

innovative office solutions, based on research and scientific investigations. The observed office had been designed in the late 1990s as an example and showcase for the company's philosophy with open settings and flexible working. The services offered range from urban planning to interior design, from a basis of strategic briefing and research.

The company was chosen for the case study because of their integrated design approach focusing on the process, going from understanding the business objectives, to understanding how people work, how space is used and what role it plays in the organisation. This approach requires an ability to translate business needs into spatial solutions, as well as working in cross-disciplinary teams, which are the two main foci of this research project.

3.2 Research methodology

This study aims to explore human experiences in detail from a qualitative point of view, thus a constructivist approach is chosen, whose subject matter is that reality is socially constructed. The task is to understand the multiple social constructions of meaning and knowledge. Hence, a case-study methodology was used (Robson, 2002; Yin, 2003), where particularly such methods as interviews and observations have allowed the acquirement of multiple perspectives. The researcher was a participant observer (Yin, 2003; Robson, 2002), working within the company for six months. During this time, primarily interactions and collective work in three projects were observed and analyzed, and several interviews made with actors from different disciplines and social worlds as respondents.

Data have been collected through multiple methods and sources of evidence. In addition to interviews and observations, documents were studied and archival records collected. The interviews have been semi-structured, following an interview guide with open-ended questions. It was then possible to triangulate the data collected, draw comparisons, and use the data in a complementary fashion to enhance interpretability, following the approach outlined by Robson (Robson, 2002).

3.2.1 The projects and interactions observed

Three very different projects were studied, all in progress during the study. The first project, called Global Pharmacy, had a high degree of user involvement. The client was a demanding client, in terms of being prepared and proactive. A pilot hub recently made in the USA became a kind of 'guideline' in addition to the research done by strategists and researchers primarily from Office Design in the USA. The request was the design of five pilot hubs, in two different countries, with the same expectations for them all. In existing buildings, the demand was design of new 'hubs' for interaction, intending connection of scientific and creative people from divergent departments.

Type of communication	Physical meetings client / focus groups and designers	Virtual meetings client / focus groups and designers	Between designers and other actors	Between designers internal
Global Pharmacy Global Pharmacy 2 hubs UK	**Face-to-face communication in physical meetings.**	Virtual meeting	**Face-to-face communication**: - construction arch & construction team on site	Interaction, collaboration between designers. **Design review internal**
Global Pharmacy 3 hubs USA		**Virtual meeting**	**Virtual meeting** with the project team including the local architect	Interaction, collaboration between designers. **Design review internal. 1 strategist ("bridge-builder") invited.**
Fast Office Fast Office Ireland	Some Face-to-face communication in physical meetings.	**Virtual meeting**	**Virtual meeting** with the project team incl. the local architect	Interactions between 2 designers, ad hoc and of short duration
Fast Office UK	**Face-to-face communication in physical meetings.**	**Virtual meeting** with the project team incl the local architect	**Face-to-face communication**: - furniture supplier - construction team on site	Interactions between 2 designers, ad hoc and of short duration
Science Park on the west coast of England	**Face-to-face communication in physical meetings.**		**Face-to-face communication in physical meetings** with the project team including the local architect	**interactions within the architects team:** discussion, interpretation and understanding of: - place: site and location - the strategic brief, the concept of space plan and concept of the building

Figure 1. Interactions observed

There was less user involvement in the second project, called Fast Office, a fast expanding IT-company. The request was for an open-plan design solution, focusing on spaces for interaction, in two existing buildings, for their main office in the UK and their European head office in Ireland. Furthermore, the demand was “fun, function and food.” The experience the designers had from several projects delivered for the client in different countries, made it easier for the designers to understand the client’s needs and expectations.

The last project observed, Science Park, was a project initiated by a developer and had no user involvement. The demand was the design of a science innovation centre for commercial use. The request was vague, and formulating the brief became a part of the delivery from the architects in the project.

3.2.2 The observation process

Four groups of stakeholders in the design process have been observed: Strategists; Researchers; but, primarily Interior Designers; and Architects. The stakeholders typically took part in different stages of a project, with periods of overlapping communication and activities. They came from different educational backgrounds, and thus had different preferred communication tools and patterns. Furthermore, individuals often change professional roles within the company (designers becoming strategists, for example) as well as within the project. This adds an extra layer of complexity in the already multi-professional environment of the projects.

For the exploratory purpose, the observation study of the interactions initially took an unobtrusive approach and became purely ethnographic (Robson, 2002). As the study progressed, interactions increased between the observer and the staff observed, which took it to the level of participant observation. However, the researcher has tried not to influence the design process and results as such. The interaction was mainly regarding how the design process was run with a focus on the role of the 'boundary objects' and the communication between the actors. According to Hastrup and Hervik, fieldwork has to be experienced as performed. The ethnographic material is composed of more than words, which made the researcher aware of the paucity of the language used to characterize it (Hastrup and Hervik, 1994).

The meetings observed have been both formal and informal, and the interactions have been face-to-face as well as using technology such as conference calls. In addition to the internal meetings, meetings with clients, focus groups, project teams and furniture companies have been observed. Some of the meetings or interactions were recorded on film, the rest were captured in notes.

3.2.3 The interview process

Among the members of the four stakeholder groups within Office Design, thirty semi-structured interviews (Yin, 2003; Robson, 2002) were conducted. Five interviews were made with representatives of the clients in the projects observed and one interview with an external project manager. Every interviewee had an interview-guide in advance, together with a powerpoint-presentation in printed version of the collection of instruments the strategists and interior designers would use.

The hand-out of the interview-guide in advance was meant to help the respondents to stay focused during the interview, and to make the interview situation more relaxed and like a conversation open to exploration of different paths to cover the questions. The focus also helped to discuss in depth, and along unforeseen paths, resulting in a richer data collection and a rise of the growth of the study as a whole (Gubrium and Holstein, 1997; Kvale, 1997; Robson, 2002; Yin 2003). The questions in the interview-guides focused on instruments in use, communication, cooperation and knowledge sharing in general in projects, as well as between colleagues and across teams internal.

Different appropriate ways of addressing the focus and the topic were chosen in the different interviews, depending on various aspects, primarily such as who the respondent was and the two actors' form of the day. The interviewees became narrators or storytellers. As the interviews went along, the stories were improvised in a meaningful talk, by aspects of experiences, opinions, feelings and expectations. By working together and having 'the active view of the interview points to a greater range of interpretive activities of both parties,' the interviews became social productions. Hence, active interviewing is inherently collaborate and problematic (Holstein and Gubrium, 1995). Divergent social realities were conveyed, while knowledge was shared and performed during the conversation between the actors with a common interest of the topic. Meaningful reflections of, and personal attitudes about, the topic were brought not only by words, but accent, choices of words and the body language. The researcher used herself as an instrument, in conducting an emotional way of comprehension, with body language as well as words (Kvale, 1997; Gubrium and Holstein, 1997; Yin, 2003).

4. INSTRUMENTS AS A MEANS OF TRANSLATION AND COMMUNICATION

In this paper we are interested in that kind of translation the interior designers and architects primarily perform in order to craft instruments containing elements which are separate in different worlds, encouraging the participating actors in the navigation across different communities, and hence enable the translation process to go more easily.

Two major factors contribute to the success of the office as an international leading consulting firm for designing office solutions. These are the development of methods, models and concepts, and the instruments we can define as boundary objects.

4.1 Instruments developed and standardized

Through more than thirty years focusing on the importance of the brief and programme to make meaningful design, a series of methods, techniques, concepts, models, tools and artefacts are developed. The elaborated collection of instruments has been further evolved, more or less, depending on the single instrument's nature, by whom and where used. Over time many of the instruments have become an implemented part of the services and the project management system at the office.

Rival firms, as well as the building construction industry, have adapted and implemented some of the instruments developed at the office. An example is the instrument called Building Appraisal, which rose from a good idea and quite quickly became a tool, later implemented in the building sector as an instrument to compare, rate and rank buildings. The instrument is intended to validate the developers' brief and programme through a series of critical evaluation of an actual building, to match the occupiers' business visions to building stock and validate the architect's design against users' brief, acting as a consumer advocate throughout the entire design process.

4.2 Four types of boundary objects

We have found instruments which are a means of translation, as well as means of communication. In analyzing the translation tasks we distinguish four types of boundary objects, which are called: repositories; standardized forms; ideal types; and coincident boundaries.

In this study, four categories of staff are of interest using the boundary objects. The matrices below show the initials of the staff involved, the researchers (R), the strategists (S), the interior designers (D) and the architects (A). Meanwhile, the strategists are actors with different skills and background.

4.2.1 Repositories

Repositories in terms of being boundary objects are ordered 'piles' of objects. They are archived or arranged in a standardized fashion, which means they fit problems of heterogeneity across the communities. All the project documents distributed between the stakeholders are such a type of instruments allowing the individual actors to use them without having to negotiate directly differences in purpose. The distributed and archived project documents, artefacts, drawings, texts and instruments are the piles of objects for the participants. The books written or co-authored by some of the founders and staff at the office, with topics as the briefing process, architectural knowledge, the distributed workplace and new office solutions, are boundary objects of this type. In terms of being a boundary object, the pictures on the wall from office interiors and visual drawings of building appraisals are repositories as well.

An important boundary object of this type is the story and the idea of the office, which was founded on the expectation that the two cultures of design and research will complement and support each other. 'The ethos' of the office was built on responsibility, in terms of being a field containing understanding of sharing and risk, crossing social worlds and being forced out of the frame of reference. During the time since the foundation of the office, lots of instruments are performed and evolved in collective work between staff from different disciplines and social worlds, for the purpose of understanding what the design is made for.

4.2.2 Standardized forms

This type of boundary objects is defined as standardized forms, which means they are worked out and designed as methods of common communication. These instruments can be transported over a long distance and bear the same information. Early in the process of formulating the brief, we found two instruments of this type used by the researchers (R) and the strategists (S).

Instruments	What	The issue	Used when and where	Whom	Characteristics identifying BO
Work pattern survey	Workplace Performance Survey Work Pattern Survey Mobility Survey Communication	Collecting data work patterns.	Results presented and discussed in an iterative briefing/ change process with the leadership, board, seniors or focus groups.	R/S	Ppt-presentations are developed in order to get a common understanding during a discussion about the value and use of space.
Utilisation survey	A quantitative study of the employees' use of space. Time Utilisation Survey Space Utilisation Study/Entity Analysis	Measuring how space is used, the time used or the entity of staff on observed places.	Results presented and discussed in an iterative briefing/ change process with the leadership, board, seniors or focus groups.	R/S	Ppt-presentations are developed in order to get a common understanding during a discussion about the value and use of space.

Figure 2. Standardized forms

4.2.3 Ideal types

Instruments	What	The issue	Used when and where	Whom	Characteristics identifying BO
Targeted insight	A qualitative study, an ethnographic study of employees' use of space. Micro study: individual use Macro study: spatial process mapping Campus: Connectivity mapping	Study of the relationship between the environment and the employees' behaviour	Often used in labs and complex working areas, to get a targeted insight in use of space.	R/S/D	Results of exercises are discussed and presented on a ppt-presentation.
Space planning	Test of and advise on the suitability of (a range of) buildings. Translate the space model into their "stacking" and "blocking" tools.	Space budget, alternative solutions showing the sizes of needs etc.	Used later in the briefing process, after formulating the brief.	R/S/D	Each step of relations, first vertically, then horizontally, must be agreed before next model is made. It is an iterative process, which ensure a common understanding and which ensure the locations of minimal footprint for the users.
Diagrams	Relationship diagrams, connectivity diagrams - graphs and 3D visualizations	Showing the relations or connectivities to other buildings, other elements etc	Used in internal discussions within the design team during the design process. Used in project meetings	A/D	Further developed, options discussed in an iterative briefing and design process.
Analytical tools	Statistical tools, building types etc.	Show sizes, dimension of space, different types of objects etc.	Used in internal discussions within the design team during the design process. Used in project meetings	A/D	Further developed, options discussed in an iterative briefing and design process.
Sketch drawings architecture	Handdrawn or Cad-drawn, 2D and 3D sketches of site and building, texted, on paper or on whiteboard or flipover.	Showing the development of the concept and the idea of the building	Used in project meetings, with the client and other actors. Used in internal discussions within the architect team during the design process.	A	Sketches of the concept further developed after each meeting with the client and decisions taken, showing the development of the translation of the client's needs. Internal several options are discussed.
Sketch drawings interior	Often handdrawn 3D sketches of interior elements, furniture, walls, colours, mood etc., on paper	Sketches showing the proposed (or some options of) interior details, furniture, rooms etc.	Used in internal interactions and reviews. Sketches showing the proposed (or some options of) interior details, furniture, rooms etc.	D	Sketches of the concept further developed, options discussed in an open and democratic iterative briefing and design process. Ppt-presentations developed further to the meetings at the end of each stage, as a part of a series.

Figure 3. Ideal types

Building types, office types, diagrams, maps, or other descriptions which in fact do not exactly describe the details of anything or one area, and which are abstracted from all domains and maybe, to a large degree, vague, are defined as an ideal type in terms of being a boundary object. Because of the contents of adaptability, guiding all the divergent actors equally, the 'Ideal Types' enable the actors to achieve an agreement. In this way ideal types can be defined as means of communication and cooperating symbolically.

4.2.4 Coincident boundaries

Common objects with the same boundaries but divergent internal contents, are another type of boundary object called 'Coincident Boundaries.' They arise in the presence of different means of aggregating data, which means the objects live in multiple social worlds and different identities, contents and associations.

Instruments	What	The issue	Used when and where	Whom	Characteristics identifying BO
Visioning session	Often series of workshops. PPT presentations with data collected and results from opinion surveys or interviews of boards and seniors.	Formulating the brief.	In an iterative briefing process with leadership, board, seniors or focus groups.	D (S)	Ppt-presentations are developed further for each workshop during an iterative process in order to get a common understanding of the needs and requirements.
Workshop with Cards	Pictures and images for drawing the needs and requirements.	Particularly to formalize the strategic vision by the change process. Formulate the brief.	In an iterative briefing process with the leadership, board, seniors or focus groups.	R/S/D	Results of exercises during the workshop are discussed and presented on a ppt-presentation.
Workshop with Jigsaw	3D sketches of interior with elements that can be used in the office,	Inspiring the client to define what they want in their new office. Formulating the brief.	In an iterative briefing process with the leadership, board, seniors or focus groups.	R/S/D	Ppt-presentation is developed and discussed in workshop in order to get a common understanding of the needs and requirements.
Emotional tools	Pictures and images of landscape and buildings. Visiting objects, drawing things, show use of colour, use of words, metaphors	Inspiring the client to define what they want in their new office. Contribute to the emotional "coctail". Formulate the brief.	In first or second meeting with the client locations and site, examples and first proposal of buildings exterior: expression, form, materials; and interiors; mood and atmosphere, contemplated spaces.	A/D	Images as a part of ppt-presentation developed and discussed in workshop in order to get a common understanding of the needs and requirements.

Instruments	What	The issue	Used when and where	Whom	Characteristics identifying BO
Physical model	3D model of the building and the landscape	Show the form and size, the relation between the building and the landscape.	Used in project meetings, with the client and other actors, as a supplement to sketches and drawings.	A	The physical model is a tactile instrument which can help the client to understand the form and size better, and help the common understanding between the client and the architect.
Board	Board with pieces and examples of materials proposed, colours or/ and surfaces	Show "the real" colours, materials and surfaces proposed.	Used in meetings with the client and other actors during the project as a supplement to sketches and drawings	D	The board is a tactile instrument which is easy for the actors to get a common understanding of, and which help the discussion about what is proposed and what the cleint wants.
The office	Open plan solution with partly nomads working on laptops, partly fixed workstations.	Show new clients and visitors new ways of working.	Currently	All staff	How the staff use the office, how the teams is organised, and spaces for interaction. New ways of working, but silos. Some nomads, some interactions across.
GBU The Good, the Bad and the Ugly	An informal knowledge sharing session organised every fortnight for all staff.	Sharing knowledge across teams and disciplines.	Currently. A session organised every fortnight for all staff. The commitee is multidisciplinary.	All staff	Experiences and skills across, presented and discussed in order to share knowledge internal between the teams at the office.

Figure 4. Coincident boundaries

4.3 The impact of boundary objects and time

Time is one crucial factor that contributes the impact of the instruments as boundary objects. Sequential and iterative processes during time have had a high impact on the understanding across the communities, the clarifying of needs and requirements, the brief, the interpretation and implementation. For all three different groups of projects, whether it was high, low or no user involvement, the process and time contributed to a high impact of the boundary objects used.

Boundary objects as PowerPoint presentations developed further after each meeting, became strong instruments facilitating the discussions, influencing a higher common understanding between the participants, enabling them to achieve agreements which again helped the translation process. The clients of the two finished projects, Global Pharmacy and Fast Office, who are very satisfied with the results, point out the impact that the powerpoint-presentations had on their understanding and the repeatedly dialogues they had with the interior designers. Meanwhile, the impact of the quality of powerpoint-presentations depends on the staffs' technological skills as well as the contents of the presentation, in terms of the graphic pictures and the multitude of information on each slide.

4.3 The collective work and knowledge sharing

The other crucial factor contributing to the impact of the instruments is the actors, individuals, as well as groups of social worlds. In terms of being a boundary objects, there are differences in the understanding of the impact of the instruments, depending on the skill and discipline. In other words, the impact of boundary objects depends on the skill and understanding by those using it.

Inside the office, the collective work across it depends on the group of communities. A few people, in the cross-disciplinary strategist team, including the researchers, is sharing and shaping knowledge, developing instruments together in an open equal way. There is some knowledge sharing and working across between the strategists and the interior designers, but only a few interior designers knew about the instruments the strategists use. Between the architects and the strategists, there is less cross-work, and little knowledge sharing. Between the architects and the designers, there is no cooperation, and very little knowledge sharing.

5. CONCLUSIONS

If the input to the design team is vague and ambiguous, it can deceive the designers and conceal the organisation's real intentions, just as the suggestions from the design team can make the organisation and the users confused by not matching their expectations.

We have seen that boundary objects act as temporary bridges during the translation process, having a high impact on the autonomy and communication between the stakeholders from different worlds. The briefing and the design processes wherein design decisions are taken depend on the values and interests of the participants involved. The way the individuals look at the problem in the design discussions is connected with the belief and knowledge about the nature of good design practice, mixed with expertise, experience and responsibility.

A tendency, as we have seen in the study, is that people seem to be more specialized. This translates into less sharing and less cooperation in working together. People are very connected to their computers, to time pressure and the timesheet. There is no 'place on the timesheet' for knowledge sharing. An important question raised by this study is how cooperation coexists and the diversity of the constituent parts remains significant in the translation process. Another central question is how the actors act to contribute to the process of translation. Future work will examine these answers.

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7. REFERENCES

Carlsen, A., Klev, R. and von Krogh, G. (2004): *Living Knowledge. The Dynamics of Professional Service Work.* Great Britain: Palgrave Macmillan.

Clarke, A.E. and Fujimura, J. (1992): *The Right Tools for the Job: at Work in Twentieth-century Life Sciences.* Princeton, N.J.: Princeton University Press.

Fujimura, J. (1992): "Crafting Science: Standardized Packages, Boundary Objects, and Translation," in A. Pickering (ed.): *Science as Practise and Culture*, Chicago: University of Chicago Press: 168-211.

Gubrium, J. F. and Holstein, J. A. (1997): *The New Language of Qualitative Method*. England: Oxford University Press.

Holstein, J. A. and Gubrium, J. F. (1995): *The Active Interview.* London: SAGE.

Hastrup, K. and Hervik, P. (1994): *Social Experience and Anthropological Knowledge*. London: Routledge.

Hillier, B and Hanson, J. (1984): *The Social Logic of Space*. London: Cambridge University Press.

Jonassen, D.H. and Kwon, H. (2001): "Communication patterns in computer mediated versus face-to-face group problem solving," *Educational Technology Research and Development,* **49**(1), March, 35-51.

Kjølle, K., Blakstad, S.H. and Haugen, T.I. (2005): Boundary objects for design of knowledge workplaces. *Proceedings of the CIB W096 Architectural Management Conference*, Copenhagen 03.-05.11.2005.

Kvale, S. (2001): *Det kvalitative forskningsintervju.* Oslo: Gyldendahl Norsk Forlag.

Latour, B. (1987): *Science in Action.* Cambridge, Mass.: Harvard University Press.

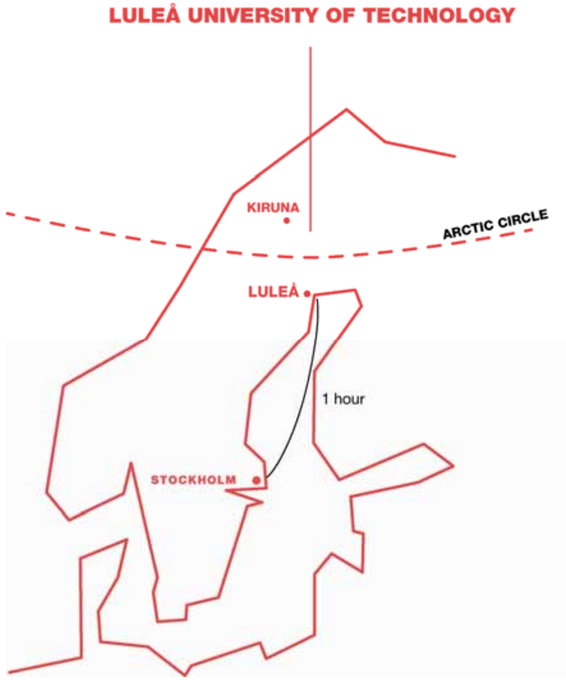
Latour, B. (1999): *Pandora's Hope: Essays on the Reality of Science Studies.* Cambridge, Mass.: Harvard University Press.

Robson, C. (2002): *Real World Research. A Resource for Social Scientists and Practitioner-Researchers.* 2nd edition. Oxford: Blackwell Publishing.

Star, S.L. and Griesemer, J.R. (1989): "Institutional Ecology, Translations, and Coherence: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-1939," *Social Studies of Science*, **19**, 387-420.

Vos, P. G. J. C., van Meel, J. J. and Dijcks, A. A. M. (1997): *The Office. The Whole Office and Nothing but the Office. A Framework of Workplace Concept.* Holland: Delft University of Technology, Department of Real Estate & Project Management.

Yin, R.K. (2003: *Case Study Research. Design and Methods.* 3rd edition. California: Sage Publications.



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