First International Conference on Construction in the 21st Century (CITC2002)
"Challenges and Opportunities in Management and Technology"
25-26 April, 2002, Miami, Florida, USA

CREATING LEAN ENTERPRISES THROUGH PROCESS ORIENTATION - MODELS FOR NEW BUSINESS OPPORTUNITIES

Christian Lindfors
Doctoral Researcher, Royal Institute of Technology, Stockholm, Sweden

Roine Leiringer
Doctoral Researcher, Royal Institute of Technology, Stockholm, Sweden

ABSTRACT
The construction industry is experiencing large and radical changes forced upon it by external influences such as changing social patterns, internationalisation, growing environmental awareness, rapid development of the IT sector, knowledgeable and demanding customers, as well as development within the industry itself. The need for organisations to adapt to this new set of circumstances is evident as companies face financial difficulties at a time when they need to come up with innovative solutions and increase their customer focus. One way of adapting – the one explored in this paper – is to make the organisation leaner. 'Lean enterprises' are resource and time efficient and agile to the point that they are able to respond to customer demands and expectations. Instead of having activities aligned according to functions, lean enterprises are organised along value chains of products or product families. This paper addresses the implementation of process thinking to the construction industry and presents a structured way of making a systematic representation of processes. It discusses initiatives, including the creation of extensive functional models that have been initiated to systematically identify processes within organisations and to create new models for more efficient enterprises. Conclusions are drawn that confirm the utility of adopting a process orientation for bringing about improvement and as a pathway towards establishing lean enterprises.

KEYWORDS
Lean Thinking, Process Orientation, Customer Focus

1. INTRODUCTION AND BACKGROUND

Although, the topic of improving the performance of the construction sector is not new, it is still very much in focus as national governments, industry bodies and individual companies routinely look at ways of raising quality, lowering costs and shortening project times (DETR, 1998; BKD, 2000). Indeed, the industry is experiencing large and radical changes forced upon it by external influences such as changing social patterns, internationalisation, growing environmental awareness, rapid development of the IT sector and more knowledgeable and demanding customers. Much has been written about the disparate and inefficient nature of the sector and concern prevails that the industry is cost driven and that too many decisions are taken on the basis of lowest cost instead of quality, safety, the environment and the actual usage of the built product. Researchers and practitioners alike have spoken of a lack of integration between design and construction and have accused the actors of having a short-term interest in buildings and other constructed facilities. Moreover, it is said that the construction sector fails to understand the needs of its customers and how to translate their needs effectively into products.

Yet, it is not unusual that overall success is achieved on individual projects, though few results seem capable of being reproduced elsewhere on a continuous basis. It has been claimed that construction project processes usually present non-routine features that do not easily lend themselves to systematic repetition (Gann and Salter, 2000).
Whilst there is little point in stating that construction is specific, as this goes for all industries, it is still important to bear in mind that the industry has its particular characteristics. Models created to achieve improvements in other industries are not likely to be successfully applied to the construction context without a certain degree of modification. However, the prevailing confusion between the process of delivery and the end product could be seen as one of the key failings of the construction sector. Even though the nature of construction makes it anything but a trivial affair, creating unique architecture and engineering solutions does not necessarily have to come hand in hand with unique procedures to achieve it. One proposed solution – and the one covered in this paper – is the implementation of process thinking into the construction industry.

The philosophy of lean thinking is high on the agenda for advocates of a modern and customer-focused construction industry. Although calls for the industry to adopt practices from the manufacturing sector are hardly new, the last decade has seen a growing academic interest in the implementation of lean production principles to construction (Koskela, 1992; Akintoye, 1995; Barlow, 1996). An area of much needed improvement is for the construction industry to recognise continuity in the building process, i.e. by defining processes and introducing relevant process measures for performance appraisals.

The aim of the paper is to address the theoretical issues of process orientation as described in the general management literature and to show how this line of thinking could be used to achieve improvement within the construction sector. The paper draws on the findings from two separate research projects undertaken at the Royal Institute of Technology, where functional modelling techniques have been used to enhance performance on an organisational as well as on a project level.

2. PROCESS ORIENTATION

Literature provides several definitions of a process. The one chosen in this paper is that of Hammer and Champy (1993), "…a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer". It has been claimed that a focus on processes, or collections of tasks and activities that together transform inputs to outputs, allows organisations to view and manage materials, information, and people in a more integrated way (Garvin, 1998). Mapping processes makes the dependencies between activities clearer, laying a foundation for organisational development and strategic management decisions. Any process orientation would thereby include elements of structure, focus, measurement, ownership and customers (Davenport, 1993). Applying this new perspective to the organisation decreases difficult functional handoffs and improves co-ordination capabilities along the product value chain. This in turn enables a lean approach to product development, production and services. A lean approach being 'lean' because it uses less of everything compared to mass production - half the human effort, half the space, half the investment in tools/machines, half the engineering hours to develop new product in half the time (Womack et al, 1990). However, this requires that an organisation's different workflows and processes are identified and modelled. Systematically identifying processes within a project organisation and particularly the interaction between them is therefore essential. A key characteristic of a process is that it is a repetitive standardised flow, i.e. it is performed multiple times. Hence, process orientation deals with designing and improving the standardised flow, which also makes it easier to measure (Nilsson, 1998).

Included in the broad concept of process orientation are a number of different approaches that adopt a process perspective on organisational development – see table1. Critique has been issued over the rather vague and ambiguous natures of these approaches. It has, for example been claimed that there is no other difference between BPR and TQM than the rhetoric that is used to present it (Green, 2001). Furthermore, several research findings point towards that individual 'attempts of implementation' fail (*ibid*.).

This paper does not try to endorse any of the approaches described in Figure 1 as being superior to the other. Instead, the approach taken is that the key focus-areas (customer focus, process focus, management focus and supplier focus) needed to create a professional process oriented champion can be identified by using examples from the various fields/approaches. These four focus areas subsequently provide the foundation on which the description of 'creating the lean enterprise' is built.

Table 1: Definitions and Descriptions of Approaches Using A Process Focus on Organisational Development

TQM	"A process which ensures maximum effectiveness and efficiency within a business and secures commercial leadership by putting in place processes and system which will promote excellence, prevent errors and ensure that every aspect of business is aligned to customer needs and advancement of business goals without duplication or waste of effort" (Pike and Barnes, 1993).
BPR	"A fundamental rethinking and radical design of business processes to achieve improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed " (Hammer and Champy, 1993).
Supply chain management	"An integrated philosophy to manage the total flow in a supply chain from supplier to end customer" (Paulson et al., 2000).
Learning organisation	"An organisation skilled at creating, acquiring and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights" (Garvin, 1993).
Lean thinking	Lean Thinking enables companies to find the best way to specify value for the customer, to identify the value stream for each product, to cause the product to flow smoothly form concept to customer, to permit the customer to pull value as needed from the producer, and to make a lean leap toward perfection (Womack and Jones, 1996).

2.1 Customer Focus

Organisations are becoming increasingly dependent on their customers and therefore have to understand present as well as future needs of the customers. Ideally they should also meet all customer requirements and strive to exceed their expectations. The different approaches (see table 1) show absolute concordances when it comes to customers. The fact that all processes start with the needs of the customer makes customer satisfaction an important measure to follow (Hammer and Champy, 1993; Davenport, 1993). Indeed processes can be considered as structures by which an organisation does what is necessary to produce value for its customers (Davenport, 1993). By analysing the process from a customer perspective, the internal ability for increasing customer value will be enhanced. Setting the goal of fulfilling customer demands and needs for the lowest price through continual improvement in which everyone is involved will go some way towards satisfying customers (Bergman and Klefsjö, 1995).

2.2 Process Focus

In contrast to a product or service focused delivery that places most of its energy on improving the end product or the service, a process approach places relatively strong emphasis on improving how work is done, (Davenport, 1993). A key aspect of a process orientation is adopting a process view of the organisation including factors such as cost, time, output quality, and customer satisfaction (*ibid*.). This structural element of processes is key to achieving the full benefits of a process orientation. A process approach starts with the identification of processes, i.e. mapping activities and their interrelated dependencies. This creates a blueprint for action and is the foundation for development and improvement related work, which leads to new or improved working methods. In this continuous process, the sequence of interrelated activities can be identified (Paulson et al, 2000). By making the organisation transparent, deviations and problems are exposed. The results are often shorter cycle times, better quality, faster results and fewer defects. From these results, processes can be changed, improved and redesigned to eliminate causes leading to deviations.

2.3 Management Focus

Identifying the activities and the necessary resources forming the organisation makes it easier to improve the overall performance of the organisation. Managing interrelated processes as a system creates a holistic view and contributes to the organisation's effectiveness and efficiency in achieving its overall goals. It is important that management focuses on flows and not on individual functions. By adapting this new perspective managers can optimise the organisation from a holistic point of view and focus on broad, inclusive processes (Davenport, 1993). The value chain is not a series of independent activities – it is a system of interdependent ones (Porter, 1985). Work integration and co-ordination is highly pertinent to organisational success, when trying to achieve a common goal and an interpretable strategy. This leaves room for reflection and analysis, time to think about strategic planning, dissection of customer needs, assessment of current work systems, and inventing new products.

“Processes that are clearly structured are amenable to measurement in a variety of dimensions. Such processes can be measured in terms of the time and cost associated with their execution” (Davenport, 1993). Analysis of data and information should form the basis for all managerial decisions and include data collected as a result of monitoring and measuring relevant sources. The organisation shall decide, collect and analyse appropriate data to demonstrate their suitability and effectiveness and to evaluate where continual improvements are best suited. There must be time for reflection and analysis. The analysis of data should provide the management with information relating customers, suppliers, human resources, financial performance and internal processes. Delegation of decision-making responsibilities should be made as close to the source of measurement as possible to decrease response times.

2.4 Supplier Focus

An organisation and its suppliers are mutually dependent of each other and a beneficial relationship enhances the ability to improve products and processes, as well as creating value for both parties. Collaborative approaches are therefore a natural way of handling supplier relationships. Active participation in mutual problem solving through the supplier group is merely an act of simple self-interest (Womack et al, 1990). Suppliers should be chosen for their speed and flexibility and not on the basis of lowest cost (Fisher, 1997). Doing so increases the organisation’s ability to achieve a culture of continual improvement and the ability to co-ordinate inter-organisational processes, as well as raising process and product quality.

3. CREATING THE LEAN ENTERPRISE

3.1 Process Identification and Definition

Identifying and defining internal processes are preconditions for creating lean enterprises. Using graphical modelling techniques for the creation of organisational process definitions increases organisational understanding and insight. One such method, which is widely used, for process definition purposes, is the IDEFØ function modelling method. This modelling method is a standardised way of developing structured graphical representations of a system or enterprise (NIST, 1993). It is designed to model decisions, actions, and activities of an organisation or system. The IDEFØ "box and arrow" graphics show the activity as a box and the interfaces to or from the activity as arrows entering or exiting the box. The ‘controls’ specify conditions required for the activity to produce the correct outputs. The ‘mechanisms’ specify resources that support the execution of the activity, e.g. personnel. ‘Inputs’ are transformed by the activity to ‘outputs’, which are the data produced by the activity.

IDEFØ models are often created as one of the first tasks of an enterprise development effort. Identification typically begins with interviews of area experts and studies of existing documentation. Hence, the modeller starts grouping together activities that are closely related or that belong to the same process phase. When an existing enterprise is being analysed, IDEFØ assists the modeller in identifying what activities are performed, what is needed to perform those activities, what is currently performed right, and what is currently performed wrong. Thus, the need of modelling the process in a formalised manner to be able to compare and refine the modelled process is supported by the IDEFØ technique (Malmström et al, 1998). Applying the IDEFØ method results in an organised representation of activities, a full understanding of the relationships between activities, conditions required for the activity to produce the correct outputs and means that support the execution of the activity.

3.2 Process Systemisation

Once the processes are identified and defined it becomes necessary to systematically order and connect them i.e. to use the process models as base structures for management information systems. Using the process models in this way enables the users to get a clearer and increasingly transparent view of the existing processes. In developing such a system, all four focus-areas explained in the earlier section, should be kept in mind. Hence, the different process phases should be organised and structured in a visual schema, lining out the sequences and the borders of the different phases. Defining the process phases in such a manner enables the creation of fixed points in the process, where decisions have to be made for the continuation of work. Furthermore, creating such a visual structure confines the actual clusters of information that are to be handled as packages that guide the daily work throughout the entire organisation. Systemising the internal processes increases organisational control and enables continuous performance appraisals and feedback, which is subsequently used to enhance and improve the system.

3.3 Process Measurement and Analysis

For most companies today, having multiple measurements for cross-functional internal business processes represents a significant improvement over existing performance measurement systems (Kaplan and Norton, 1996). The earlier described process systemisation enables process phases to be singled out and critical decision points to be defined, thereby facilitating a more stringent manner of measurement and analysis of internal processes. The defined decision points indicate where it is appropriate to measure. Measuring between phase input and outputs ensures that relevant data is captured and provides a highly pertinent capture for performance appraisal and detection of improvement areas. Typically, cost, quality, throughput, and time measures would be defined and measured for these processes (Kaplan and Norton, 1996). Measuring the internal processes supplements feedback for complementary performance appraisals, relating to customers, suppliers, human resources, and financial performance.

4. PROCESS THINKING – TWO APPROACHES

4. 1 Project Case Study

In 1996, the Swedish government initiated an investigation within the Ministry for Industry, Employment and Education with the aim to create long-term reductions in the costs for construction and maintenance of social housing. This case study[1] was conducted on one of the test projects initiated within the scope of this investigation. The main objective of the research was to measure and evaluate how an increased collaboration between client–contractor–suppliers could influence the quality of the end product and the costs of production and maintenance. The work was undertaken as 'design and build' with the construction phase running over nine months and the main actors being a regular client of the sector and a 'design build' company. The method adopted for the research was based principally on a detailed analysis of the processes supporting the housing project. Information was gathered through repeated interviews with key personnel, observations at site and through reviews of project documentation. A single model of the project was compiled from a functional decomposition of the project as whole, using a computer software based upon the IDEFØ functional modelling technique.

Overall the project was considered a success and the main actors agreed to continue their relationship in coming projects. However, a detailed analysis of the workings showed that large parts of the process were not adequately defined and assigned and that many of the time, cost and quality errors that occurred could have been avoided or kept to a minimum. The produced process model was used to pinpoint the underlying sources of the occurred errors – sometimes differing significantly from the views taken by participants.

Some of the performance failures on the project were traced back to the inadequate definition of needs and the relative ordering of priorities. One cause was that the project objectives and priorities were not recognised and shared by all members of the project team. Certain issues that were disputed by the parties during the project came as a direct consequence of misinterpretations in these early stages. Moreover, it transpired that there were actors who had not recognised the full extent of the work that lay ahead of them. The effect was that they could not fulfil their commitments and the knock-on effects from their default effectively impeded the performance of several other actors. Great effort was on the behalf of the 'design and build' company put into the control of on-site activities to minimise waste. Yet, it turned out to be difficult to assure the timely delivery of supplies and the arrival of specialists as the 'hidden' off-site activities generally were viewed as being someone else's problem. Furthermore, several failures in the performance of the buildings resulted from mistakes made at the interfaces between components and/or the organisations responsible for them. Two typical examples being insufficient assembly instructions and product information delivered by the supplier of the pre-fabricated modules to those in charge of the assembly and the lack of communication from the supplier of the floor components.

The findings show that even though the project was judged as successful it turned out to conceal plenty of unnecessary procedures and wasteful working that clearly could have been handled in a far more effective manner. A more effective construction process comes out of all parties being fully conversant with their roles and responsibilities, knowing what to expect and what to do. Furthermore, even though no quality-control regime is capable of turning a bad job into a good one, knowing the real cause of a defect can lead directly to improvement in the product, process or both.

[1] This case study is more thoroughly described in Atkin and Leiringer, 2000; and Leiringer, 2000.

4.2 Organisational Case Study

A large Swedish housing developer have through a thorough investigation into their work processes established a solution for systemising their project process[2]. The developer employs approximately 300 employees and is certified according to ISO 9001 (since 1997) and ISO 14001 (since 2000). The research[3] leading to the finished result included a pre-study, process modelling and processes systemisation through the development of a new management information system.

During the pre-study the aims and objectives of the research were clarified. It was decided to concentrate on the project process, clarifying information and communication flows (inputs and outputs), process-related resources and process related control and support documentation (routines, knowledge documents, checklists, and templates). Process activities, control and support documentation, were derived from company specific documentation, i.e. the management system, the quality management system, the environmental management system, the project control system and the operation control system. The process model was built using the IDEFØ technique, relationship matrices, the design structure matrix (DSM) method and interviews with relevant personnel. The end result being an 'as-is' process model displaying the project process and its interrelated activities.

Following the development of the process model, a new management information system was developed using the models as a base structure. The system was developed to include activities and appurtenant control and support documentation (routines, knowledge documents, checklists, and templates). The new system, integrating all project-related systems (management system, quality management system, environmental management system, project control system and operation control system) into one tool, combines the concept of project collaboration tools and quality management systems. Thus, simplifying information/documentation handling and improving system usability. By structuring the system after the project process, the flows have become increasingly transparent and clear for the actual user, guiding the daily work and facilitating information and communication exchange throughout the entire project.

Going from traditional functional management to a process management is not done over a night and the benefits gained are difficult to measure. To analyse the effects on the organisation, by the new management information system, a questionnaire survey was performed measuring the factors of perceived individual productivity, perceived work transparency and information retrieval satisfaction. During the time of the study approximately half of the employees were using the new integrated management information system (six months use) and the other half were still using the old systems. Measuring the divergence in the survey result between the two groups indicates a 15% increase in individual productivity, a 12% increase in work transparency and a 12% increase in information retrieval satisfaction by the users of the new system. The survey results indicate that benefits accrue from the use of a process oriented management information system and the emergent need for simplicity.

5. DISCUSSION

There are certain key differences that distinguish construction from manufacturing that cannot be disregarded and have to be taken into consideration in a study such as this. For example, construction projects are often geographically dispersed and most firms, their supplies and services only come together when there is a project. Furthermore, the personal incentives employed by corporations and project organisations alike tend to hinder collective development efforts. Indeed, it could be argued that the individual independence enjoyed by project managers in the construction industry inhibits a warm welcome for a 'lean and process thinking' approach.

As described in the earlier sections, identification and systemisation of processes helps single organisations as well as project organisations to become leaner and improve their performance in a number of aspects e.g. information and communication handling, waste minimisation, work productivity and work transparency. Two typical examples of insufficient information and communication identified in the project case study were the insufficient assembly instructions and the inadequate product information delivered by the supplier of the pre-fabricated modules and the

[2] All projects are performed according to the developers total package concept. Project development, product development, detailed design, production management, sales, product delivery, customer commitments and customer services, being the main stages of the total package concept.

[3] This case study is more thoroughly described in Lindfors, 2000; and Lindfors, 2001.

lack of communication from the supplier of the floor components. The findings from the case study show that the use of a defined process structure could have prevented this. This is supported by the findings in the organisational case study there a 12% increase in information retrieval satisfaction from the deployment of a process oriented management information system was achieved.

According to Gilchrist and Kibby (2000), all the major enterprises look for greater business effectiveness through improved information access or efficiencies in information retrieval, which free time for more productive use. One of the answers to information overload might be a process-oriented management information system providing a 'knowledge map' for information and communication channels and a road map to the intellectual capital. Using a well-defined process model facilitates that many time, cost and quality errors can be avoided or kept to a minimum thereby eliminating or mitigating waste. This turned out to be the case in the project case study where the produced process model was used to pinpoint the underlying sources of occurred errors. Furthermore, improved productivity and work transparency is implied in both case studies. Thus, improvements are achieved when all parties are fully acquainted with their roles and responsibilities and know what to expect and what to do. The organisational case study showed a 15% increase in individual productivity and 12% increase in work transparency from the deployment of a process oriented management information system.

As a compliment to process models, introducing relevant process measures for performance appraisals, is seen as a needed improvement for the construction industry

6. CONCLUSIONS

The research presented in this paper is based on a literature review of the current best practice within process orientation together with detailed case studies conducted on a large housing development company and a housing project. Construction is by no means a trivial affair, but the results indicate that the use of an accurate representation of the process, with the help of process models, could be used to achieve improvements on both the organisational as on the project level. Extending the scope of process orientation to comprise the customer, process, management and supplier focus groups provides a basis for further improvements. Furthermore a clear allocation of activities in processes facilitates for work to be carried through in a more effective manner. Lean thinking is about continuously striving for improvement and one cannot help but wonder if this is not the signal that the private sector needs to send to its customers. Further research should therefore be put into attaining empirical validity of the theoretical discussion given in this paper.

7. REFERENCES

Akintoye, A. (1995). "Just-in-time application and implementation for building material management". *Construction Management and Economics*, (13), pp 105-113.

Atkin, B. and Leiringer, R. (2000). "Achieving Project Success in Building: A Best Practice Guide", Från byggsekt till byggsektor, Part 2, *Swedish Government Official Reports (SOU) 2000:44*, Fritzes Offentliga Publikationer, Stockholm, Sweden, pp91-132.

Barlow, J. (1996). "Partnering, lean production and the high performance workplace", *Proceedings 4th Annual Conference International Group for lean Construction*, IGLC-4, Birmingham, England.

Bergman, B. and Klefsjö, B. (1995). *Kvalitet – från behov till användning*, 3rd edition, Studentlitteratur, Lund, Sweden.

BKD (2000). Från byggsekt till byggsektor, Byggkostnadsdelegationens betänkande, *Swedish Government Official Reports (SOU) 2000:44*, Fritzes Offentliga Publikationer, Stockholm, Sweden.

Davenport, T.H. (1993). *Process innovation: reengineering work through information technology*, Harvard Business School Press, Boston, USA.

DETR. (1998). *Rethinking Construction*, Department of the Environment, Transport and the Regions, London, UK.

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

Garvin, D.A. (1993). "Building a learning organization". *Harvard Business Review*, July-August, pp. 78-81.

Green, S.D. (2001). “Towards a critical agenda in construction management”, *Proceedings CIB World Building Congress*, Wellington, New Zealand, April.

Gilchrist, A. and Kibby, P. (2000). *Taxonomies for business: access and connectivity in a wired world*, TFPL ltd, London, U.K.

Fisher, M. (1997). “What is the right supply chain for your product”. *Harvard Business Review*, March-April, pp.105-116.

Hammer, M. and Champy, J. (1993). *Reengineering the corporation – a manifesto for business revolution*, Nicholas Brealey Publishing, London, U.K.

Kaplan, R.S. and Norton, D.P. (1996). *Translating strategy into action – The balanced scorecard*, Harvard Business School Press, Boston, Massachusetts, USA.

Koskela, L. (1992). Application of the new production philosophy to construction, *Technical Report No. 72*, CIFE, Stanford University, Stanford, USA.

Leiringer, R. (2000). “Integrating the efforts of off-site production with on-site construction”, *Proceedings of the 17th IAARC/CIB/IEEE/IFAC/IFR International Symposium on Automation and Robotics in Construction*, Taipei, Taiwan, Sept 18-20, 2000, pp. 665-670.

Lindfors, C. (2000). “Value chain management in construction: modelling the process of housebuilding”, *Proceedings of International Conference on Construction Information Technology CIT2000*, The CIB-W78, IABSE, EG-SEA-AI, Reykjavik, Iceland, pp. 575-583.

Lindfors, C. (2001). “Process orientation: An approach for organisations to function effectively”, *Proceedings of the Ninth International Group for Lean Construction Conference*, National University of Singapore, Singapore, August 6-8, pp. 435-446.

Malmström, J., Pikosz, P. and Malmqvist, J. (1998). “The complementary roles of IDEFØ and DSM for the modelling of information management processes”, *Proceedings of the Fifth ISPE International Conference on Concurrent Engineering: Research and Applications*, Tokyo, Japan, pp. 261-270.

Nilsson, G. (1998). “Process orientation, integration of work teams and management control”, *Proceedings of the 4th International Seminar on Manufacturing Accounting Research*, Kolding, Denmark, June 10-12.

NIST. (1993). Integrated Definition for Function Modelling (IDEFØ), *Federal Information Processing Standards (FIPS) Publication 183*. National Institute of Standards and Technology, Gaithersburg, USA

Paulson, U., Nilsson, C.-H., and Tryggestad, K. (2000). Från funktionsbaserade till flödesorienterade aktiviteter, in U. Paulson, C.–H. Nilsson and K. Tryggestad (eds) *Flödesekonomi – supply chain management*, Studentlitteratur, Lund, Sweden, pp. 17-43.

Pike, J. and Barnes, R. (1993). *TQM in Action: A Practical Approach to Continuous Performance Improvement*, Chapman & Hall, London, UK.

Porter, M.E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*, NY: The Free Press, New York, USA.

Womack, J.P., Jones, D.T. and Roos, D. (1990). *The machine that changed the world*, Rawson Associates, New York, USA.

Womack, J. P. and Jones, D.T. (1996). *Lean Thinking: Banish Waste and Create Wealth in your Corporation*, Simon and Schuster, New York, USA.