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A conceptual framework for mobile value chains

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ABSTRACT

In order to meet automotive manufacturer's demands, component suppliers like RCT must operate their value chains extremely efficiently and be able to rapidly establish new value chains at different locations (*mobile* value chains). This report aims at supporting such suppliers by providing a conceptual framework with principles and guidelines.

The framework takes into consideration trends in the automotive industry like globalisation, consolidation, platform use, shorter product lifecycles, use of alternative materials, Extended Enterprise principles and information technology. While suppliers become increasingly more powerful, they also must fulfil extreme requirements regarding product quality, delivery performance, cost efficiency, continuous improvement and technological competence.

The framework links corporate strategy to operations strategy through *competitive priorities* and presents the three decision areas *operations strategy and design*, *Extended Enterprise design* and *Extended Enterprise operations*. It then recommends focusing on *performance measurement* and points out important issues when designing a performance measurement system. Next, the use of an *operations model* is introduced as the key to efficient operations management. The importance of approaching difficult decisions systematically is emphasised and extensive use of *decision support tools* recommended. Finally, some qualitative localisation factors are presented and knowledge management systems defined.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	logistics	logistikk
GROUP 2	car component supplier	bilindustri
SELECTED BY AUTHOR	operation model	styringsmodell
	decision support	beslutningsstøtte

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1 Introduction

This report is the first of a series of SMARTLOG deliverables to the Norwegian company Raufoss Chassis Technology (RCT). Its findings can, however, be useful also to other component manufacturers within the scope described in chapter 2. Large parts of the report are taken from first results from the MOMENT project.

Funded by the European Community, the MOMENT project aims at developing and applying a methodology to support rapid establishment and efficient operations of new Extended Enterprises in the European automotive and electronics supplier industry. At early stages of the project, the MOMENT conceptual framework was developed containing guidelines and principles for the development and operations of Extended Enterprises. The attribute "mobile" in the title of this report refers to value chains that rapidly and efficiently can be transformed or even copied to other geographical locations if required. This is exactly the scope of MOMENT, which stands for MObile Extended Manufacturing ENTerprise. At later stages, the MOMENT project is going to develop tools supporting the concepts and principles established in the framework.

2 Scope

This framework is developed for manufacturing enterprises that are positioned as suppliers in the value chain, with a focus on suppliers to the automotive industry. It shall be suitable for enterprises that deliver high-volume products or components to industrial customers. Products in this type of manufacturing are typically customer-specific and developed together with the customer, and the collaboration with customers is typically based on a long-term contract that specifies price, product features, delivery terms and information sharing. The demand for products is regulated by the contract, and can be characterised as stable and predictable.

Furthermore, the framework addresses manufacturers that are establishing and operating a network of geographically distributed enterprises. It is particularly suitable for manufacturing networks where several enterprises are being established to produce almost identical products to globally distributed OEMs.

Figure 1 shows the framework's Extended Enterprises perspective, which includes suppliers, carriers, warehouses and customers. Each value chain is seen and modelled from a focal enterprise's point of view. While considering the whole value chain, the project limits itself to Operations Models that include the closest customers and suppliers of the focal enterprise. The focal enterprise could be any supplier in a value chain, and one value chain can in principles be controlled by series of Operations Model that communicate with each other.

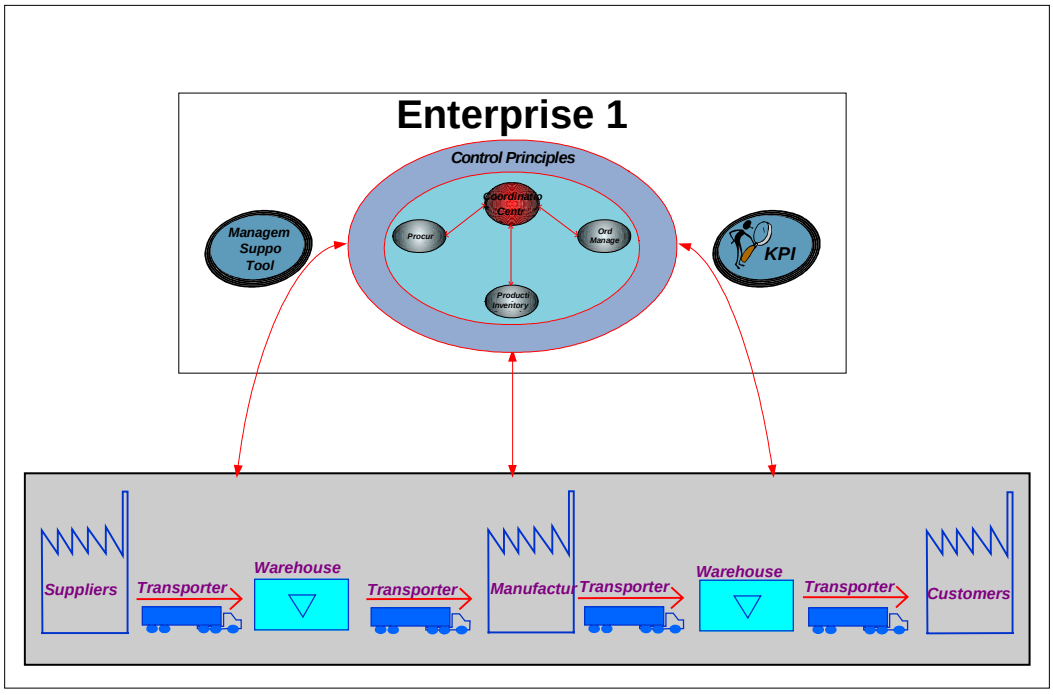

Figure 1: Operations management in Extended Enterprises

3 Status in the automotive industry

3.1 Market situation

The global automotive market of today could be split into six geographical markets, three of which are high volume markets close to maturity (North America, West Europe and Japan plus Australia) and three of which are developing, long-term growth markets (developing Asia, East Europe and South America). In the global automotive market, six main "global actors" can be identified GM, Ford Motor, Toyota Motor, Volkswagen, Daimler Chrysler and Renault. In addition, further nine automotive manufactures of scale can be identified: Fiat and PSA, Honda, Hyundai Group (including Kia), Mitsubishi, Daewoo Motor, BMW, Suzuki and Subaru. These nine manufactures are without the scope to be individually global, but still pursue selective internationalisation strategies based on their current market position and perceived strengths. The total global excess production capacity in the automotive industry is estimated at 24 million units yearly– the equivalent of 96 modern assembly plants and a considerable fixed overhead.

3.2 Production strategies

Three elements seem to be of dominant importance regarding production strategies in the automotive industry: Globalisation, Consolidation and Platform Use. Two different "globalisation strategies" do exist: The "Global Balance" approach, in which production distribution is built in line with the perceived regional share of global output. And secondly, the approach that combines national market dominance with strategic, global goals (GM, Ford, Toyota and VW). Consolidation aims to decrease the cost base supporting relatively stable volume, usually through the elimination of duplicate / redundant assets, such as the number of production facilities and suppliers. Platform-Use strategy aims to provide a wider end-product range across a smaller number of basic design structures, thereby leveraging development and other costs for a presumably greater volume opportunity. Standardisation is the one tool that explains the basic purpose of the topic "platform use".

3.3 Product strategies

Looking at the product lifecycles of automobiles[1] today, a continuous trend to shorter lifecycles can be seen. Nearly all types of automobiles have a much shorter time to market development phase and when one type is entering the market the next successor is already being developed. The shorter product lifecycle of automobiles puts increasing pressures on all partners involved in the development process of new automobiles. Today OEMs are forced to calculate with very short product life cycles and have to adapt these changes when starting the development process.

3.4 Environmental and material use strategies

Strategies concerning the environmental aspects in automobile manufacturing are becoming more and more important. The manner of how the automotive industry is dealing with environmental issues has become an important competitive factor. Life cycle issues, the use of modern materials and the term of recycling are becoming increasingly important when selling automobiles to the customer. The automotive industry is seeking to reduce the environmental impacts caused by transport and the use of aluminium in automobiles can help to meet this challenge. Aluminium provides lightweight, improved performance and improved safety. The global use of aluminium in the automotive industry has increased from 2,5 million tonnes in 1991 to nearly 4,5 million tonnes

[1] The product life cycle of the automobile is that period of time in which the automobile itself is being produced. On the other hand, the life cycle of the automobile is that period of time that goes from its production to the end of its life, i.e. the end of the recycling process.

in 1999. The use of aluminium in automobiles is predicted to double because of more cars worldwide and the more aluminium in automobiles.

3.5 Extended enterprise strategies

Significant changes are about to take place in the value chain in the automotive industry, and most OEMs have already started to reconfigure their value chains into networks. By outsourcing core competencies to the most efficient and most capable member of such a value network, highly efficient extended enterprises are achieved. It is very important to be aware of the increased responsibility for the final product that suppliers do have today.

The OEMs have been developing great efforts towards lean production, not only in terms of the manufacturing processes but also in terms of the size of the assembly plants. They are simultaneously transferring responsibilities in terms of the development of parts and, more importantly, the design and assembly of systems and modules in standardised platforms. On the other hand, the combination of the strategic advantages of production based on economies of scale with fleet complementing commercial strategies and the exploitation of niche has been encouraging the tendency for OEM agglomeration. More specifically, suppliers' positioning seem ever more dependent on the undertaking of activities that are being abandoned by OEMs. As such, the capability to development and integrate components is a crucial medium-term success factor. The automotive industry value chain is well on its way to being transformed from push to pull. However, the automotive value chain reinvention on the horizon may deliver the single largest benefit and at the same time the most critical challenge the automotive industry has ever faced. Forming collaborative value chains will be critical for future success, regardless of which value chain discipline a company focuses on. In fact, companies will need to form multiple value chains around multiple parameters. A technology and process plug-and-play capability will be an important success factor, as companies need to plug into and integrate with multiple systems and processes across multiple entities.

3.6 Information and communication technologies

The use of the Internet as a means to bring players closer will contribute towards this industry's re-organisation and that of its relationship typology. The impact of e-business on the automobile industry has still to be determined but it cannot be disregarded: the potential application of technologies that permit business to be carried out via internet is significant, reaching in 2005, in this industry's global value chain, potential savings of 174 000 million dollars annually, according to projections from the Automotive Consulting Group. As an example of technologies supporting e-business, the Covisint electronic platform is designed to be a central hub where OEMs and suppliers could come together to do business in single business environment using the same tools and user interface; one of its major benefits is that non-EDI-user suppliers can communicate through the web with their OEM or trading partners in the SC. Daimler Chrysler intends to spend more that three billion US dollars on future developments of this system; it is not the only alternative, though: BMW and VW, just to mention, have chosen private exchanges instead of systems like Covisint. When taking into consideration the future of supply chain management in the automotive industry, however, it is also essential to take the efforts of ERP vendors into account. Solutions for supply chain management within ERP systems like the initiative mySAP.com from the SAP AG tend to synchronise all parts and participants of the supply chain by defining new functionalities, processes and interfaces. This initiative combines the R/3 version of SAP with several enhancements like for example the SAP Advanced Planner and Optimizer (SAP APO).

4 Challenges for suppliers to the automotive industry: example Raufoss Chassis Technology

Raufoss Chassis Technology (RCT) has defined its role to be a supplier to the automotive industry. It acts as a 1st or 2nd tier supplier to the Original Equipment Manufacturers (OEMs) and has focused its strategy on being a World-Class supplier of lightweight wheel suspension components.

This strategic focus has several consequences.

- The market is strongly limited (automotive and only a small selection of components)
- The components are crucial regarding safety and lifetime of the cars
- RCT will normally achieve Single Source Life Time contracts for car models
- RCT must in the bidding phase compete against alternatives in other material (like steel) that normally are cheaper in material cost and well proven by decades of use
- RCT must adapt to the contract concept of the Automotive Industry implying yearly price reductions.

This again leads to the following:

- RCT must fulfil extreme requirements regarding product quality of own produced parts as well as purchased sub-components
- RCT must fulfil extreme requirements regarding delivery performance
- The location of RCT plants is strongly influenced by the OEMs location of assembly plants
- RCT must from Start of Production (SOP) until End of Model Lifetime be able to operate its plants extremely cost effectively
- Continuous improvement is a must since prices are decreasing by contract every year.
- RCT must thoroughly understand the automotive business, and have strong competence of the functional requirements for components that are supplied.

The combination of these demands, the high volumes of identical parts, and the fully automated manufacturing, makes RCT very vulnerable to any kind of disturbances. From the Operations perspective of the company the overall competitiveness is dependent on the ability to manufacture and deliver with:

- Zero defects
- Full delivery precision
- Fast response to changes
- Correct and speedy information flow

To be able to achieve its business goals, RCT must make continuous efforts to reduce total costs. With logistics contributing with 60 % to the total costs, excellence in this area is a must. From a logistics point of view, the main challenges are:

- No defects or deviations are allowed in the logistics process (quantity, delivery time windows, labelling, etc)
- The extreme speed of production and delivery, combined with limited space and equipment for storage allows no stop of flow to make corrections
- Information-process and -quality vary between the receiving plants of the customer GM in format, technical mean (fax, e-mail and EDI), frequency, time horizon, accuracy.

5 Concepts

This chapter describes some of the concepts and terminology that are central in the conceptual framework presented in chapter 5. The framework's main concern is Operations Management in Extended Enterprises. Operations is traditionally viewed as a transformation process, where input such as human resources (workers, managers etc), facilities (buildings, machines, equipment etc), as well as materials, technology, and information are *transformed* into outputs such as products and services[2].

The main grouping of concepts are as follows. *Operations strategy*: How to develop operations that provide competitive advantages for a manufacturing company; *Operations management*: how to develop efficient operations in Extended Enterprises; and *Industrialisation*: how to establish a systematic process for the development and localisation of new products and processes. Finally, some key terms are presented.

5.1 Operations strategy

Operations must develop capabilities or core competencies that support the corporate strategy and provide for competitive advantages. Strategy is a long range plan or vision for a business[2]. Formulating effective strategies requires an operations response to be developed that is consistent with the understanding of the market, its customer segments and the requirements of these segments. But the corporate strategy would not be very successful if there is a misalignment between the intention and the capabilities of the company. The formulation of a corporate strategy involves defining a primary task or mission, assessing core competencies, determining order-winning and order-qualifying criteria, and positioning the company in the marketplace[3]. An effective corporate strategy considers the strengths and weaknesses of the company, and the competitive situation (customer requirement in different markets, the position of competitors, taxes, regulations etc), and determines how the company will compete in the market place.

The operations strategy is the plan or set of decisions that specifies how operations can provide competitive advantages for a company[3]. The operations strategy is linked to the corporate strategy through competitive priorities (costs, quality, delivery, flexibility etc) that enable products to qualify and win orders in the marketplace. The set of decisions that are considered in a operations strategy may include facilities, production processes and technology, sourcing and make-or-buy choices, organisation, production planning and control, and value chain collaboration.

The strategy formulation will be an ongoing process, as the customer requirements (and thereby the order-winning criteria) are market and time specific, and depends on the actual competitive situation. One year a company might win orders by providing improved delivery times, the following year they will have to continue to provide this delivery time in order to qualify for the market. Each market/product combination requires operations that enable the product to win orders in the current competitive situation.

5.2 Operations management in Extended Enterprises

Operations Management tries to ensure that the transformation process is performed efficiently and that the output is of greater value for the customer than the sum of inputs. Thus, operations can be defined as the process that transforms inputs into outputs of greater value[4, 5, 6].

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[2] Reid, R. & Sanders, N (2002) ”Operations Management” John Wiley & Sons.
[3] Rusell, R & Taylor III, B (1998) ”Operations Management – Focusing on quality and competiveness” Prentice Hall
[4] Hanna, M.D. & Newman, W.R.(2001) ”Integrated Operations Management – adding value for customers”, Prentice hall
[5] Rusell, R & Taylor III, B (1998) ”Operations Management – Focusing on quality and competiveness” Prentice Hall
[6] Meredith, J.R. & Shafer, S.M (2002) ”Operations Management for MBAs” John Wiley & Sons

Operations Management is the organisation and control of processes that are needed to produce a company's goods and services. Operations Management is directly responsible for the satisfaction of customers through activities that include [4]:

- the design of the physical transformation processes that provides the specific value a customer desires
- the design of concepts and systems for planning and controlling the physical work, and the material and information flows within those transformation processes
- the design of systems for monitoring and improving the company's effectiveness in satisfying customers
- the effective operation of the planning and control systems to create products or services that satisfy customers

For Operations Management to be successful, it must add value during the transformation process[2]. The value is created for a customer that receives the products or services, and a network of suppliers and customers is linked together in order to satisfy the final customer. In other words, every manufacturing plant is situated in a *value chain*, defined as the network of actors that are involved, through upstream and downstream linkages, in the different processes that produce value in the form of products and services for end consumers.

A value chain spans from the initial source of raw materials to the end-consumer of the product and encompasses all the intermediate processes of manufacturing, transport and storage. Each actor (plant, warehouse, carrier etc.) in the value chain acts as a customer as well as supplier. An actor receives (buys) unfinished goods from upstream suppliers and transforms the products to a higher value and passes (sell) them to the next actor downstream the chain. Implicit in this definition of the value chain is the fact that value chains exists whether they are managed as chains or not. Even if none of the actors involved implements solutions that enables them to control the value chain, the value chain – as a phenomenon of business – still exists.

Today, there are two predominant perspectives of the value chain, the *Supply Chain* and the *Extended Enterprise*, which difference is rooted in their focus in the transformation process. While the Supply Chain perspective focuses on the supply aspect of value creating (transport and storage), the Extended Enterprise perspective emphasis the physical transformation of products (manufacturing).

The Supply Chain is a set of independent enterprises that are linked together by the flow of materials, information and money between them[7]. A major contribution from the supply chain perspective is that each company in a chain is dependent on each other and yet paradoxically by tradition does not closely co-operate with each other. Supply Chain Management has been an integral part of Operations Management theory since the 1980s, and entails co-ordination with customers and suppliers[7]. Supply Chain Management can be defined as the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole[8]. Competitiveness can be achieved through chain integration and process redesign that enables reductions of stock and quick response to customer demand.

The Extended Enterprise is a set of enterprises with processes that are jointly involved in the manufacturing of a product. The Extended Enterprise perspective emphasises that manufacturing

[7] Jagdev, H.S. & Thoben, K.D. (2001) "Anatomy of enterprise collaborations" In Production Planning and Control, vol 12, no. 5, pp. 437-451.
[8] Christopher, M. (1998) "Logistics and supply chain management – Strategies for reducing cost and improving service" Pitman publishing

systems are no longer confined to a single factory, but cross enterprise boundaries. Thus, manufacturers, who solely focus on improving their internal processes, have little influence over a significant part of the manufacturing of their product[7]. The core concept of the Extended Enterprise is that "the Extended Enterprise can no longer treat their suppliers and customers as them, they are all now part of larger us"[9]. Manufacturers therefor need to create integrated manufacturing systems that are extended to value chain partners.

Extended Enterprise collaboration can occur between any two or more enterprises across the value chain, and requires a closer integration than Supply Chain collaboration [7]. The development of an fully integrated Extended Enterprise can be defined as "the formation of closer co-ordination in the design, development, costing, and the co-ordination of the respective manufacturing schedules of co-operating independent manufacturing enterprises and related suppliers"[10]. The key word in this definition is the "co-ordination of respective manufacturing schedules". An efficient Extended Enterprise requires that production schedules, dispatch, transportation/delivery, and receipt notifications are co-ordinated within and across company boarders. The task of Extended Enterprise (Operations) Management is therefor to organise and control the total manufacturing system so that internal and external processes are performed efficiently and are responsive to customer demands.

The Operations Management in Extended Enterprises can be executed through a computerised *Operations Model*. The Operation Model is a representation of the operations in Extended Enterprises, and also an ICT-tool that ensures efficient and co-ordinated control, and real-time information and communication, in Extended Enterprises. The Operation Model gives access to on-line and structured information regarding all processes, performance and status in the Extended Enterprise, and can be used to view current or future states of the Extended Enterprise. The Operations Model also contains tools and directions for management, collaboration, and control in the Extended Enterprise.

5.3 Industrialisation

To be able to compete, suppliers are not only required to run their existing operations very efficiently. To win new contracts, they are also required to be fast and efficient in their *industrialisation* process, i.e. the entire development process from market opportunity to start of production.

An industrialisation process involves all the process steps from the identification of a market opportunity for a component, until start of production. Efficient industrialisation processes require that each step are carried out systematically, so that the right decisions are made at the right time, and development processes from different departments (product development, manufacturing, logistics etc) are integrated.

An established model of the industrialisation process in the automotive industry is the Advanced Product Quality Planning (APQP) process developed by Chrysler, Ford and General Motors. It is a structured method of defining and establishing the steps necessary to assure that a product satisfies the OEM. However, it doesn't sufficiently consider the supplier aspects of industrialisation processes. Moreover, the APQP process is a textual description, and does not provide suppliers with the necessary support to carry out industrialisation processes efficiently.

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[9] Browne, J., Sackett, P.J. and Wortmann, J.C. (1995) "Future manufacturing systems - Towards the extended enterprise", Computers in Industry, Vol. 25, pp 235-254.

[10] Jagdev, H.S. & Browne, J. (1998) "The extended Enterprise: a context for manufacturing" Production planning and control, Vol 9, No 3, pp. 216-229.

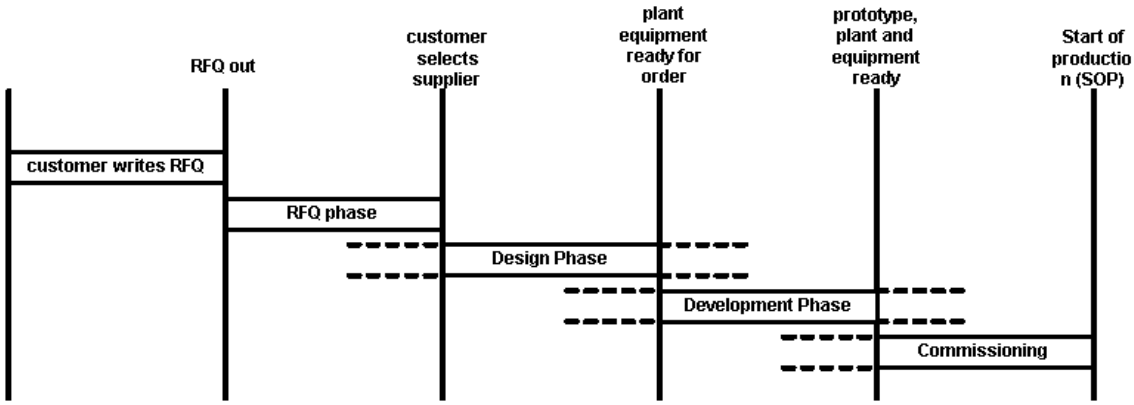

Figure 2: A way of organising the industrialisation process

While an industrialisation process is different in every case, we here organise it into several phases (see Figure 2).

The RFQ phase
First, an OEM writes a "request for quotation" (RFQ) for a new component. This document specifies requirements for the component and its future supplier. Potential suppliers are now officially invited to write an offer (a quotation) containing price, contract conditions, product specifications, quality standards and other relevant information. If the OEM is interested in the offer made by a certain supplier, details are negotiated and a long-term contract is written and signed.

The design phase
The design phase starts with the signing of the contract and includes the design of the component, production facilities and equipment.

The development phase
The development phase includes the construction of facilities, installation of equipment, product and process design reviews, error detection and elimination as well as the development of operations management.

The commissioning phase
In the commissioning phase, the final step before production, earlier selected operational staff receives training at the new equipment, and the factory is prepared for serial production. Finally, operations take over and serial production as well as delivery to the customer begins.

The industrialisation process may be simplified when the process is supported by an ICT-tool that enables analysis and well-considered strategic decisions. The industrialisation process may also be simplified when existing tools, processes, and ICT-systems can be easily transferred to a new plant in a new value chain. In such industrialisation processes, the Extended Enterprise is *mobile* in the sense that processes and knowledge in existing Extended Enterprises can be rapidly transferred and implemented at new locations. Suppliers can develop this mobility by standardising their KPIs, operations and control in an ICT-based Operations Model that can be utilised at new sites. The MOMENT project intends to provide such a model.

5.4 Key terms

Operations is the process that transforms inputs into outputs of greater value.

Operations Management is the organisation and control of processes that are needed to produce a company's goods and services.

A value chain is the network of actors that are involved, through upstream and downstream linkages, in the different processes that produce value in the form of products and services for end consumers.

The Supply Chain is a set of independent enterprises that are linked together by the flow of materials, information and money between them.

Supply Chain Management is the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole

The Extended Enterprise is a set of enterprises with processes that are jointly involved in the manufacturing of a product.

Extended Enterprise (Operations) Management is the organisation and control of the total manufacturing system so that internal and external processes are performed efficiently and are responsive to customer demands.

The Operation Model is a representation of the operations in Extended Enterprises, and also an ICT-tool that ensures efficient and co-ordinated control, and real-time information and communication, in Extended Enterprises

The Operations strategy is the plan or set of decisions that specifies how operations can provide competitive advantages for a company.

The industrialisation process is the entire development process from market opportunity to start of production.

The Advanced Product Quality Planning (APQP) process is an established model of the industrialisation process in automotive industry, which defines OEM requirements of products and processes in all the steps from Request For Quotation to Start Of Production.

Mobile Extended Manufacturing Enterprises are Extended Enterprises with processes and knowledge that can be rapidly transferred and implemented at new locations.

6 The MOMENT conceptual framework for mobile value chains

6.1 Introduction

This framework was developed in the MOMENT project as a first step towards a methodology providing companies with a systematic approach for the establishment and operations of Extended Enterprises. The methodology is limited to operations management and will cover the decisions related to the physical transformation process, systems for planning and control, systems for monitoring and control, and the effective operations of planning and control to create products that satisfy customers. It will also cover the introduction of new products, i.e. the industrialisation process, and how operations should adapt to changes in the product mix when products are developed.

6.2 Decision areas

Figure 3 shows the major decision areas in the MOMENT conceptual framework, and how they are linked to corporate strategy, products and customer requirements. The figure shows that the operations strategy guides the establishment, design and operations of a set of Extended Enterprises. The three decision areas (*operations strategy and design, Extended Enterprise design* and *Extended Enterprise operations)* are described below.

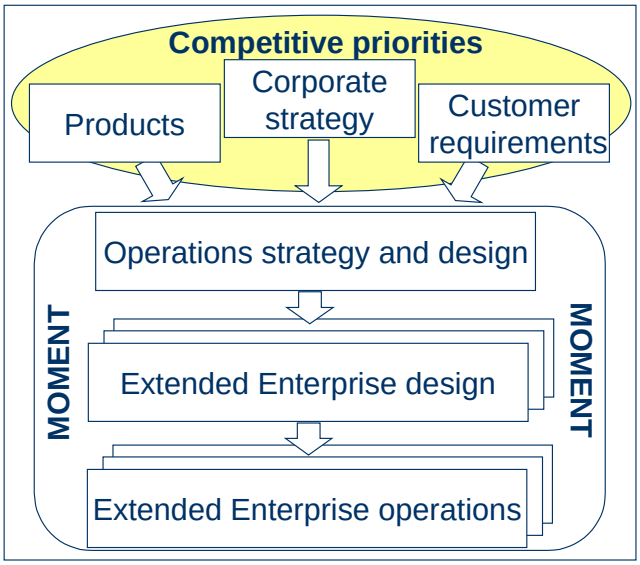

Figure 3: The decision areas in the MOMENT conceptual framework

6.2.1 Competitive priorities

The development of an efficient set of Extended Enterprises requires that operations be linked to the corporate strategy. The corporate strategy considers the strengths and weaknesses of the company, its competitive situation (customer requirement in different markets, the position of competitors, taxes, regulations, etc.) and determines how the company will compete in the market place. Operations Management is linked to the corporate strategy through competitive priorities (costs, quality, delivery, flexibility, etc.) that enable the company to gain advantage over competitors. Customer requirements can be different for different products and markets, and the choice of competitive priorities should be based on the actual competitive situation for a certain product or product group.

The competitive priorities for different products and markets are guidelines for the company operations strategy. The corporate strategy is translated into a operations strategy that aims to

develop the required capabilities through strategic decisions regarding facilities, production processes and technology, sourcing and make-or-buy choices, organisation, production planning and control, and value chain collaboration. The operations strategy formulation is an ongoing process as new products are industrialised, and/or the global competitive situation changes.

6.2.2 Operations strategy and design

This area focuses on the physical structure of a company's global manufacturing operations, and involves the following:

- Determine the locations and capacities of manufacturing enterprises
- Determine the logistics structure, i.e. distribution requirements, modes of transportation, warehouses, and suppliers
- Determine how industrialisation processes should evolve, and how new products/contracts should be incorporated in the existing product mix of the company.

6.2.3 Extended Enterprise design

This area focuses on the design or redesign of a particular Extended Enterprise through the development of an Operations Model. Decisions taken involves the following:

- Determine the control principles, layout, KPIs and inventory levels for the Extended Enterprise
- Configure the systems for controlling the physical transformation processes and the material flows within those transformation processes
- Configure the systems for monitoring and improving the Extended Enterprise's effectiveness in satisfying customers.

6.2.4 Extended Enterprise operations

This area involves the effective operation of the planning and control systems to create products or services that satisfy customers. The goals are to:

- Implement the Operations Model successfully
- Develop the skills and competence in Operations Management through training and education of employees.

6.3 Key performance indicators

Performance measurement provides information about how well a process is being conducted, either in a single enterprise or within a value chain, and how good the results from a process are. The availability of relevant performance data about the processes in a value chain is important for strategic decisions about the establishment of new plants, and also for transforming plants and their partners into Extended Manufacturing Enterprises with highly efficient operations. In many cases an organisation collects a considerable number of performance indicators. These performance indicators are then aggregated up to a small number of Key Performance Indicators (KPIs).

In terms of single-enterprise performance indicators, work has been performed in the ESPRIT project AMBITE, and the ESPRIT project ENAPS. Other ESPRIT and later IST projects have looked into performance indicators for specific industrial sectors and types of enterprises, but despite extensive searching very little work has been uncovered on supply chain performance measurement indicators. A singular exception is the work undertaken by the Supply Chain Council in the development of the SCOR model, which also includes some performance indicators.

Figure 4 illustrates the use of performance indicators when establishing and operating Extended Enterprises.

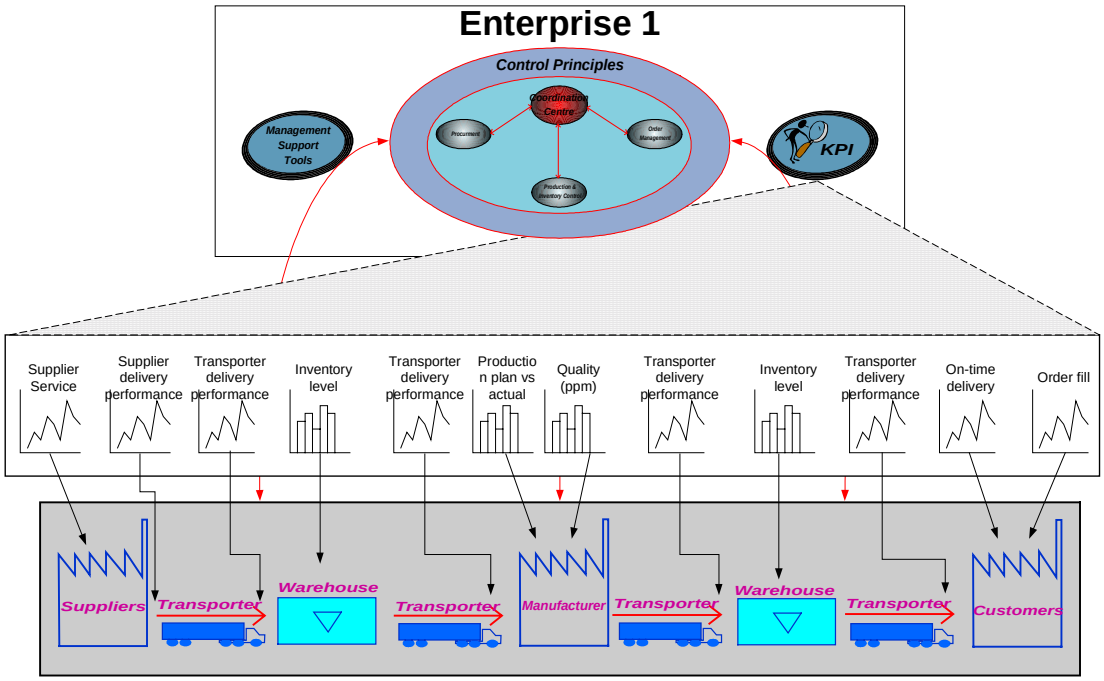

Figure 4: Performance Indicators in Extended Enterprises

There are many reasons why companies should measure performance in their organisation. Performance data can:

- provide a general information basis that can give feedback on the work being performed, and even more importantly be exploited for decision-making purposes, both for management and for all levels of employees
- monitor the development over time, i.e., the performance trend
- identify business processes, areas, departments that need to be improved and assess success of improvement projects
- form the basis for benchmarking against other organisations, either competitors or others.
- help motivate the organisation through the feedback it can provide to individuals and departments.

When designing performance measurement systems, the following issues are important:

- Use a balanced set of indicators in order to understand the performance of the process. Often, non-financial measures are more appropriate to reflect performance of key processes.
- Identify a few, but highly significant, indicators that support the control of the operations throughout the value chain. Measure what is important, and not all that is measurable.
- Find some of these KPIs (1-5) that can give an overall picture of how the company operates.
- Expand the view from internally to externally, and measure along the value chain (e.g. measuring precision of collaborative planning or accumulative stock-levels in the Extended Enterprise).
- Define KPIs for strategic decisions supporting the establishment and optimisation of Extended Enterprises. These long-term activities require that the basic KPI set be integrated with KPIs for investment and strategic analysis, as well as KPIs measuring social, regional and environmental factors.
- While traditionally measurement has had a historical perspective (lag), KPIs should support operations and demand management as well. That is, they should support decision-makers in their control of the Extended Enterprise by providing forward-looking information and acting as an early warning system (lead).
- Display the KPIs online, with real-time information.

6.4 Operations model

The Extended Enterprise should have an on-line operations model containing control principles and process descriptions. It should visualise processes, structures, flow of materials and flow of information. It should further give access to on-line and real-time information regarding all processes, performance and status in the Extended Enterprise. It should have direct links to all the software applications used in operations. Finally, decision support tools, learning tools and guidelines should also be included. Figure 5 shows a generic operations model.

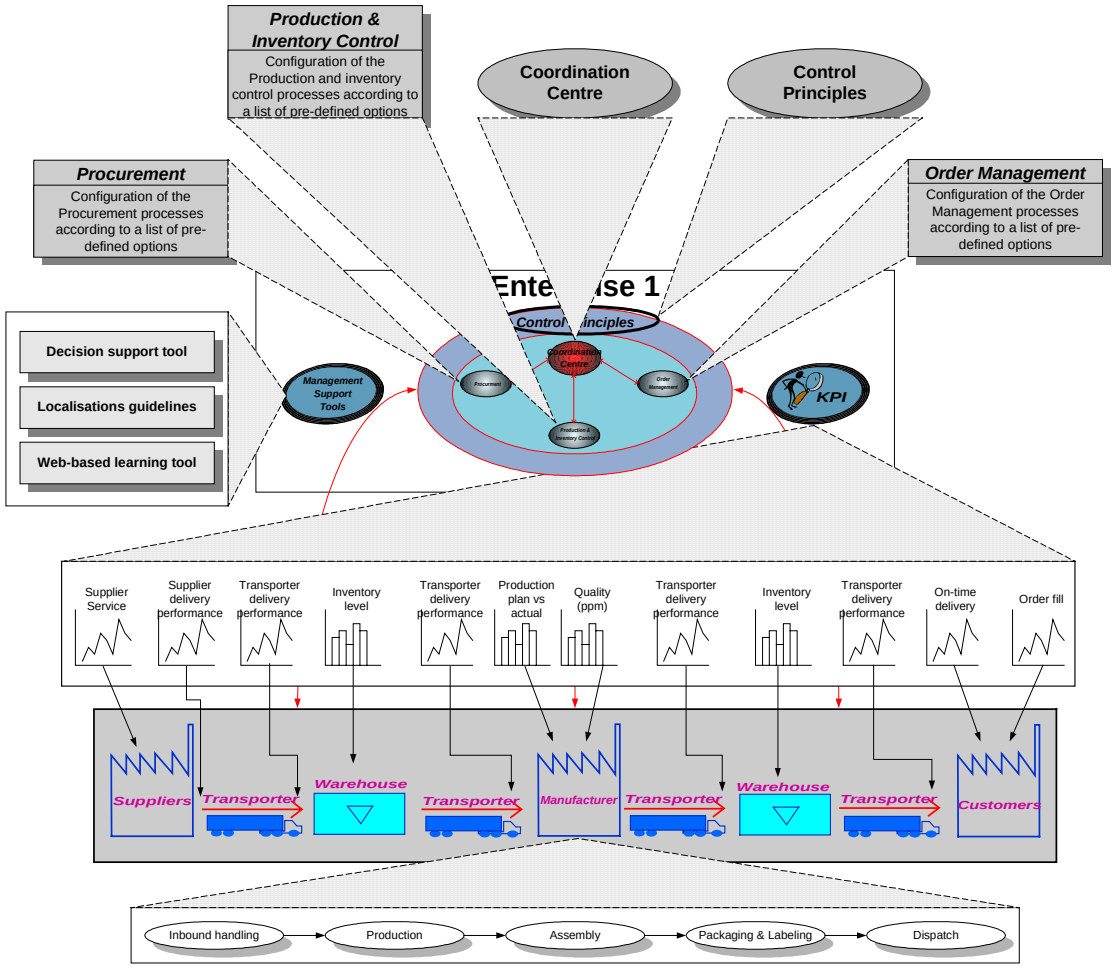

Figure 5: The MOMENT operations model template

The rationale for establishing such a model is:

- To have a common description with all the relevant information about the operations in the value chain.
- To secure that all description and information is stored once and only once, and is globally available in real-time to all personnel involved.
- To create one single information pool whose flat structure with cross-linking and hypertext features is preferred to the more traditional hierarchical- and partition-based one. This makes the user's information quest process more time- and cost-efficient.
- To enable multimedia technical support, helpful in a wide range of situations (e.g. machinery breakdown or machinery upgrading design, etc.)
- To use it as a tool for future development of the value chain as well as developing operations itself
- To use it as a learning tool for new employees

The operations model should be established in a continuous process through the different stages of an industrialisation project. When in use, it should be easily accessible to all personnel involved.

Typically, the model consists of five actors:
- suppliers
- carriers
- warehouses/distribution centres
- manufacturers
- customers

Besides the actors, the operation model consists of *primary processes* and *administrative processes.* In the MOMENT framework, the primary processes are defined as those concerning the physical material flow in the value chain. Each actor will therefore always contain one or more out of the primary activities. The following are considered to be primary processes:

- Reception
- Quality control
- Buffering
- Inbound handling
- Production
- Assembly
- Internal transportation
- Packaging
- Labelling
- Dispatch
- Distribution
- Storekeeping

Real-time and on-line information regarding primary processes should be easily accessible in the operation model by selecting the relative actors in the value chain. Administrative processes, on the other hand, are defined as those concerning the management activities undertaken to support the primary processes. The following three administrative processes are defined:
- Production and inventory control
- Order management
- Procurement

A co-ordination centre should be established dealing with all transactions regarding the focal node in the value chain, and consisting of a dedicated group of people who have a complete and shared responsibility for all value chain processes related to information and flow of goods. This centre is responsible for the yearly planning process and the three administrative processes.

6.5 Decision support

Both during the industrialisation process and when in operations, manufacturers continuously have to make difficult decisions regarding for example:
- location and size of production facilities
- sub-supplier availability - sourcing strategy
- transport systems and providers
- warehouses and 3rd party logistics solutions
- production and inventory capacities

The issues and decisions should be approached systematically using ICT based decision support tools. The tools should give the ability to consider a set of Extended Enterprises from many perspectives by considering different operating trade-offs, such as:
- total logistics cost
- time
- resource utilisation

- customer demand
- service
- quality (customer perception)
- financial ratios
- material availability

When market opportunities are identified or the competitive situation has altered, several possible solution alternatives should be modelled and compared. For example, when a request for quotation occurs, the estimated volumes and time frame of the contract can be fed into an operations model. Information from the operation model will be used together with information on existing contracts and projects to evaluate investments, new contracts and new projects.

A particular challenge is the large amount of information needed to take reasonable decisions. While some data is given and certain, other is highly uncertain, for example raw material prices, foreign exchange quotations, demand, political issues and local working conditions. The decision support tools should support risk analysis taking into consideration these uncertain factors.

A systematic approach to decision-making avoids cost and risk driving solutions because more elements and considered in the early stages.

6.6 Some qualitative localisation factors

When evaluating possible locations for a new production site, traditional decision factors are cost, physical infrastructure (access to motorways, airports and industrial areas) and availability of marked, customers and suppliers. In addition, more qualitative factors should not be overlooked; some of them are presented in this section.

Political aspects include stability of government and political situation in the considered country, level of taxes, public arrangements and possibilities for regional growth. Amongst cultural aspects we find culture of production and culture of co-operation. Culture of production includes working routines, equipment and machines, resources and types of knowledge and competence. Culture of co-operation is given by the way a country/area communicates and establishes mutual trust.

There is a link between geographical agglomeration of firms and industrial development. The development of enterprises and their success are very often influenced by conditions in the region where they are located, and these conditions can be of crucial importance in processes of innovation. It is for example possible that an enterprise causes positive effects on other enterprises because the proximity contributes to create a larger marked for end products, inputs or key resources like workforce and capital[11].

Cultural-ideological factors refer to a strong local identity and solidarity, which develops through history and tradition, and can be expected to exist in industrial areas where hard work has been viewed as a matter of course to be able to succeed. While hard working employees certainly are desirable, strong solidarity can make it harder for new enterprises to integrate and be accepted.

Socio-economic factors deal with the question if working force is central (functional) or peripheral (numerical). Central employees are well organised, have specialised knowledge and have great influence on their working conditions. Peripheral employees have no formal education or specialised knowledge, and have generally more insecure working conditions.

[11] Norman, V. (2000): "Lokalisering av næringsvirksomhet". SNF-project, arbeidsnotat nr. 44/00. Bergen.

Techno-economic factors take into consideration whether enterprises are founding their production on strong or weak competition, i.e. if they are founding the production on innovative activities (strong) or competition on price (weak). Innovative activity has been said to contribute to increased capability to compete.

Political-institutional factors consist partly of the regional parts of national structure (institutions of education, public R&D, health care, etc.), and partly of a region's relative autonomy according to the nation state. The greater degree of relative autonomy, the easier it will be to expand the regional institutional infrastructure. Interaction with different schools can be of importance because this gives enterprises the possibility to influence the development of the education possibilities and courses that are given, which gives a foundation to recruit the workforce that the enterprises need.

Proximity to R&D can also be of great importance, since these institutions give access to technological developments, which are very important inputs to be able to be effective and up to date continually. It can then be important to check out the culture that different universities, R&D facilities and enterprises have when it comes to co-operating and learning from each other in a locality.

6.7 Knowledge management

Knowledge management deals with conceptualisation, review, consolidation and action phases of creating, securing, combining, co-ordinating and retrieving knowledge[12]. Since transfer and replication of knowledge in highly competitive environments is embedded by the existence of strong barriers, knowledge management becomes a strategic tool that represents the organisational asset to enabling sustainable competitive advantage[13]. Knowledge management, though, is not only concerning the description of a company processes; it involves much more, especially regarding the design of technologies to support knowledge-use, and its function in promoting and enabling innovation.

It is clear that the company who is most aware of what's going on within and out of the *four-walls*, with regard for example to customers, products, technologies, markets, processes, and how they are linked, has the capability to cover best-practice positions[14]. Since knowledge management plays a key role in enabling companies to win competition, knowledge management systems should be developed and implemented. They should use enterprise systems, multimedia and web technologies like the Internet, Intranets and Extranets supporting the creation and dissemination of knowledge as well as the training of the workforce throughout the extended enterprise.

[12] Beckman T., *The current state of knowledge management.* In: Liebowitz J., editor- Knowledge management handbook. New York: CRC Press, 1999. p.54-72.
[13] Wickramasinghe N., Mills G.L., *Integrating e-commerce and knowledge management –what does the Kaiser experience really tell us*, International Journal of Accounting Information Systems 3 (2002) 83-98.
[14] Zack M., *Knowledge and strategy*, Boston: Butterworth-Heinemann, 1999