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From materials handling to packaging and logistics  
- findings from the Volvo and Ericsson cases

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ABSTRACT

This paper shows the importance of adopting a wide perspective when analysing packaging and logistics and of having an understanding of how the package is related to logistics activities. It also exemplifies and discusses the importance of understanding the logistics chain and making sure that all parts of the logistics chain work together and support each other. The packages are good examples of enablers in this process. The aim of this paper is to show how new policies in the supply chain force an integration of materials handling with logistics and packaging development. It also exemplifies the potential of using a packaging approach when the supply chain is analysed. Finally the paper adopts a lean value chain perspective when analysing packaging logistics.

Two case studies have been conducted, one at Volvo and one at Ericsson. Both companies are recognized as being in the forefront regarding logistics development. The cases show that packaging has a great impact on inbound logistics efficiency as well as on production efficiency. In addition, the cases show that proper consideration of packaging and logistics in product design makes it possible to influence product costs and that logistics people with a knowledge of packaging need to be engaged early in any new design project. The paper also illustrates the potential of working with the packaging aspect in two such different businesses as Volvo and Ericsson as well as similarities in the process.

Key Words: Packaging, logistics, production, benefits, savings, product design, lean value chain, materials handling.
1. INTRODUCTION

The globalisation of markets is a strong driving force in the world today. Intense competition within the global marketplace is giving rise to modes of economic production with fundamentally different space-time arrangements from those of yesteryear (Cervero, 2003). In addition to increased markets, the consequence of the success of a global market is an increased demand on logistics and transportation.

New strategic uses of logistics will continually alter the nature and culture of operations in companies. Logistics is also likely to be more pronounced as the ability to adjust procurement, production and transportation to customer demands will become essential in future business environments (Shankar, 2001). New areas must be analysed as to what benefits logistics will generate for the total system. Packaging is such an area that can be used to develop the benefits of the system. If logistics people are allowed to join the product development teams, even greater advantages are possible (Klevås, 2004).

Both case companies, Volvo Car and Ericsson, have a developed and complex network of suppliers and customers.

Volvo has created its own organisation that is responsible for all logistics and related activities.

1.1. Focus area

Volvo Car and Ericsson have gone through a highly intensified change of their structures, including both the organisation and its processes, regarding product development and packaging requirements. The focus of this paper is on the package and how the package can be used as an enabler for making logistics more cost-effective.

An efficient packaging system is a smart and, not least, a profitable investment. It quickly yields tangible results in the form of higher quality and lower cost. Volvo Logistics is part of a constantly ongoing process in which it works closely with its customers to design and develop flexible systems that offer its customers "package trips in first class – at economy prices.”

All assignments at Volvo Logistics begin with an analysis phase. Together, Volvo Logistics and the customer sketch a solution that will secure future packaging materials requirements in a cost-effective way. If any sub-suppliers are needed, they too are brought into the discussion so as to achieve the best possible total economy. Volvo Logistics commands the best support possible in the area of packaging materials.

1.2. Method

The method used in the research described in this paper is based on action research using the case study technique. Action research is one way of building theory and descriptions within the practice itself. The theories are tested by means of intervention in the organizational laboratory (Braa et al., 1999). 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, 2003). Case study is also a research method with the overall objective of gaining a deep understanding of the research phenomena chosen (Stake 2000). The case company, Volvo, has been chosen because one of
the authors has been able to follow the development while being employed in the company. The other two authors have been involved in projects concerning the development of the packaging. Due to its size, Volvo also has possibilities to place demands on the supply chain, which makes it possible to register the impact of handling equipment and packaging decisions on costs and logistics efficiencies. The results cannot be generalized, but in combination with other studies such as Klevås, 2004 and Bramklev, 2003 they will provide evidence within the areas of product development, packaging and logistics. Consequently, the case study will contribute to developing a product development platform where few contributions (Bjärnemo et al., 2000) are found in the literature today.

1.3. Functions studied

Several functions can be studied in the interface between packaging and logistics. In these case studies, the following have been studied:

- Production
- Packaging
- Materials handling

2. Frame of reference

2.1. Product and packaging

The connection between packaging and logistics has been recognized by several researchers, for example Bowersox et al. (2002), who point out packaging-related activities that influence efficient materials handling. They mention package design (standard configurations, order quantities, elimination of air, reduction of weight etc.), unitization (reducing product damage, increasing handling efficiency etc.) and communication (information about content, handling instructions etc.). Johnsson (1998) has shown that integration of packaging and logistics will create added product values and service values of major importance in a competitive world. Twede et al. (2000) confirm these findings.

The connection between product development and packaging has been recognized by e.g. Bramklev (2003) and Paine (1990). Klevås (2004) has demonstrated the connection between product design and packaging and logistics.

The influence of packaging on supply-chain efficiency has been recognized as significant by Lee et al. (2003) and Twede (1992). Although the influence of packaging is not covered in the literature, several cases have shown that supply-chain efficiency is closely related to the design of the package. The design of the package can result in a better utilisation of unit loads and reduced use of materials.

The package plays a nuanced role in a logistics system, and it has a considerable influence on the efficiency of the logistics system. (Twede, 1992). This is mainly related to the close relation to the product and to the fact that it follows the product when it goes through the various activities along the supply chain that all place their requirements on the package. The most common requirements found in the literature on packaging are (Johnsson 1998):

1. -protect the product
2. -group the products
3. -contain a specified number of products
4. -make handling and storing cost effective
5. -make distribution cost effective
In this paper the focus is on numbers 1 – 5.

The risk of damage in a logistics system depends on what type of handling and transportation equipment is used (Fiedler 1985). One example is when the package is reloaded along the distribution chain, which increases the risk of damage caused by drops and shocks.

2.2. Materials handling

Manufacturing includes a number of activities that create demands for products, and consequently demands on transportation and facilities to execute the activities. Saghir (2000) illustrates the complexity of a packaging system that includes materials handling (see Figure 1). This model shows the relationship that exists between the different packages and the activities. Each activity has a special connection to packaging, which can be used to increase the performance of the system.
Materials handling is the technical system that the company uses to meet its objectives, in this case producing cars and mobile phones.

The materials handling system is built around the companies’ production systems and serviced by their own facilities, such as warehouses and transports that are owned or purchased by external companies. The materials/product facilities are independent, but supply the company production system. It is important to design the materials handling system so that it can meet new supply-chain requirements without the company having to make large investments in the production facility.

This materials handling system prevailed until the end of the 1970s and the beginning of the 1980s. Many companies, e.g. Volvo and Ericsson, had big warehouses filled with products, many of them already outdated. The idea behind these warehouses was that it was necessary to have products available to ensure continuous production.

The logistics system, on the other hand, is then seen as the flow of materials within and from a specific production facility, where specific products are being manufactured on behalf of another production facility, in this case a car assembly line, and delivered to the assembly line, where the products are assembled into a final product and delivered to the ultimate user.

In the 1980s the JIT principle was increasingly launched as a philosophy in logistics (O’Grady, 1988). The production facilities were no longer seen as independent. Suppliers, manufacturers and customers were interfaced. Transport was included in the system and is now seen as one of the activities in a value adding chain, where, in principle, each link should add maximum value at minimum cost.

At the same time, products were becoming more complex, transport distances were increasing and every manufacturing unit was becoming part of an increasing number of chains, as one product manufacturing plant usually services several car producers. A web of great complexity developed.

The rapid development of logistics is greatly influenced by the growth of Information and Communication Technology (ICT). It is not possible to manage flows of materials/products in a logistics system or flows of goods in a transportation system without exchanging information among the actors involved. Managing information flows has always been important, but today it is actually crucial for an efficient product flow. Inaccurate and false information can spoil logistics operations (Bowersox, 1996). From the JIT concept we have developed the lean value chain approach, which takes a more holistic view than JIT was able to do.

3. The Volvo case

The focus in this case is on how the package can be used as an important enabler for creating more efficient solutions in both production and materials handling. The Volvo case has been in progress for a long time and shows a long development time.

3.1. Background to the Volvo case study

At the end of the 1970s, there was a situation of old products in big quantities making materials handling costs increase. The problem was that the materials handling used for different products was very diversified. A mixture of big and small packages arrived at the production sites. There was also a wide range of packages and packaging materials, from wooden boxes to cartons. This setup required a great deal of manual handling, which was very labour intensive.
When Volvo took the decision to buy products wherever they were found to be the best, it was important to secure competitive production despite long transport distances and a great number of external transports, which leads to high logistics costs.

The common carrier and handling used by Volvo was the pallet. It was introduced already during the Second World War in order to make handling by forklift trucks possible. The pallet was the only standard package and handling unit that existed. This caused a quality problem, as the carton material used in some packages was often damaged, and consequently the products were also damaged. People were also injured, for example by the sharp nails in the wooden boxes and pallets. As the working environment was an important policy in Volvo, it was crucial to solve the problem.

3.2. Production at Volvo

At the time when Volvo took the decision to buy products all over the world, the company’s production/capacity planning had improved and its interest in the capital tied to the materials flow had increased. Consequently the pallet became a very important tool in identifying not only the volume unit but also the suitable delivery take-home quantity.

The lack of standards made it difficult to build good internal materials handling systems and to optimise transports, since the packages were tailor-made for the product sizes. They did not fit the trucks or the pallets, and could therefore not be moved and stowed as efficiently as required. Hence both transport technology and materials handling technology suffered, as the packages were not adapted to the existing systems.

3.3. Packaging at Volvo

An introduction of materials handling equipment in the warehouses and in the loading and unloading areas made it important to address packaging. The packages used had to be made of the right materials and have the right dimensions to facilitate the pallets and the handling equipment in an optimal way.

The packages used for delivery of supplied products were developed independently of the handling systems used by Volvo. Often no consideration was given to the main Volvo interest - the inbound use of packaging. Volvo had little interest in the package itself, as long as it met the performance requirements concerning strength and information during transportation between Volvo and its suppliers.

When Volvo analysed the packages and pallets delivered, they actually found examples where three hands were needed to handle a package. It became obvious that Volvo also had to address the packaging demand and change the packaging system. Volvo’s focus was then directed towards the primary packages to ensure quality in the unit loads.

When this first step in the development was taken, it turned out that there was no information available to describe how the packaged products should be packed on the stacked pallet and how it should arrive at the production plant to ensure ergonomic conditions and efficient handling at the assembly line. There was still little understanding of the need of proper packaging design and the development of packaging, and it was impossible to make the production management see the need for a suitable layout of the receiving area at the production facility.

Nobody knew what floor space the products actually took up when they arrived from the various suppliers. Nor was it possible to optimise the racks that were available in the warehouses, as nobody knew the product and package design. The result was that Volvo had
to create an entire materials handling department to receive the products. Sometimes it was necessary to repack the products to make them fit the production line. Several hundred people were engaged.

However, the absolutely greatest practical problem was the damaged products and consequently the shortage caused by these damages. Either the production line was stopped or the production was changed. This situation was not acceptable, and it was necessary to find a solution.

3.4. Handling at Volvo

Another important step in the package development process was to introduce a facility called “Central Preparation”. This development required that the receiving layout should have the same layout in all Volvo plants that made the same type of products. Central Preparation prepared kits of products for the operators at the assembly line, so that they could concentrate on assembly work and did not have to spend time looking for materials to be assembled.

Today this demand on the layout of the receiving areas does not seem very remarkable, but it was at the time of its introduction, since it changed the view of management to make a total optimal efficiency and not a sub optimisation of the different parts. Consequently it became necessary to get the suppliers to supply the same packages to all the plants. By focusing on the package, it was possible to make handling and production more efficient.

This development was found to be very beneficial for the suppliers as well. They could use the same package system to supply different packages for the same product and article numbers to different plants. This requirement also applies to spare parts, which meant that they could be delivered to central warehouses in the same unit loads as the ones used for products going to the production line.

The receiving department, which used to employ several hundred people, was reduced by 90% after the change of packaging.

3.5. The Volvo small boxes

The packaging concept was further developed when the impact of packaging on costs, work environment and efficiency was recognised. To ensure that Volvo would get the products delivered correctly, pallets meeting Volvo standards were distributed to the suppliers to be used for the packing of the products. These pallets were distributed at no cost to the suppliers. Later on, the pallets were complemented with different types of standard packages (see Figure 3).
Before deciding on a specific Volvo pallet standard, a survey of Europe showed that the German standard packages did not fit the Volvo materials flow. The reason was that most deliveries in Germany went by rail, while the Volvo materials were transported on trucks and required different standards.

British standard packages for the product flow to car manufacturing did not function either, as they did not meet the ergonomic demands set by Volvo. In Volvo’s eyes, they actually caused damage to both products and people. The product damage could be linked to the layout of the receiving area decided on by Volvo. In Sweden, most of the unloading took place under a shielded roof with no walls. As rain could reach the packages, it was necessary to use waterproofed and tight packages. The British packages were not tight, however.

In the US the same types of problems were experienced concerning packages and units arriving at assembly plants. As a matter of fact, Ford carried out the same type of project as Volvo to improve deliveries.

3.6. Results from the case study at Volvo Car

From this case we learned that the package is an important enabler for the development of the materials handling system and the production system. It is important to have an overview that includes all parts of the supply chain. Because the package system links the various suppliers, it is also important in a broader perspective. The package system will also help suppliers to increase their performance thanks to a standardized handling system.

4. The Ericsson case

4.1. Background to the Ericsson case study

The Ericsson case was initiated in early 2000. The ability to use information logistics efficiently will have a dramatic impact on industry as well as society. This information logistics combined with workflow management will allow an efficient co-ordination of human intellectual design work and complex supply chains. Packaging may then seem to be a minor factor in this system. However, correct design of packaging will have a greater impact than is generally acknowledged.
The Ericsson case was based on the fact that there was a need for filling out the cardboard container. Fill out the size of the pallet and 1250 mm heights with master packs (10 pcs). It was also important to find a solution that could be used for the half pallet standard.

4.2. The Ericsson case

When the master pack (the group package) and the dpy box (the product package) are developed, they have to be designed to fit within the standard sized pallet. To make the solution as flexible as possible, they should also fit on a half-pallet. Furthermore, they should fit in both airfreight and truck freight, which gives a height module of 550 mm (2x550=1,100 mm) when the pallet is excluded. There are also requirements from some customers to get 10 pcs in a master pack, which coincides with what Channel Logistics at Ericsson wants. This gives very limited possibilities to design the dpy box. Twisting and turning the master packs and the dpy boxes results in some possible solutions. Showing the barcode lable when opening the master pack or not provides some extra minor possibilities, but the following restrictions remain: staying within 800 mm width, 600 mm length, 550 mm height and 10 pcs/master pack. Calculating on the basis of these conditions gives us 2-3 sizes each in the heights 57 and 75 mm that can be chosen from when designing a new type of packaging. Ericsson has basically two different transport packages in addition to the solution with the master pack: the standard corrugated cardboard container (often called cardboard container) placed on a one-way pallet and a plywood container (Vikex box made by Nefab) with an integrated pallet. These come in different models: standard half-pallet, half-pallet in different heights, and cardboard container placed on a EUR pallet. Information about the most common transport packages is given in Table 5.2.

Although the pallets are always meant to be 1,200x800 mm and the half-pallets 600x800 mm, the one-way pallets that Ericsson uses are not always that size. The height of the pallet is 140-150 mm.

4.3. Production at Ericsson

To meet the increasing price competition and to reduce costs, Ericsson has decided to transfer production from high-cost to low-cost countries. At the beginning of 2001, the mobile phone production in Kumla and Lynchburg moved to other suppliers. Linköping takes care of the industrialisation phase, introduction of and production of high-end phones. Production of low-end phones moved to countries in Asia, Eastern Europe and Latin America. Ericsson has also started an outsourcing program with Arima in Taiwan.

Unless a kitting centre is set up in Europe, the requirements for the dpy box to be light and small will be very large. The economic gains of a kitting centre are very great, as the air freights from Asia to Europe cost ten times more than the packing of the kit costs in Kumla. We think that a kitting centre can also do most of the packing that is done in the production sites today.

The positive feature then is that this gathers all phones to one site that can send mixed orders. It also provides an opportunity to do customisation for the customers, e.g. including leaflets and SIM cards in the dpy box. This "last minute" customisation would imply great competitive advantages.

Kitting the telephones is a very labour-intensive part of the production, and 4-6 people are needed to keep up with the speed of the telephone line. When the line receives an order, the pack instructions are checked and the line is prepared with the required inbox accessories, inserts and cardboard boxes. The kit configuration is often country-specific, with different
manual languages, adapters, etc. for different countries. They can also be customised with special artwork on the box, extra leaflets or manuals.

In the past, the major part of production and the largest number of customers have been in Europe. But today the major part of production is shifting over to Asia. Production of some low-end phones only takes place in Asia. Most customers are still in Europe, which means that the airfreights from Asia to Europe will be increasing. Shifting the production of a product to a low-cost country at a great distance from the customers has led to increasing logistics costs as a part of the total product costs. The airfreight costs alone are approximately 25 SEK/kg from Asia to Europe (cheaper the other way because of more empty space in that direction). When it is necessary to charter a whole plane to transport larger volumes, the prices are around 40-50 SEK/kg.

In the year 2001, 400,000 phones and in 2002, 1,000,000 phones were sent from Asia to Europe every month. If the phone is sent in the dpy box, the kit weighs 10 times more than if it is sent as 1/KRC, which is the phone alone without the software. The savings in airfreight costs are around 20 million SEK/month if the Asia-produced phones are kitted in Europe. Therefore a decision has been made to kit and configure phones for the European market in a kitting centre in Europe. The kitting centre needs to be situated in connection with a production site in order to flash the phones.

4.4. Packaging at Ericsson

The most important requirement from logistics and customers is to get more dpy boxes on the pallet and in the transports, which basically means designing a small packaging solution.

The insert is designed the way it is in order to support the requirements from the internal organisation of a specified content. The things that have to be included in the packaging and that have a predetermined size are the phone and the battery. There are different models and consequently different sizes of charges. Different countries have different plugs for the charger, which also requires a different size. The second accessory that differs in size, or, more correctly, thickness, is the manual. Different countries require from one, up to three languages. Different paper quality can also result in different thickness of manuals. Taken together, all this results in two strategies, as we see it: either designing one bigger type of packaging for each phone that can accommodate all of this content at its largest size, or designing a smaller type of packaging with different inserts for different requirements, e.g. two or more inserts for each phone. In some cases the latter strategy can also be solved by designing an extra, larger outer type of packaging as a complement to the smaller one instead of extra inserts.

The strategy today is to have only one size of the packaging and insert for each phone. This is a strategy that should be questioned in some cases, for example the new packaging 1284 for phone X. It had a good size for use in both the master pack and the standard transport packaging. But after late information that the manual printed in Asia became thicker than planned when it was printed in three languages, the box had to be made higher by three extra mm, which means that it has a much lower fill rate in the master pack and transport packaging. As a matter of fact, the few countries that require three manuals could get this higher packaging, and the rest of the markets could get the smaller packaging. In a way this can be seen as a customisation made for the countries that require three manuals. One problem with different sizes of packages for each phone is that it increases the number of variants. This is unwanted, as it increases the stock and also the risks of packing the wrong things. It is important to discuss this kind of problem with the Purchase Department, so that they will understand the consequences in logistics of a thicker manual etc. The next example
of content in the insert is the plugs that vary considerably in size. Examples show that the two largest plugs are 50 and 54 mm. Combined with the manuals, that gives the minimum inner height of the packaging, unless the manual is placed beside the charger and the box is made wider and longer. Likewise, the idea of customising a packaging for three manuals makes it important to also consider the largest plugs.

Most packing operations will continue to be manual, and Ericsson's phone packages are well designed to be packed manually as well as automatically. The moving of production from high-cost to low-cost countries strengthens the picture that manual packing will continue and that possible cost savings in the production by optimising the packing will be small. However, the idea to place a kitting centre in Western Europe contradicts this statement. In a kitting centre it would be possible to reduce costs in the packing by partly automating some of the activities and by decreasing the number of packing operations. A cost reduction by reducing the number of accessories units must be compared with a probable cost increase due to more expensive accessories.

Figure 4 reveals that some packaging types will affect the cost of shipment due to the weight of the package. The weight is also an important aspect to consider when shipment is to be done over long distances.

4.5. Handling at Ericsson

The advantages of master pack for customers are that they get easier handling as well as free and “ready to ship” transport packaging for their stores or customers. The standard transport packaging used by Ericsson is not easy to reuse. It can be used as a transport packaging from the production site to Ericsson’s customer, but in most cases the customer must repack the dpy boxes into smaller transport packages when shipping them to the retail store. The advantages of master pack are that it is a transport package in itself, but when Ericsson ships it, it is placed in a transport packaging made of shrink wrap and straps. This transport packaging can be removed by the customer, who now has a convenient master pack to pick from the pallet and ship to his customer. We are of the opinion that the master pack is a better solution for Ericsson than the transport packaging, and that the advantages are even greater for the customer. As a change of transport packaging affects the whole logistics chain, we do not think that the master pack can replace the other solutions for some time. During a transition period it will be necessary to have both packaging solutions, but we think that it is good to change the mindset over to master pack.

If the dpy boxes can keep two measurements the same for a number of different boxes, it will make it easier for the customer to pack different phones in the same master pack. This is not easy to achieve, as there are many other requirements for how to design the dpy box that are more important.

A greater and closer co-operation with the key customers would probably make it possible to meet the customers’ requirements. A meeting with Orange showed that their main (indeed, only) important issue was to get more boxes per pallet. Personal meetings between the customer and people from the Packaging Department, Customisation Department and the Local Company in question, like the one with Orange, would give all the parties involved interesting input and a better understanding of each other’s situation. It would probably increase the Packaging Department’s possibility to change and influence the customers’ requirements.
4.6. **Results from the Ericsson case study**

The case study indicates that from many perspectives packaging should play a more prominent role at companies than it does today. For further research, it might be necessary to expand the study to include more companies in order to increase the possibility to generalise results.

5. **Experiences and findings from the case studies**

The initiative to develop the packaging in order to make the logistics performance more efficient has provided the following experiences:

- Suppliers did not have the knowledge/competence to handle the needs that Volvo had in order to get the logistics required. Detailed problems were solved from time to time, but not the total system, which would have been necessary to obtain efficiency in the delivery and production logistics.
- The packaging development was crucial to ensure efficiency in the production line.
- The packaging concept also increased efficiency for the suppliers.
- Designs with softer forms, sensitive posturing etc. require very different packages than old models, where the designs are less sensitive. Suppliers have usually built fixtures to handle such products, which has increased the logistics costs.
- Today’s suppliers will increasingly put together whole units that are to go directly to the line for assembly.
- There would be great benefits and possible cost savings if the Packaging Department and Purchasing Department could co-operate more closely. The Packaging Department should be able to give their opinion about newly sized accessories. The Purchasing Department must have knowledge about the costs and logistics consequences for a purchase decision. Cost savings from a cheaper purchase can easily be consumed by increased logistics costs.
- When the Packaging Department has developed a new packaging, it ought to be responsible for developing a pack pattern for the transport packaging. The pattern shows how the packages should be packed in the corrugated cardboard container, Vikex box and in master packs on pallets. The latter way of packing will probably become more important in the future, as master pack solutions will be more common. Master packs are a better alternative than the traditional transport packages not only for the distribution, but also for the Supply Units. The average cost per handset for packing in master packs is approximately the same as for cardboard containers.
- Some packages are used as very important display products in many markets. Supplying some markets and shops with display boxes provides a possibility to increase the impact on the consumer and improve sales.

6. **Conclusions**

The case studies show that packaging is important for building efficient logistics, which provides:

- protection against damage, so that no disturbances occur in production
- units to fit production schedules
- ergonomic working conditions for personnel and
- information.
It is actually the packaging that opens up possibilities for efficient logistics. However, this is seldom recognised and is therefore not considered a core competence in the logistics profession. This results in less efficient logistics than necessary and in increased costs for companies involved in transports.

The case studies show the following results:

- Production facilities can no longer be seen as independent units. Suppliers, manufacturers and customers must interface, and the need to internalise external transport within the production plans is important.
- Transport is only one activity in a value chain, where each activity should add value at a minimum cost. Materials handling is also a very important inbound activity that will support the production system.
- Every manufacturing unit is part of an increasing number of chains, and complexity develops rapidly.
- It is of major importance that the people involved have a holistic view of how the package can be used as an enabler to develop processes in the supply chain.

The case studies also show that both logistics and transportation are deeply impacted by changes in information technology. It must therefore be the responsibility of logisticians to actively engage in the development of such systems and their consequences.

7. References


O’Grady, P.J., (1988), Just-In-Time filosofin i praktiken – Strategin för produktionsstyrning, Studentlitteratur, Lund, Sweden


