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## SUPPLY-CHAIN COSTING

### ANALYSIS OF CORRUGATED PAPER AND PLASTIC TRANSPORT PACKING IN THE RETAIL CHAIN

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**"SUPPLY-CHAIN COSTING" -  
ANALYSIS OF CORRUGATED PAPER AND PLASTIC  
TRANSPORT PACKING IN THE RETAIL CHAIN**

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## **SUMMARY**

### **BACKGROUND**

Provisions are transported from the producer via wholesalers to retailers in either corrugated paper boxes or in returnable plastic boxes. Previous investigations show that the systems are equal from an environmental point of view, almost equal from an ergonomic point of view but with a certain advantage to corrugated paper boxes in consideration of the weight of plastic boxes and that comparative bacteriological studies are still missing. The logistic consequences also need to be analysed for a purely economic comparison of the systems.

### **PURPOSE**

The purpose of the study is to analyse the economic consequences for the participants the retail chain when it comes to the choice of transport packing; boxes made of corrugated paper or plastic.

### **DEMARCATIONS**

The calculations of cost are based on theoretical estimations, results of international studies supplemented with interviews with key figures in the affected trades.

It is not possible to make a clear-cut stipulation of the costs in such a complex system of logistics. Therefore the analysis generates an interval of cost instead, within which the real cost is assumed to lie. The aim is to have 80% of today's provision transports fall within the given interval of cost. Continuous analysis is needed to make closer determinations of the cost items.

### **METHOD**

An abductive approach has been used, i.e. induction and deduction have been used alternately to refine the results of the study. Empirical material has been collected via interviews with key figures and through search on the Internet along with educational visits at international supply-chains within the food industry that use transport packing made of corrugated paper as well as plastic.

The analysis is based on differential costs, i.e. additional costs of plastic boxes compared to those of corrugated paper, caused by a possible decision to introduce plastic boxes.

### **RESULTS**

The study shows that, in the same way, as when it comes to economy and ergonomics, corrugated paper and plastic are equal when it comes to purely economic aspects. The study indicates that a changeover to a recycling system will be somewhat more expensive than the present system of corrugated paper boxes. The differential cost of the whole system is 0,38-0,61 EUR for corrugated paper and 0,46-0,88 EUR for plastic boxes. The producer pays 0,42-0,67 EUR of this cost, the wholesaler pays 0,01-0,10 EUR and the retailer pays 0,03-0,11

EUR. Within retailing, the corner shops will be the ones most heavily affected by the introduction of plastic boxes.

Thus the question of what system to prefer, corrugated paper or plastic, changes from being a question of cost into one of strategy. The supply-chain should agree upon and choose the system that is the most flexible and that creates most freedom of action in the future.

Figure 1 below shows the main process in the delivery chain, which is responsible of each respective link as well as the main activities that are contained in each link. Added to this are a few cost items that have the character of affecting the whole delivery chain:

- Deposit costs
- Wastage
- Spoilage
- Trademark

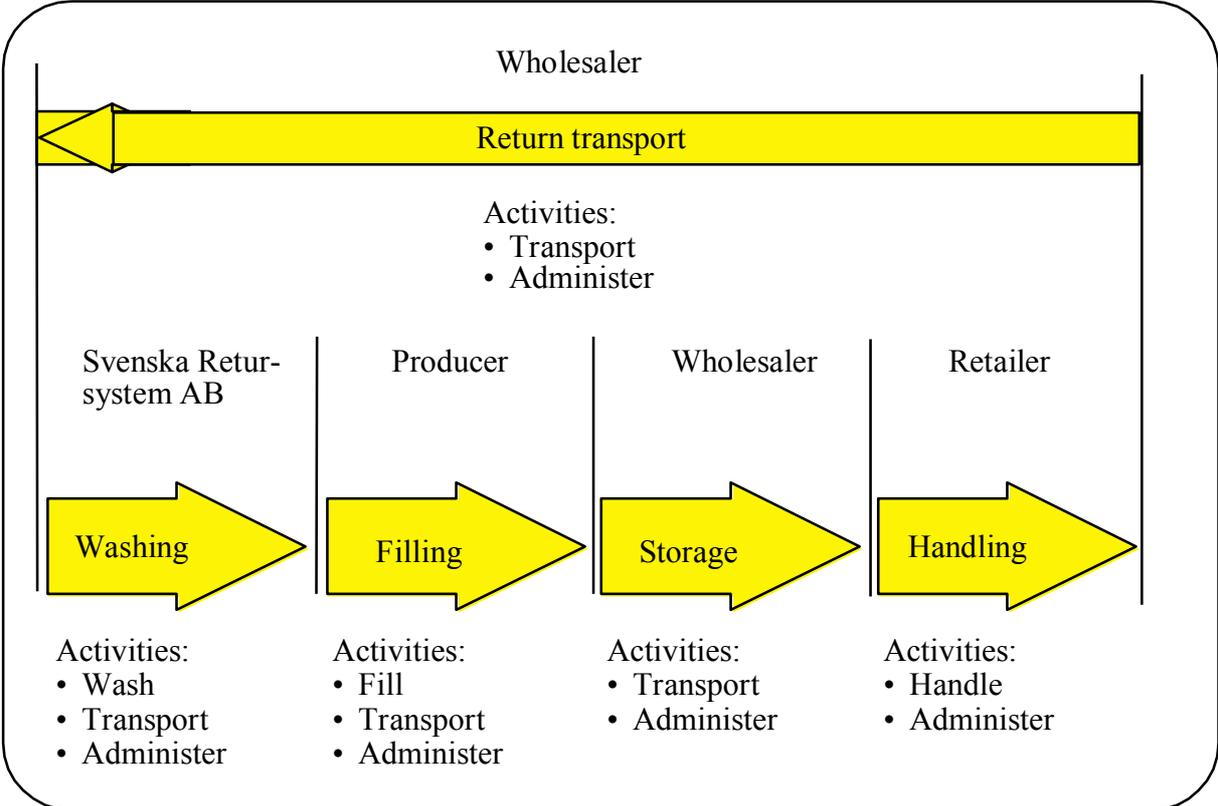


Figure 1. Main processes and activities for each process owner in the recycling system.

**Trademark**

The possibility of differentiating the products through prints on the packing will be of greater importance in the future if competition hardens. Research within strategy theory development points at an increasingly tough competition, and

words such as hypercompetition<sup>1</sup> are used to characterise the situation. Corrugated paper wrapping makes it possible to market products by tailor-making the form of the wrapping for the specific product as well as printing advertisement on the wrapping. To estimate the value of these possibilities is difficult, and the benefit of tailor-made wrappings and the possibility of printing advertisement on the box vary with the products. The surplus value of these two means for positioning is higher for those products that are exposed to the final consumers in their transport wrapping, e.g. fruits and vegetables. A cautious estimation says that the market value per transport wrapping amounts to 0,17 EUR per trip. The cost of these lost possibilities at the choice of plastic boxes is divided equally between the producer, the wholesaler and the retailer, 0,06 EUR each. There are however products for which this possibility of positioning has no significance. The interval for this lost revenue is therefore set at a total of 0 – 0,17 EUR.

The distribution of surplus costs for lost positioning:

Participant	Cost per trip (EUR)
Svenska Retursystem AB	0,00
Producer	0,00 – 0,06
Wholesaler	0,00 – 0,06
Retailer	0,00 – 0,06
Return transport	0,00

## Washing

In Sfa the cost of washing is stated as 0,03 EUR per box (guessed value) and in the OH material for Pfr as 0,11 EUR /box. These numbers include storage of dirty and clean boxes. The operating cost of washing in the foreign systems is 0,17 EUR for Kisten-pool in Austria, 0,23 for Kesko in Finland<sup>2</sup> and 0,23 for Tesco in England. The costs concern unloading from the truck at the 'incoming' platform of the washing plant, washing and unloading of clean boxes at the 'outgoing' platform. Transports to and from the washing plant are counted as separate items.

The washing is a considerable cost item. It is very likely the most important one, and the one that will steer the cost of the system almost entirely. This gives cause for a closer study of this cost. The most interesting object of comparison is Tesco's system in England, which uses the same box that will be used in SRAB's system in Sweden. Tesco, who owns distribution cars and wholesalers as well as stores, has recently sold the box-system that they started and buys in the wash-service from Salveson logistics on businesslike bases and with open books, i.e. all of Salveson's costs are shown to and paid by Tesco. Transports to and from the washing plant are however administered and paid for directly by Tesco.

A comparative table shows the similarities, but above all the differences, concerning the conditions of the systems.

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<sup>1</sup> D'Aveni, 1994

<sup>2</sup> Bergheim , 1997, p. 58

	Tesco, England	SRAB, Sweden
Population <sup>1</sup> (-93)	58 080 000	8 727 000
Population density (people/km <sup>2</sup> )	237,9	21,2
Normal delivery per store (semi-trailers/day)	9	?
Average distance between wholesaler and washing plant	500 meters	?
Washing plant	9	2-3
Washed boxes per year (-98)	130 000 000	Prognosis 20 000 000
Washed boxes per washing plant	14 400 000	10 000 000
Motive	Environmental taxes or withdrawal of paper an deposit on waste paper	Economy
Activities in the washing plant	Washing, baling of corrugated cardboard, roller containers	Washing
Structure of cost, fixed and variable costs	50% - 50%	?
Average cost of salary (all shifts incl. social fees)	13,60 EUR	17,00 EUR
Investments	Approx. 45,30 M EUR	?
Washingfees excluding transports	0,23 EUR	? <sup>2</sup>

Table 1. Conditions of recycling systems in England compared to Sweden.

It is worth noting that Tesco's system is a company internal system, which is built entirely based on their already existing wholesale and retail structure. Thus the washeries have been put next door to the existing distributioncentres. SRAB's system will do the washing for several wholesalers, which makes it impossible to put the washing plant close to the wholesaler. Likewise the number of washeries is lower in Sweden and this too will increase the average distance to the washing plant. Furthermore the population distribution is more disadvantageous in Sweden than in England, where the population is heavily concentrated around London. To be able to compare the population distribution of Sweden to that of England, Stockholm and Gothenburg would have to be assembled somewhere in the middle of Småland. This is not the case; the Swedish population is more scattered. A reasonable assumption of the average distance in Sweden is approx. 300 km.

All in the comparison in table 1 (of the conditions of a recycling system in England and in Sweden) shows that all factors will increase the costs in a recycling system in Sweden compared to one in England.

<sup>1</sup> Encyclopedia Brittanica, 1994

<sup>2</sup> Svenska Retursystem AB has chosen not to openly account for the values that concern SRAB.

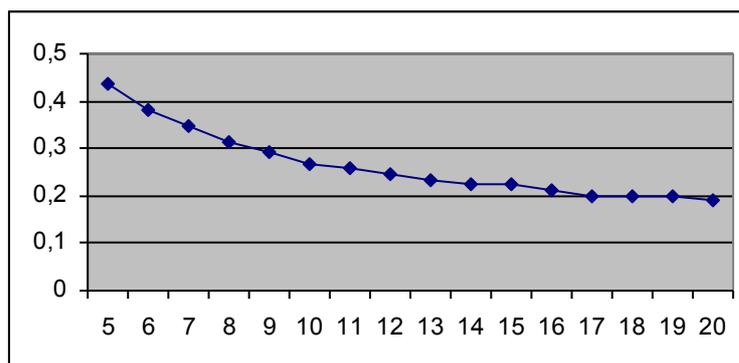


Figure 2. Tesco's washing cost in EUR per box as a function of annual wash-volume (million washed boxes per plant and year).

An assumption that the cost of washing in Sweden is in parity with Tesco signifies a pure washing cost excluding administration of approx. 0,20 EUR per box. The washing will cost considerably more in the development phase, probably 0,34 EUR per box. In the case of each washing plant washing 7,5 M boxes per year the washing cost will be 0,33 EUR per box.

Surplus cost distribution for washing:

Participant	Cost per trip (EUR)
Svenska Retursystem AB	0,20 – 0,33
Producer	0,00
Wholesaler	0,00
Retailer	0,00
Return transport	0,00

## Transport

An outgoing delivery of empty boxes in a truck can maximally hold 50 pallets. Each pallet contains 192 boxes. This is equivalent to 9600 boxes. A corresponding transport of corrugated paper wrapping can contain 40 tons of corrugated paper, which is equivalent to 40000 pcs./0,7 kg/pcs. = 57000 flat boxes, i.e. approx. 6 times as much material. IFCO states the cost of this transport as 0,08 EUR. Thus the surplus cost of plastic is  $0,08 * 5/6 = 0,07$  EUR.

Plastic trays weigh 1,1 kg, which is approx. 0,4 kg more than the corresponding corrugated paper-box. This generates a surplus cost for transport. According to EU-regulations a filled box must not weigh more than 15 kg. In the distribution cars limitations on transport volume may be set either by weight or volume. The volume in a plastic box is 10-15% less than the corresponding corrugated paper box (taking into consideration differences of wall thickness and shape). The supplementary level varies greatly depending on the product. Sydgrönt has carried out tests on plastic boxes and they have come to the conclusion that the supplementary level in standardised plastic boxes in relation to corrugated paper wrapping varies between 63% (iceberg lettuce) and 94% (tomatoes and apples).

Total transport-costs are assumed to be 0,08 EUR according to IFCO. When it comes to products with high density, for example apples, the weight is assumed to be the factor that sets limits in the distribution cars while reduced volume due to plastic boxes is not a problem. The heavier plastic boxes will thus take 0,4 kg / 15 kg of the cargo capacity i.e. 2,7%, which is equivalent to an increase in transport cost of  $2,7\% * 0,08 \text{ EUR} = 2,27 * 10^{-3} \text{ EUR} / \text{box}$ .

When it comes to products with lower density such as iceberg lettuce the volume will be the factor that sets limits and the surplus cost in the case of iceberg lettuce will be 37%, which is 0,03 EUR per trip. Thus the extra costs are in the interval  $2,27 * 10^{-3} - 0,03 \text{ EUR}$ . In the same way as for the producer the extra cost is assumed to be in the interval  $2,27 * 10^{-3} - 0,03 \text{ EUR}$ .

SRAB assumes that the return transport will be taken care of by the cars that transport the perishables to the stores. The idea is that as the car is emptied, pallets of empty boxes are loaded. The question is whether this is a reasonable assumption:

- Firstly it is a bacteriological matter whether it is permitted to transport contaminated returnable boxes in the same cars as the perishables. In the extreme case a bloodstained box has turned rancid after a week in a corner shop. But even more moderately contaminated boxes can be problematic from a hygienic point of view.
- Secondly it creates some handling-work to rotate the products in order to bring out the perishables and to get the empty boxes into the car.
- Thirdly a truck with a trailer, which is the kind of return transport that SRAB presupposes, can only be used for returns from supermarkets. Standard stores and corner shops in the cities are placed in ways that make it necessary for distribution cars to handle the deliveries. In these cases the empty boxes must be transported to a reloading central, and thereafter be reloaded on a truck with a trailer for transport to the washing plant.

Consequently systems with returnable boxes involve extra transport. The cost of these extra transports is difficult to estimate. In Sfa SRAB states that the fee to Returlogistic AB for transport handling is 0,07 EUR/box and trip, most likely calculated on a supplementary level of 100%. At a supplementary level of 80% the cost would increase to 0,08 EUR (0,07 EUR/80%). These costlevels presupposes that the return transport can be taken care of by the same cars that transport the perishables to the store. Otherwise the transport will be considerably more expensive.

Surplus cost distribution for transport:

Participant	Cost per trip (100*EUR)
Svenska Retursystem AB	6,57
Producer	0,23 – 2,94
Wholesaler	0,23 – 2,94
Retailer	0,00
Return transport	6,80-8,49

## Return transport

The entire surplus cost for the return transport must be paid by SRAB in the long run. According to the conditions that have been presupposed in this analysis the surplus costs for the return transport will be in the interval 0,07-0,09 EUR. This cost is passed on to SRAB.

## Service fee

Svenska Retursystem intends to charge a service fee per trip. In the short term to start the system the fee might, due to strategic and marketminded reasons, be put low in order to convince the participants in the chain to switch to the recycling system. This service fee is however, in the long run, supposed to cover all costs connected to the start and operation of the recycling system. Since SRAB neither is supposed to bring in a profit nor be subsidised by any operator, the fee must in the long term absorb all of SRAB's costs.

In the existing systems that are in use in Europe the service fees are 0,50 EUR for IFCO, 0,23 EUR for Tesco and EURO-pool states that their fee is 0,16 EUR + administration. The administration of IFCO is estimated at 0,03 EUR, which would mean a total service fee for EURO-pool of 0,18 EUR. In general, Sweden's transport geographic conditions and population density are factors that cause the costs in a Swedish system to be higher than in any of the existing systems in Europe.

Under the conditions that have been assumed in this analysis, the cost for SRAB will be in the interval 0,39-0,54 EUR.

## COST COMPILATION

Specification	Wholesaler Return	Retur AB Washing	Producer Filling	Wholesaler Storage	Retailer Handling	Total
Deposit capital binding	0,11	0,45	0,45	0,45	0,45	1,36
Wastage/Loss Discarding	0	- 0,11 2,9	0,23	0	0,23	0,45
Branding			0-5,7	0-5,7	0-5,66	0-17
Washing		20,4- 33,1				
Filling			0-2,3			0-2,3
Transport	6,8-8,5	6,6	0,23-2,9	0,23-2,9		0,45-5,9
Administration	0,57	1,8	1,3	0,57	2,49-5,10	4,8-7,4
Return transport		x 7,5-9,17				
Cost of service		!	x 39,5-53,9			39,5-53,9
Total	7,5-9,17	! 39-54	! 42-67	1,3-9,6	3,2-11,4	46-88

Table 4. Cost compilation for the entire supply-chain.

## **CONSEQUENCES AND SUGGESTIONS FOR A CONTINUOUS ANALYSIS**

### **SVENSKA RETURSYSTEM AB**

The costs that arise at Svenska Retursystem AB (SRAB) will through fees and deposits be equally divided among the other participants in the chain.

Strategically speaking SRAB should initially subsidise the system in order to convince a critical majority of participants to make the change to plastic boxes. A low service fee can be concealed in the cashflow that a growing system generates through the influx of money that arise the first time that SRAB gets the deposit for a box. The subvention must go on until the number of participants that SRAB wants in the system has made the change to plastic boxes. A transition initially involves high fixed costs for the other participants and these costs are 'sunk costs', i.e. they can not be retrieved at a return to corrugated paper boxes. This way SRAB can lock participants in the system of plastic boxes with the help of the introductory subvention. It is most important to SRAB to convince all the other participants in the supply-chain that the plastic boxes will be cheaper and better for all participants in the chain.

The fees must however in the long run cover the actual costs, which means that the fee must be raised in order to correspond to the real costs.

If SRAB fail to engage enough participants, the system will go bankrupt. It is therefore important to all of SRAB's owners to invest as little capital as possible in SRAB. It is also important to divide the recycling company in as many companies as possible, one for fullpallets, one for halfpallets and one for returnable boxes, in order to minimise one's own risk exposure. In case of a bankruptcy it is easier to convince the credit-granter about a reconstruction of one of the three companies than about one joint company.

### **PRODUCERS**

For most producers the introduction of plastic boxes will initially involve considerable investments. A new packing-line for plastic boxes in addition to the already existing line for corrugated paper. Most producers will need both packing-lines, as some customers will continue to want the products delivered in corrugated paper boxes. Even the producers who only deliver to customers who are participants of the plastic box-system should not – for reasons of security and flexibility - destroy the corrugated paper-line since there is a risk of SRAB running out of clean boxes for various reasons; wastage, miscalculation, deliveryproblems, fire etc.

There are indications showing that EU-norms demand special establishments for handling plastic boxes, owing to the increased fire hazard that a stock of plastic boxes involves. Sprinklersystems may have to be installed and the insurance fees may be affected as well.

The investments involved in a changeover to plastic boxes are in the size of 100 000 EUR for many producers. The producers should therefore wait as long as possible and let some other willing producer take the initial risks involved when testing the system. Not until it is proven that the plastic box-system works and that the fees stays at the level notified at the start, is it the right time to decide whether to join or not. A suitable period to form an opinion of the stability of the system is approx. 2-3 years. After this period there will be unambiguous analyses that show the costs for the use of corrugated paper compared to the use of plastic boxes. These analyses will probably be able to indicate what type of producers, wholesalers and retailers that will profit and lose respectively by the system. This makes the basis of decision much safer for the one who waits than for one who joins the system at the start. Neither does it involve any increased costs to wait, as corrugated paper and plastic are equivalent from a purely economic perspective. It may possibly involve a cost saving, and it will postpone a large initial outlay for another 2-3 years for sure.

To guarantee that the producers are not convinced to join the plastic box-system on false economic grounds the producer should ask for a warranty of the wash-cost from SRAB that stretches over a period of 5-10 years, i.e. the life of a plastic box. The value of the guarantee increases if another company but SRAB makes it out, on account of the risk of bankruptcy that SRAB runs. The wholesalers in the retail chain say that the system of plastic boxes is not only a system that is run by SRAB but also a joint project in the trade (Presentation, 981216). In that case it is advisable for the producer to ask the wholesaler for a warranty.

## **WHOLESALEERS**

In the same way as for the producers it involves a great risk for the wholesalers to join at the introduction of a plastic box-system. Just as in the producers' case the most effective strategy is to wait and see if anyone else is prepared to take on the costs and risks involved in starting the plastic box-system.

To reach full effect in a system of plastic boxes the distributioncentres and washeries must be integrated from the start. Every wholesaler should furthermore be big enough to provide and consume one washing plant's entire productioncapacity, approx. 15 M boxes per year. This does most likely imply that the wholesalers need to join forces and eliminate the small units.

If the wholesalers and SRAB initiate the system as a joint project it is important for the wholesalers to strive towards minimising their risks through minimising invested capital in SRAB and to strive towards guaranteeing the system via SRAB and not through them.

## **RETAILERS**

Corrugated paper handling is today a system that pays for itself. The large stores have their own compressing machines. If the utilisation degree decreases this system will run at a loss. The corrugated paper plants will be needed in the

future, as corrugated paper will continue to exist even if plastic boxes are introduced.

Store managers and employees in the retail chain are of the opinion that corrugated paper boxes are well suited to use when exposing products. The staffs feel that it is a simple and practical system. Each box comes with a pre-printed trademark and is all set to be exposed.

The retailers' strength of negotiation in the supply-chain is not as strong as that of the other participants', as the volumes are not as concentrated as in the other parts of the chain. The retailers will probably have to adjust to the decisions agreed upon by the other participants. It will nevertheless involve increased expenses for all retailers. The smaller the store the higher increase of cost will the introduction of plastic boxes bring. This also generates an indirect environmental effect if consumers are steered towards the supermarkets due to increased prices in the small stores.

### **SUGGESTIONS FOR A CONTINUOUS ANALYSIS**

Firstly the cost items that have not been included in this report by way of precaution should be settled and calculated on.

Secondly the risks and costs in connection with impact damages should be analysed for plastic boxes as well as for corrugated paper.

Thirdly the conditions of the transports should be produced to show whether health regulations allow transportation of contaminated plastic boxes together with perishables. This should be checked with national as well as EU legislation. It should also be analysed whether this legislation can be expected to change. The analysis above is based on the assumption that co-transportation is permitted. If it turns out that it is not permitted to transport contaminated plastic boxes along with perishables the price-figure of a plastic box-system will deteriorate noticeably.

Fourthly it is interesting to analyse and compare national plastic box-systems with international systems.

Fifthly national as well as EU-regulations should be investigated in order to decide what technical measures for fireprotection the introduction of a plastic box-system brings in the supply-chain. In the analysis above this cost is put to 0 EUR, but if it appears that measures need to be taken throughout the entire chain this will involve a noticeable increase of cost for the participants of a plastic box-system.

Sixthly the effects of an introduction of a plastic box-system should be analysed from the point of view of different types of producers, wholesalers and retailers in the supply-chain:

#### Producers:

- Fruits and Vegetables

- Meat and Delicatessen
- Dairy
- Bakery

It is also interesting to analyse whether the cost differs noticeably between the large and the small producers.

Wholesalers:

Here also size can be a dimension of analysis and geographic placement another.

Retailers:

One of the main questions for the retailers is how large influence a recycling system has on the retailers as a function of size. The indirect environmental effect is also interesting.

## REFERENCES

- Bergheim, E. (1997) Store Handling Systems - The Packaging Implications, Kesko Oy.
- Cox, A. and Hines, P. (1997) Advanced Supply Management, Earlsgate Press, Great Britain.
- D'Aveni, R. (1995) Hypercompetitive Rivalries - Competing in Highly Dynamic Environments, The Free Press, London.
- Jönson, G. (1997) Corrugated board boxes and plastic boxes used in the distribution of food - Theoretical prestudy, Dep of Engineering Logistics, Lund University.
- Lea, R. (1997) Valg av transportemballasje - transportmessige konsekvenser, Transportøkonomisk institutt, Oslo, Norge, TØI notat 1080/1997.
- Lindahl, P. och Notsten, J. (1994) Retursystem inom svensk grönsakshandel? - En utvärdering av de ergonomiska konsekvenserna, Institutet för produktions och arbetsplatsutveckling AB, Beckholmen, Stockholm.
- Svenska LogistikByrån AB (1997) Produktionssystem för returemballage - förstudie, preliminär version, april.
- Svenska Retursystem AB (1997) Sammanfattning för användare, 970703.
- Presentation (981216) av en tidigare version av rapporten för representanter för SRAB och logistikansvariga för de stora svenska grossister.