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Customer Oriented Return-flow Management

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Abstract – This paper deals with the application of IT in circular supply chains (CSCs). We consider information on the installed base critical, and present an illustrative example. Next we discuss a framework of different kinds of value contained in a return, and IT-applications useful in supporting its recovery or neutralisation in case of negative externalities. Also we show which kind of CSC is needed for which kind of return. We illustrate our work by three real life case studies.

Key words - reverse logistics, supply chain management, circular supply chains, product life cycle management, value creation, E-business/IT

1. Introduction

Traditional wisdom holds that return flows are something compulsory and obnoxious. (Stock et. al, 1998) conclude that "the state of development of Reverse Logistics is analogous to that of inbound logistics of 10-20 years ago". However, the importance of the field is gaining recognition. (Rogers and Tibben-Lembke, 1998) state that "while much of the world does not yet care much about the reverse flow of products, many firms have begun to realise that reverse logistics is an important and often strategic part of their business". Also, pioneering business companies have found opportunities to gain a competitive advantage through reuse and recycling. Let us illustrate this by a number of examples.

(Giuntini and Andel, 1995) report an example of an airline manufacturer where, due to competition for scarce manufacturing capacity, new production was given priority over out-of-production spare parts. The company created a repair and remanufacturing scheme for impaired components, avoiding drastic cost increases for spare parts, improving availability from 81% to 93% and also preventing 3rd parties from taking over their spare parts business.

(Marien, 1998) reports on a paint case, regarding of reverse logistics management, based on the concept of source reduction, as well as identifying various reverse logistics strategies for leftovers and residuals. Business benefits include saving on procurement and (pre-) manufacturing costs of materials and components, saving on disposal costs, improving disposal services to the customer an retailer, attracting 'green' consumers, being pro-active to environmental legislation and showing social responsibility.

(Caldwell, 1999) presents a case study on Estee Lauder regarding commercial returns. Their reverse logistics program comprehended streamlining of reverse logistics processes including returns authorisation, information systems and developing reuse markets amongst which company stores.

From extensive case study research, for overviews see (Bloemhof et.al, 1999), (Fleischmann et.al, 2000), (Guide and Van Wassenhove 2002), it can be concluded that successful reverse logistics programs have taken an integrated approach: hence integration of forward and reverse chains and integration with product life cycle management (Krikke et.al, 2002). Therefore we prefer to speak of circular supply chains rather than reverse logistics. The circular supply chain covers the combined forward and reverse supply chain. In case of reuse in the original chain we speak of closed-loop supply chains, otherwise of open-loop supply chains.

Circular supply chain management is defined as "the integration of business processes that create additional value for all original and new players[1] in the supply chain through closing goods flows". (Additional) value creation refers to both traditional supply chain objectives, customer satisfaction and cost reduction, as well as environmental objectives. The forward chain is extended by a Reverse Chain incorporating key business

[1] Actors in the return channel

processes such as product acquisition and collection, asset recovery, secondary sales and re-distribution as well as related information and financial processing.

Integration with PLCm is essential and extensively described in general terms in (Krikke, et.al, 2002). PLCm is the process of optimising service, cost and environmental performance of a product over its full life cycle. Key issues include product design for recovery, re-engineering, product data management, installed base management and evaluating (end-of) life scenarios. In this paper we like to go into more detail on the integration of circular supply chains and Installed Base management, as well as Ebusiness. A general introduction on IT in circular supply chains can be found in (Krikke et. al, 2002b).

The installed base is defined as the total number of placed units of a particular product in the entire primary market or a product segment. Installed base management concerns the care of products during operations. It comprehends replenishment, maintenance repairs, overhaul, spare parts management, and system upgrades. Installed base support is traditionally looked at from a technical point of view. However, the installed base can also be monitored on more commercial parameters. For example, when a customer with a high volume copier only makes a few copies a week, there is a clear case of misfit. Early takeback and recustomisation by retrofit or product exchange might be an appropriate strategy. Moreover, one may offer additional support services such as pro-active repair and early maintenance. But also the use of recovered items should be stimulated. New business models need to be developed, in which the use of 'recycled stuff' is promoted rather than hidden, and in which the customers see this as an added value. For example, some car insurance companies offer green policies, through which a damaged car is repaired with parts cannibalised from dismantled wrecks. Xerox leases a green line of copiers, providing a lower cost per copy. The trend towards 'function selling' may be helpful to solve this.

E-business comprehends all aspects of doing business electronically by using IT such as the internet, EDI, mobile phones, satellites and so on. Major components of E-business are E-commerce (sales), Customer Relation Management and fulfilment.

Circular supply chains add complexity to overall supply chain management: traditional objectives of customer service and cost are extended by environmental concerns and the scope is extended by return processes. This leads to a number of new design and control issues, including choosing recovery options, optimising degree of disassembly, dual sourcing and so on. It is generally acknowledged that uncertainty plays a big role in CSCs, both on the return and on the reuse side. This uncertainty in turn is partly due to lack of information; value is lost through misjudgement and time loss.

This paper addresses the question how to use IT/E-business to reduce uncertainty and hence improve efficiency, customer service and environmental impact of the CSC. Our starting point is that the installed base plays a critical role, because it serves both as a source of returns and as a sink for reuse. A logical hypothesis is that information on Installed Base is essential. From here, we develop the following research questions:

?? Which value is contained in different return types?

?? How is this value related to characteristics of the CSCs?

?? Which information from the Installed Base is needed?

?? Which information is needed about the return process itself?

?? Which forms of IT/E-business can be helpful?

?? What is known from business and what can we learn?

The paper is set up as follows. In Section 2, we give an illustrative example on using Installed Base related information. In Section 3 we develop a basic framework on the value of returns and the kind of CSCs needed. Also, we define the types of information needed. In Section 4, we describe IT that may support in obtaining this information and in Section 5 we describe some practical cases and draw lessons from this. In Section 6 we draw conclusions.

2. An illustrative example: value of using information in operations

In this section, we quantitatively assess the value of using information on the installed base. The use of information enables more efficient use of resources and henceforth creates value. We discuss the situation in which products positioned at customers require maintenance and occasional repair, in short: service. It is assumed that the status of products (i.e. its technical condition) can be measured providing information on whether maintenance or repair is required within a certain time interval, in particular to prevent emergency calls for repair. We focus on the routing of technicians that service products at customer sites.

Traditionally, (preventive) maintenance is done on the products on a regular basis, while repair is performed at customer calling, in most cases on an emergency basis. The status of the machines is measured only when a technician is at the customer site. This traditional approach results in fixed routing of technicians to customers for routine maintenance with additional emergency repair calls. In general, before the actual visit, the status of the products on site is not known.

In case of remote and continuous status monitoring of the products, maintenance and/or repair decisions are based on direct pro-active assessment of the status of the products, where customer interference is not required. Routing of technicians based on actual status information with the appropriate priority and service parts becomes feasible. There are other efficiency gains that will not be incorporated in the example. First of all, information on the installed product may reduce the service time on that product. Secondly, reduced service and travel times may increase the service capacity of a technician per day. Thirdly, appropriate supply of service parts and better preparation may result in other savings than service labour time, such as lower service part inventory in service vehicles, etc. But for the moment we restrict ourselves to the routing problem described.

We assume there is one product per customer, thus the installed base will be characterized by customer locations and status of the products. For our purposes the latter comes down to the following priority categories: (1) the product does not need a visit now, (2) a visit to the product will prevent an emergency call from the product or customer, (3) an emergency call from the product or customer coming down to the fact that a visit to the product is necessary immediately. Deriving these three categories of priorities from product status information is determined by e.g. technical aspects and service level agreements. Obviously, if preventive service visits are ignored (category 2), routing is steered by emergency calls. It is the aim of this example to assess the value of using the monitoring information and preventing emergency calls in order to improve the efficiency of routing. In order to assess the value of status information, let us formalize the business case to some extent.

Each customer is characterized by its geographic position x and its product status s. We assume that each service vehicle will service Q customers per day. The costs that we focus on in this example simply are the travel costs linear with the length of the route along the Q customers. The aim of using installed base information here is to reduce the average length of the service route.

A tour length L is defined by the order in which customer locations $x_1,\dots,x_Q$ are serviced, namely $L = d(x_0, x_1) + d(x_1, x_2) + \dots + d(x_Q, x_0)$, where x_0 is the location of the service center from which the service vehicle departs and where it arrives at the end of its service tour, and where d(x,y) is the travel distance between locations x and y. An optimal tour length is obtained by servicing the customers in an optimal order. This optimal tour will be denoted by $L^*(x_1,\dots,x_Q)$. Finding such an optimal tour is the aim of the Traveling Salesman Problem. It is also possible to settle for a near-optimal tour using a heuristic. For details, see (Bramel and Simchy-Levi, 1997).

Information on the installed base should enable an additional optimisation step. Each day, it should provide a customer pool of N customers, where N > Q, from which Q customers are to be selected. This large pool of customers use products that either need immediate servicing (category 3) or that may need servicing in the near future (category 2). Given N customers $x_1,\dots,x_N$, one needs to find Q customers $x_{k(1)},\dots,x_{k(Q)}$ from this population that optimises $L^*(x_{k(1)},\dots,x_{k(Q)})$. In the selection of the subsample of Q customers, there may be the restriction that a limited number of customers must be selected anyway, namely category 3, products that require immediate servicing.

The foregoing optimisation procedure may seem an almost impossible task. First of all, finding an optimal tour is not easy (the problem is NP-hard). Secondly, all subsamples of Q customers from N customers need to be checked. However, using heuristics to obtain near-optimal routes may resolve computational problems. Further, some first results indicate that efficiency improvements are considerable, as the following numerical experiment shows. This may result in sufficient benefits without checking all possible subsamples.

A simple example in which Q = 2, so that $L^*(x_1,x_2) = d(x_0, x_1) + d(x_1, x_2) + d(x_2, x_0)$, and an efficiency parameter that is the quotient of the sum of the customer distances $d(x_0, x_1) + d(x_0, x_2)$ and the tour length, provides the following. It is not difficult to see that the worst case scenario results in an efficiency parameter value of ½, and that the best case scenarion results in an efficiency parameter value of 1. The following diagram (Figure 1) shows simulation results of N customer draws from a homogeneous distribution of customers from which the optimal tour involving Q = 2 customers is selected. As N increases, the average efficiency converges to 1. This can be proved rigorously, also for more general instances.

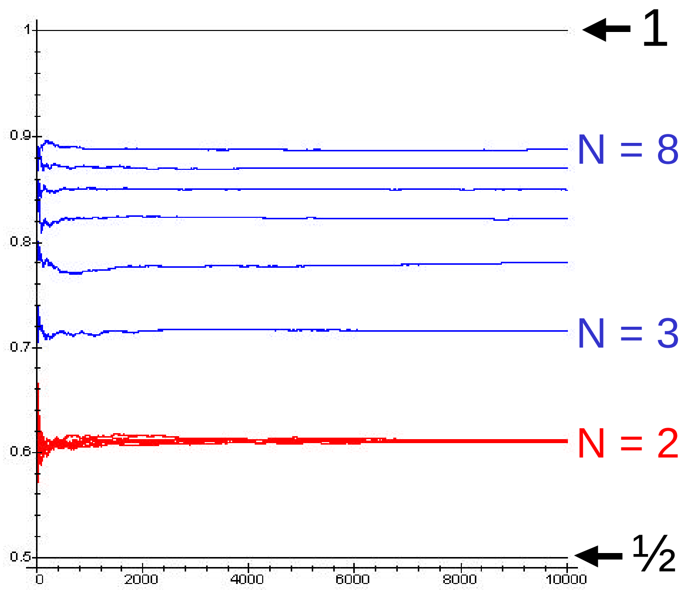

Figure 1: Average efficiency parameter for different values of N and Q = 2.

This example focuses on transport costs savings in operations. To the authors of this paper it served as an eye opener in the sense that information on the Installed base can be crucial. IT requirements to enable the aforementioned provision of data is probably quite straightforward but the economic issue may be delicate and will depend on the value of the product and to the other efficiency gains mentioned. However, other factors may be of even greater importance. For instance: pro-active servicing also prevents damage and downtime. In situations where not only the defect component incurs cost, but particularly the domino effect through the entire system, the installment of (expensive) monitoring systems is justified by reducing indirect cost and improving customer service. Moreover, once discarded, valuable information can be obtained on e.g. the condition of the return product/component, generally acknowledged to be a critical factor in value recovery. Using this information, e.g. the internet can consolidate supply and demand of reusables. In the remainder of the paper we focus on value recovery of returns. In Section 3 we develop a framework that described the different kinds of value we are actually talking about.

3. A basic framework

The first issue we address is general: what is the (kind of) value of returns?. Based on our earlier studies (summarised in (Krikke, et.al, 2002)) and discussions with academics and practitioners in the field (CLSC/WEEE workshops INSEAD) we derive that there are three basic kinds of value contained in returns:

?? Negative value of possible externalities. This often refers to impact on the environment and related disposal cost to be paid by tax payer money. But it can also involve controlled destruction by the OEM to avoid third parties taking over the repair business. At all times one wishes to avoid or minimise damage.

?? Positive intrinsic value. This positive value of a return may lies in invested resources. The latter of course refers to materials and energy but also labour. (Ford, 1926) already observed that "We will use material more carefully if we think of it as labour. For instance, we will not so lightly waste material simply because we can reclaim it- for salvage involves labour. The ideal is to have nothing to salvage".

?? Positive or negative time based value. This value relates to both previous ones, but deteriorates quickly over time. Positive time based value is most likely customer or market driven. Examples include seasonal or fashion products. An example of negative time based value is nuclear waste. (LeBlanc et.al, 2002) describe the case of degassing returned LPG tanks .

Note that all kinds of value can in principle be market (customer), cost or environmentally driven. The negative or positive value contained in the returned item must be neutralised or regained respectively. It depends on many factors which processing option (disposal, open loop recovery, closed loop recovery) is most feasible. Note that a return may be in different classes regarding market, environmental and cost value. Dealing with conflicting drivers is one of the most challenging aspects of CSCs.

The next issue is: what are the requirements for CSCs based on the value classification? In (Krikke et.al, 2002) we describe a typology of circular supply chains per typical return defined. We move into a higher level of abstraction and relate the CSC characteristics directly to the value contained in the return. We do so in Table 1, in a manner similar to (Fisher, 1997). Fisher presents a framework for forward supply chains, in which the type of supply chain (responsive or efficient) depends on the kind of product (innovative versus functional). Note that the characteristics of the CSCs are matched with returns and have nothing to do with the original product.

Table 1: Returns and circular supply chains similar to Fisher

	Responsive CSC	Efficient CSC	Control CSC
Returns Time Based Value - Market driven - Cost driven - Environmentally driven	FIT		
Returns Intrinsic Value - Cost driven - Market driven - Environmentally driven		FIT	
Returns Negative Externalities - Environmentally driven - Cost driven - Market driven			FIT

A control CSC focuses on neutralisation of negative externalities or in short damage control. It needs to be secure, ensuring a responsible processing of the returns. These chains may involve some burocracy, and are often slow moving. The returns are pushed into the channel, and finding markets is often difficult. IT focuses on careful registration of input and output, to e.g. verify mass balances or prevent leaks in the system.

An efficient CSC deals with valuable items in stable markets. It is able to separate valuable parts of the returns from the non-valuables at an early stage The non valuable fluff may be transferred to a control CSC. There is still a market, and the CSC must be able to balance supply push and demand pull well in a time-phased manner, which is also the main focus of IT support.

A responsive CSC acts quickly because the value of returns is running out (of time) or damage to the environment is getting worse by the minute. These CSCs are demand driven, but collection (acquisition) may be hard. IT supports primarily in consolidation of Supply and Demand, tracking and tracing and testing/diagnoses.

In order to optimise planning and control, i.e. to minimise negative or maximise the positive value, CSCs need information. Exchange of consistent, reliable data makes that for individual parties in the reverse chain exogenous variables turn endogenous. Below we list control variables for CSC optimisation using Installed Base information.

On the return side the aim is to collect reliable information on volume, quality, timing, location and composition of returns. This means concrete:

- ?? Supplying reliable product information (disassembly BOMs, hazmat, yield factors)
- ?? Tracking and tracing locations and numbers of products and systems
- ?? MTBF: hence return rate
- ?? Phase outs of systems or components
- ?? Supporting product acquisition (consolidation and pricing mechanisms)
- ?? Preventing failures and downtime (diagnostics)

One the (re) use side it is important to determine secondary demand hence volume, composition, quality, location and timing required. In other words:

- ?? Monitoring actual use and customer profile
- ?? Reconfiguration and upgrade planning
- ?? MTBF, hence demand rate
- ?? Recovery BOMs (replacement factors, commonalities)
- ?? Support secondary sales (trading, consolidation)
- ?? Mass balances and environmental impact reporting
- ?? Re-engineering through feed back of failure information to designers

Specific returns process related IT might involve tracking and tracing of the returns and e.g. recovery capacity planning. However, most of the information needed during the returns process is Installed Base (or market) related We first discuss a range of technologies that are applicable in this context in Section 4.

4. Information Technology applications

Information technology pervades logistics management and will continue to do so in the near future. One next major step is likely to be the introduction of smart cards and smart labels that will enable the identification at a distance of individual products through the use of radio frequency. Applications of this technology are emerging. For example, smart labels are being used to improve product rotation of perishable goods, to track equipment that is for rent and to monitor in-process parts and finished goods (computer parts and cars).

Data storage capacity is nowadays sufficient to accommodate the information needs of multiple actors in a supply chain. The technology has particular potential for products that are (i) time-sensitive, (ii) unique (in their characteristics: qualities, routing, use) and (iii) valuable. Many products in reverse logistics qualify on each of these attributes as candidates for the application of smart technology.

4.1 Product data management and data logging

PDM in general serves to maintain accurate data on complex products (many parts, variants, alternatives), record maintenance changes on a product during its lifecycle and disseminate product data at an intra-organisational or inter-organisational level. PDM improves the quality of data and reduces labour intensity, since it reduces the amount of manual data transfer of information in the chain. Whereas PDM systems capture information provided by communicating partners, they may not record information on products' condition and configuration that result from the operations of the product.

Data-logging automates the registration of important use related variables. Examples include peak loads, total running hours, average temperature. (Klausner et.al, 1998) report on a so called green port implemented in Bosch power tools for EOL optimisation. Based on the monitoring of a few parameters during the products life time, a DSS is capable of classifying returned cores into ‘reusable’ and ‘scrap’. Substitutes may involve the use of scan units. A scan unit is able to make an X-ray of returned goods and make a reliable estimate of product parameters otherwise monitored by PDM.

The use of recycling passports for consumer electronics is imposed by EU legislation as of 200X. The internet is used to exchange the passport between various members of the CSC (Spengler, 2002). The recycling passport enables to identify hazardous materials at an early stage but also to separate material fractions in a better way. Many material fractions in electronics need to be separated perfectly otherwise they are worthless and might as well be dumped. Reliable identification helps to obtain pure fractions.

4.2 Remote condition monitoring and diagnostics (smart products)

New communications protocols can be combined with embedded control systems to monitor product data dynamically and transmit the data logged upon some event. Based on this proactive action can be undertaken. Examples include early detection of technical failures, optimisation of fuel consumption and automated replenishment. Often condition monitoring is installed for maintenance purposes. But once installed it also provides the means for remote (on line) monitoring of critical parameters in the operations phase of the product to be passed on to the recovery stage. Disposition decisions can now be made at an early stage without physical inspection or disassembly. It can also be used for pricing mechanisms in E-market places. Moreover, re-engineering by feed back of return info to product design and production stages results in product quality improvements.

Monitoring is one thing, diagnoses is another. Diagnoses is complex because often it is not a single (defect) component that causes the trouble, but an unexpected interaction components in the system. So the trick is not only to detect the direct cause of failures, but in particular the chain of reaction following it. It is essential to distinguish which product parameters to be monitored and their 'alarm levels', but also to limit the number of parameters to be monitored. Fuzzy logic and neural networks provide interesting opportunities. The use of complicated techniques to deal with complicated issues is tempting, but certainly requires justification by means of examples that show successes in practice. There is some reason to be careful mentioning the use of these "general purpose" techniques.

4.3 Tracking and tracing

In order to ease collection, it is important to know the condition, but also the location of the returns in advance. Many companies are implementing chips in containers and pallets, companies are able to track and trace them for logistics purposes. The capability of linking with geographic information systems, often done for other reasons, increases opportunities to e.g. follow containers online and plan their return.

4.4 E-marketplaces

E-commerce is often also seen as a cause of returns. However, it may also be used in prevention. Dell Computer's small- and home-business sales division found that returns for Web ordered PC's were lower than PCs ordered by phone, thanks to a configuration feature that DEL added to its site in 1996 (Caldwell, 1999). Most of all, the internet serves as a means to consolidate (geographically) fragmented markets for product acquisition and re-sales. Regarding new e-business models one can distinguish three types. (Kokkinaki, et. al, 2001).

Returns aggregators bring together suppliers and customers, automates the procurement of returns and creates value through consolidation: high throughput and minimal transaction costs. Many returns aggregators follow subcontracting third parties to do some or all of the described logistic functions.

Speciality locators are vertical portals, which focus on niche markets for highly specialised used parts or products, such as authentic antiques, exact replicas parts or equipment in historic restoration projects or the maintenance process for vehicles and industrial equipment. Their services include training, frameworks for catalogue search, selection and configuration, financing and technical support. Speciality locators are mostly used for information dissemination and address the marketing aspect of electronic commerce.

The integrated solutions providers go a step beyond facilitating and matching demand and supply of returns. The model for Integrated Solution Providers does not view E-commerce as a migration of existing practices and services but as a new tool to restructure a business activity and offer new services. Furthermore, they actually become the owners of the returns instead of implementing a brokering mechanism as the previous two models. By definition, each integrated solution provider focuses on the reverse logistics network in an industry/sector. More information can be found in (Krikke et.al, 2002b).

4.5 E-ERP

Existing ERP-systems are not geared for recovery. An extensive description can be found in (Krikke, et.al, 2002b). Here we briefly discuss how MRP and WMS ideally should support CSCs.

On the recovery side alternative BOMs for one product are needed to represent alternative routings in the MRP-system depending on the recovery option chosen. On the return side, various routings can also be represented by alternative disassembly BOMs. With regards to inventory control, cores returned must be registered distinguishing between different types (statuses) and owners of returns inventory. Note that cores and components disassembled can be found in different states e.g., "to be dismantled", 'scrap, 'repairable' or 'reusable'. Moreover, identification of identical components retrievable from various cores at different indenture levels must be supported. Some components might not be identical but fulfil the same function. Often, specific components can be obtained by cannibalising cores or modules, and the availability of these components must be visible in the inventory control system, not only must the modules be registered as a whole, but also an explosion into components must be visialised. Forecasting can be improved by adding a line with a returns forecast to the Master Production Plan. This works best in the so called dual bill method. At the level of components, one would like a re-planning functionality after core disassembly, since actual quality of the components is known then.

A warehouse usually has to deal with three kinds of returns: retailer returns, supplier refusals and packing returns. Returns cause additional, labour intensive processes in the warehouses, which constitute around 6% of total logistics costs. The Warehouse Management System (WMS) gives administrative support primarily of the return process itself. Ideally, it determines next steps to be made further down the channel (recovery options) and communicates this information to the players involved, including the potential re-users. Table 3 summarises the basic features.

Table 3: CSC requirements to WMS
1. Disapproved supplier lots blocked for delivery
2. Sales to alternative secondary markets must be registered with separate article number or lot number
3. Scrapped lots must be written off
4. In case of refused supplier lots, supplier should be debited
5. In case of customer returns, customer should be credited according to conditions as defined by return policy
6. Customer returns must be traced back to original delivery and reason of return codes are necessary
7. Original product specifications must be made available for recovery operations
8. Returns waiting for further processing must be registered separately at a distinct location
9. Inventory levels must be adjusted according to process option (recovery, sell, etc)
10. Testing and inspection instructions must be given to support recovery option choice and recovery options assigned must be registered
11. Returns being recovered must be registered as (temporary) shipments and receivables and recall functions must support control
12. Repair/recovery instructions must be given
13. Report functions, for example to analyse returns per channel or retailer

5. Cases

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No formal models are known to the authors by which the value regain in various CSCs can be assessed or optimised. However, in Section 5 we do analyse a number of cases in which IT was exploited.

5.1 Omron

Omron is a global corporation with its headquarters in Japan manufacturing products in 30 factories, and has 71 subsidiaries in 35 countries. The company supplies products and services in the fields of industrial automation, automating services, medical health care and information processing. Typical products are card readers, vision systems, switches, sensors, counters, controllers, relays and connectors.

With headquarters in the Netherlands, Omron Europe BV oversees sales, distribution and support activities in Europe, the Middle East and Africa. Omron's European organisation comprises more than 20 fully owned subsidiary companies, including 18 national sales companies in virtually all of the European countries, and includes a European logistics center and a European repair center. Repairs of products are a major component of OMRON's after sales service. Prior to 1999, the forward and repair flows in Europe followed the logic presented in the following Figure.

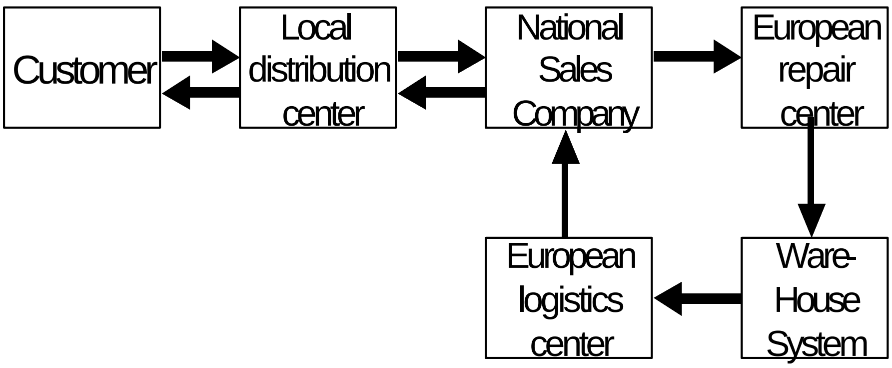

Figure 2: Logistics network Omron

The corresponding process proceeds as follows. Responding to a customer's call an OMRON engineer comes to inspect the problem at the customer. If instant repair is not possible the defective part is removed and a temporary replacement installed. The defective part is returned to the European repair center. After repair the part is returned to the engineer for local pick up at a distribution center. The engineer then replaces the temporary spare with the repaired part. The customer is billed based on the details of the repair that has been made.

The process and its performance produced several problems and difficulties: long lead times (3 weeks – 3 months), the double substitution a faulty parts inducing production problems at customers, and the whole process needing repairs to be traced back to the customers/applications over a long period. Two options to improve were identified:

- ?? Option 1: (i) reduce the lead time of all processes involved and (ii) optimize inventory control
- ?? Option 2: (i) reformulate goals and (ii) change the structure of the processes

OMRON followed the second option: from a 5 layer process a new 3 layer process was created to handle repairs as depicted in the next figure.

Figure 3: re-designed logistics at Omron

To support this structure the subsequent measures were introduced additionally. All transportation involving repairs was to be carried out by DHL. The objective was to shorten lead times to such an extent that engineers would no longer need to install a spare for a defective component while yet shortening the duration of the repair process. As a further administrative simplification customers were to be charged a fixed fee for repairs irrespective of the repair details.

In the new structure, fast and reliable transportation carried out at a premium substitutes for less expensive and slow transportation. However on the whole benefits accrue from the shortening and simplification of the repair process.

Customer benefits:

- ?? clarity on repair costs,
- ?? less shut downs due to replacement components,
- ?? less costs

OMRON benefits:

- ?? lead time reduction to approximately 5 days
- ?? a decrease in product replacement activities by 90 %
- ?? a decrease in repair engineering time by 30%
- ?? a reduction of after sales costs by 30%.

Of course, the success of the system requires state of the art information technology for tight monitoring of the transportation and repair processes.

5.2 L'Oreal

Laboratoires Garnier Paris is one of the subsidiaries of the French L'Oreal Organization and market leader in several markets of personal care products. One such product is Ambre Soleil, a sun protection product. In France this product is distributed to retailers through two channels: the 'circuit direct' (delivery at store level) and the 'circuit société' (delivery at a regional distribution center of a chain of stores). The sales of Ambre Soleil are highly seasonal with a strong peak of demand in the (early) summer.

The great variability of demand augments the retailer's risk of having many products of Ambre Soleil at a season's end when demand is low. On the other hand, low stocks of the product at stores during the selling periods can easily result in stock-outs or poorly filled shelves and displays and thus make L'Oreal incur lost sales (while at the same time risking boosting a competitor's sales of products for which the availability poses no problem). This pressures the sales department to strive towards a wide exposure of consumers to Ambre Soleil products. To entice retailers to dedicate store and shelve space to Amber Soleil's product, the sales managers of Laboratoires Garnier assume the retailer's risk of unsold products at a season's end. This means that displays and products can be returned by the retail organizations at no additional cost for their organization.

In most of the retail outlets the products are placed and presented to customers in so-called assortment displays. These are distributed at the season's start together with the products themselves. Both displays and the products they contain are returned to Laboratoires Garnier Paris. Returns amount to over 30% of gross sales.

The returns are handled by the same system as the forward flows: the same transportation facilities and distribution centers are involved. A large fraction of returns can be used for re-selling in the next season but some products have to be disposed of or channelled to other markets.

In any case, each volume of returns has a substantial negative effect on the value of the profit margin. Currently, the beginning of a new season products marks the beginning of an intense effort to push large quantities of products into the sales channels based on forecasts of yearly demand. Laboratoires Garnier Paris has come to realize that this push strategy together with a remuneration of sales personnel based on gross sales (and ignoring returns) has led to a volume of returns that is inefficient and costly. Instead a responsive supply chain in which a limited number of products is distributed early with a responsive re-supply during the selling season could be more profitable. The implementation of such a responsive strategy will require accurate and timely information on retailer inventory during the season. Here tracking and communication technology will play an important role.

5.3 PHILIPS

In 1998 Philips DAP (Domestic Appliances and Personal Care), a division of Royal Philips Electronics in The Netherlands, worried increasingly about its handling of returned products. At the same time it was felt that customer trends were such that more and more of the future sales volume would be realized during promotions. So there arose increasing pressure on the sales department to push product down the channels to support such promotional activities, which in turn was to lead to larger volumes of commercial returns. This concern was further compounded by an urge felt to keep up or rather forerun the need to boost the satisfaction of retailers/customers while reducing costs and stock levels by international consolidation throughout the supply chain.

The project that was carried out to address the problems was to find solutions that would organically include handling of returns in logistics, operations and management of customer relationships.

Philips DAP is the division that focuses on the manufacture and supply of personal and domestics appliances such as electric shavers, beard trimmers, hair clippers, female epilators and shavers, hair, skin and body care products, tanning products, electric toothbrushes and water jets, kitchen appliances, irons and vacuum cleaners. The total product line comprises some 600 different products. Essentially the markets for the products used to be approached through national sales organizations (NSO-s) with product supply occurring through a national distribution center.

In the Netherlands and Germany the supply network of Philips DAP looked prior to 1998 as depicted in the following figure. In Figure 4 solid arrows represent regular sales flows and dotted arrows represent return flows.

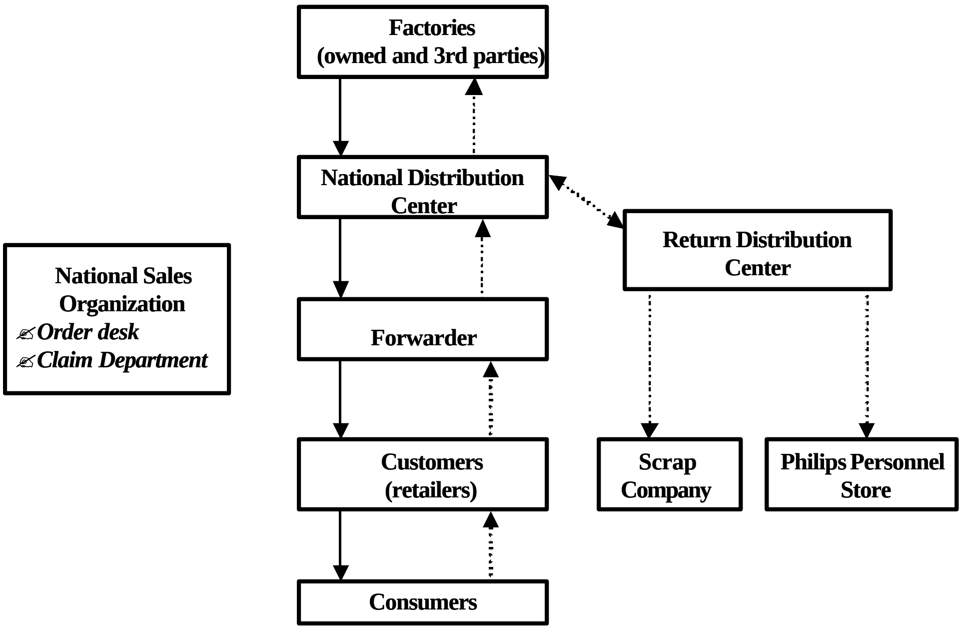

Figure 4: logistics network for Philips

For the region The Netherlands, Belgium, Germany, and Luxemburg, which served as a pilot project, two major lines along which to change the supply chain were identified as:

- divide activities and responsibilities principally along the characteristics of front stage versus backstage in stead of division along national borders
- reduce the number of stock locations from 16 national warehouses to 5-6 regional distribution centers.

Of course both lines needed to be supported by information technology infrastructure such as document management systems to render the ensuing management at a distance viable.

Three type of returns occurred: defective products, returns do to administrative errors, and commercial returns. The first two types are usually accompanied by complaints. Complaints came in two types: complaints of an administrative nature and those with a nature of physical distribution (damaged products). Customer service (a part of an NSO) deals with the first type of complaints and the Complaints Department (part of the DAP Service Center) to be located near the Regional Distribution Center deal with the second category. (The latter may vary slightly according to country). The following figure illustrates to situation with respect to complaints and returns handling.

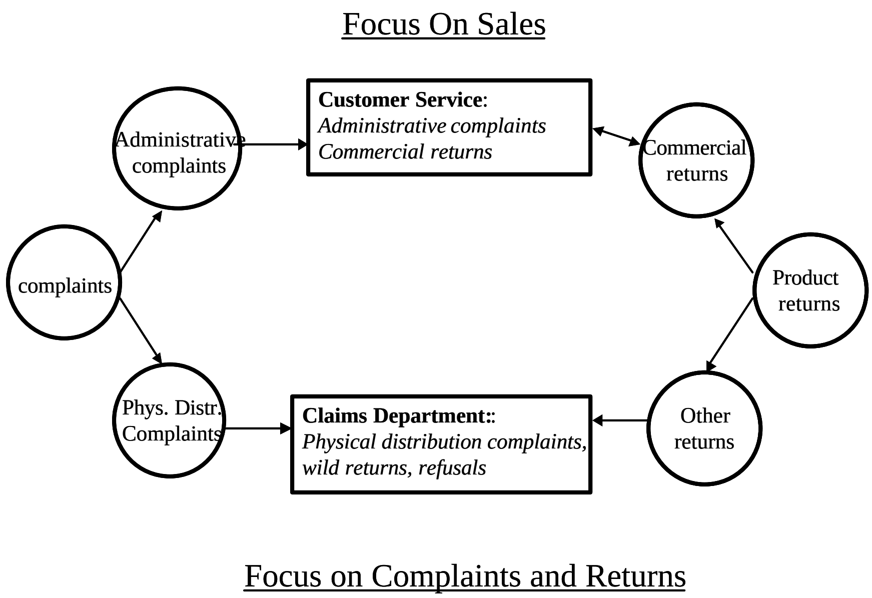

Figure 5: Complaints and returns handling at Philips

Although the centralized Complaints Department (close to the regional distribution center) may ultimately not be implemented two advantages advocate its introduction: efficiency and resource sharing.

The features for handling the return flows that stands out in the solution followed by Philips DAP is that (i) no separate logistics infrastructure is created for returns (although dedicated departments are created), returns are integrated in the forward flows and (ii) following the control of the forward flow, returns are handled centrally.

5.4 Discussion

Considering the value model presented in Section 3 of this paper the three cases presented clearly fall into different categories.

In the Omron cases one deals with returns for which the handling has enormous time-based value for the customer. The value for Omron's customers and Omron itself is so high that it outweighs the extra costs incurred from utilizing fast transportation that to a large extent is independent of the forward flows. Here the time-based value is higher than the intrinsic value and this warrants a dedicated highly receptive channel for returns handling.

In the Philips and L'Oreal cases the intrinsic value of the returns is a dominant consideration. Hence, as the value model predicts, efficiency is a main concern for management. This manifests itself in the fact that forward and return flows share the major part of the logistics facilities

The urge to reduce the number of complaints and the need to closely monitor the processing of these complaints (both to be classified as negative externalities) play a major part at Philips DAP in their management of returns. IT solutions are sought to deal with the distributed management involved, depending on the types of return. However, one sees that IT solutions are always part of a bigger scenario, such as redesign of the network, reducing returns, complaint handling and so on. Also, they do not always deal with the installed base, but also with the return channel itself. The relative contribution of various kinds of IT in various parts of the CSC is hard to estimate based on the case studies described in this section.

6. Discussion and conclusions

This paper aims to contribute to the CSC fields body of knowledge by taking a value creation perspective. We illustrated by an example that information on the installed base can be crucial in improving efficiency of operations. We suggest that is also applicable to returns management. We posed a number of research questions:

- *Which value is contained in different return types?*
- *How is this value related to characteristics of the CSCs?*
- *Which information from the Installed Base is needed?*
- *Which information is needed about the return process itself?*
- *Which forms of IT/E-business can be helpful?*
- *What is known from business and what can we learn?*

to which the answers can be summarised as follows.

Value contained by returns involve negative externalities, intrinsic value or time based value. Depending on this, a control, efficient or responsive CSC is needed. An illustrative example showed the potential of using information on the installed base. Control variables on the installed base are the key to which information is exactly needed. Examples include MTBF, product composition and market consolidation. A range of IT applications was discussed to support this. Finally we discussed a number of cases, where we found that IT-applications are useful, but only if part of a broader solution. Moreover, we found that much of the success can be traced back to proper management of the forward channel e.g. by demand management, and the reverse channel itself e.g. by tracking and tracing

Future research will focus on a more detailed specification of the installed base control variables, preferably differentiated per type of CSC, and the development of formal models to assess and optimise value recovery through application of IT. Related issues are the impact of changing business models on CSCs, contracting and outsourcing and logistics concepts of CSCs.

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