How to organise return handling: an exploratory study with nine retailer warehouses

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Abstract

Already for a long time retailers take back products. In this paper we explore the factors contributing to the decision of combining vs. separating inbound and outbound flows during the return handling process. We do so through a comparative analysis of the operations in nine retailer warehouses, which can be divided in three groups: food retailers, department stores and mail order companies. We identify both aggravating factors and facilitating actions for return handling. Furthermore, we bring about recommendations for practice. At the end we put forward propositions that are useful in feeding studies on return handling efficiency. In particular, we conjecture over the impact that return volume and product diversity have on the decision for combining vs. separating the reverse and forward flows.

Keywords: retailing, product returns, return handling, inbound and outbound flows, case studies.

Introduction

Flows of returned products have been increasing during the last years. Several factors have contributed to this, like the environmental consciousness of customers, take-back legal enforcement and the economic value of re-using products. Accordingly, handling return flows has become an important assignment in modern warehousing operations. Whether the handling of returned products should be done together with that of new products, or not, is one of the issues to be addressed by warehouses. Thus, warehouse management have to decide, among other matters, whether to combine or separate transportation and storage of returned and new products. Although the systematic study of return flows has been increasing (see RevLog, '98-) little attention has been given to the previously mentioned matters. Environmental aspects (Corbett & van Wassenhove, '93a; '93b) were the main topic in early literature. Later literature has studied decisions in remanufacturing of returned products (Thierry et al., '95; Krikke, '98), and inventory strategies with a remanufacturing option (van der Laan et al., '99; Toktay et al., '00). In addition, Bloemhof-Ruwaard et al., ('99) and Fleischmann et al., ('00) consider strategic aspects of distribution network structures and Autry et al., ('00) deal with the bond between reverse logistics performance and satisfaction. Besides that, there is relevant literature scanning the general issues / problems in reverse logistics (Stock, '92; Kopicky et al., '93, Rogers & Tibben-Lembke, '99 and Guide, '00). Hardly any attention has

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been paid to operational and financial aspects of return storage, handling and transportation. Two exceptions are the studies by Beullens et al. ('98) and Dethloff ('01). The first models transportation costs when backhaul of returns is included while the latter treats the vehicle routing problem with simultaneous delivery and pick up.

It is really necessary to pay more attention to operational aspects of return handling, because return flows are not only increasing in number, but also in importance. As reported by the Reverse Logistics Executive Council (see Rogers & Tibben-Lembke '99) US firms have already lost billions of dollars on account of inefficient handling of return flows.

In this paper we investigate factors contributing to the decision of combining vs. separating inbound and outbound flows during the handling process of product returns. We do so by comparing nine retailer warehouses. The comparison allows us to identify some of the factors contributing to the differences. The analysis brings further insights about the complicating issues, possible simplifying solutions and practical implications. At the end, we postulate several conjectures that will be later used for further research on return handling efficiency.

The remainder of the paper is structured as follows. Next section reports relevant operational issues regarding the handling of returns. Subsequently the methodology is discussed. After that, the nine case studies are described and analysed. Finally, the last section is dedicated to overall conclusions, recommendations for practice and research opportunities.

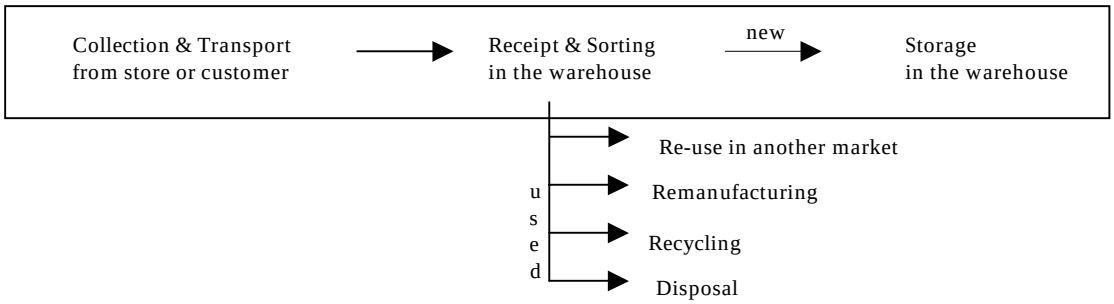
Handling returns

Note that it is not only the product itself that may return, but also the product carrier and packaging materials. Therefore, handling returns may involve dealing with a variety of products, as well as a variety of packaging materials. Furthermore, products may return before use due to commercial agreements or after use at the end of the life cycle. The former, also known as commercial returns, are not always saleable at the original price, but in many situations these are new products that can be put again in inventory (see De Brito & Dekker, '01). The latter, a consequence of environmental legislation that it is steadily increasing in the European Union, may later be reused, remanufactured, recycled, or properly disposed. In this paper, we only take into account commercial returns because end-of-life returns are currently negligible for the retailers investigated. In another paper Koster et al. ('00) accommodate end-of-life returns.

In order to handle returns in practice, decisions about the logistics process of the returned products have to be considered. In this paper we focus on the decision of combining vs. separating inbound from outbound flows during the return handling process. Figure 1 exhibits the three stages of this process, as considered in this paper. For the first stage companies have to decide about whether to simultaneously pick up returns and distribute new goods. The

trade-off here is between the exploitation of existent resources (trucks, route planning) and the increase of complexity (e.g. new and returned products sharing truck capacity). Later, returned products have to be received and sorted at the warehouse. In this second stage, receipt and sorting, companies have to decide whether or not these operations are to be done at the same area / facility where procured products are handled. Finally, in the third stage products in good condition are put back in inventory to be sold again, a common practice in several businesses. The decision about combining vs. splitting reverse and forward flows embraces in this case both the physical storage and the registration of information in a warehouse management system.

Figure 1 The process of handling returns



In general terms, firms have to decide whether they will use the same facilities and network structures to handle both the forward and the return flow of products. This may imply additional transport, space, or even buildings and specialised labour requirements. Moreover, all these decisions are subordinated to the overall objectives of the company such as minimising costs, providing high service and keeping controllability high.

Next, we go over the case studies planning. The different stages of handling returns are the central aspects of the case studies analyses.

The case-studies: brief description and design

The handling of returns in warehouses of three lines of businesses were investigated: food stores, department stores and mail order companies. All of these are mature industries that deal with returns on a daily base. In total nine retailer warehouses in the Netherlands were considered, three per industry branch allowing inter- and intra-industry comparison. In this way we protect both internal and external validity. Food retailing is a business with large volumes and small profits. The margin in the Netherlands is about 1 to 2% per item (see Koster & Neuteboom '01). The three food retailers studied, identified as FR1, FR2, FR3, have full line warehouses. This means that the full line of products are stored in the warehouse, and supplied via the warehouse to the supermarkets. The department stores are here called DS1, DS2 and DS3 and they are the largest department stores in the Netherlands. Finally, the mail

order companies similarly labelled as MO1, MO2 and MO3 are as well the largest mail order companies in the Netherlands. Customers usually order from catalogues, which are freely distributed. Nevertheless, the Internet is also increasing its role as a market channel.

The information on these retailers was obtained through interviews with at least the logistic manager at one of the company's distribution centers. The first contact with the company was by phone. Next, two researchers pursued in-depth interviews with the logistics manager and in most cases also with the information technology manager. Thirdly, three researchers made repeated visits to the company. In many cases, students also visited the companies, and descriptive reports were requested. After that, phone calls followed to clarify doubtful aspects. Later, interviewees had the opportunity to check the collected information. The field research took place in 1999 / 2000.

Information about the handling process (transport, receipt and storage regarding each warehouse) was gathered. In addition and to facilitate the understanding of the conditions in which decisions are taken, data on the product and materials being returned, return policy, and return volume were collected. Moreover, background information on the space and manpower assigned to return handling, as well as the associated costs were estimated.

Contextual factors

- Type of returned product or material (goods or carrier materials)
- Return policy (constraints in time and others)
- Return volume (per return flow, and compared with total outgoing flow)

The process (focus: separated vs. combined with outbound flows)

- Transport (also: self-executed or not)
- Receipt (also: automated vs. manual handling)
- Storage

Manpower, space and associated costs

- Manpower during receipt and storage (amount of labour dedicated to return handling)
- Space for receipt and storage (the area devoted to return handling)
- Personnel and space investment

The costs of stocking and handling returns have been estimated on the basis of the used space for return handling and storage processes. The estimation was carried out as follows. In presence of dedicated areas to returns, these areas were simply measured. In the situation that return storage was combined with outbound storage, the space was estimated.

Next, the yearly facility costs for returns were obtained by depreciating the total investment costs of the facility in 30 years and taking a part of this amount proportional to the space for returns. In addition, personnel costs were considered, with an average of 60,000 annual guilders (NLF) per employee. We have to stress that these are not the total costs of returns, since transportation costs and inventory holding costs are not included. Furthermore,

for returns substantial investments in information systems usually have to be made (Olsen, '00; Linton & Jonhston, '00), which have a depreciation period much shorter than 30 years. Finally, it is very difficult to include costs of internal transportation personnel (for instance forklift truck drivers), since they are not solely dedicated to return handling.

Any other particularities, retailer specific, or directly related with the handling of product returns, may also be mentioned in the next section for clarity purposes.

The case-studies: analysis and comparison

Contextual factors

Food retailers

From the three investigated food retailers, FR3 is active in the whole country, while FR1 and FR2 operate at a regional scale. A variety of products, from dry groceries, dairy products, beverage, and meat, to vegetables, fruit, and frozen products have to be stored in the warehouse.

FR1 has one central distribution centre (DC). The national market share is about 2%, and the 30 supermarkets are served from the DC. The supermarkets are totally owned and exploited by the FR1 organisation. The majority of the 8 000- 9 000 stock keeping units (SKUs) are mainly shipped to the 30 supermarkets via the DC. Fresh dairy products, bread and cheese are directly shipped from the suppliers. The distribution center of FR1 deals with returns of products, carrier material (roll cages, crates, pallets), and waste (paper, plastic, disposable products, etc.).

The food retailer FR2 is also a regional chain with a single DC. The national market share is 1.4% and the 30 supermarkets are served from the DC, including the bread and the meat that are manufactured in house in integrated factories. In total, this supermarket organisation deals with about 11 000 SKUs. FR2 deals with return types identical to FR1 i.e. products, different carriers and waste. The warehouse has two buildings, one for cold store, return handling and waste, and the other for the remaining activities including bread and a meat factory.

FR3 is actually a wholesaler with about 500 franchised supermarkets, for which the operations of storage and distribution are similar to those of FR1 and FR2. The national market share is of 10.6% with an assortment of 12 000 products including tobacco and cosmetics. FR3 has several warehouses. For this study, we considered the newest warehouse, from which 134 supermarkets are served. FR3 receives back few products and little waste because the supermarkets are responsible for disposing the packaging materials and waste. If the supermarkets wish the DC to handle it, they have to pay. Therefore, the returns are mainly product

carriers. The warehouse has a two-floor structure, with the top floor dedicated to freeze and cold storage.

At all retailers, FR1, FR2 and FR3, return products have to be authorised to obtain money restitution.

Table I. exhibits quantitative data concerning the return flows (expressed in roll cages) at the three food retailers. It is clear that the majority of returns at the food retailers consist of empty carriers, e.g. empty roll cages and crates (more than 60% of the returns in all cases). Actually, almost all returns at FR3 are empty carriers because independent entrepreneurs have to pay if they want the DC to handle their own returns. Waste handling is significant only at FR1 and FR2, both having a policy to centrally collect and handle returns and waste.

Table I. Weekly outgoing and return flows (in roll cages) at FR1, FR2 and FR3.

Description	FR1		FR2		FR3	
Outgoing flow DC (RCs/week)	17,000		14,950		28,000	
Return crates and bins	6,500	38%	5,600	37%	8,400	30%
Returned Paper / Plastic / Waste	4,000	24%	3,000	20%	paper 105 plastic 150	0.9%
Products: to be reused / discarded	100	1%	100	1%	20	0.1%
Total returns per week (RCs)	10,600	63%	8,700	58%	8,675	31.0%

Department stores

DS1 is part of a European retail organisation with five different store chains in the Benelux in the shoe and sports sector. There are three shoe store chains, with 87, 40 and 65 stores, respectively. The two sports chains have 30 and 16 stores, respectively. All these stores are served from the central warehouse studied in this paper. The assortment is about 4,000 articles. However, when size and colour are included, there are about 20,000 SKUs, divided in the categories men's, women's, children's and sports shoes and clothing, and accessories.

DS2 is a chain of seven large department stores in The Netherlands in the luxury market segment. The assortment consists of shoes, clothing, white and brown goods, books, CDs etc. (about 300,000 SKUs, changing constantly). All stores are delivered 1-3 times a day from the central warehouse. There, on average, 30,000 SKUs are stored, half of which consist of fashion.

DS3 is a chain of 66 department stores in The Netherlands, with clothing, shoes, white and brown goods, books, CDs etc. The total assortment consists of about 200,000 SKUs (not all on stock). The stores are replenished at least once a day by one of the four warehouses. All warehouses carry a different part of the assortment. In this paper we studied the central warehouse with fashion, books and media products and responsible for 50% of total revenues.

The three distribution operations are therefore largely comparable. They serve own stores with a fairly similar assortment and a large number of SKUs on average on stock, although the total assortment of DS2 and DS3 is much larger than that of DS1. The other difference be-

tween DS1 and the other two retailers is that DS1 does not have hanging garment. For the other two retailers this requires special storage and handling systems like overhead conveyors. The main return decision is taken centrally, given to the DC more control over the returns. DS1 tries actively to find the best sales outlet for the products and reallocates products (so-called condensation returns) to different stores. All the companies have considerable amounts of product returns, varying between 7.3% to 14% of outgoing flows (Table II).

Table II. Yearly outgoing and return flows (in roll cages) at DS1, DS2 and DS3.

Description	DS1		DS2		DS3	
Outgoing product flow	4, 500, 000		18, 000, 000		55, 000 000	
Total returns	630, 000	14%	1, 700, 000	9.4%	4, 000, 000	7.3%

Mail order companies

Customers can order by mail, phone, fax, or internet and can return the merchandise without any obligations up to two weeks after reception.

MO1 is a US company that trades in exclusive collector items, like miniature cars, dolls, porcelain and jewels. We investigated the European Distribution Center, from which all customers in Europe are delivered, usually by national post offices. Products are shipped from the DC to hubs of these PO's in Europe. The assortment is about 10000 SKUs, the return time limit is 30 days. About 7000 products are shipped per day. This is approximately 7000 customer orders. Besides products, also product certificates have to be included, as well as leaflets.

MO2 is a home shopping company, with a wide assortment. The company has two DCs. The DC we studied carries hanging garment, small household appliances and small technical products, about 10000 SKUs in total. Products are shipped via parcel carriers, in total 10 million units per year and 25000 orders per day on average in 1995. The return time is 1 week.

MO3 is a German mail order company. The Dutch DC ships to customers in The Netherlands and Belgium. The assortment of this DC consists mainly of small household appliances and fashion. Registered customers receive a catalogue twice a year. The return time is 2 weeks.

Apparently, all mail order companies accept all returns and customers are usually credited. Product return flows are about 10%, 30% and 25% of the outgoing flow respectively for MO1, MO2 and MO3.

Table III summarises the information presented before concerning the return type and policy of the nine retailers.

Table III. Return type and policy at the nine retailers.

Return type & policy		
FR1	**FR2**	**FR3**
Products, different carriers, and waste.		Few products and little waste. Mainly empty carriers.
Return products have to be authorised to obtain money restitution.		
Central collection of packaging materials and waste at DC.		Supermarkets are responsible to dispose packaging materials and waste. They have to pay if they want DC to collect their waste.
DS1	**DS2**	**DS3**
Products (sports shoes, clothes and accessories), paper, roll cages and store decoration material.	Products (shoes, clothing, white and brown goods, books, etc.), hangers, plastic bins and clothing stands.	Products (clothing, shoes, white and brown goods, books, etc.), hangers, plastic bins and packaging material.
Condensation returns are initiated at the sales department and are credited to the stores. All other returns e.g. complaints, are initiated by the stores, which remain owner of the products.	Products can be returned when the purchasing department grants permission. Except for off-season returns, of which the stores keep the ownership, stores are credited for returns.	The purchase department decides what should be returned. The DC decides the return instant. Returns are credited to the stores. Except for fashion all returns are sold out at reduced prices.
MO1	***MO2***	***MO3***
Collector items (miniature cars, dolls, porcelain and jewels, etc.)	Garment, small household appliances	
All products can be returned at no cost but within the allowed time to return.		
Time to return: 4 weeks.	Time to return: 1 week.	Time to return: 2 weeks.

The process

Food retailers

In FR1, small swap bodies with cooling capacity are used for transport between the DC and the stores several times per day. Transport is self-executed. After dropping off a full swap body at the store, the truck picks up the previous swap body, which is now full with returns, and transports it to the DC. All returns are received for inspection in a separate zone of the shipping area. After inspection, products are sorted and separated. A third party will subsequently discard products in poor state, paper, bread, vegetables and other waste. Product carriers are sorted manually and send for separate storage areas (there is a separate area for empty roll cages, empty crates, and empty pallets). Products as good as new are manually put back in the inventory together with the procured products. All packaging material and waste generated in the supermarkets is centrally collected at the DC, for scale advantage (see Stock, '01).

Trailers are used to transport to and from the supermarkets in the case of FR2. Although there are 4 deliveries per day, supermarkets can only return twice a week. This has to do with the fact that returned material is only picked up at the last supermarket in each route (2 or 3 stores). Returned products are received in a separate zone of the second building, while returned carriers are received in both floors. Carriers will then be inspected in separate zones of each of the buildings. The integrated bakery and butchery handle respectively bread and meat waste. Other waste types are undertaken by third parties. Products in an as good as new state go back to inventory. The collection of packaging material and waste is centralised at the DC.

FR3 self-executes the transport by means of trailers, many with three temperature compartments. Usually there are three deliveries per day per supermarket, giving opportunities to pick up the empty carriers. The returns are received in both floors of the warehouse, while the empty carriers are received through special dock-doors at the top floor. There is a special shuttle truck that moves returns between the two storeys, to make sure that the returns are handled at the proper dock. Crates are sorted and palletised through an automated system.

The information presented before can be found summarised in Table IV. All transport is daily and self-executed. However, when excess capacity is needed, transport is outsourced. Returns collection is included in the route, although this is done differently at all three retailers. The internal handling differs as well. All retailers have separate loading docks for empty (beer and soft drink) crates. All have separate areas where empty product carriers are stored. Waste materials at FR1 and FR2 are received and handled (sorted) in separate areas, as well. FR2 also disposes meat and bread waste. FR1 has outsourced this. Returns of good products, close to the keeping date, form a minority in all organisations and are added to ordinary stock locations. These are usually sold at selected outlets at a lower price. At FR3, all waste material is weighed per store, since the stores have to pay for the disposal. This is not done at FR1 and FR2. All return handling is done manually, except empty product carriers at FR3, which are sorted and palletised automatically. As exhibited in Table I, the volume of such returns is the largest at FR3.

Department stores

Returns are picked up by the delivery truck and are included in the route. DS3 self-executes while DS1 and DS2 outsource the transport. Nevertheless, both DS1 and DS2 keep control of the transport planning. Receipt and inspection of returns is rather similar for the three department stores. However, while DS1 and DS3 have a separate storage area for returns, DS2 only has a separate storage place for out of season products (see Table IV).

Mail order companies

After unpacking, inspection, packing and re-labelling, the good products are eventually added to regular stock. MO1 has a temporary location for returns, from where orders are first served. However, when capacity is reached in this location, product returns are stored together with initial stock. MO3 also has a hybrid storing strategy. It distinguishes on the one hand bulk locations for initial stock and on the other hand multi-SKU locations for later replenishments (small quantities) and for returns (Table IV).

In order to handle the large number of returns, each of the three mail order companies uses dedicated software.

Table IV. The return process at the nine retailers.

Transport, products' receipt, sorting and storage		
FR1	***FR2***	***FR3***
Transport is self-executed, combined with several deliveries per day, per store.	Transport is self-executed, combined with daily deliveries. However, returns are possible only twice a week per store.	Transport is self-executed, combined with three daily deliveries.
Separate area for checking and separate storage per carrier type; products as good as new go back to inventory of new products.	Similar to FR1. However, bread and meat waste are handled at the integrated factories.	Returns are received at both floors while empty carriers are received only at top floor. Sorting and palletising empty crates is automated.
DS1	***DS2***	***DS3***
Transport is outsourced, but transport planning is self executed.		Transport is self-executed. About 1 delivery per store per day, usually only 1 store per truck route. Returns are picked up at the store by occasion of deliveries.
Several deliveries per store per week, several stores per truck route. All deliveries are in roll cages. Empty roll cages and returns are picked up at the stores.	About 1 delivery per sales department per store per day, usually only 1 store per truck route. Returns are picked up at the store.	
Returns are received at a separate part of the dispatching area, checked, and sorted.		
Paper is discarded. Good products are manually stored in separate areas respectively for condensation returns, complaint returns and decoration material.	Off-season returns are stored on special pallet locations. Other good products are stored on free locations (bin storage area) or added to the regular stock.	There is a separate storage area (basement) where products are re-priced and stored in bulk before they are sold out at the "budget market" special outlet. Expensive fashion is added to the regular stock.
MO1	***MO2***	***MO3***
Transport is outsourced. Orders are shipped to hubs of national P.O.s in Europe. Products are returned via national P.O.s. Transport of forward and return flows is not combined.	Transport is outsourced, but transport planning is self executed. All shipments are automatically sorted by postal code area. Returns are integrated in the truck route and are picked up at the customer.	Transport is outsourced to P.O. Only sortation per country is necessary. Transport of forward and return flows is not combined.
Returns are checked, reconditioned if necessary, repacked, labelled and added to the regular stock. There is a separate return receipt and handling area.		
All products are stored in pallet racks. Product returns are at first (and until capacity is reached) stored in a separated location, from where orders are picked first.	There are three main storage areas: bulk (pallets), pick stock and hanging clothes.	All regular products that are received in small quantities are stored on multi-SKU bins. This also holds for all returns. There are three main storage areas: boxed clothing, hanging clothing and a bin storage area for other products. Bulk stock is stored elsewhere.

Manpower, space and associated costs

The (internal) warehousing costs have been estimated. From the subsequent analysis it appears that the warehousing costs for returns (storage and handling only) form an appreciable amount of the total warehousing costs. In fact, the total costs of handling returns are much higher when transportation, and handling in stores would be included.

Food retailers

Table V exhibits quantitative data on the manpower and dedicated space to handle returns in the warehouse as a percentage of total area and manpower employed.

In matters of space, FR3 needs almost the triple of area for the returns than FR1, one third of the space used by FR2 (Table V). One must recollect that on the one hand FR3 deals with little waste and FR1 has outsource disposal, while FR2 integrates the treatment of bread and meat waste.

The absolute estimated yearly costs to handle returns are 668, 705 and 867 thousand Dutch guilders respectively for FR1, FR2 and FR3. In percentages, these correspond to 6.5%,

12% and 5.8% of the total warehousing costs. Costs per returned roll cage vary between 1 and 2 Dutch guilders, with FR1 at the low end and with FR3 closest to 2.

Department stores

DS1 uses 12.3% of the total warehouse's area and 10% of the total employees to handle returns. The numbers for DS2 and DS3 are respectively about 2.8% and 10%, and 6.0% and 9.1% (Table V)

The estimated yearly costs to handle returns are in absolute values 423, 713 and 812 thousand Dutch guilders respectively for DS1, DS2 and DS3. These values match with 10.6%, 3.6% and 6.5% of the total investments in the respective warehouse. This corresponds to much less than 1 Dutch guilder per return unit, with DS3 and DS1 having respectively the lowest and the highest costs.

Table V. Manpower and space at FR1, FR2, FR3 and DS1, DS2, DS3.

Description	FR1		FR2		FR3	
Manpower in the DC (FTE)	149		70		198	
Manpower for returns (FTE)	10	6.7%	7	10%	12	6.0%
Total DC area (m²)	15, 000		35, 000		43, 000	
Area used for returns (m²)	770	5.1%	6, 000	17.1%	2, 108	4.9%
	DS1		DS2		DS3	
Manpower in the DC (FTE)	50		240+±50 temporary labours		170	
Manpower for returns (FTE)	5	10.0%	About 8	±2.8%	10	5.9%
Total DC area (m²)	15, 000		45,000		33, 000	
Area used for returns (m²)	1, 850	12.3%	About 4,500	ab. 10%	3, 000	9.1%

Mail order companies

The impression given by the companies' visits is that the studied mail order companies use between 5% to just above 10% of the warehouse space to handle returns, and around 10% to 15% of the working force. However, a careful estimation was not possible for all mail order companies due to the way some handle returns. For this reason, we do not discuss the associated costs of handling returns. Still, one should keep in mind that mail order companies have a large number of product returns. Related to it, all the three mail order companies had a separate module in the Warehouse Management System dedicated to return handling, which demands substantial investment costs since it is hardly found as a standard functionality. This software helps to monitor returns as for instance the number of times an item has been returned.

Discussion and implications

In the previous section, we depicted the operational aspects of handling returns associated with nine retailer warehouses in the Netherlands. Next we put forward two general proposi-

tions, based both on literature and on our empirical analysis, which feed future studies on return handling efficiency.

P1: Reducing uncertainty (not only on quality, quantity, and time, but also on product diversity) is critical for return handling.

Reverse Logistics has been associated (see RevLog, '98-) with high uncertainties on time, quantity and quality. The empirical research allows us to state that not only when, how much and the state of products, but also the product diversity is a central source of uncertainty (see also conjecture P4). Moreover, one can expect that different combination scenarios of those four factors are more or less problematic for return handling. For instance more of the same, i.e. large volume of similar type of products are likely to be handled more efficient than a group of products with divergent characteristics. Indeed, we could notice that all retailers had mechanisms to reduce the aforementioned uncertainty while steering the return scenario as attainable. Every retailer with stores centralised the return authorisation. Although with limitations, this gives possibility to determine the instant (time) for certain types and amounts of returns (quantity, quality and diversity) being collected. For example, a retailer may determine that only one stream of waste is being returned, or that complaint returns are collected on Thursday, etc. Mail order companies have less chance of reducing uncertainty, specially the ones that use P.O. services. MO2 however integrates the delivery route with return pick-ups at customers. In this case, the customer phones the retailer requiring a pick up, after which the retailer proposes the pick up date. Although customers are entitled by law with the right of returning products, the mail order companies formally restrict the return period from one to four weeks after the customer has received it. Still, there is evidence that customers not always respect the time of the return constraint (see Schmidt et al., '99). Though mail order companies have limited control over returns, all invested in information systems dedicated to return data. Mail order companies showed concern in limiting the number of times a returned item goes back to the market and in recognising customers that repeatedly return merchandising. From the interviews it was not possible however to assess which action is taken in the case of customers that frequently return products. Nonetheless, each retailer was clearly involved in reducing uncertainty on quality, quantity, time, and product diversity of returned products.

P2: Return handling has distinct warehousing requirements that are fundamentally different than those of forward flows, being of importance for efficient handling.

Both academics and practitioners have been pointing that Reverse Logistics is likely to have different basic requirements than forward logistics either in respect to infrastructure (Gentry,

'99) or knowledge (Meyer, '99). Our analysis brings out symptoms that this is valid for product flow handling in the warehouse. An observation of Table V and Table I, allows the following remark. FR3 uses 33% more Full Time Equivalents (FTE) to deliver 65% more products than FR1, per week. In spite of automatic crate handling in FR3 and manual handling at the other two food retailers, FR3 uses more people than FR1 and FR2 to handle less volume of returns. This has a direct impact on the cost per returned roll cage: FR1 with a cost slightly above 1 Dutch guilder and FR3 with a cost close to 2 Dutch guilders per roll cage. Still, for almost all retailers an FTE handles on average around 10% more flow, when it is reverse than when it is forward. However, when space is considered, for some retailers returned products require more average space for handling than the space required by outbound products. Apart from these mixed facts the point is that, as in the case of FR3, a retailer may have a very good relative performance in forward flow, but the opposite relative performance with the reverse flow (similar outcome when comparing DS1 and DS2). All the above fits in the context of our conjecture: return handling has different warehousing requirements than those of forward flows. Indeed, return handling encompasses operations as inspection, which is not part of forward handling. Yet, this implies that there is room for research to identify potential specific needs that matter in efficient warehousing handling.

Table VI. Decisions of combining (C) vs. separating (S) the forward and the reverse channels.

Handling process	Food Companies			Department store companies			Mail order Companies		
	FR1	FR2	FR3	DS1	DS2	DS3	MO1	MO2	MO3
Transport	C	C	C	C	C	C	S	C	S
Receipt	S	S	S	S	S	S	S	S	S
Storage (products)	C	C	C	S	C/S	S/C	C/S	C	C/S

Table VI sums up the decisions of combining (C) vs. separating (S) the inbound from the outbound flows during the three stages of return handling: transport, receipt, and storage. All the retailers with stores (food and department stores) combine the transport of product returns with outbound flows. All the warehouses have a separate area to receive returns. On storage, the majority of the retailers combine the flows, one separates and three retailers have a mixed or hybrid arrangement. Below we discuss three conjectures with these facts in mind.

P3: For retailers that supply (a sufficient number of) stores it is most efficient to collect the returned material to the DC with the same truck that delivers the products.

The rationale behind this is very simple. The truck returns to the warehouse anyway and it also saves precious space for the stores, which are often placed in urban areas with little expansion possibility and very high land prices. In addition, in case of waste or obsolescence, a number of stores should be included in the return route to have economies of scale (Stock, '92). One should notice that however when more than one store is included per route, the

loading of return material complicates the unloading of purchased products at the stores following in the route. This is the case for FR2 and DS1. Nevertheless, FR2 was able to simplify the operation by allowing each store to return material only when they are the last in the route, which happens maximum twice a week. This emphasises the importance of self-executing the truck route planning. Actually most of the retailers considered in this study kept control of the route planning. FR1, FR2, FR3 and DS3 self-execute the transport operations. The department stores DS1 and DS2 outsource the transport but they keep the route planning in-house. MO2 uses a delivery service but also keeps the route planning in-house.

P4: For retailers that handle a high volume of returns, it is more efficient to unload and sort returns in a separate area of the DC.

All the warehouses separate the inbound and outbound flows during the receipt phase and all the retailers deal daily with large volumes of product and material returns. Product returns demand operations additional to those of purchased products, like inspection. If the volume of returns is not substantial it could still be reasonable to combine the forward and reverse flows, but in the converse situation it is not likely. A complicating factor for return handling is the diversity of products. Yet, handling of large homogeneous flows may be automated. For instance at FR3 all empty crates are automatically unloaded from roll cages, sorted per type and stacked on pallets. In practice the design of the warehouse's layout has to take into account the return handling. Comparing the numbers for return costs as part of total warehousing costs enforces this. They vary from 3.6% at DS2 to 12% at FR2. The fact that FR2 uses two separate buildings to receive product and material returns demanding transportation between the buildings is likely to contribute to this relatively higher percentual cost.

Separating vs. combining storage is related with the market for returns, as follows:

P5 a: If the market for returns is different from the original market then product returns are stored in a different area of those of purchased products.

P5 b: If the market for returns is the same then storage of product returns is likely to be combined with purchased products. Exceptions will be found in case of high-intended control over returned products.

For food retailers all returned products in good condition are stored together with procured products and they are sold in the same market. The same holds for mail order company MO2. Department store DS2 combines storage apart from off-season products, which are sold in another market. DS3 mainly sells returns in "budget" outlets so they separate storage. This retailer only combines the storage for expensive articles, which are sold in the original market. DS1 is an exception in the sense that it separates storage but returned products go

back to the same market. This is related with the fact that DS1 is very concerned about keeping track of returns. This comes along with the active role of DS1 in finding the best store to reallocate product returns. MO1 stores returns at first in a separate location from which orders are picked first. This goes with MO1's aim of sending before long the returned products to the next client. Such an approach provides a quick means to learn more about the market, the product, and even the process. For instance, repeated returns may indicate that some aspect is being overlooked during return check or that customer expectations are not being met at all. When capacity is reached in the temporary location, product returns are put together with purchased products. MO3 uses a hybrid solution: small amounts of received products, including returns, are stored in a single bin (max 10 SKUs) on one location. For MO3 the control over returns is an issue of great importance. Mail order companies have an additional difficulty because they have a substantial volume of returns and elevated product diversity (number of SKU's) coming back in small quantities (per customer).

Before we started this study we suspected that the combination of volume and product diversity would have an impact on the storage decision. From the analysis though the complicating factor seems to be the decision of controlling returns. Yet, both volume and product diversity can be a point of further research since they might not be a complicating factor by itself but be so when combined with other factors.

Furthermore, to have a relevant degree of return monitoring and control a separate module for returns in the warehouse management system is a desirable situation, as is the case for mail order companies.

Conclusions

This exploratory study facilitates on the development of theory for return handling and supports both recommendations for practice and research. Regarding the first, we uncovered that not only quantity, quality and timing are relevant sources of uncertainty in the reverse stream but also product diversity. Besides this, there is empirical evidence for the existence of different basic requirements in return handling vs. forward handling, also in the warehouse scene. Among the studied companies, we observed cases of retailers having a good relative performance in handling forward flows but not being able to perform as well when reverse flows are concerned. With regards to the focus on factors contributing to combining vs. separating the reverse and forward flows, we postulated three conjectures. In those we established relations between 1) serving stores and the transport phase decision; 2) return volume and the receipt at the warehouse; 3) the market for returns and the storage decision. Table VII refers to these findings during all the three stages of return handling. Below, we consider in more detail some associated recommendations for practice and research opportunities.

Table VII. Combine vs. separate outbound and inbound flows during three stages of return handling: a summary

	Combine vs. separate outbound and inbound flows		
	Collection & Transport	Receipt & Sorting	Storage
Remark	All retailers with stores combine transport.	All retailers separate receipt.	The majority of retailers combine storage.
Influencing factor	To serve (a sufficient number of) stores.	A substantial volume of product and material returns.	The market for returns.
Complicating factor	More than one store per route.	The combination of volume and variety of return flow.	Intended controllability over returns.
Example of simplifying action	To allow stores to return material only when they are the last in the route.	To automate sorting of homogeneous returns.	Small amounts of purchased and returned products are stored in the same location.
Practical implication	To keep route schedule in-house.	To design warehouse (also) with return handling in mind.	
		To anticipate packaging legislation.	Information system on product returns.
Associated conjecture	P3	P4	P5a, P5b

Recommendations for practice

For retailers with stores wishing to reduce return uncertainty there are two key-factors: to centralise return authorisation and to keep routing in-house even when outsourcing transport. Those actions give the retailers the opportunity to restrain return uncertainty by determining the exact moment of which pick up (taking into account the stores' needs). For an efficient handling, the design of the warehouse's layout has to bear in mind the return handling (receipt location and future storage locations) and not only the forward flow. To automate the return handling for homogenous returns may simplify operations. However, the previous calls for substantial investment and it relates above all to returned product carriers. This is a sensitive matter, especially with the legal affairs of the European Union. Therefore, retailers should anticipate packaging legislation before investing heavily on return handling automation. The last recommendation goes to employing a dedicated module within the warehouse management system for return handling monitoring. This suggestion is related with the indication of fundamental differences in handling the two types of flows and of deficiencies in standard software regarding return handling.

Research opportunities

The conjectures presented in this paper facilitate future studies on return handling efficiency. For this reason, the perceived relations between factors contributing to decisions during the handling process will be further investigated. One aspect not taken into consideration here is the overall strategy of the firm, which may justify different return strategies and handling processes. This presumably contributes to understand why some retailers do not object so much to costs when the matter is to keep track or control of returns. Indeed, research towards mechanisms to cut back uncertainty in its four fronts (quantity, quality, time and product diversity) would be of practical value. In general terms, there is a need for research on issues of monitoring, control and efficiency in return handling. In addition, the technical literature, as

mentioned in the introduction, may benefit from a close look to warehouse running costs**.** Authors will be more apt to incorporate a realistic de-coupling of model parameters for forward vs. reverse flows. The environment that surrounds forward and return operations today should also have a place in academic research. To mention only two: packaging legislation in the European Union and e-commerce. On the one hand there is the question of the impact of packaging legislation (standardisation and reuse) on actual warehousing operations. On the other hand, the result of fairly tolerant return policies of the e-business era (see Piron and Young, '00) in manoeuvring return flows. To conclude, return handling offers plenty of research possibilities that are of great practical significance.

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