ACCOUNTING FOR REVERSE LOGISTICS ACTIVITIES

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Abstract

Traditional logistics systems aim at minimising total (logistics) costs. At the same time, these systems focus on forward material flows in the supply chain. Concerns for the environment, and warranty-related product returns have led to both end-of-life and commercial product take-backs, introducing the question of reverse material flows in these systems. These are backward moving inventories that have to be (re-)processed and show several coupling points to the forward materials flows in the logistics system. We argue that modern accounting systems are challenged with the phases of remanufacturing and refurbishment in the reverse supply chain. Many reverse logistics and reprocessing activities are integrated in other corporate processes, and their costs are difficult to separate from other cost objects, hindering the correct costing of reverse flows. By an analogy to safety management accounting, this paper proposes an activity-based method to account for the costs of reverse material flows. Accounting for these costs will help to take a more holistic view on total logistics costs and improve management control of logistical flows.

Keywords: management accounting, reverse logistics, activity based costing

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1. Introduction

Material, information and capital flows are central to supply chain management (Lambert *et al.*, 1998; Mentzer *et al.*, 2001). Material typically flows downstream in the supply chain, i.e. from supplier to customer, while information flows are most often discussed upstream. However, product take-backs out of various reasons lead to products and materials also flowing upstream in the supply chain. Warranty periods and extended producer responsibility oblige companies to handle different streams of product returns. Thus the flow of returns is one of the processes discussed in the supply chain management framework (Lambert *et al.*, 1998). Therefore also, the supply chain operations reference model SCOR was extended to include reverse flows (Supply Chain Council, 2005). Moreover, volumes of product returns are predicted to increase (Guide *et al.*, 2003a) as environmental legislation becomes more stringent. Nonetheless, reverse flows are still largely neglected and not seen as a continuous business process, but rather as unrelated activities in random departments of a corporation (Guide *et al.*, 2003a). Costs related to reverse logistics activities are therefore registered in different accounts of various cost centres in a company, even though reverse logistics literature stresses the importance of considering the chain of these activities, emphasising the interfaces between them in particular (see Fleischmann *et al.*, 1997). Cost-minimising models for reverse logistics such as Teunter and van der Laan's (2002) inventory cost minimising model, and Hu *et al.*'s (2002) model to minimise total operational costs of handling hazardous waste exist, but are constructed under the assumption that all these costs are known and identified. Unfortunately, given an unsystematic registration of these costs at various cost centres across a company, this is not typically the case. Thus companies still lack basic data for identifying the costs related to reverse logistics activities, and thus be able to control and manage reverse flows.

Therefore, the aim of this paper is to identify reverse logistics costs and thus increase the cost transparency of reverse logistics activities. This framework takes an activity-based perspective on reverse flows, and therefore introduces a method based on activity cost analysis to identify relevant cost drivers and categories.

The paper begins with a discussion of management accounting and control, before turning to each reverse logistics activity. These activities are then analysed from the perspective of activity based

costing before presenting conclusions for managing reverse flows.

2. Management accounting and cost transparency

Cost and time efficiencies are of utmost importance to logistics. Thus many logistical decisions are based on core accounting data, costs. Accounting in its simplest form is an information system aimed at registering, processing and reporting financial information to relevant decision makers within or outside of the company. Accounting is usually divided into at least two separate fields called financial accounting and management accounting.

The focus of financial accounting is on collecting and reporting financial information for external decision makers through (mainly) financial statements and the annual report. Financial reporting is governed by various standards such as International Accounting Standards and accounting regulations in each country. Furthermore, information presented in the annual report has to be audited by external auditors and thus subjected to various auditing standards, which aim to ensure the quality of this information including e.g. completeness, accuracy, timeliness and objectivity. The impact of reverse logistics on financial reporting has been addressed previously in e.g. reports from some of the larger auditing firms (KPMG, 2003). On the other hand, management accounting – which is the focus of this paper – can be seen as the financial information system of managers. As such it is not regulated by any standards or regulations but only by the needs of managers for decision relevant information. Management accounting systems are therefore not standardised and serve different purposes in companies depending on industry, size, technological sophistication and management needs (Chenhall, 2003). A formal definition of management accounting is e.g. given by The Institute of Management Accountants (IMA, 1981: p. 2):

"A value-adding continuous improvement process of planning, designing, measuring and operating both nonfinancial information systems and financial information systems that guides management action, motivates behavior, and supports and creates the cultural values necessary to achieve an organization's strategic, tactical and operating objectives."

The role of management accounting information is thus supporting strategic (planning), operational (operating) and control (performance evaluation) management decision-making and is intended to meet specific decision-making needs at all levels in the organisation. Examples of management accounting information include (Atkinson *et al.*, 2004):

- The reported expense of an operating department, such as the assembly department of an automobile plant or an electronics company
- The costs of producing a product
- The cost of delivering a service
- The cost of performing an activity or business process – such as creating a customer invoice
- The costs of serving a customer.

Although modern management accounting can address both financial and non-financial information (as e.g. in the Balanced Scorecard) the focus of this paper is on financial information or more specifically cost information. There is, however, no single definition of *cost.* Costs are developed and used for some specific purpose and the way cost information is to be used will define the way it should be computed (Atkinson *et al.*, 2004). In any case, cost information is the basis for providing management with the necessary basis for decision-making. As long as, though, costs and their drivers are not identified, managers cannot control a process, nor improve its performance. As for logistical cost drivers, the IMA (1992) lists materials (such as the number of stock keeping units and items), the number of suppliers and customers, and their locations in the supply chain, inventory levels, customer demand levels and patterns, customer service levels, transportation and warehousing as the typical logistical cost drivers.

While cost minimisation is a traditional goal of logistics, surprisingly little literature can be found on the topic of identifying costs and cost drivers, nor where in the accounting information system these might be found. The registration and classification of costs is a significant activity in modern companies. Accounting systems provide the facilities to register costs, attribute them to those locations, persons or units in the organisation that are responsible for the costs (often called cost centres), or if these are overhead costs allocating them to the locations, persons or units which have used the capacity that has generated the costs. But even though Rogers and Tibben-Lembke (1998) discussed the appalling scarcity of information systems for reverse logistics already in 1998, no enterprise resource planning (ERP) system is designed to register reverse logistics costs even today.

Costs can be classified into a variety of categories depending on the uses to which the information is to be put. Costs can be direct or indirect, flexible or capacity related, variable or fixed. They can be classified into manufacturing costs and non-manufacturing costs as well as material costs, labour costs and overhead. It is this last classification that will be primarily used in this paper i.e.:

1. *Material costs:* Costs of materials used in the business process that can be traced to individual units of production

2. *Labour costs:* Costs of employers used in the business process that can be traced to individual units of production
3. *Overhead costs:* Costs that cannot be traced to the individual units of production but rather to production or operation capacity.

A significant issue in the above is the issue of cost transparency. Cost transparency is the ability of managers to discern the actual costs of a cost object, which is the entity for which the costs are computed. This entity can be a product, a product line, an organisational unit or a process. An example would be a company producing two products. Product A requires more materials and labour (costs which can be attributed directly to each produced unit) than product B but uses less setup time (costs of capacity not directly related to each produced unit). If the same machine is used to produce both products then the accounting system would have to distribute set up costs between the two products. If the accounting system does not do this and for instance splits the costs equally between the two products, then the actual costs of producing each product are not visible. Product B would appear to be more expensive to produce than it actually is which again would affect the view of managers of how profitable it is to produce and sell.

Unfortunately, when it comes to costs related to reverse flows, they are often not registered separately from forward flows, e.g. transportation costs for distributing finished goods and collecting returned items in backhauls are rarely separated but rather accounted for as one. Therefore this paper sets out to identify and separate the costs of reverse flows, in order to increase the cost transparency of reverse logistics activities.

3. Reverse logistics activities

Reverse logistics commonly refers to the upstream or backward movement of materials in the supply chain (Goldsby and Stank, 2000; Rogers and Tibben-Lembke, 2001). This does not imply that materials are necessarily ending up at their original manufacturers, but refers to the collection of product returns, disassembly and disposal aspects of reverse logistics, regardless of their final destination (Carter and Ellram, 1998; RLEC, 2004). Companies involved in the reverse supply chain do not have to be identical with the manufacturers of the original product, but can also include new auxiliary channel members (Carter and Ellram, 1998; Huge Brodin, 2002). With and without the use of auxiliary channel members, the reverse supply chain is closing the loop of the material flow (Guide and van Wassenhove, 2001). Definitions of reverse logistics focus on either the business, or the ecological aspects of handling product returns (Kopicki *et al.*, 1993; Murphy and Post, 2000: RevLog, 2002), and also differ as to whether they incorporate resource reduction activities in the forward supply chain or only look at materials that flow "the wrong way in a one way street". Obviously, reverse logistics processes also differ depending on the type of returns and even the type of original products concerned. Guide *et al.* (2003b) thus categorise different reverse logistics processes depending on product volumes and flow patterns. But while the complexity of these processes differs substantially across companies, many similarities can be detected on an activity level.

Many different activities are associated with reverse logistics. Rogers and Tibben-Lembke (2001) list a variety of them, distinguishing between those related to products and others related to packaging returns. They range from returning items to the supplier to refurbish them, even donate them or reclaim materials. Guide *et al.* (2003b) also list product acquisition, testing, sorting and disposition, various alternatives of refurbishment, selling and distribution amongst reverse logistics activities. More systematically, Rogers and Tibben-Lembke (1999) discuss the reverse logistics process to consist of the activities of gatekeeping, collection, sortation and disposition. On the other hand, Fleischmann (2001) describes the reverse logistics process to start with the collection of items, their inspection and separation, going through various alternatives of reprocessing, and to end up at either redistribution or disposal. These three process descriptions are thus, rather similar. While gatekeeping, however, refers to the decision whether to take products back in the first place and how to avoid any types of product returns, this paper focuses on those activities that occur once a product enters this chain of activities.

The following activities are thus discussed here (see Appendices

Table **1**):

- *Collection*
- *Inspection and separation*
- *Alternatives of reprocessing (reuse, repair and refurbishment, material recycling, and remanufacturing)*
- *Disposal, and*
- *Redistribution.*

According to Fleischman (2001), *collection* refers to activities rendering used products available and physically moving the products to some point where further treatment is taken care of. In general collection may include purchasing, transportation and storage activities. The second step in the reverse logistics process is *inspection and separation*. Inspection denotes all operations involved in determining whether a given product is reusable and in which way. Thus inspection results in splitting the flow of used products according to distinct reuse and disposal options. *Reprocessing* entails the transformation of a used product into a usable product. This transformation may take forms such as

recycling, repair and remanufacturing. The *disposal* phase of the returns process includes activities such as landfilling and incineration (Fleischmann, 2001; Thierry *et al.*, 1995). Disposal is required for products that cannot be reused for technical or economic reasons, e.g. excessive repair requirements or insufficient market potential. *Redistribution* refers to directing reusable products to a potential market and to physically moving them to future users (Stock, 1998).

< Insert Table 1>

3.1 Collection activities

Depending on the collection scheme, a company either needs to pick up returned items from the site of customers in kerbside schemes, or at least take them back at a pre-defined point of take-back from customers in bring schemes (C2). Thus picking up the items in question (C3) depends on the collection scheme in place. In some cases the items taken back are a mixture of many different products and materials (such as general household waste), in these a sorting according to main product categories is necessary (C4). Some companies also have centralised collection facilities to decide on the inspection and separation of goods (C5).

3.2 Inspection and sorting activities

Some of the activities associated with inspection and sorting actually have to happen before the return occurs such as training employees in the use of separation technology, training employees in separating materials (I1) etc. Checking the quality of each item is an important activity if the product will remain in the process (I2). The actual separation process can either be personnel intensive or technology intensive depending on the item ad materials in question (I3). Locations of further usage can be, in the case of reuse as is, the retailers the items have been collected from; to landfills in the case of shredding (I4).

3.3 Reprocessing activities

Even if the quality of a good is as new, certain legal requirements have to be met and checked for before redistributing it as such. In the case of mobile phones, these are set in the form of a time limit on the actual usage of the phone (e.g. calling 20 minutes) (RU1). Some items that are reused have to still be prepared for their *reuse* anyway. Such is the washing of glass bottles before refilling them (RU2).

If the returned item did not meet the requirements for reuse as is, the quality check needs to assess which components of it are faulty (RP1). This again stresses the need to train the personnel that performs inspection and sorting activities. Special tools and materials are often necessary to *repair* or *refurbish* a product (RP2), only then can it be disassembled (RP3, M1, RM1) and perform product-specific repair activities (RP4). Another quality check is then needed for the refurbished good (RP5).

Before redistributing these items, even the ones that are reused as is need to be repackaged (RU3, RP6) – especially as most returned items do not come in the same packaging as they have been distributed in previously, and might not even be redistributed in the same market. Reused and refurbished products can then be transported further for redistribution (RD1), while faulty components can still be undergoing activities of material recovery and are thus transported further to recycling facilities (RP7, RM3). Here they can be assessed with special equipment, separated and reprocessed (M2 and M3).

Once disassembled, many materials and components can be used in manufacturing processes. These are typically considered secondary raw materials in manufacturing. A modular product design helps in being able to integrate these components in the remanufacturing process (see RM4). If products cannot be disassembled to the same component level as used in the original manufacturing process this process might need to be changed to accommodate for components from reverse flows.

3.4 Disposal activities

There are many ways to finally dispose of an item, which largely depend on the type of the original product (D1). While incineration is typically discussed as a "better" option than landfill disposal (see Carter and Ellram, 1998; Thierry *et al.*, 1995), for some materials like e.g. glass, its energy value from incineration is negative, that is, to incinerate glass needs more energy than it creates.

3.5 Redistribution activities

To redistribute items, these are transported downstream in the supply chain (RD1). Depending on the quality of the item (e.g. in reuse "as new") it can be redistributed in the original or in secondary markets, or can even be donated to charity (Rogers and Tibben-Lembke, 1998). All activities in a reverse logistics process have the potential to cross several organisational boundaries and should thus be seen in the context of a supply chain.

4. Accounting for reverse logistics activities

Using the activity overview shown in Table 1 the focus now turns to the issue of cost transparency. Cost transparency in the current context basically focuses on the question "How much does the reverse logistics process cost the company". As shown below, these costs might not always be transparent.

Building on the work of Herold and Kovács (2005) the value chain of reverse logistics reprocessing flow activities (and thus the cost elements of such a flow) can be illustrated as in could look like the one shown in Figure 1.

< Insert Figure 1>

The activity perspective is important in understanding the elements of cost transparency regarding reverse logistics processes. It focuses on the resource use of an activity and the costs generated by this resource use. These resources can be hours of labour, tons of material, kilowatts of electricity etc. The resource use is then "translated" into monetary terms using the price of the resource.

The value chain/business process perspective also illustrates that the reverse logistics process includes directly related activities specific to the reverse logistics process that generates costs directly attributable to the reverse logistics process. But the reverse logistics process also includes activities that are common to other business processes including administration and legal activities. These costs are indirectly attributable costs as one would have to discern how much of these activities was taken up by the reverse logistics process and how much resources this consumed. It also illustrates, as pointed out by Herold and Kovács (2005) that an important goal of reverse logistics is to generate a competitive advantage and a positive margin. However, to be able to do that the costs of the reverse logistics processes have to be identified.

In an accounting perspective this means that if the intention is to identify the true costs of some of the activities – say reprocessing activities only – then the common costs will have to be allocated to the individual activities drawing on the resources generating the costs. Furthermore, if the intention is to identify the costs of the reverse logistics business process as a whole then an additional challenge emerges as some of the costs involved are not registered as such in the accounting system and would have to be identified through a cost analysis.

Figure 2 shows some of the costs that have to be registered in a reprocessing reverse logistics process. These are loosely grouped into operating costs including personnel costs, materials, tools and consumables as well as capacity costs and other costs.

< Insert Figure 2>

In short, the cost transparency of reverse flows might not always be high if only depending on traditional cost registration systems. To discern the true costs of reverse logistics activities additional analysis is needed. The systematic activity costs analysis method (SACA) is a general framework to analyse costs based on activity analysis (Rikhardsson, 2005). This method has been applied in cost analysis in other areas of the company, e.g. for accounting for occupational accidents (Rikhardsson and Impgaard, 2004). The basis for the SACA method is activity mapping (see Figure 2). Activity mapping has originally been used in e.g. management accounting, business process reengineering and business efficiency improvement studies (Kaplan & Cooper 1997). In activity mapping, company costs are seen as being caused by the resource use by activities performed by its employees and managers. Thus by identifying the activities, evaluating the resource use the costs can be identified. This method has been used to identify costs associated with reverse logistics activities as in Table 2.

< Insert Table 2>

Examining Table 2, several issues emerge.

First the activities can span across several functional boundaries including transportation, marketing, legal department, human resources, production and general management (Guide *et al.*, 2003b). Even if the company does have a central facility for reprocessing it is not necessarily certain that all reprocessing costs are registered and allocated to this facility (see Rogers and Tibben-Lembke, 1998). This would depend on whether the company would need continuous information about the costs of the reprocessing activity or whether periodic analysis was enough. In the case of the former then the company would need to establish registration procedures in the accounting system identifying the reverse logistics flows as a specific cost object and associating certain activities and resource use with this cost object. Furthermore, allocating procedures would have to be identified regarding the resource consumption of activities that are not directly related to the reverse logistics process. If the company only needs periodical information about the costs of the reverse logistics process then a cost analysis can be carried out identifying costs through e.g. interviews and analysis of accounting documents.

Secondly, Table 2 classifies costs primarily into operating costs and capacity related costs. Operating costs can then be divided into costs which can be directly attributed to the reverse logistics process and costs of support activities which are also used by other processes. Capacity related costs could typically include the share of cost of storage space, cost of trucks and transportation material, cost of rent etc. A number of indirect activities support the reprocessing process such as training, legal services, marketing analysis, administration, communication and health and safety. If reprocessing is not a cost object and if there is no internal billing then these activities are registered as overhead costs. Depending on later allocation procedures it is not certain that all activities are recognised or allocated.

5. Conclusions

Reverse flows are increasing in volume and importance for many companies. Nonetheless, no ERP system can currently handle reverse logistics processes, account for "backward moving inventories" or just assess the true costs related to product returns. While attempts have been made at constructing models to minimise the costs of reverse

logistics (e.g. Hu *et al.*, 2002; Teunter and van der Laan, 2002), the basic cost data for conducting these calculations is often missing. Cost transparency is, however, essential for the management of a business process, as costs are the basis for many management decisions. Therefore this paper addressed the identification of costs. The systematic activity cost analysis method has been employed here to identify relevant costs in reverse logistics, and categorise them into material, labour, and overhead costs. The identification of these costs is expected to contribute to the management of reverse flows.

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Appendices

Table 1. Reverse logistics activities

	Returns process							
	Collection	Inspection and separation	Reprocessing types				Disposal	Redistribution
			Reuse	Repair and refurbishment	Material recycling	Remanufacturing		
Related activities	C1. Communicate with customer C2. Pick up item C3. Transport items to sorting facility C4. Sort items C5. Transport items to collection facility	I1. Train personnel for quality checks I2. Check the quality of each item I3. Sort items according to usability I4. Transport items internally for the location of their further usage	RU1. Check legal requirements for reuse RU2. Restore as new quality of item RU3. Repackage item	RP1. Identify faulty components RP2. Find appropriate materials and tools RP3. Disassemble item RP4. Perform repair activities RP5. Check final item quality RP6. Repackage item RP7. Transport faulty components to recycling	M1. Disassemble item M2. Separate materials M3. Process materials M4. Transport materials to further manufacturing facilities	RM1. Disassemble item RM2. Separate faulty components RM3. Transport faulty components to recycling RM4. Transport usable components to appropriate manufacturing steps	D1. Sort items for shredding, incineration or landfill	RD1. Transport item(s) to retailers

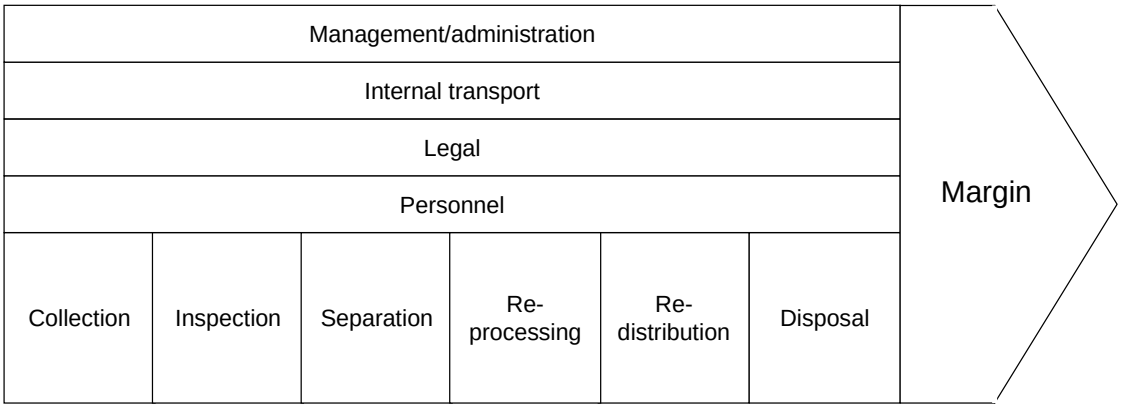

Figure 1. Value chain activities in a reverse logistics process

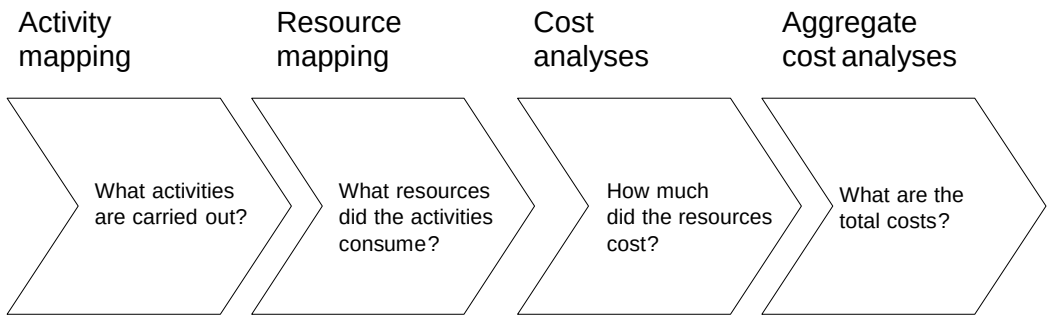

Figure 2. Systematic activity cost analysis

Table 2. Examples of costs associated with reverse logistics activities

Costs/Activities	Collection	Inspection	Separation	Reprocessing	Disposal	Other/Support activities
Personnel: Labour	Extra time needed to collect items	Time for registering items on arrival to facility Time for inspection of items Time for transportation of items from arrival facility to inspection facility	Time for separation of materials in item Time for registration of materials Time for transportation of items from inspection facility to separation facility	Time or reprocessing items and materials	Time for preparing items for disposal	Management and administrative costs including legal, accounting, personnel etc. management and administration Time needed to transport items and materials internally in the company between facilities
Personnel: Training	Special training of collection employees	Special training of inspectors	Special training of employees in separation	Special training of reprocessing employees	Special training for handling of disposal items	
Materials			Cost of materials needed for the separation processes	Cost of materials needed for the reprocessing processes	Cost of materials needed for the disposal processes	
Tools			Costs of tools needed for separation	Cost of tools needed for reprocessing	Cost of tools needed for disposal	
Consumables	Extra fuel due to weight of items or rerouted transport	Cost of transportation materials used such as palettes				
Capacity costs	Part of depreciation of trucks	Part of costs of storage capacity	Costs of separation facility or parts of facility costs if not separate from other facilities	Costs of reprocessing facility or parts of facility costs if not separate from other facilities	Costs of disposal facility or parts of facility costs if not separate from other facilities	Part of collective facility costs such as electricity, heating and lighting
Other	Take-back fees				Disposal fees	