1 Introduction

Calculating logistics costs in manufacturing companies may be a real challenge as logistics procedures are usually integrated in the general production processes. Thus logistics costs and performances are difficult to be identified exactly and the logistics oriented elements of production costs may remain unknown.

The methods of operative cost calculation and controlling are often used to improve production costing in the manufacturing industry. The basic idea of such approaches is that direct costs (e.g. used materials) are allocated to profit objects (products) directly while indirect costs are collected in so called cost objects (e.g. business units, manufacturing sites, service centers) first. The allocation of cost elements collected in cost objects is then carried out by using the performance flows. These performance flows can be identified between cost objects or between cost and profit objects. By doing so all cost elements are allocated to the products on a cause-effect basis ignoring the use of arbitrary calculation regimes (e.g. simple averaging).

Applications of product costing in manufacturing concentrate often on the activity based costing methodology as one of the realizations of operative cost calculation [5]. The corresponding models are proposed mainly for complex production systems and can be used for production planning effectively [1, 4]. Some attempts of integrating some specifications of logistics (mainly procurement or inventory) into manufacturing costing models can also be found in the literature [3]. Nevertheless, no comprehensive solutions of logistics costing in manufacturing environment are yet available.

Logistics costing can be set up as an integrated part of the operative manufacturing cost calculation system. The methodology described above can be applied to evaluate the cost effectiveness of logistics processes and to allocate logistics costs to products in an exact way. This, however, needs to be supported by preliminary methodological considerations.

The following analysis and modeling try to supply the basic methodological proposals which can contribute to improving logistics costing in the frame of “classic”
operative cost controlling. The first task is to give some guidelines for the identification of logistics related costs and performances within manufacturing or production processes. After having these inputs the next step is the inclusion of logistics activities in the manufacturing cost calculation model. In possession of the extended costing model the elementary procedures of logistics cost calculation can also be elaborated.

2 Identifying logistics costs and performances in manufacturing companies

As mentioned earlier, problems may arise when defining logistics costs and performances. This is the case mainly when logistics can be regarded as an intern service function in a certain company specialized in manufacturing or producing goods. Here the planning and monitoring of logistics operations (transport, inventory, material handling, etc.) is carried out along with the manufacturing processes: logistics related performances can hardly be separated from manufacturing related performances.

The following gives a short overview on how to tackle this methodological problem area. The recommendations are based on preliminary researches [2].

The identification problem of logistics performances is company specific. Some general principles, however, can be recommended to describe and systematize them. At first it is advisable to distinguish between physical and dispositional elements. Within these broad categories performance elements can be further differentiated depending on their nature. There are performances of making available certain goods/materials or information while the others are related to movements. It is essential that the decomposition of logistics performances and the definition of logistics cost objects are harmonized. Exact measures (like the number of handled pieces, machine hour, the distance of movements, etc.) shall be assigned to each performance element.

Logistics related cost items are also to be identified and systematized. The relevant cost items represent the monetized resource consumption of logistics procedures (inventory, warehousing, in-house and long distance transport, material handling, loading, etc.). These items can be obtained from the general ledger directly provided it has an adequate quality level of data gathering and processing. Otherwise custom-designed queries and additional cluster analyses need to be applied by using the classification method mentioned before.
It is also important to separate direct and indirect logistics cost items. The general experience is that manufacturing companies rarely have direct logistics costs (apart from certain outsourced activities). Thus the identified logistics costs and performances are to be collected in logistics cost objects which shall be integrated into the manufacturing costing model.

3 Integrating logistics related elements into the operative cost controlling model of manufacturing

The operative cost controlling model in manufacturing describes the cost objects, the profit objects and the performance flows between them. This structure assures that (indirect) cost allocations in the manufacturing company are transparent and based on cause-effect interactions. Figure 1 shows a simplified (sample) operative cost calculation model (model #1) of a given manufacturing company. It consists of a central service and three manufacturing cost objects while four products as profit objects consume the performances produced by the manufacturing cost objects. The central service cost object may provide the manufacturing units with performances like information technology, administration, management, etc.

*Fig. 1 The basic operative cost calculation model of manufacturing*

![Diagram showing the basic operative cost calculation model of manufacturing](source: own edition)

Logistics related costs and performances can not be evaluated in this basic model. They are integrated into the database of the central service and the...
manufacturing cost objects and into the corresponding performance flows. To overcome this shortcoming dedicated logistics cost objects shall be included in the calculation model. The simplest version of it can be when additional cost objects integrating all logistics functions in the company are used: one of them delivers logistics performances to cost objects (‘logistics service cost object 2’), while the other one to profit objects (‘logistics service cost object 1’). Of course the costs behind these performances are also collected in these objects. Figure 2 shows the possible realization of this costing model (model #2).

**Fig. 2 The operative cost calculation model of manufacturing extended by integrated logistics cost objects**

The extended costing model makes it possible to calculate and allocate logistics costs and performances within the manufacturing company. Even efficiency analyses of logistics activities can be carried out as the relevant costs and performances become comparable. It requires, however, that these data are recorded and handled separately from manufacturing related data (see chapter 2).
The main advantage of model #2 is that it extends the functionality of the basic costing model in a simple way: only two additional cost objects and their integrated logistics performance flows are to be taken into account. Nevertheless, this advantage may be a disadvantage at the same time when logistics services in the company are not homogenous. In this case integrated logistics cost objects shall be replaced by multiple cost objects as shown in figure 3 (model #3). This makes it possible to differentiate the customized logistics costs and performances form each other and allocate them separately, which enables a more sophisticated logistics cost calculation.

Fig. 3 The operative cost calculation model of manufacturing extended by multiple logistics cost objects

Although model #3 is the most favorable solution of improving logistics costing in manufacturing companies its implementation has even more prerequisites: logistics performances and the related cost items are to be collected and measured more in
detail instead of using integrated indicators. This question, however, leads the analysis to the concrete calculation procedures which are explained in the following chapter.

4 Calculating and allocating logistics costs by using the proposed models

When using the basic cost calculation model (model #1) no direct results on logistics costs can be expected. Here the costs of different manufacturing activities or of the central services or even the costs (direct items and allocated indirect items) of various products as profit objects can be analyzed. That is why if logistics related costing information is also needed at least model #2 shall be implemented.

The application of model #2 delivers logistics costing information in an integrated way: the total costs of logistics activities serving the manufacturing units and the total costs of logistics activities serving the products directly are available. It is essential that the logistics activities and their performances are divided into two clusters: activities connected to manufacturing processes (e.g. in-house transport, procurement of input resources for manufacturing, inventory of semi-finished products, etc.) and activities connected to products (procurement of materials, distribution and inventory of finished products, transport, etc.).

As no further differentiation within the two clusters is envisaged in model #2 generalized performance indicators have to be used when allocating logistics costs to manufacturing cost objects or to products as profit objects. Such indicators can be for example the service time or the operation time. By dividing logistics costs with these performance indicators the (generalized) specific costs of logistics activities (e.g. EUR / service hour or EUR / operation hour) can also be calculated. Such kind of data may be useful when establishing out- vs. in-sourcing decisions of logistics services in the manufacturing company.

The logistics related cost of a certain product will also be transparent when applying model #2. It consists of two parts: the allocated logistics cost coming directly from a logistics cost object (‘logistics cost object 1’ in figure 2) and a certain ratio of allocated manufacturing costs. The latter part can be calculated when analyzing the cost structure of the relevant manufacturing cost objects: here the cost items coming from the logistics cost object serving the manufacturing cost objects (‘logistics cost object 2’ in figure 2) shall be taken into consideration. Logistics cost allocations are performed according to or in line with the measured logistics performances consumed by the examined entities (and expressed in service or operation hours). Thus it is guaranteed that costs are transferred on a cause-effect basis only.
Model #3 operates similarly as model #2 does but it delivers more sophisticated information on logistics costs. Here logistics activities (corresponding to the logistics cost objects) are to be differentiated also within the two main clusters and so multiple performance indicators have to be used instead of the generalized ones. Table 1 summarizes some of the most relevant logistics activities (possible cost objects) and their performance indicators (as cost drivers).

**Fig. 4 Logistics activities (cost objects) and their performance indicators**

<table>
<thead>
<tr>
<th>Logistics activities</th>
<th>Performance indicators</th>
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<tbody>
<tr>
<td><strong>Procurement</strong></td>
<td>no. of orders</td>
</tr>
<tr>
<td></td>
<td>time of order</td>
</tr>
<tr>
<td><strong>Distribution</strong></td>
<td>no. of deliveries</td>
</tr>
<tr>
<td></td>
<td>time of delivery</td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td>distance (vehicle kilometer)</td>
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<tr>
<td></td>
<td>transport performance (ton kilometer)</td>
</tr>
<tr>
<td><strong>In-house transport</strong></td>
<td>no. of movements</td>
</tr>
<tr>
<td></td>
<td>time of movements</td>
</tr>
<tr>
<td><strong>Inventory</strong></td>
<td>no. of items</td>
</tr>
<tr>
<td></td>
<td>lead time</td>
</tr>
<tr>
<td><strong>Disposition</strong></td>
<td>no. of operations</td>
</tr>
<tr>
<td></td>
<td>operation time</td>
</tr>
</tbody>
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Source: own research

As more performance indicators are available more specific cost values for logistics activities can be calculated (e.g. EUR / order, EUR / delivery, EUR / km, etc.). Thus efficiency analyses will be more reliable too. The cost allocations and so the logistics related costing data of products will also be more accurate; the logistics performance flows are differentiated (not integrated – see figure 3) and the performance consumptions are measured by various indicators (expressed not only in service or operation hours but also in other measures – see table 1).

In costing model #3 logistics costs and performances are fully transparent and logistics cost allocations to manufacturing units or products are performed in an exact way. It leads to a more detailed and more accurate logistics costing than model #2 does. At the same time the calculations in model #3 require a more detailed and well structured input data base of logistics cost items (collected in multiple logistics cost objects) and an intensive measurement of logistics performances (connected to multiple logistics cost objects).
5 Conclusions

Logistics costing in manufacturing companies can be improved significantly if the operative manufacturing cost calculation models are further developed by including logistics cost objects. It makes possible to collect logistics costs and performances separately from manufacturing data, to evaluate the efficiency of logistics activities and to determine the logistics related cost items of products.

The researches conducted in the field of logistics costing have yielded the models meeting the requirements of up-to-date costing methods. Adapting these theoretical models to company specific characteristics and then implementing them can contribute to better decisions aiming to monitor or reorganize logistics processes within manufacturing companies or in their supply chains.

There are two phases of integrating logistics costing elements into the basic manufacturing cost calculation mechanism (model #1). The first phase (model #2) concentrates on integrated logistics cost objects and performance flows while the second, more sophisticated solution (model #3) prefers the application of differentiated (multiple) cost objects and performance indicators of logistics functions. Both extended models deliver value added information on the cost effectiveness of logistics processes but their information quality regarding accuracy is different: model #2 is less accurate and simple while model #3 is more accurate and complex. It depends on several factors – like the information needs, the importance of logistics compared to manufacturing, the share of logistics costs, the resources available for costing improvements, the data quality of information systems, etc. – which costing model is preferred by the decision makers.

References


Resume

Several manufacturing companies operate logistics services or functions contributing significantly to the performance output of the company and inducing a significant share of total production costs. At the same time their costing regimes often disregard the detailed and separate calculation of logistics related costs. This paper aims to give modeling proposals on how to integrate logistics costing entities into “classic” manufacturing cost calculation systems so that the cost effectiveness of logistics activities and the production costs caused by logistics services or functions can be determined more accurately. The model is developed in more versions. It demonstrates that the improvement of logistics costing can be realized at different levels of information quality depending on the demands of interested decision makers.

Key words

Logistics costing, operative cost calculation, manufacturing.

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