COST CALCULATION IN COMPLEX TRANSPORT SYSTEMS

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1 Introduction

Determining the real operation and service costs is essential if transport systems are to be planned and controlled effectively. Cost information is necessary not only for pricing or charging issues but also for analyzing efficiency or managing resource allocation. Therefore special attention shall be paid to the calculation of transport costs so that decisions based on this information become as correct as possible.

Several methods can assist decision support procedures aiming to determine transport costs. Nevertheless, understanding the cost structure in complex transport systems may be very difficult due to the extensive intern service relations within the examined company. In such transport systems a considerable amount of resources is consumed by multiple intermediate or end services. It means that cost calculations cannot be performed in a simple way but shall be governed by an exact methodology.

The purpose of the modeling process presented in this paper is to recommend a method which is able to cope with the problems of cost calculation in complex transport systems. The proposed costing tool makes advantages from the results of related researches but at the same time tries to present a slightly alternative solution to cost allocation. It aims to determine the costs of elementary transport services more exactly and more accurately. Such elementary services can be for example freight transport tasks, passenger transport services, road or track use services, traction services, etc.

Before going into the details of the improved costing method it is worth reviewing the so called traditional transport costing tools. This short review will highlight the arguments which explain the need for introducing a more sophisticated cost calculation instrument in the case of transport companies operating complex and heterogeneous service systems.
2 Traditional transport costing methods

Traditional costing methods based on simple cost allocation techniques are often used in the transport practice [3]. Figure 1 illustrates the most simple calculation method where the total costs of the transport company or system are distributed among the elementary transport services, i.e. transport profit objects \((j = 1 \ldots m)\) gaining revenues, in one step.

![Fig. 1 Simplest allocation of total transport costs to transport profit objects](source: own edition)

In the starting point the total transport costs can be distributed on an equal basis so the cost of a transport profit object (i.e. prime cost) can be calculated as follows:

\[
C_j = \frac{C}{m} \quad (1)
\]

where \(C_j\) – total cost of transport profit object \(j\);

\(C\) – total cost of the transport company.

This solution assumes that the transport services are fully homogenous. Nevertheless, this is generally not the case so it is worth using a cost driver reflecting the differences between the transport services. Various transport performance indicators, e.g. gross ton kilometer, passenger kilometer or vehicle kilometer etc., are usually used for this purpose. Thus the calculation formula can be modified as follows:

\[
C_j = C \times \frac{P'_j}{\sum_{j=1}^{m} P'_j} \quad (2)
\]

where \(P'_j\) – performance of transport profit object \(j\).
The application of this formula requires the measurement of transport performance not only in the aggregated but also in the elementary levels of the operation structure. Although formula (2) takes into account that the different transport services are produced at different transport performance levels it still ignores the fact that the set of total costs may not be homogenous. There are namely cost items which can be connected to the profit objects directly while others can not be allocated to the elementary transport services in such a way. The former cost items constitute the set of direct costs while the set of indirect costs consists of the latter cost items. The cost structures of transport companies or systems having complex operation mechanisms are often characterized by high ratio of indirect costs. So it is advisable to differentiate between the allocation of direct and indirect costs as showed by Figure 2.

**Fig. 2 Differentiated allocation of direct and indirect transport costs to transport profit objects**

![Differentiated allocation of direct and indirect transport costs to transport profit objects](source)

If the accounting system is able to register the direct costs of transport profit objects only the indirect costs shall be distributed. The registration of direct costs can in general be absolved through the up-to-date enterprise resource management systems used by transport companies. In case of homogenous service system the following differentiated calculation formula can be created:

\[
C_j = C_j^d + \frac{C_{id}}{m}
\]

(3)

where \(C_j^d\) – direct cost of transport profit object \(j\);

\(C_{id}\) – total indirect cost of the transport company.

If the service structure is not homogenous in the complex transport company or system the general transport performance indicators mentioned before can also be used
to allocate the indirect costs to profit objects. Thus, the formula can be modified as follows:

$$C_j = C_j^d + C_j^{id} \frac{P_j'}{\sum_{j=1}^{m} P_j'}$$

(4)

If the use of natural performance indicators is not preferred, the direct cost based indirect cost allocation may also be used as showed by equation (5):

$$C_j = C_j^d + C_j^{id} \frac{C_j^d}{\sum_{j=1}^{m} C_j^d}$$

(5)

Nevertheless, the ratio of direct costs is not likely to reflect the ratio of indirect costs from the point of view of profit objects. That is why the application of performance indicators as cost drivers in the allocation of indirect costs leads probably to better results, i.e. to more accurate prime cost data. So formula (4) would theoretically be an adequate cost calculation formula for complex transport systems. Moreover, such approaches, i.e. indirect cost allocations based on general transport performance indicators, are often utilized in the transport sector.

Thus general transport performance indicators can effectively be used in the cost calculation regimes of transport companies or systems having complex operation structures. The calculation procedures can, however, be further improved through applying multiple performance indicators as cost drivers. The related methods benefit from the fact that the modeling of the operational system can be an effective tool for supporting cost allocations in complex business-technology systems [4]. So the adaptation of improved costing methods to the specific features of transport may deliver real advantages in cost calculation and hereby in the operative planning and evaluation of transport systems.

3 The improved transport costing model

The backbone of the improved costing model is the operation model which serves as a logic model for cost allocations. The logic model depicts the operational processes of the examined entity, i.e. company or service system, and gives a guideline on how to trace indirect costs on a cause-effect basis. The operation model or logic model is based on transport technology knowledge while the costing model can be regarded as one of the transport economics and management tools. Through
integrating the logic model into the costing mechanism an effective combination of transport technology and transport economics knowledge can be realized.

One of the methods corresponding to the requirements set before, i.e. combining technology and economics knowledge is activity-based costing (ABC). This costing approach uses activities or activity chains to trace indirect costs. ABC was traditionally developed to solve the calculation problems of complex manufacturing processes with high overhead costs [7]. After its intensive application in the manufacturing industry the methodology was successfully adapted to the service sectors as well. So applications in transport and logistics can also be found in the literature.

Although ABC has its focus on manufacturing operations, it is applicable to other company functions like distribution logistics management [20]. ABC has been used to examine the applicability of different drivers for assigning activity costs to products in warehouse logistics environment [25]. Another example is when the conversion of storage systems in a cellular manufacturing environment has been evaluated through estimating the economic effects of the logistics improvements [21]. ABC has been used for introducing a new cost management and decision support system applicable for order management in supply chains. The main advantage of such systems is that they can even perform on-time profitability and cost analyses based on the identified cost driver schemes [12].

In order to evaluate the material flows and the related logistics activities in production companies a transparent reporting of logistics costs is needed. These costs remain, however, hidden in the traditional accounting systems. Activity-based costing can help identify logistics costs classified as overhead costs in production systems [13]. It has also been concluded that traditional financial accounting fails to reveal real logistics costs, and ABC combined with the economic value added (EVA) method can effectively be used to tackle the problem of indirect cost allocation in logistics [24].

Supply chain management (SCM) needs more accurate cost data on logistics activities. By providing such data, ABC can significantly contribute to the success of SCM [1]. ABC is a tool which helps managers understanding logistics costs when using the total cost approach in managing supply chains [14]. Traditional intra-firm costing systems are not appropriate in the context of supply chains due to the missing standards of cost definitions and allocations. ABC extended to supply chains can, however, be a powerful inter-firm logistics cost management tool [22]. ABC can even be used for supporting tactical production planning in supply chains. This type of planning is usually based on physical parameters. ABC can also integrate financial parameters in order to assess the costs of related logistics tasks [8].
Indirect costs accounts for a high percentage in the total costs of logistics enterprises so it is worth applying an activity cost accounting model in case of such companies [16]. The cost structure of third-party logistics service providers has been analyzed with special regard to warehousing and transporting activities. It has turned out that ABC is a useful tool for assessing the operational costs of logistics service providers [10].

Although the determination of true service or operation costs is one of the methodological difficulties in transportation, there are few related real-life applications presented in the literature [2]. For example, an activity-based cost management system has been introduced for timber harvesting and long-distance transport, where ABC systems were formulated separately for each of the main operations such as trucking. The foremost use for this type of costing method is the ability to calculate the efficiency of an individual activity or of the whole logistic system as well [19].

ABC has been used to calculate the costs of elementary air transport services, i.e. individual flights through identifying the corresponding cost items and their drivers [23]. The financial performance of air transport services has also been evaluated by ABC and the costing procedure have been combined with data envelopment analysis (DEA) in order to get information not only on the costs but also on the relative efficiency [15]. It shall be noted that DEA is one of the most significant methods used in the transport sector for efficiency analysis [17].

The most detailed and sophisticated analysis of transport costs based on ABC has been carried out for the case of a land transportation company. It has been justified that ABC utilizing business process modeling yields more accurate cost data of transport services than traditional costing [2].

After analyzing the ABC applications, it can be concluded that this is a useful method for enhancing the capabilities of transport and logistics costing. A similar but slightly different approach is the multi-level full cost allocation (MFCA) technique where indirect costs are traced along the intern service relations identified in the multi-level structure of various organization units. This approach has already been applied in logistics management [6]. Here, however, an attempt is made to build up a general transport MFCA model and demonstrate its functions. The modeling process utilizes the earlier outcomes of the related researches as well.

The proposed costing model is shown in Figure 3. This is the improved version of the model presented in Figure 2. The main difference is that here the set of indirect transport costs is further differentiated and the transport cost objects are introduced as new entities.
Cost objects are the operational elements causing the indirect costs. They are organizational units and pieces of equipment or other resources, and are arranged into a multi-level hierarchical structure. Typical cost objects in transport systems are for example central management units, background service units, tactical or operative planning and control units, disposition units, vehicles, infrastructure elements, etc. They can serve other cost objects or can contribute to the production of end transport services. So the relations within the set of transport cost objects and between these units and the elementary transport services are also added to the model. Cost objects are indexed as \( k = 1 \ldots n \). When cost objects play a role as service cost objects they are indexed as \( i = 1 \ldots n \).

Indirect costs are first recorded in the cost objects as primary costs. The primary cost of a cost object can be determined on the basis of the resources assigned to it. Such resources can be for example employees, various means of service production, etc. Each cost object shall be provided with an indicator measuring its performance. These indicators serve as cost drivers during the cost allocation.

The relations between the objects represent the performance consumptions. These are the basis of indirect transport cost allocations. The allocation of indirect
costs goes from the highest level to the lower levels of object hierarchy. The allocation is finished when all indirect transport costs appear in the transport profit objects. The model shall preferably be created without performance feedbacks because they may lead to iterative or heuristic solutions. Of course the distortion of costing information due to ignoring some relations of minor importance shall be reduced as far as it is possible.

Using the MFCA model of Figure 3 the total cost of a cost object in the examined transport system can be determined by the sum of its primary cost and the cost items allocated according to the relative performance consumption:

\[ C_k = C_k^p + \sum_{i=1}^{n} C_i \frac{P_{ki}}{P_i} = C_k^p + \sum_{i=1}^{n} C_i P_{ki} \]  

(6)

where \( C_k \) – total cost of cost object \( k \);
\( C_k^p \) – primary cost of cost object \( k \);
\( C_i \) – total cost of service cost object \( i \);
\( P_{ki} \) – performance consumption of cost object \( k \) at service cost object \( i \);
\( P_i \) – total performance of service cost object \( i \);
\( p_{ki} \) – performance intensity, i.e. relative performance consumption of cost object \( k \) at service cost object \( i \).

Similarly, the total cost of a profit object in the examined transport system is the sum of its direct cost and the cost items allocated according to the relative performance consumption:

\[ C_j = C_j^d + \sum_{i=1}^{n} C_i \frac{P_{ji}}{P_i} = C_j^d + \sum_{i=1}^{n} C_i r_{ji} \]  

(7)

where \( P_{ji} \) – performance consumption of profit object \( j \) at service cost object \( i \);
\( r_{ji} \) – performance intensity, i.e. relative performance consumption of profit object \( j \) at service cost object \( i \).

It shall be noted, that the sequence of the calculation is fixed: the cost of a given object can be calculated only if the total cost data of its service objects are already available. According to the rules of full cost allocation, all costs have to be allocated to the profit objects in the end. It means that the entire performance of each service cost object is to be consumed so the following restriction shall be taken into account for all \( i \):
\[
\sum_{k=1}^{n} p_{ki} + \sum_{j=1}^{m} r_{ji} = 1
\] (8)

The core elements of the MFCA model are the performance intensity indicators representing the cost drivers. These parameters can be described in matrices as well. One of the matrices contains the relative performance consumptions identified between the cost objects while the other one consists of the relative performance consumptions registered between the cost objects and the profit objects. Table 1 illustrates the merged matrices by paying attention to the restriction defined by formula (8). Cost objects shall be listed in a sequence determined by their hierarchy and cost object 1 is at the top of the hierarchy. It is obvious that \( p_{ki} = 0 \) if \( k = i \). The calculation can be solved without iteration if no performance feedbacks are allowed in the model, which means that \( p_{ki} = 0 \) if \( k < i \).

**Table 1** The merged performance intensity matrices

<table>
<thead>
<tr>
<th>cons./serv.</th>
<th>co. obj. 1</th>
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<th>co. obj. i</th>
<th>...</th>
<th>...</th>
<th>co. obj. n</th>
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<tr>
<td>co. obj. 1</td>
<td>-</td>
<td>( p_{12} )</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>( p_{1n} )</td>
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<td>...</td>
<td>( p_{21} )</td>
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<tr>
<td>co. obj. k</td>
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<tr>
<td>co. obj. n</td>
<td>( p_{n1} )</td>
<td>...</td>
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<td>-</td>
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<tr>
<td>pr. obj. 1</td>
<td>( r_{11} )</td>
<td>...</td>
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<td>...</td>
<td>...</td>
<td>( r_{1n} )</td>
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<td>pr. obj. j</td>
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<tr>
<td>pr. obj. m</td>
<td>( r_{m1} )</td>
<td>...</td>
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<td>( r_{mn} )</td>
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<td>( \Sigma )</td>
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The MFCA operation model helps identify the relations of performance consumption, while performance intensities have to be measured by appropriate technology information systems or at least estimated on the basis of verified technology plans or dedicated statistical surveys. Some mathematical models like regression analysis or analytic hierarchy process (AHP) may also be useful here [2, 3]. It is worth noting that AHP is also used in other transport management tasks, for example in the assessment of supply quality of public transport [9]. Nevertheless, sound factual knowledge of the operational characteristics of the investigated transport system or company is needed before running the model, regardless of the methodologies and techniques used for identifying and measuring the performance indicators.
4 Application

After defining the MFCA-based transport costing model a sample application is carried out to demonstrate the calculation process. A conceptual model of a transport company is used where the examined transport system can be regarded as complex. So the sample model depicts the operational structure of a rail freight transport company (see Figure 4). It is notable, that the operational characteristics and costs of complex railway systems are investigated by other related researches as well [18].

Fig. 4 MFCA model for rail freight transport

Source: [5]
The model presented is not applied to a particular company but relies on observed and documented operational features of rail transport service providers [5]. Thus it should be adapted to the concrete company characteristics before a real-world implementation. The pilot application does not aim to deliver exact figures of transport costs but it intends to demonstrate how the cost calculation can be put on a more exact basis through utilizing the MFCA model. That is why parameters are used instead of real data when elaborating the calculation formulas.

The operation model supporting the sample cost calculation comprises 5 levels of cost object hierarchy. Levels 4 and 5 contain the organizational units of central and general management and the information technology (IT) unit. Cost objects assigned to levels 1-3 are responsible for the tactical and operative planning and execution of rail freight transport services. The vehicles used can also be found in this group: wagon types \( (v = 1 \ldots V) \) and engine types \( (z = 1 \ldots Z) \). These cost objects are served by the cost objects of levels 4 and 5 and serve each other or the profit objects directly. Some relations between the cost objects of levels 4 and 5 and the ones of levels 1-3, and also within levels 1-3 are depicted in a simplified way; for further details see the calculation broken down later on. Each cost object is provided with a performance indicator. The dimensions of the indicators appear in brackets. Note that some performance feedbacks may be ignored in levels 4 and 5. As the cost connected to these relations amounts to only a minor part of the total cost of the company, these simplifications will presumably not affect the ultimate cost data significantly.

Profit objects are arranged into two levels. The ultimate profit objects are the consignments \( (\chi = 1 \ldots X) \), i.e. the transportation tasks of consignments. Some direct costs and indirect cost allocations, however, can not be defined at this level so freight trains \( (\gamma = 1 \ldots Y) \) have to be introduced as technical profit objects. Extern logistics service costs are the direct cost items of consignments while the costs of freight trains are allocated to the consignments on the basis of “consumed” transport performance. The costs of infrastructure use and of extern traction service are the direct costs of freight trains. The other allocations can be performed by following the identified performance relations depicted by the model of Figure 4.

As mentioned, the pilot calculation is carried out in a parametric way by using and extracting the general formulas (6) and (7). Before defining the concrete calculation formulas a dedicated notation is introduced for the objects and their performance indicators (see Table 2). Note that the extended performance indicators substituted for the formulas represent the relative performance consumption. For example means: (the number of directions “consumed” by financial management) / (the total number of directions “produced” by general management) and so on.
Tab. 2 Abbreviations used for the calculation formulas

<table>
<thead>
<tr>
<th>object</th>
<th>abbr.</th>
<th>name</th>
<th>abbr.</th>
<th>performance indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>general management</td>
<td>GM</td>
<td>direction</td>
<td>dr</td>
<td></td>
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<tr>
<td>information technology</td>
<td>IT</td>
<td>data volume</td>
<td>dv</td>
<td></td>
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<tr>
<td>financial management</td>
<td>FM</td>
<td>transaction</td>
<td>tr</td>
<td></td>
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<tr>
<td>human management</td>
<td>HM</td>
<td>served staff</td>
<td>ss</td>
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<tr>
<td>service planning</td>
<td>SP</td>
<td>operation time</td>
<td>ot</td>
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<tr>
<td>operative control</td>
<td>OC</td>
<td>disposition</td>
<td>ds</td>
<td></td>
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<tr>
<td>vehicle maintenance</td>
<td>VM</td>
<td>operation time</td>
<td>ot</td>
<td></td>
</tr>
<tr>
<td>commercial services</td>
<td>CS</td>
<td>operation time</td>
<td>ot</td>
<td></td>
</tr>
<tr>
<td>sales</td>
<td>SA</td>
<td>transaction</td>
<td>tr</td>
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<tr>
<td>engine drivers</td>
<td>ED</td>
<td>working time</td>
<td>wt</td>
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<tr>
<td>wagon type</td>
<td>WT</td>
<td>running</td>
<td>ru</td>
<td></td>
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<tr>
<td>engine type</td>
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<td>ru</td>
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<tr>
<td>freight train</td>
<td>FT</td>
<td>transport performance</td>
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<td>consignment</td>
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The cost calculation can be done in the sequence explained in the following. As a first step, the total costs of general management and IT can be determined as these objects are placed at the top of calculation hierarchy. Their total costs equal to their primary costs:

\[ C_{GM} = C_{GM}^p \]  
\[ C_{IT} = C_{IT}^p \]

The second step is the calculation of the total costs of financial management and human management. Their total costs consist of their primary costs and the allocated costs coming from general management and IT:

\[ C_{FM} = C_{FM}^p + C_{GM}^p d_{FM/GM} + C_{IT}^p d_{FM/IT} \]
\[ C_{HM} = C_{HM}^p + C_{GM}^p d_{HM/GM} + C_{IT}^p d_{HM/IT} \]

The total cost of service planning can be calculated in the third step by adding up its primary cost and the allocated cost items coming from the management cost objects and IT:

\[ C_{SP} = C_{SP}^p + C_{GM}^p d_{SP/GM} + C_{IT}^p d_{SP/IT} + C_{FM}^p d_{SP/FM} + C_{HM}^p s_{SP/HM} \]

The total costs of operative control, vehicle maintenance, commercial services and sales are determined in the fourth step. The total costs of these cost objects consist
of their primary costs and the allocated costs coming from the management cost objects, IT, and service planning:

\[ C_{OC} = C_{OC}^p + C_{SP} o_{OC/SP} + C_{GM} dr_{OC/GM} + C_{IT} d_{OC/IT} + C_{FM} tr_{OC/FM} + C_{HM} ss_{OC/HM} \]  

(14)

\[ C_{VM} = C_{VM}^p + C_{SP} o_{VM/SP} + C_{GM} dr_{VM/GM} + C_{IT} d_{VM/IT} + C_{FM} tr_{VM/FM} + C_{HM} ss_{VM/HM} \]  

(15)

\[ C_{CS} = C_{CS}^p + C_{SP} o_{CS/SP} + C_{GM} dr_{CS/GM} + C_{IT} d_{CS/IT} + C_{FM} tr_{CS/FM} + C_{HM} ss_{CS/HM} \]  

(16)

\[ C_{SA} = C_{SA}^p + C_{SP} o_{SA/SP} + C_{GM} dr_{SA/GM} + C_{IT} d_{SA/IT} + C_{FM} tr_{SA/FM} + C_{HM} ss_{SA/HM} \]  

(17)

The fifth step contains the total cost calculation of engine drivers, wagon types and engine types. The total cost of engine drivers is the sum of its primary cost and the allocated costs coming from operative control, IT, financial management and human management. The total costs of wagon types and engine types consist of their primary costs and the allocated costs coming from operative control, vehicle maintenance, IT and financial management:

\[ C_{ED} = C_{ED}^p + C_{OC} ds_{ED/OC} + C_{IT} d_{ED/IT} + C_{FM} tr_{ED/FM} + C_{HM} ss_{ED/HM} \]  

(18)

\[ C_{WT} = C_{WT}^p + C_{OC} ds_{WT/OC} + C_{VM} o_{WT/VM} + C_{IT} d_{WT/IT} + C_{FM} tr_{WT/FM} \]  

(19)

\[ C_{ET} = C_{ET}^p + C_{OC} ds_{ET/OC} + C_{VM} o_{ET/VM} + C_{IT} d_{ET/IT} + C_{FM} tr_{ET/FM} \]  

(20)

The sixth step is the calculation of the total costs of freight trains. These are the sum of their direct and indirect costs. The direct cost items are the costs of infrastructure use and extern traction service. The indirect costs are allocated from the engine drivers, engine types and commercial services:

\[ C_{FT} = C_{FT}^{inuse} + C_{FT}^{ext.trac} + C_{ED} wt_{FT/ED} + \sum_{z=1}^{Z} C_{ET} ru_{FT/ET} + C_{CS} o_{FT/CS} \]  

(21)

At last the total costs of the ultimate profit objects, i.e. consignments, can be determined by registering their extern logistics service costs as direct costs, adding the allocated indirect costs coming from wagon types, commercial services and sales, furthermore, allocating the relevant costs form the technical profit objects:
\[ C_{CO_i} = C_{CO_i}^{ext.\;ser.} + \sum_{y=1}^{\nu} C_{FT_y} \cdot t_p \frac{CO_i}{FT_y} + \sum_{y=1}^{\nu} C_{WT_y} \cdot r_u \frac{CO_i}{WT_y} + C_{CS} \cdot t_{CO_i} \frac{CS}{CS} \]

\[ + C_{SA} \cdot t_{CO_i} \frac{SA}{SA} \]  

(22)

Theoretically, the intermediate formulas (9) – (21) can systematically be substituted for the final formula (22) and so the cost calculation of elementary transport services can even be carried out in one step. Thus, finally the costs of elementary transport services are described as a function of the direct transport costs, the primary transport costs and the relative performance consumptions. Nevertheless, if the calculation is realized in one step the detailed costing information of cost objects and technical profit objects is lost. When this intermediate information is also needed for decision making purposes, it is worth preferring the stepwise cost calculation procedure presented above.

5 Discussion

The application of the MFCA model in transport systems can deliver significant advantages for decision makers. The main positive methodological contribution is that the costs of elementary transport services, just as in the corresponding ABC models, can be determined on a more exact basis through allocating indirect costs in a transparent way. Furthermore, the cause-effect based allocation makes it possible to explore and identify the influencing factors of transport service costs so that the interventions aiming to improve cost efficiency in transport systems can be established more effectively.

There are further cost and performance management functions in transport companies which can be supported by using the MFCA costing model. For example the impacts of smaller business process reengineering (BPR) actions not altering the operational structure may be modeled through incorporating the modifications of cost or performance parameters and evaluating the outcomes from the point of view of changing service costs. Moreover, when using the model for integrated business-technology planning, a detailed analysis of plan-fact deviations can also be carried out.

Besides the advantages, the possible constraints of the implementation shall also be identified. The most important requirement of running the transport costing model is the availability of high quality additional input data presented in the requested format. These are the primary costs of cost objects and the relative performance consumptions. Providing the additional input data may, however, need extra data transformations or collections consuming considerable financial or human resources.
Sometimes even estimations or industrial norms relying on practical experience can only be used instead of real data.

Another important methodological difficulty to be considered is the fact that the operational model is generally a simplified depiction of the real-world business and technology processes. It means that some simplifications shall be made and accepted during the modeling phase in order to make the model applicable and calculable. Using estimations and acknowledging simplifications may reduce the correctness of transport costing. Nevertheless, the accuracy of transport service costs calculated through MFCA will probably be higher than of the cost data delivered by traditional costing regimes. Similar experience has been verified by the relevant ABC applications as well [2]. A possible solution to the problem of simplified operation modeling can be the use of process mapping tools which can be adapted to the specific features of transport companies as well [11].

Consequently, it can be stated that the MFCA method adapted to transport can deliver real methodological advantages in management and engineering practice but at the same time may need extra resources. Due to the contingent simplifications and estimations the accuracy of the model is not absolute but it is generally still more accurate than the traditional costing procedures.

6 Conclusions

As accurate service and operational cost data are essential to plan, evaluate and manage transport systems or companies, special attention shall be paid to the calculation methods applied in practice. Traditional costing methods may be sufficient cost management tools in the case of transport companies characterized by a relatively simple operational structure or a homogeneous set of services. Transport systems with complex operational features and inhomogeneous service structures, however, need an improved cost calculation where the allocation of indirect costs can be performed on a cause-effect basis. One of the applicable methods is the multi-level full cost allocation technique.

It has been shown that MFCA can be adapted to transport and delivers advantages for cost and performance management through combining technology and economics knowledge. The elementary transport cost data become more accurate while other management or engineering functions like cause-effect analysis, impact analysis or business-technology planning can also be supported effectively. Nevertheless, the implementation of the improved transport costing method may have
several constraints so a sound consideration of the positive results expected and the requirements to be met is recommended before deciding on the actual introduction.

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References


Resume

Accurate costing information is required for several transport management and engineering tasks. Thus it is essential to use adequate cost calculation methods in transport with special regard to complex transport systems characterized by a high ratio of indirect costs. Allocating indirect costs in complex operational systems requires a transparent and cause-effect based calculation technique like multi-level full cost allocation. This paper aims at adapting this method to transport through highlighting the general as well as the specific methodological considerations. The costing model is applied to rail freight transport as a parametric sample calculation. The theoretical and the empirical modeling have showed that the improved costing mechanism delivers advantages to transport planning and controlling. At the same time some constraints shall also be taken into account when implementing the calculation tool in practice.

Key words

transport cost calculation, full cost allocation, multi-level allocation, operation model, rail freight transport

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