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IMPROVING TRANSPORT COSTING BY USING OPERATION MODELING

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Abstract. Transport costing methods applied in practice rely mainly on traditional, accounting approaches. These methods are not able to provide reliable cost of information for decision makers on elementary services as they use arbitrary allocation principles. The operation based on costing is one of the methodological developments whose adaptation can contribute to improve the accuracy of transport cost management. To support costing improvements in transport, this present paper aims to identify the shortcomings of currently used techniques and give a guideline on how to overcome them. The theoretical basics of a new transport costing model are developed while some experiences of early pilot applications are also considered.

Keywords: transport costing, operation modeling, cost objects, profit objects.

1. Introduction

Transport companies generally operate in complex service networks and use high amounts of various resources. Thus, it has been more and more important for company managers to be able to investigate the cost efficiency of business and technology processes so that the effectiveness of capacity allocations can be improved significantly (Bokor 2008).

The applied costing – cost calculation and management – schemes of the companies operating in the transport sector are, however, often not suitable enough to support this kind of decision making tasks. They rely on traditional accounting principles which limit their capabilities to deliver the necessary management information on the core elements of the transport service chain.

To make transport cost management systems more accurate it is inevitable to assess their weaknesses and find some ways on how to eliminate or at least mitigate them. According to the outcomes of the research work conducted in this topic, the integration of operation modeling techniques into transport cost calculations is a possible solution to make current management procedures more effective.

The results of the research, published in related topics can be used to specify the new transport costing model. This kind of model is not an often examined topic in the literature. Nevertheless, there are some research results which can contribute to the application of operation modeling in transport cost calculation.

Pohlen and La Londe (1994) identified the adaptation possibilities of activity-based costing in logistics. Comelli *et al.* (2008) used an evaluation tool for logistics planning which combined financial and physical factors. Activity-based costing was applied in supply chains by Dekker and Van Goor (2000), Lin *et al.* (2001) and Askarany *et al.* (2010). The performance indicators of supply chains were elaborated by Cai *et al.* (2009), Fawcet and Cooper (1998). Baykasoğlu and Kaplanoğlu (2008) used the activity-based costing method in a case study aiming at calculating operation costs in a freight transport company. Pirttilä and Hautaniemi (1995), and furthermore, Satolglu *et al.* (2006) analyzed the application possibilities of activity-based costing in distribution systems. Siepermann (2007) carried out a comparative analysis of various logistics costing approaches by considering their strengths and weaknesses.

After evaluating the relevant literature it can be concluded that most of the related costing models and applications have been developed in the logistics sector. Furthermore, the research results cover mainly specific areas of logistics or transport. The aim of this paper is to propose a more general costing approach focusing on a broader set of transport operations.

2. Problems of Current Transport Costing Practices

Traditional transport costing approaches based exclusively on financial and accounting rules do not meet the requirements of up-to-date management information

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systems. Such costing regimes have typical problems which can be classified as follows:

- too high level of aggregation regarding the costing and profitability information;
- missing definitions of cost and cost driver structures;
- widespread use of simplified average values for the detailed calculations;
- ignoring performance flows and cause-effect relationships during cost allocations;
- application of arbitrary allocation procedures when distributing general costs.

Cost and profit calculation systems have the task to deliver reliable information on business and technology processes so that their contributions to the company's success or failure can be determined. Transport companies, however, prefer using aggregated data not only in the balance sheet and in the profit-loss statement but also in their intern management information systems. These data do not make it possible to have suitable costing information on elementary services, business units or activities.

The problem of aggregation can be mainly derived from the lack of information on the companies' cost structures. Transport companies often do not pay enough attention to model the cost flows in detail and to find out the drivers explaining the cost allocations within the organization. Instead of going into detail and calculating dedicated cost (and prime cost) values for the various services or organizational units they apply simplified and unified average values in the planning of operational processes. These average values are calculated on the basis of aggregated costs and performances (Bokor 2009).

If simplified average cost data are used the cost allocations do not take into account the cause-effect relationships in the operation structure. So, cost items are taken over from a certain cost calculation object to another one by ignoring the related performance flows (or company-intern services). It is mainly the case when distributing general costs. These cost items can not be connected to the transport services directly so they need additional allocation procedures. Nevertheless, the current cost distribution procedures in transport are set up essentially in an arbitrary way (e.g. allocating indirect costs proportionally to the direct costs).

Although the methodological problems have been identified for the Hungarian transport-logistics market they will probably apply to other Central- and East-European countries as well. That is why it is worth considering their consequences on the management practices and exploring the possible solutions reducing the negative impacts.

3. Consequences of the Identified Methodological Problems

The simple application of traditional costing methods may cause significant errors in the cost calculation process. This is especially the case when the cost efficiency of companies running complex transport or logistics services is investigated. So the methodological problems mentioned often lead to the following distortions:

- sketchy evaluations which are not going into the details;
- inaccurate values of calculated unit costs and margins;
- uniformed calculations concealing the various specifications of different service elements or technology/business operations;
- insufficient resource allocations.

The sketchy evaluation of transport services and organizational units does not allow pinpointing the profit or loss generators in the company or in the supply chain. Due to the arbitrary allocations the calculation results (prime or unit costs, gross or net margins, profits) may deliver inaccurate information for decision makers, which may initiate incorrect management resolutions.

Special attention shall be paid to the use of generalized costing values: here the special features of different transport services or operations are homogenized. By doing so important information on the cost efficiency of elementary calculation objects may be ignored. And if wrong information is made available resource allocations will not bring about efficient operations in transport companies: profit generators will not be supported while loss generators will not be eliminated or they will be identified incorrectly.

After analyzing the methodological problems and their negative consequences it can be concluded that the current transport costing practices have to be further developed significantly. There are no perfect solutions which overcome all of the disadvantages. Nevertheless, considerable improvements can be achieved when technology parameters and relations are integrated into the accounting procedures. One of the applicable methods corresponding to this approach is operation-based costing. Its principles and practical adaptation issues are worked out in the following chapter.

4. A Possible Solution for Mitigating the Distortions of Traditional Costing Procedures

Modeling the operations and using these models for depicting the cost flows in the given company or service chain can help overcome the methodological problems of traditional transport costing mechanisms. The main idea of this approach is that cost allocations among the various elements of the service structure and the objects generating these services are performed by taking into account the performance flows between them.

The phases of the proposed methodology can be summarized as follows:

1) building up the operational model of the investigated company. The model consists of:
   - the profit objects: elementary transport services whose profitability (or margin, cost coverage ratio, etc.) shall be evaluated;
   - the cost objects: entities which generate performances contributing to the production of trans-

port services or to the operation of other cost objects;
- the performance relationships and flows between the objects;

2) integrating the cost flows into the operational model with special regard to the indirect cost elements.

Fig. 1 illustrates the theoretical framework of the transport costing tool based on operation modeling.

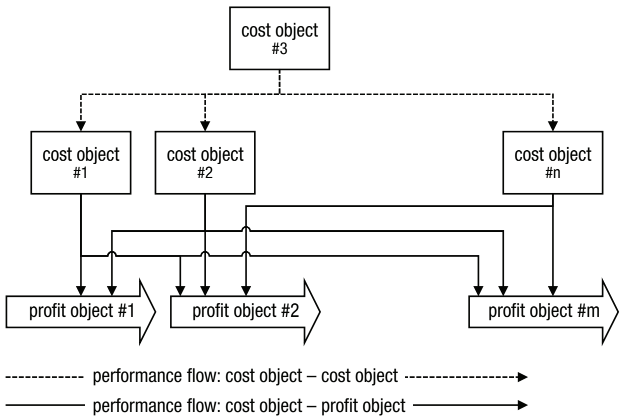

Fig. 1. The transport costing model based on the modeling of technology operations

To begin with, the first step is to identify the profit objects; it means those services which gain revenues for the transport company. Table 1 demonstrates some of the applicable profit objects for the transport branches in different aggregation levels.

The second step of operational modeling is to determine the cost objects. These are organizational units, activities, constructive works, vehicles or other pieces of machinery which consume various resources (materials, extern services, work force, etc.) and at the same time produce performances. The monetized resource consumption of cost objects represents the set of indirect costs.

The performances of the cost objects shall be measured by indicators. These performance indicators are then used as cost drivers. Table 2 contains some entities which can be regarded as the cost objects in transport companies. The possible performance indicators (cost drivers) of the cost objects are also indicated.

It has to be noted that the profit and cost objects are chosen according to the specific operation circumstances of the examined transport company.

Having identified the profit and cost objects the performance relationships between them shall be investigated. The results of this investigation are the performance distribution matrices. Table 3 shows the performance distribution matrix containing the performance flows form cost objects to profit objects (the cost objects – cost objects matrix (if relevant) can be set up similarly). The number of cost objects (CO) is n, the number of profit objects (PO) is m. The values (p_{ij}) are measured in percentage: the performance flows from cost object i to profit object j (P_{ij}) divided by the total performance of cost object i (P_i).

Table 1. Profit objects in transport

Transport branch	Profit objects
Passenger transport	• journey; • passenger; • service; • service network
Freight transport	• shipment; • shipment type; • service; • service network
Infrastructure provision	• line section; • line; • line network

Table 2. Cost objects and their drivers in transport

Cost object	Cost drivers
Central administration	• working hours
Facilities	• area used
IT services	• number of operations; • service hours
Traffic planning	• operation time
Traffic management	• number of operations; • operation time
Vehicle operation	• running performance (vehicle kilometre); • occupation (time)
Vehicle maintenance	• working hours; • number of vehicles
Infrastructure maintenance	• working hours; • lengths of line sections
Tracking and tracing	• distance; • journey time

Table 3. Performance flows: cost objects – profit objects

	PO_1	PO_2	…	PO_j	…	PO_m
CO_1	p_{11}	p_{12}	…	…	…	p_{1m}
CO_2	p_{21}	p_{22}	…	…	…	…
…	…	…	…	…	…	…
CO_i	…	…	…	p_{ij}	…	…
…	…	…	…	…	…	…
CO_n	p_{n1}	p_{n2}	…	…	…	p_{nm}

Based on the operational model cost flows have become more transparent. The direct costs can be allocated to the profit objects directly. The indirect costs are allocated to the cost objects first (based on the resource consumption).

Then the costs of the cost objects are driven over to the profit objects based on the performance consumption (registered in the performance distribution matrix). Some cost items may be allocated to other cost objects too. An example of such allocations may be that of the maintenance cost objects.

This model is able to describe the cause-effect relationships of cost calculations by examining and measuring the performance flows. The prime cost of transport profit object j can be calculated as follows (C_d – direct cost, C_{id} – indirect costs collected in the cost objects):

$$C_j = C_{d_j} + \sum_{i=1}^{n} C_{idi} p_{ij}.$$

If revenue data are available for the profit objects, margins can also be determined – where appropriate. So, the indirect cost component is calculated using the performance relations but not in an arbitrary way. It gives more reliable costing information than the traditional, on account of doing cost management procedure. Furthermore, the cost efficiency of the cost objects can be measured as well by comparing the costs and the performances and evaluating their ratio.

5. The First Experiences of Related Pilot Applications

There are only few applications similar to the proposed costing procedure available in the international literature. The most sophisticated example is published in a road (freight) transport company (Baykasoglu *et al.* 2008). Here activities were used as cost objects to make the cost calculations more accurate. Cost drivers were determined by using the AHP (analytic hierarchy process) methodology. The results of the traditional and the activity-based cost calculations showed considerable differences. It was proved that the use of traditional costing leads to distortions when evaluating the profitability of transportation services. At the same time activity-based costing – as a certain form of operation-based costing – delivered more correct data on prime costs and margins. Of course, even these values are not fully perfect but due to the cause-effect oriented cost (re)allocations their authenticity is much higher.

Activity-based costing is often regarded as a possible tool for enhancing the efficiency of logistics or the supply chain. The experience gained with such kind of projects may be useful for transport oriented applications too. For example, one of the important outcomes is that financial and physical flows can be evaluated in a combined way and this approach supports the tactical production planning (Comelli *et al.* 2008).

Another finding is that activity-based costing offers improvements to supply chain management and to the performance of the organizations. However, when implementing the new costing method non-manufacturing firms (like the ones in the transport sector) need more attention to proceed with the high level adoption (Askarany *et al.* 2010).

Some pilot projects using the basic ideas of the operation-based costing model have already been carried out also among Hungarian transport companies representing the rail market (Bokor 2009). Two of them have yielded valuable results.

The first case was when pilot examinations were conducted for the case of the freight transport branch of a regional integrated rail company. The goal of these investigations was to establish the margins of freight trains and shipments as profit objects. Almost all cost elements had to be considered as indirect as no intern service charging system – e.g. infrastructure or traction – was operated between the business areas. Another problem was that the basic input data were available as aggregated values only. Thus, several simplifications had to be introduced. Nevertheless, the application of the model contributed to refine the profit object calculations by making the prime cost structure more transparent.

Another, more sophisticated application of the operation-based costing approach was the estimation of average and marginal costs in rail infrastructure management. Here – similarly to the first case – activities represented the cost objects. Activity costs had been made available by the management information system directly. The main task was to find appropriate cost drivers for the cost categories. The cost drivers came from the dataset of performance indicators. Selecting the cost drivers to each activity cost category was carried out by regression analyses (as an alternative solution to AHP). As a result of the regression, analysis cost functions were set up for the activity groups. Then the average and the marginal cost data of the main rail infrastructure activities could be produced by averaging or deriving the cost functions.

Summarizing the first outcomes of the pilot applications explained above, it can be emphasized that some general remarks concerning the pre-requisites and the constraints of the new costing method are possible. Table 4 gives a summary of the most relevant influencing factors of operation-based costing (OBC) applied in the transport sector.

Table 4. The Main influencing factors of transport OBC

Pre-requisites of OBC	Constraints of OBC
• defined cost and profit object structure; • identified performance flows; • measured performance indicators; • differentiated (direct vs. indirect) costs elements; • input data availability according to the model structure; • information technology background for the automation of calculation procedures	• the level of sophistication is determined by the resources and the data availability; • finding the best cost drivers is complicated; • some indicators cannot be measured exactly; • some cost elements can not be exactly classified (as direct or indirect)

So the implementation of OBC in transport may deliver several advantages and at the same time requires additional resources. That is why it is advisable to consider the benefits and the costs of the model development and its practical realization before introducing it.

6. Conclusions

The managers of transport companies require sound and detailed information of cost effectiveness and efficiency in business and technology processes. The traditional – accounting oriented – cost calculation procedures do not support this intention due to their methodological shortcomings. These methods shall be reconstructed or completed by introducing the operation based costing principles.

The principal idea of the new approach is to replace the arbitrary cost distribution with cause-effect oriented allocations. The main pillar of OBC is that it makes use of measured performance flows representing the operation of the transport company. It is worth noting that more sophisticated methods are also available to model technological processes in transport (Baublys 2009). An interesting research task for the future is to assess whether these modeling techniques can be integrated into OBC.

The implementation of OBC in transport requires the adaptation of its techniques to the specific operation features of transportation technologies. Profit and cost objects, and even performance indicators shall be defined and their relationships are to be modeled. By doing so, the prime costs and margins of selected elementary transport services can be evaluated in a more exact way and additional cost efficiency analyses in the field of business units or activities can also be conducted.

The introduction of OBC, however, has several conditions which shall be thoroughly considered. It is also should be noted that even this method has its constraints. Nevertheless, further researches and the development of information technology may alleviate the effects of these methodological barriers.

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References

Askarany, D.; Yazdifar, H; Askary, S. 2010. Supply chain management, activity-based costing and organisational factors, *International Journal of Production Economics* 127(2): 238–248. doi:10.1016/j.ijpe.2009.08.004

Baublys, A. 2009. Principles for modelling technological processes in transport terminal, *Transport* 24(1): 5–13. doi:10.3846/1648-4142.2009.24.5-13

Baykasoğlu, A.; Kaplanoğlu, V. 2008: Application of activity-based costing to a land transportation company: a case study, *International Journal of Production Economics* 116(2): 308–324. doi:10.1016/j.ijpe.2008.08.049

Bokor, Z. 2009. Elaborating cost and performance management methods in transport, *Promet – Traffic & Transportation* 21(3): 217–224.

Bokor, Z. 2008. A költséggazdálkodás korszerűsítése a közlekedésben, különös tekintettel a közösségi közlekedésre [Improving cost management in transport with special regard to public transport], *Közlekedéstudományi Szemle* [Review of Transport Science] 58(4): 31–36 (in Hungarian).

Cai, J.; Liu, X.; Xiao, Z.; Liu, J. 2009, Improving supply chain performance management: a systematic approach to analyzing iterative KPI accomplishment, *Decision Support Systems* 46(2): 512–521. doi:10.1016/j.dss.2008.09.004

Comelli, M; Féniès, P.; Tchernev, N. 2008. A combined financial and physical flows evaluation for logistic process and tactical production planning: application in a company supply chain, *International Journal of Production Economics* 112(1): 77–95. doi:10.1016/j.ijpe.2007.01.012

Dekker, H. C.; Van Goor, A. R. 2000. Supply chain management and management accounting: a case study of activity-based costing, *International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management* 3(1): 41–52. doi:10.1080/13675560050006664

Fawcett, S. E.; Cooper, M. B. 1998. Logistics performance measurement and customer success, *Industrial Marketing Management* 27(4): 341–357. doi:10.1016/S0019-8501(97)00078-3

Lin, B.; Collins, J.; Su, R. K. 2001. Supply chain costing: an activity-based perspective, *International Journal of Physical Distribution & Logistics Management* 31(10): 702–713. doi:10.1108/EUM0000000006286

Pirttilä, T.; Hautaniemi, P. 1995. Activity-based costing and distribution logistics management, *International Journal of Production Economics* 41(1–3): 327–333. doi:10.1016/0925-5273(94)00085-9

Pohlen, T. L.; La Londe, B. J. 1994. Implementing activity-based costing (ABC) in logistics, *Journal of Business Logistics* 15(2): 11–12.

Satoglu, S. I.; Durmusoglu, M. B.; Dogan, I. 2006. Evaluation of the conversion from central storage to decentralized storages in cellular manufacturing environments using activity-based costing, *International Journal of Production Economics* 103(2): 616–632. doi:10.1016/j.ijpe.2005.12.003

Siepermann, C. 2007. Logistics cost accounting: which system is best suited?, in *Proceedings of the 12th International Symposium on Logistics (12th ISL)*, 8–10 July 2007, Budapest (K. S. Pawar, C. S. Lalwani, M. Muffatto Eds.), 270–278.