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Elaborating Cost and Performance Management Methods in Transport

Transport companies are facing management problems of enhancing operation efficiency at limited resources. The decision making procedures applicable to solve such problems can be made more reliable if relevant information on basic components of business or technology processes are available. This information base can be produced by using cost and performance management methods combining financial and technology system parameters. The paper aims to summarise the research results conducted in the field of developing cost and performance controlling tools using this approach for the case of different transport companies. After explaining the main modelling principles the experiences of empirical pilot projects are discussed. The preliminary results of these projects have proved the significance of the elaborated methodology. At the same time, it can also be concluded that the modelling tool shall be adapted to the specific circumstances of the examined transport companies before practical implementations.

Key words: cost calculation, performance management, controlling

1. Introduction

Quality requirements against transport services are getting higher and higher. At the same time the available financial resources are limited. In such a business environment transport companies shall pay special attention to the – as far as possible – optimal resource allocation during decision making. Public transport services are particularly affected by efficiency problems as they are in the forefront of social interest. Their organisation and financing tasks are determined by many, sometimes contradictory factors like accessibility, the need of cost savings, attractive prices, etc [1].

To solve the resource allocation related management tasks of transport companies, reliable information are needed also about the basic components of business and technology processes. Aggregated values are not (always) sufficient when evaluating operation efficiency: the exact costs (and margins) of elementary transport services or “products” (as so called profit objects) shall be made calculable, too. However, these calculations are performed in practice by using arbitrary cost distribution keys or averaged values. For example, transport companies often apply universal average cost values (e.g. EUR / vehicle kilometre calculated by the simple division of total costs and performances) for the planning of their activities. This procedure ignores the cost differentiation factors (like vehicle features or service characteristics, etc.) and so can lead to distorted judgements regarding profitability and cost efficiency. In the end distorted decisions may result in insufficient resource allocation.

Cost allocation problems in transport can be interpreted in macro as well as in micro level. In the former case the social cost structure of the whole transport system shall be examined by distributing the cost elements among service providers, users and other affected parties. In the latter case transport companies analyse their operation cost structures, the cost drivers and the relations between cost and performances. This paper deals with micro level cost and corresponding performance management problems and their possible solutions.

Mainly the vertically or horizontally integrated transport companies can benefit from the results of improved cost and performance management as they operate with a high ratio of indirect costs. This is the case when certain resources are used by multiple elementary transport services/products and so the costs of these resources can not be assigned to profit objects in a simple way. The stronger competition in open transport markets supports company integrations (mergers or acquisitions). These trends can already be observed in road and rail freight transport, logistics and air transport. So we can expect more integrated or big sized undertakings in transport, which promotes the elaboration of controlling methods concentrating on the right management of indirect costs.

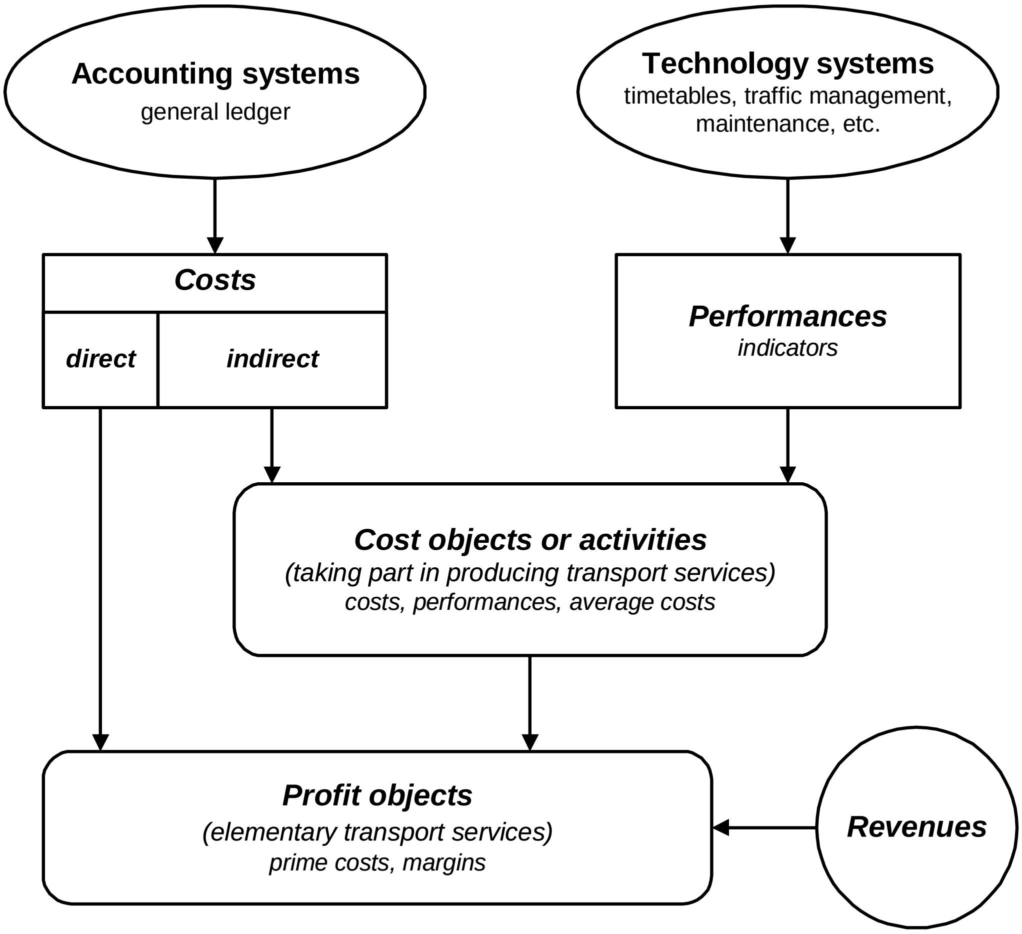
2. Basic hypothesis

Several authors propose to extend the functionality of traditional accounting systems by introducing an operation costing solution able to give more accurate information on product or activity costs. The models developed to reach this management goal had been first applied in the manufacturing industry [2]. Attempts for adapting the methodology to other sectors have showed that the principles of operation costing can be used in industries producing different kinds of services – among them transport or logistics services –, too [3,4,5]. The broader application of modern controlling tools can be expected even in the Hungarian transport-logistics sector. These tools can help cope with management problems derived from the anticipated trends [6]. Based on these experiences it is reasonable to set up a general framework for an improved transport costing and performance management by taking into account its specific business characteristics.

The basic idea of improving transport costing is to include additional, technology related information into the calculation. Doing so indirect costs are allocated to profit objects through using technology performance flows instead of ad-hoc distribution keys. Performance flows reflect the cause and effect relations between the value chain elements. It is assumed that the combination of accounting and technology data prevents or at least mitigates the information losses caused by simple averaging or aggregation. The proposed method uses average values, too (see later), however, these values are calculated on lower levels of organisation hierarchy so information distortions can be reduced significantly.

Figure 1 shows the general approach of the transport cost calculation methodology taking advantages of technology performance indicators. The mechanism of the model seems to be not too complicated: the cost elements which can not be allocated to profit objects directly shall be assigned to cost objects or activities taking part in the production of elementary transport services or products. Technology systems deliver performance indicators for each cost object or activity. It makes possible to elaborate calculation prices (specific or average costs) for the cost objects or activities. After monetising the performances “consumed” by a certain profit object and adding its direct costs the prime cost of a transport service/product will turn out. If revenue data can also be made available at this accounting level the margins of profit objects can be analysed, too [1].

Figure 1: The theoretical framework of proposed transport cost and performance management model



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Although the basic principle of the model is relatively "simple" its practical adaptation is in general more difficult. The high number of profit or cost objects, activities, furthermore the performance flows which contains numerous feedbacks may hamper the implementation procedure. Many times the lack of appropriate performance indicators prevents the detailed calculations. So each practical application of the model needs a careful preparatory research work when the intern and extern environment features of the examined transport company or service chain are taken into account. After all, there are some general considerations which give guidelines for the system developers – they are discussed next.

As a summary of the initial topic analysis the work hypothesis can be defined as follows: the integration of technology related operation parameters and the detailed cost and profit object calculations using these indicators make transport costing more reliable with special regard to indirect cost allocations.

3. Research methodology

Before defining the proposed costing model in details it is worth having a short overview of the applicable alternative methods. Sophisticated descriptions of the corresponding operative transport cost controlling tools are rarely available in the literature (from business management point of view). The applications concentrate rather on macro economic issues (e.g. social costs, external costs of transport) or optimisation problems (e.g. routing with lower costs). So the concrete adaptation of improved (and in other sectors widely used) cost management methods – like activity based costing – to transport business cases is of lower importance in related research works.

The situation is slightly better in the field of logistics where the requirements against cost accounting are clearly determined by targeted researches. They can be adapted to the transport sector, too. The most important requirements are the followings:

- appropriate cost allocation by exploring dependences of cost elements and cost drivers;
- variable and fixed cost items shall be differentiated – as far as it is possible – to make distinction between short and long term decision making;
- controlling information are to be provided on a direct as well as on a full cost basis (in the latter case: including indirect costs, too).

There are various attempts to fulfil the criteria mainly using the activity based costing principles. However, no a "perfect" solution can be found when evaluating the state of the art [7].

The followings intend to set up and explain the operation mechanism of a general transport costing model which is complete and comprehensive enough to enable its implementation in the case of different cost and organisation structures, at the same time relies on former experiences and tries to meet the requirements identified before. This model serves at the same time as an evaluation tool for transport performances and their generators.

As alternatives to the proposed methodology some traditional cost accounting method can be mentioned, like the direct product profitability (DPP) or the customer product profitability (CPP) analyses. The DPP analysis tries to identify the costs associated with a product moving through the distribution channel while the CPP tool collects the costs connected to the service process of a selected customer [5]. Both methods result in calculated prime costs – and margins (where appropriate) – of defined profit objects (products or customers). Theoretically these approaches could also be applied in transport. Nevertheless, transport (and logistics) processes can be better evaluated when the relations between costs/profits and performances are also considered. It means that the specific technology performance data are combined with accounting information – like in the model described in the followings. The main steps of the methodology can be observed in figure 2.

During the practical adaptation of the transport costing model the first step is to define the profit objects which have to be evaluated. This definition is very important from the point of sophistication level. What shall or can be the elementary transport services/products? There is no simple answer to this question. It depends on several influencing factors like:

- the information demand of decision making;
- the resources available for introducing the new controlling system;
- the availability and technology standards of information systems.

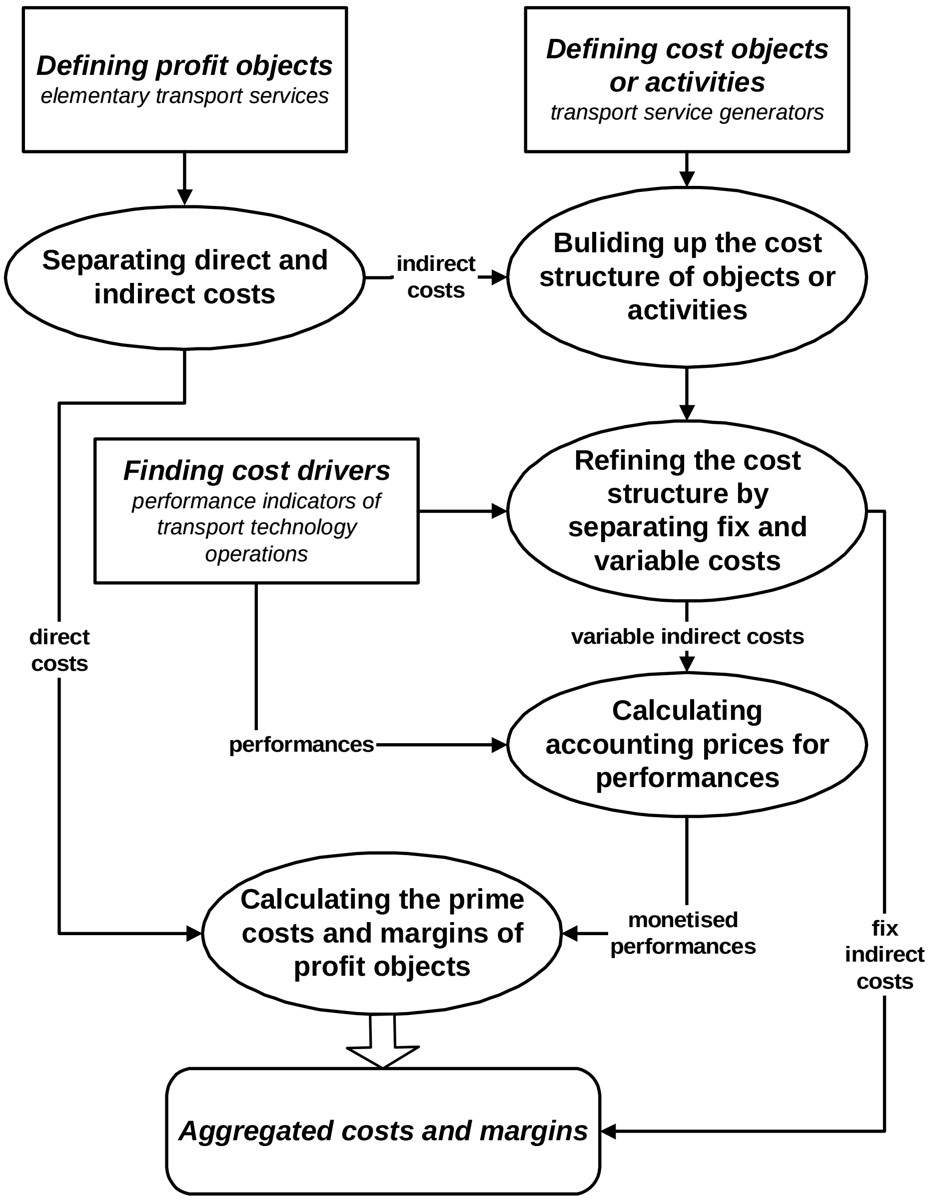
Possible profit objects in transport can be – at different aggregation levels – the followings:

- passenger (public) transport: a journey, a service, a line, etc.;
- freight transport: a shipment, a service, a line, etc.;

- infrastructure provision: an elementary line section, a line, a certain piece of the network, etc.

Of course these considerations shall be customised according to the factors mentioned before. It is worth noting that the ratio of indirect costs grows with lower aggregation levels. Revenue allocations may become more difficult, too (mainly in passenger transport). Thus the more detailed are the defined profit objects the more sophisticated calculation models and supporting IT systems are needed. At the same time the continuous development of IT enables to make cost and performance management practices more and more refined.

Figure 2: The operation mechanism of proposed transport costing and performance evaluation model



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After having defined the profit objects a clear differentiation between direct and indirect cost elements can be carried out. These cost elements are taken over from the general ledger. Direct costs can be allocated to the profit objects straightaway. The more aggregated are the profit objects the more cost elements can be assigned to them directly. What can be the direct costs? As having seen before it depends on the definition of the profit object. For example in the case of a certain transport service infrastructure user charges or the fuel consumed (if it is measurable) are in general direct costs, etc. Nevertheless, there remain such cost elements which can not be assigned to profit objects on a cause-effect basis. Here comes into forefront the additional use of cost objects or activities as “mediators”.

Cost objects are units which serve the production of multiple profit objects (i. e. elementary transport “products”). Such objects can be for example maintenance, sale or disposition units, vehicles or vehicle types, construction works, etc. If business or technology processes are the basis of depiction operational activities can be used for indirect cost distribution instead of cost objects. Here maintenance, sale, planning, disposition, operative management, accounting, etc. are considered as process elements. The main organisational units or process elements can be – of course – further differentiated if necessary (depending on the aggregation level). The activity based (or process oriented) approach reflects better the service orientation of transport so it is advisable to prefer it when developing the controlling model. Theoretically the two approaches can be combined but it is not applied in practice due to inconsistencies.

Thus indirect costs shall be first driven over to cost objects or activities. It can be solved by assigning the resources – working force, materials, tools, procured services, etc. – to them and record the costs caused by resource consumption. This may expand the bookkeeping tasks as each cost record is to be extended by a cost object or an activity code. If ignoring this additional recording an ex post harmonisation of the account structure and the cost object or activity structure may be necessary.

After having built up the cost structure of cost objects or activities another task is to find appropriate performance indicators – cost drivers – for these entities. A starting point to that are the parameters collected in the technology (sub)systems like traffic, vehicle, human and maintenance management, etc. The selected performance indicators are to be measurable or at least estimable. Generally time, volume or movement based parameters can be used for measuring the performance intensity of cost objects or activities in transport, for example: operation time, working time, pieces, tonnes, passengers, handlings, vehicle kilometres, passenger kilometres, etc. If (long term) time series of object/activity costs and potential performances are available a regression and correlation counting can help choose the suitable cost drivers (see later).

In possession of cost drivers the object or activity costs can be further differentiated into fixed (e.g. fix depreciation, monthly salaries, etc.) and variable (e.g. material costs, piece rates) parts according to their relations to performance intensity. So the total as well as the variable average cost of each cost object or activity can also be calculated through dividing the respective cost value by the performance value. Theoretically both specific cost values are applicable for accounting price purposes – for monetising the performance flows – but it is more reasonable to choose the average variable cost. In this case only performance dependent cost items are posted up, which meets better the requirements of cause-effect based calculations. Specific object or activity costs are important information sources itself, too. They make it possible to investigate the balance between resource consumption and performance realisation. The reasons for occasional deviations – volume or monetary based – can also be assessed.

The prime cost of a certain profit object (i.e. an elementary transport "product") can be calculated by adding the monetised performance consumption – coming form the cost objects or activities taking part in the production – to its direct costs. To do that the performance consumption of profit objects shall be measured or at least estimated, furthermore, the performance flows shall be evaluated by using the accounting prices (specific costs) mentioned before. The margin of a certain profit object turns out through debiting its revenue with its prime cost. If variable average costs have been used for performance monetisation margins are gross values as fixed (object or activity) costs are not yet considered. They can be included into the calculation in higher aggregation levels (e.g. when evaluating the profitability of a "product" group, a division or the whole company).

The ideal case is when the complete cost and performance management system (see figure 2) can be set up and operated in a transportation company. However, the methodology can also be used when only some modules or procedures – constituting a simplified but consistent subsystem – are implemented. The pilot applications analysed in the next chapter show examples for this finding.

4. Research results

The proposed transport costing model – or at least its main principles – has been tested in several pilot projects in Hungarian transport system for the last decade. However, no complete application is available yet: the considerable data requirements, the limits of information sources and the business secret considerations have enabled only partial implementations.

The main implementation area has been the railway sector. Railway companies are the most suitable entities for the recommended cost and performance model verifications as they operate a very complex service system with a high ratio of indirect costs. It is still valid even after the reorganisations resulting in the disintegration of former monopolistic operation structures. The followings give an overview of the main outcomes of railway oriented transport costing projects.

The first examinations had been carried out for the case of integrated railway companies: profit object analyses of the incumbent and a regional railway company. The goal of these investigations was to elaborate the gross margins (revenues debited with prime costs) of different profit objects (freight trains and shipments). That time all cost elements had to be considered as indirect as no intern service system – e.g. infrastructure or traction charging – was operated between the different business areas. Another problem was that the basic input data necessary for the calculations were available in information systems operating with aggregated values (costs, revenues and performances) only. So several averaging were to be used when counting the gross margins of selected rail freight transport "products".

Nevertheless, the application of the model contributed to refine the profit object calculations by making the prime cost structure more transparent and by differentiating the use of existing (generalised) average cost values. Table 1 summarises the – simplified – calculation results of a selected block freight train (carrying containers). The calculations showed that the gross margin of a freight train is about 30-40% and of a shipment is about 50-60%. Note that these values contain only allocated items of cause-effect cost distributions [8].

Table 1: Gross margin calculation of a block train as profit object (in EUR at 1999 prices)

Prime costs		
Main cost elements	*Main cost drivers*	*Values*
Infrastructure use (operation, maintenance and depreciation of constructive works, operation of stations)	gross tonne kilometre, no. of trains	459.05
Carriage rents	- (direct calculation)	100.55
Commercial services (operation of stations)	no. of stops, no. of trains	67.05
Shunting (operation and maintenance of engines)	gross tonne kilometre, no. of trains	89.96
Technology services for carriages (operation of technology units)	gross tonne kilometre, no. of trains	13.79
Traction (operation and maintenance of engines)	gross tonne kilometre, no. of trains	132.43
Total:		***862.83***
Revenues		
Charges for transportation and additional services:		1359.75
Total:		***1359.75***
Gross margin:		**496.92**

Source: own calculations

The reorganisation – disintegration – process of the incumbent railway company enabled to conduct more detailed cost and performance analyses. The most sophisticated application of the developed transport costing procedure (so far) was realised for the case of the infrastructure manager unit as a partly independently operating business area. This targeted research had been worked out in the frame of EU 6. FP R&D project GRACE. It aimed to give estimations on average and marginal costs of infrastructure management by using the activity based costing approach. The results can be applied to better establish the infrastructure user charges in Hungarian rail network [9].

The first step of applying activity based costing was the creation of appropriate input data. The starting point to that was the data base of the integrated accounting management system of incumbent railway company. Here all transactions (causing costs or revenues) are recorded by using also the so called activity code. So each cost item – reflecting various resource consumptions – can be coupled to one or more activities during recording it.

The examination of activity codes resulted that about 700 activities are totally or at least partially related to the infrastructure unit. A directed query to the selected activity codes resulted in a quite big size set of cost data for five years: 2001-2005. A complex performance measurement is not electronically supported within the railway company. Therefore the necessary performance indicators – train km, station usage, passenger and tonne kilometre, seat kilometre, tonnes – were collected from multiple information sources (transactional systems) like the freight forwarding management or the traction management system, etc. All data entities were further divided into train categories, geographical entities and organisational entities.

For those activities related to infrastructure operation proper cost drivers had to be found. The cost drivers came from the dataset of performance indicators. Finding the most appropriate cost driver to each activity code was carried out by regression analyses. All activity costs in the reference years were examined with a variety of regression functions: time series of activity costs and performance indicators were coupled (for the reference time period). The calculations were carried out for each performance indicator separately. In case of each activity the best correlation had to be found. The correlation between costs and performances was then described with the proper regression functions.

The former procedure resulted in about 700 different cost functions (one per activity) which could not be handled by the model so some simplifications should have been added. Thus the main aims of further regression analyses were to build homogenous activity groups that can be analysed independently but compress information at an acceptable level. Grouping of activities and their cost functions was carried out in two steps: rough grouping according to the textual contents of each activity and then refinement of grouping through the similarity of cost drivers. This process resulted in 6 activity groups. Cost data were also added and a second round regression analysis took place to find out the general performance indicators (cost drivers) for each activity group. According to first estimations less than 10% of the reliability of final statements was lost because of this grouping.

Thus cost functions for the 6 activity groups were created. These functions were dependent from at least one but in some cases even from three performance indicators. Marginal costs could be received by the derivation of the cost functions while in the case of average costs the current cost values had to be divided by actual transport performances. Table 2 contains the estimated marginal and average cost data calculated by using the most suitable cost drivers. Note that the results can only be validated within the examined time and performance intervals.

Table 2: Calculated marginal and average costs for core activities of rail infrastructure management (in EUR at 2005 prices)

Activity groups	Marginal costs	Average costs
train movement (depreciation, maintenance of line segments; renewal works that are not assigned to stations; control of traffic safety, signalling)	0.22 (per train km)	3.5 (per train km)
path allocation (timetabling; capacity control; planning traffic volumes, planning of charges)	2.52 (per no. of trains)	29.8 (per no. of trains)
interim passenger train services (station signalling for passenger trains, passenger infrastructure usage – platforms, underground passes, waiting rooms)	1.09 (per no. of pass. train stops)	13.4 (per no. of pass. train stops)
beginning/end of line passenger train services (using station infrastructure for reversing trains, pre-heating or cooling; providing passenger information)	1.85 (per no. of pass. trains)	17.1 (per no. of pass. trains)
marshalling/shunting for freight wagons (using marshalling facilities, their depreciation, maintenance, renewal and	0.81 (per no. of marsh. wagons)	5.03 (per no. of marsh. wagons)

operation)		
consignment of freight wagons (before/end-of journey serve of freight wagons, including personnel, traction power and energy; security check)	0.74 (per no. of cons. wagons)	8.22 (per no. of cons. wagons)

Source: GRACE Task Report 1.2F, 2006

Currently the former integrated national railway company is operated as a holding company coordinating the work of its affiliated undertakings like the passenger transport, the traction and the maintenance company. Infrastructure management and some background services (like centralised procurement or facility management, etc.) are still integrated parts of the holding company. The freight transport unit has been privatised – taken over by the freight transport company of the Austrian Railways. A research project assessing the controlling and management procedures of this new rail transport system has just been launched. The first results are available mainly about the rail passenger transport company.

The general finding of the preliminary observations is that the organisational separation has made the accounting systems more transparent: the former intern services – like traction, maintenance or infrastructure provision – are governed by service agreements. It has simplified also the cost structure of the passenger transport undertaking as the ratio of direct costs has been higher: 60-70% of total costs can be connected to infrastructure or traction charges (as purchased services) which can be directly allocated to passenger trains as profit objects. However, the volume of remaining 30-40% – mainly indirect – cost items is high enough to improve the cost and performance management system by introducing a more intensive use of monetised performance flows.

Although the continuous business process reorganisation has improved the management information system the current business planning and reporting practices of the rail passenger transport company are still determined mostly by top-down approaches. It means that the starting points of cost and performance calculations are in general aggregated values. It is due to data collecting mechanisms not supporting the depiction of performance flows and corresponding cost distributions. The main methodological shortcoming of the controlling system is the lack of detailed profit object calculations. The “products” are evaluated from the point of view of cost effectiveness in aggregated levels only (e.g. product groups by market segments or revenue types). No information on the cost coverage ratio of passenger trains is available (yet), although this information would be necessary for public service contracts, too.

Some initial steps towards bottom-up controlling processes, however, have already been taken. Planning procedures contains several feedbacks when refining the business and technology plans. Technology performance data (mainly in aggregated forms) are used – as cost drivers – for cost planning. The main organisational units (e.g. the regional passenger transport service centres) serve as cost objects and are responsible for their operation costs and performances.

The planned developments of the controlling system rely on two key areas. On the one hand the cost object structure – and the corresponding cost and performance management mechanism – is intended to be made more detailed (less aggregated). On the other hand considerable improvements of information systems have been launched. They aim to make visible the costs and revenues of rail passenger transport lines (as possible profit objects). The principles of the proposed transport costing model can be applied here, too, to better establish the cost distribution and allocation methods used by the modernised management information system.

5. Discussion

The findings of the pilot projects aiming to adapt the theoretical transport costing model to practical circumstances have made clear the advantages, the limits and the operation conditions of improved cost and performance management. The main advantage of the model implementation is that transport activities or “products” (services) are become assessable in the elementary levels of organisation/product hierarchy without relying on inaccurate and uniform data coming from arbitrary allocations. These allocations can be namely managed on a – at least partly – cause-effect basis when using the model.

The method can be theoretically brought to 100% perfection when the distortions in cost allocations are totally eliminated. It would, however, need a very extensive and precise performance measurement and cost collection which can not be realised under reasonable conditions. It would cost more than the gained benefits. A 100% adaptation of the model is not even necessary in practice. It can be accepted as a satisfying result when the integration of technology parameters into economic calculations makes the correctness of costing information better – with special regard to the core activities – in comparison with the outcomes of traditional, accountancy based approaches.

One of the most important implementation prerequisites is the availability of appropriate input data bases. The basic data can generally be obtained from the transactional information systems. However, these data shall be transformed, combined and stored according to the input requirements of the calculation model (cost items and performance indicators coupled to objects or activities). These data management tasks can be arranged in a more effective way when a dedicated data warehouse and a business intelligence tool exploiting it are introduced.

6. Conclusion

After verifying the elaborated transport costing and performance evaluation approach it can be concluded that the application of calculation methods combining technology and economic parameters/data contributes significantly to the more exact establishment of decisions on resource allocation. The decision making process is supported particularly by the more reliable information on elementary (or of less aggregated level) business activities or objects, furthermore by the better understanding of performance relations and cost drivers within value chains. If analysing the connection between the cost structure and the costing model it can be stated that the higher is the ratio of indirect costs the more sophisticated calculation method is necessary.

Regarding the possible directions of further (related) researches the following considerations can be drawn:

- it is often not clear how to select suitable performance indicators to cost objects or activities. Regression and correlation analyses are possible solutions to that (as seen before) but more research is necessary to find other applicable methods for this problem;

- performance flows in the calculation models are often dependent form each other. It requires an iterative approach which could be further refined to avoid inconsistencies;
- the distinction between fixed and variable cost elements is often difficult. More guidelines on this problem area would help to cope with the differentiation problem in practice;
- the transport cost controlling practices are still inflexible, accountancy based. More emphasis should be given to transform them into a process or activity based environment which reflects better the business features of transport.

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