1 Introduction

Rail infrastructure has a significant role in the whole transport network, so most of the European countries started strong developments and reforms. The structure reforms and the liberalization of the railways have been going on in Europe for almost two decades with more or less success. The final aim is to construct a uniform rail market considering the legal, the economic and the technological aspects. At the same time rail companies and governments have to face the fact that in spite of several innovations they have not been able to cope with the decreasing competitiveness in the last years [6].

Rail infrastructure management is a stressful point of the rail liberalization but it was treated only marginally because of several difficulties. Hence its reform shows some deficiencies. Therefore it is inevitable to analyze rail infrastructure management also from a costing point of view. It requires the application of new controlling and cost calculation methods with corresponding adaptations for the specific characteristics of rail infrastructure.

The aim of the study is to work out the theoretical scheme of a new cost calculation model which is able to determine the overhead costs of the infrastructure manager and the costs of infrastructure services in a better and more precise way.

The second chapter gives an overview of the most important principles and steps of Value Stream Costing, which, combined with the cost calculation model, elaborated in the previous phases of the research, can be applied in rail infrastructure management.

The third chapter gives the framework of the future cost calculation methodology including an overview flow diagram to show its inner structure and the main steps of the calculation.

Finally the last chapter contains the main results and conclusions of the paper.
Note that the methodology presented in this paper takes advantages of the related costing methods aiming to improve the correctness and transparency of corresponding cost calculation regimes. One of these methods is the so called multi-level full cost allocation technique which has already been applied in transport and logistics [2, 3].

2 Evaluation of the value stream costing from the rail infrastructure point of view

This chapter contains the most important principles, advantages and steps of the value stream costing, which offers new possibilities for the cost calculation of the rail infrastructure.

Lean management was improved by the Japanese management experts, which has an important methodology, the Value Stream Costing (VSC). It is a new thinking for the definition of business processes. Its requirements are mostly based on the continuous, structural transformation of the companies, which is very characteristic of rail infrastructure companies.

The new way of thinking brings the needs to develop new methods for measuring and analyzing the performance of the companies. Counter to the standard controlling and accounting methodologies, VSC does not require the varied division of general costs. Otherwise the rate of the amount of general costs is much smaller, because the costs are directly related to the value streams and their activities, before they are assigned to the products and services. Furthermore, planning happens at the level of value streams, instead of the various departments of the company.

In general the core problem is that the companies use their old accounting systems for the new, restructured business processes. Lean management has the main target to rationalize the processes.

This methodology has more advantages: accurate and timely information, reduction of unnecessary processes, supporting long-term strategies, suitable cost-drivers, which connect the real performances, their costs and finally the products.

Lean analyzes the value stream on the level of activities. On the same level the costs are collected and the performances are measured. The costs related to the products, services and value streams are separated from each other. The processes are focused on value creation.

The standard methods support only the standard company structures. The costs, coming from these methods are based on standard service structure, so it can contain
not proper data. These have the premise that all elements of the business processes require follow and control. It is called hidden operation, where the unnecessary transactions are realized. Visible operation means the processes related to the production of products or services.

The lean perception looks for the reasons of the results and outputs and hereby the redundancy is terminated, which finally results in cost savings. One of the most important parts of lean management is the measurement of the performance through adequate cost-driver selections. The long-term goal is to create and maximize the customer value and this point is the main difference from the standard notion, where the cost reduction is the only one aim equally in long- and short-term [7].

Value Stream is every business activity and process which creates any value. Through value streams are the main cash-flows and the value creation realized. Important question of the creation of this value stream is how many and how great streams we need. The literature suggests minimum 25 and maximum 150 within a value stream [9]. Furthermore, it is ideal to define approximately 3 main value streams and another one for additional and supporting activities and processes. One value stream should contain between 10 % and 60 % of the whole corporate value.

Value Stream Costing is focused on processes instead of products or services and adjusts to the more rational Lean production and not to mass-production. The cost is directly allocated to the whole value stream, so it needs less cost-information.

In the last decades the cost structure of corporations has significantly changed, the general costs take more and more proportion of the whole cost yearly. In case of rail companies this rate has overtaken the ratio of 80 %. The standard cost calculation methods have several cost-drivers for cost dividing and this brings distortions into the system, which can result over or under pricing. In contrast to the previously mentioned methods, value streams contain not only the direct, but also the indirect costs, which are allocated directly to value streams, so very little cost allocation through cost-drivers is required [10].

The framework of the methodology explained above can afford effective support for such kind of complex systems (like rail infrastructure management) to calculate their real service-costs and control them.
3 Overview of the new hierarchical, multi-level cost calculation methodology based on combined value stream and activity based calculation

This chapter overviews the new methodology, including the review of main steps in the cost calculation.

3.1 Framework of the developed methodology

Here the overall scheme of the new cost allocation methodology will be set up including the main interfaces and relations between each step, illustrated by a diagram.

The scheme of the new methodology is indicated in Figure 1. The cost calculation model consists of four main parts. These are the following:

- Value stream of the rail infrastructure management,
- Activity-level cost collection,
- Hierarchical, rail activity based cost calculation methodology,
- Cost difference analysis.

The first part analyses the value stream of rail infrastructure management. It requires determining the main value stream and the subservient value stream, which has the role to serve the main value stream. Then the rail activities within the value streams have to be identified. This will be an input for the activity-level cost collection.

Value stream costing continues with the pricing of rail activities. Two important clusters of information are needed for this calculation: the consumer prices and the escort. This pricing gives the planned costs of each rail activity or activity group. This is explained in chapter 3.2.1.

The second step actually contains the pre-condition of the new methodology: how the activity-level cost-collection can be realized and how the rail infrastructure management activities have to be aggregated according to the nature of costs.

In the part of activity-level cost collection cost objects (so called rail cost codes) have to be generated and a rail activity and cost hierarchy has to be set up as well. This will be explained in chapter 3.2.2.

The third step is the new, hierarchical, rail activity based cost allocation process, where first is to be decided which cost drivers belong to the subservient activities (subservient levels of cost drivers), this assigns the directly managed part of general costs (costs of indirect activities) to the direct activities through cost allocation in several stages. After defining these parameters – hereafter called primer, secondary,
etc. activity drivers (see Figure 1. and chapter 3.2.3.) – and splitting the general costs the direct activity costs will be identified.

After that the critical point is the determination of the activity based, elementary level cost drivers (hereafter referred to as rail performance drivers). It requires a new data collection method, which collects the natural indicators and rail performances and it denotes a database managing system (time-registration system). This is explained in chapter 3.2.3.

The last step of the methodology is the cost difference analysis. From the cost collection the real costs of each rail activities are originated and the planned costs are calculated in the value stream costing of the rail infrastructure. This analysis displays and examines the differences between the real and planned costs in order to facilitate the decision making process. This is explained in chapter 3.2.4.
Fig. 1 Overview map of the hierarchical rail activity based multi-level cost calculation methodology
3.2 The main steps of the methodology

This chapter discusses the following main steps of the new model:

- Value stream costing of rail infrastructure management,
- Activity-level cost collection,
- Multi-level cost allocation process,
- Cost difference analysis.

Value stream costing of rail infrastructure services

The first main part of the methodology is based on the recently developed Value Stream Costing (VSC) and Value Stream Mapping (VCM) [7]. Using this new approach can provide rail infrastructure operators with the opportunity of defining their value streams on the one hand and next to this, also their rail activities, which represent the biggest amount of costs inside the company and the highest value for the customers (i.e. for rail transport operator companies) [7]. On the other hand the costs of all rail activities and functions within the value streams can also be optimized. After having determined the main value streams of rail infrastructure management (hereafter referred to as rail value streams and in case of infrastructure services as rail service streams) and the value stream map for rail infrastructure services can be presented.

This part of the methodology has four main points, as presented in chapter 3.1. These are:

- Determination of the main rail infrastructure value streams and determination of the subservient value streams,
- Identifying the rail activities within the value streams,
- Pricing the rail activities with consumer prices and covers,
- Determining the planned costs of rail activities.

One main and three subservient value streams can be defined for rail infrastructure management:

- Main value stream, which contains more core activity processes:
  - Basic procedures required for the production of the rail infrastructure services: operation, maintenance, supervision, renewal and depreciation of the rail infrastructure, their facilities, equipment.

- Subservient value streams:
  - Primer value stream: directly supporting the production of the rail infrastructure services (mostly traffic management),
  - Seconder value stream: additional activities which are required for managing the rail infrastructure and support the services indirectly (mostly in the level of the operational management),
- Tercier value stream: functional (human, accounting, logistic services),
  general costs of rail infrastructure management (financial transactions
  and expenses, provisions, taxes, penalties, compensations etc.),
  management costs (labor and administrative costs of the rail
  infrastructure and strategic management).

After identifying the value streams, rail activities can be assigned to each value
stream. These rail activities will be the input of the next step (activity-level cost
collection – see next chapter) on the one hand and all of the planned costs of the
activities will be determined through pricing on the other hand.

The pricing procedure requires the following relevant information: the consumer
prices and the cover. The consumer price can be calculated in several different ways.
The simplest case is that the given activity is found at one of the rail market segments
and their market price is known as well (for instance: shunting of a freight car). If the
given rail activity does not exist at the rail market (it is not a market activity) and that
is why the price is unknown, then the price can be created according to the
international practice (for instance: overhead costs of an InterCity train). In that case,
if none of the previous is available, a market price of a similar activity (not necessary a
rail one) has to be found, which can be the base of the price of the rail activity (for
instance: maintenance of the rail track superstructure).

After that it is necessary to determine a value of the cover. Considering the cost
management of the Hungarian Incumbent Railway Company in the previous years and
the national law for the state subsidy, a value of 20 percent can be used for the covers.

Now we can calculate the planned cost of each rail activity (both elementary and
subservient) with the following formula:

\[ RAC_i = RACP_i - RC \]

where \( RAC_i \) \( \ldots \ldots \ldots \text{planned cost of the } i^{\text{th}} \text{ rail activity}, \)

\( RACP_i \) \( \ldots \ldots \ldots \text{consumer price of the } i^{\text{th}} \text{ rail activity}, \)

\( RC \) \( \ldots \ldots \ldots \text{cover of the activities (20%).} \)

Activity-level cost collection
One of the results of the value stream costing presented in the previous chapter is
the input of the activity-level cost collection.

This kind of cost collection has several advantages. First the costs of every rail
activity can be detected separately. In depth activity and cost analysis is also possible.
Through the analysis the unnecessary and too expensive activities can be pinpointed.
and eliminated. Furthermore, the data from the plan-actual differences can be identified and the amount of rail activity costs can be analyzed.

The activity-level cost collection has four steps, these are the following:

- Definition of the cost objects,
- Setting up the rail activity hierarchy,
- Assigning the costs to the cost objects,
- Setting up the rail infrastructure cost hierarchy.

Definition of the cost objects means that the activities, created in the process of value stream costing, are broken down to elementary levels and a code will be assigned to each elementary rail activity. This is the object of the cost collection and it is called multi-level rail infrastructure cost codes (shortly: rail cost codes).

The cost objects of rail activities designate the elementary rail activities, where the costs are collected. Subservient rail activities (in three levels – see below) report all of the activities which do not take part directly in producing rail infrastructure services (for instance: Treasury, Accountancy, Controlling, Human Resource, and Security).

Then the activity hierarchy can be built. It is necessary to define four cost allocation levels, which are

- Central management (Tercier subservient level),
- Management of rail infrastructure (Secondary subservient level),
- Operative rail infrastructure management (Primer subservient level),
- Enforcement (primary rail activity level).

To central management belong the costs of central management of the incumbent railway company (Treasury, Human Management etc.) and the internal services, provided by this company (Accountancy, Human Services etc.).

To primer subservient level belong the costs of operative management. Within this we can distinguish two separate cost groups. The first one is the operational rail infrastructure management which is required for the direct operations of train traffic. The other one is the cost group of the direct enforcement which can not be allocated directly and clearly to one definite rail infrastructure service (for instance: costs of station inspectors).

After creating rail activity hierarchy, based on costs collected to the rail cost codes, the direct cost hierarchy can be generated. Now the costs are ready for carrying out the right cost allocation procedure.
3.3 Multi-level cost allocation process

Using the methodology presented in the previous chapter some main steps are to be detailed in this section. Due to the limits of this paper the other steps will not be explained here. Only the following three core steps are presented: determination of the rail activity costs and defining the elementary rail activities and creating cost-driver algorithm for the allocation of the rail activity costs.

The assignment of the cost elements is realized through a special algorithm of cost-driver generation (see subchapter 3.2.3./c).

a.) Determination of the rail activity costs through multi-level rail activity drivers

Costs of the direct rail activities consist of two parts: the sum of the costs which are squarely allocable (direct costs) and a certain part of the general costs once convertible to direct costs within the first level of cost drivers.

Three groups of the subservient level cost drivers (activity drivers) are differentiated:

- Primer activity drivers,
- Secondary activity drivers,
- Tercier activity drivers.

For the cost-hierarchy group, for primer subservient activities the primer, for secondary activities the secondary and finally for tercier activities the tercier activity drivers are applied. As an example let us review what kind of cost drivers can be identified for some cost groups. The second columns of Tables 1 and 2 show the currently used dividing factors, called natural indicators [8].

According to the observations at the incumbent rail company, the presently used cost drivers are relatively simple and belong to the transaction types but the problem with these is that they can not reflect the real relationship between subservient and direct rail activities and they also make distortions in the assigning process [1, 4]. The time period type cost drivers which are based on estimated time required for performing the rail activities, have to be used to revise the accuracy of the cost allocation. For this it is indispensable to measure the time of the activities. This can be realized through using a time registration database.

The last column of Table 1 shows the identified new cost drivers based on the operation time analysis. The majority of the costs can be allocated by the time period cost drivers but where the time measurement is not possible a rail performance indicator which assigns values to the given activity has to be found.
Table 1 Currently used natural indicators and suggested cost drivers of subservient activity cost groups

<table>
<thead>
<tr>
<th>CA cost groups</th>
<th>Currently used natural indicators</th>
<th>Proposed rail activity drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities of building industry</td>
<td>direct cost</td>
<td>duration of the activity (hour, minute)</td>
</tr>
<tr>
<td>Costs of road and other vehicles</td>
<td>direct cost of the vehicle</td>
<td>running km or working hour</td>
</tr>
<tr>
<td>Costs of material management</td>
<td>unit</td>
<td>duration of the activity</td>
</tr>
<tr>
<td>HR services</td>
<td>direct cost</td>
<td>per capita</td>
</tr>
<tr>
<td>Accounting services</td>
<td>direct cost</td>
<td>duration of the activity or number of invoices</td>
</tr>
<tr>
<td>Other management services</td>
<td>direct cost</td>
<td>duration of the activity</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Source: [5] and [8]

b.) Defining rail performance drivers for identifying the costs of services

The other problematic point of this methodology is to determine the second level cost drivers, called rail performance drivers. As mentioned in the previous subchapter performance data have to be collected with the estimated time of rail activities in a time registration database.

The role of the elementary level cost drivers is to assign the costs of direct rail infrastructure activities (for example: shunting, traffic operations) to the rail infrastructure services (see next chapter).

The currently used cost drivers, also called natural indicators – as in the case of the first allocation – incorporate the problem that they are mostly based on the complied services by the sections of the used train route, so they can not show the difference between the services (for instance: shunting of a passenger or a freight train). Considering the duration of performing the activities eliminates the former problem [5]. Table 2 gives examples for the presently used and the suggested cost
drivers through some direct cost groups of rail infrastructure activities. Due to the limits of the paper all the cost groups are not reviewed.

*Table 2 Currently used natural indicators and suggested cost drivers of cost groups of services*

<table>
<thead>
<tr>
<th>Cost groups of rail infrastructure services</th>
<th>Currently used natural indicators</th>
<th>Proposed rail performance drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs assigned to open track section</td>
<td>Costs of using overhead cable</td>
<td>direct cost</td>
</tr>
<tr>
<td></td>
<td>Costs of network access services</td>
<td>direct cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>duration of the activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>duration of the activity</td>
</tr>
<tr>
<td>…</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>Costs assigned to stations</td>
<td>Costs of using overhead cable</td>
<td>direct cost</td>
</tr>
<tr>
<td></td>
<td>Usage of the stations for stops</td>
<td>sections of the used train route</td>
</tr>
<tr>
<td></td>
<td></td>
<td>duration of the activity</td>
</tr>
<tr>
<td></td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>Costs of service groups</td>
<td>Shunting etc.</td>
<td>sections of the using train route</td>
</tr>
<tr>
<td>Common costs of services</td>
<td>Traffic operations, block systems etc.</td>
<td>sections of the using train route</td>
</tr>
<tr>
<td></td>
<td></td>
<td>duration of the activity</td>
</tr>
</tbody>
</table>

Source: [5] and [8]
c.) Generation of the cost-driver hierarchy based on time registration database

One of the most problematic points of calculation is the selection of the proper cost-drivers for rail activities on every level. For this work a time registration database system is to be created as it was mentioned in the previous chapters, which collects rail performance data based on measured, estimated time of the rail activities.

The following cost-drivers can be identified and labeled:

- For subservient rail activities:
  - Tercier activity drivers,
  - Secondary activity drivers,
  - Primer activity driver,
- For primary rail activities:
  - Rail performance drivers.

The proper cost-drivers can be selected through an algorithm from the collected rail performance data. The principle of the algorithm is that the pre-generated running bases will be assigned to the activity groups, which has been generated from similar, unmanageably numerous rail activities. After that, the primer, secondary and tercier costs can be allocated to the adequate activities to produce the costs of elementary activities and finally the costs of each rail activity service. Figure 3 shows the structure of the cost-driver algorithm [5].
Cost difference analysis

Sensitivity analysis comprises a comparison of the real and optimal costs of the rail activities. The optimal costs arise as results of the value stream costing and the real costs are produced by the multi-level cost allocation.

According to the multi-level cost allocation process the real costs are calculated and according to the value stream costing of the rail infrastructure the planned cost is generated. The analysis can be done for all of the rail activities or activity groups based on the real and the planned costs. Presenting the difference between the two types of costs shows whether the given activity is too expensive or on the contrary it has lower costs than expected.

The reasons of the differences lead to two different outputs both in case of over fulfillment or underperformance. If the planned costs of the given rail activity was overcome, then in case of wrong cost management the planned value has to be kept, in
other cases the planned value should be modified for the next planning period. In case of underperformance the same changes can be implemented.

4 Results and conclusions

Here the main results and conclusions of the new multi-level cost allocation methodology are summarized which have been explained in detail in the previous chapters: how this methodology gives better transparency of the overhead costs, how unnecessary rail activities will be strained off the main value streams and how this model rebuilds the whole cost structure of rail infrastructure management.

It could be seen that one core element of rail liberalization is the improvement of the accounting and cost collection system of the rail infrastructure manager companies. The Hungarian incumbent railway company would like to renew its lately used, outdated financial and accounting system because the foregoing corrections have not brought about complete success. Due to the problems mentioned above, it is required to develop a completely new methodology for cost allocation of the rail infrastructure.

The second chapter explains the main principles and advantages of Lean management and its calculation methodology, the value stream costing. The evaluation of the VSC points, how it suits for rail infrastructure controlling.

In the third chapter the framework of the developed methodology was presented. The model applied two different methods. The first one is the value stream costing and the second is the activity based costing.

The new, value stream costing of rail infrastructure helps define the value stream within the company and all of the rail activities within these value streams on the one hand, and the planned cost of each activity is created through market pricing on the other hand.

The new hierarchical rail activity based, multi-level cost calculation methodology generates the actual and real costs of rail activities and finally the overhead cost of every rail infrastructure services.

A cost difference analysis is also incorporated into the model. With the help of this, the difference between the planned and the actual costs can be examined.

The critical point of the model is to identify the relationship between activities and rail infrastructure services through the right selection of the cost drivers. The analysis gives a solution for this. The basic idea is to measure the time period of each activity if it is possible. These durations will be the weighting factors of the cost
drivers, not only on the elementary, but also on every subservient levels (not only rail performance drivers, but primer, secondary etc. activity drivers). If the measurement is not possible or is useless depending on the nature of the activities, the real rail performance has to be found and assigned to these activities. In chapter 4 this methodology is translated into a mathematical model which integrates the two level cost allocation into one formula.

The developed cost calculation methodology makes the value-creating processes clearer, and also it seizes the real causes and relationships between the subservient and direct rail infrastructure activities (primer, secondary, etc. levels) and between rail activities and rail infrastructure services (elementary level) through more detailed selection of proper cost drivers based on estimated time required for performing the activities.

References


[5] HOKSTOK, Cs.: Combined value stream and activity based cost calculation model developed for rail infrastructure management. 1st Graduate Transport Regulation Seminar -GTRegS, European University Institute, Fiesole, Italy, 24-25 May 2011


Resume

Nowadays the structure and operational system of the rail transport sector is changing significantly. Rail liberalization has arrived. The legal and the technological framework of the liberalization are already worked out in detail and the development and the opening of the rail markets are in an advanced phase. At the same time the financial situation of the rail companies including rail infrastructure management is still not arranged. The aim of the research is to clarify the costing system of rail infrastructure management. In light of what has been explained above, the challenge of the work is to develop a new cost calculation mechanism based on recently used cost calculation methods, especially Value Stream Costing (VSC) and partly Activity Based Costing (ABC) suitable for rail infrastructure management. The specific aim of the study is to create a complete cost calculation method for rail infrastructure management including an extensive process and activity analysis and cost driver selection. On the basis of this methodology a new costing model will be developed to identify costs of rail infrastructure services. Using this model results in more accurate cost identification by selecting proper cost drivers with better defined rail activities on the one hand while costs based on more exact calculations can lead to more realistic determination of the user charges on the other hand. The Hungarian incumbent railway company would like to renew its lately used, outdated financial and accounting system because the foregoing corrections have not brought about complete success. Implementation of this methodology gives better transparency of the costs of rail infrastructure management and the planning of costs and rail charges of services will be placed on a new and more precise basis by using accurate allocation procedures. Last but not least this methodology may increase the competitiveness of the whole rail transport sector too.

Key words

Cost calculation, controlling management, value streams, cost-drivers

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