

EvaRail – activity-based transport cost model for evaluation of improvements in the rail freight system

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ABSTRACT

There is an increased need for cost information about rail freight, both among railway undertakings as well as among actors outside the sector. In the scientific field improved cost information is crucial not least as input for mode choice and freight forecasting models.

This paper presents EvaRail, a cost model for rail freight developed by the author at the Royal Institute of Technology Stockholm (KTH). The model is based on an Activity-Based Costing approach and covers a wider variety of production systems in rail freight. It allows cost calculations and analyses both on flow-level and on system-level.

KEYWORDS

Rail freight, transport economy, cost model, Activity-Based Costing, Wagonload, Intermodal

1. THE NEED FOR COST INFORMATION IN THE RAILWAY SECTOR

The liberalization of rail freight in Europe has led to an increased need for cost information in the railway companies. An increased focus on costs in the railway sector imposes a better cost knowledge and cost understanding even on stakeholders and actors outside the sector, which are affected by railways decisions and development.

Important target groups for cost information are thus: (1) Train operating companies, (2) Government and public administrations, (3) Shippers, (4) Infrastructure Managers, (5) Scientific researchers. Table 1 shows for which purposes they may be in need of cost information.

Table 1 - Users of cost information about rail freight and fields in which they may use it for decision-making. (G.Troche)

Train operating companies	Government and public administration	Shippers	Infrastructure Managers	Scientific researchers
Pricing	Legislation	Choice of transport mode	Socio-economic analysis	Model development (demand forecast)
Investments	Transport infrastructure development	Logistical planning	Infrastructure investments	Evaluation of transport systems
Operations	Subsidies		Policy strategies	Cost understanding
Business strategies	Policy strategies			

2. GOAL, PURPOSE AND DELIMITATIONS

In order to address the needs of the different actors an activity-based transport cost model has been developed by the author at the Royal Institute of Technology Stockholm [1]. The model covers a wide variety of production systems in rail freight and calculates costs both on system and flow level. Detailed output-data allow in-depth analyses of cost effects of technical and operational improvements in the rail freight system.

The *goal* was to develop a model, which makes it possible to enhance the understanding of costs in rail freight and to analyse possible ways to improve the profitability and/or cost competitiveness of the rail freight system. The model has been given the working name *EvaRail – Model for Economic evaluation of rail freight services*.

EvaRail aims to describe the supply and demand side of rail freight on a detailed level. The model delivers cost data on both system and flow/shipment-level (micro and macro level). At the same time, it is general in the sense of being able to depict (almost) every production system and combination of production systems in rail freight, both those used today and potential future systems. By doing so, the model can describe the railways' development opportunities in a more dynamic perspective, taking into account changes in the rail supply as a result of new production methods, improved technical solutions and operational performance.

The *purpose* of the model is to address the needs for information from the different players identified above. Concerning the use of the model in the scientific field one key aspect was to build a model delivering better input data for transport choice and freight forecasting models. EvaRail is a business-economic cost model calculating costs *from the view of a train operator*. Therefore it does not take into account external effects if they are not internalized, e.g. by infrastructure access fees.

The scope of a business-economic model is influenced by the organizational structure of the sector. In the railway industry – as in other industries – this structure is changing over time, and there also exist differences between different countries and railway companies. EvaRail is designed in such a way that it to a certain degree can adapt to different organizational models.

3. MODELLING APPROACH

The EvaRail-model is based on the concept of Activity-Based Costing (ABC). In the comparison of Traditional Cost Accounting (TCA) versus ABC, the latter has advantages both when it comes to the accuracy of the results, as well as the possibility to analyze obtained data, since ABC creates a more direct connection between costs and cost drivers.

The main advantages of ABC can be summarized as follows: (1) ABC is an accurate methodology, (2) ABC focuses on indirect costs, (3) ABC traces rather than allocates each expense category to a particular cost object, (4) ABC makes “indirect” expenses “direct”. Thus ABC is suitable for businesses where overhead costs are high, products are diverse, i.e. characterized by high complexity, volume and amount of direct labour, when cost errors are high and where competition is stiff [2]. All these factors are fulfilled in the rail freight business.

EvaRail is able to depict different production systems in rail freight. Four different production systems can be discerned:

- Trainload
- Wagonload
- Combined Traffic
- High-speed rail freight

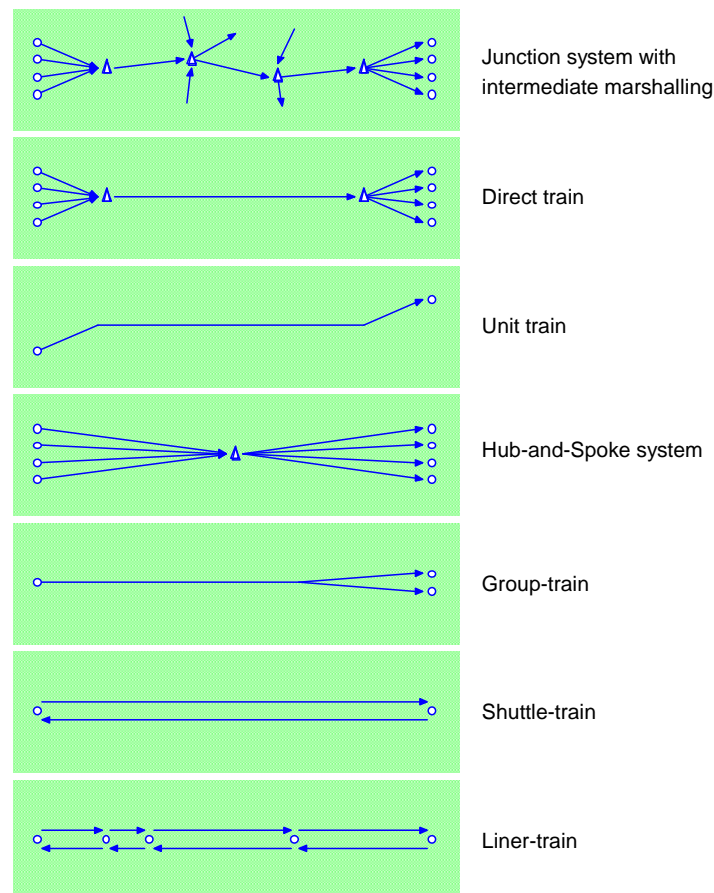


Figure 1: Operating principles in rail freight (G.Troche)

Table 2 shows how common different operating principles are in different production systems.

Table 2 – Train operating principles in different production systems (G.Troche)

	Trainload	Wagonload	Combined Traffic	High-speed rail freight
Junction system with intermediate marshalling	-	++	o	-
Direct trains in junction system	-	++	o	-
Unit trains	++	-	-	+
Hub-and-spoke system	-	+	++	+
Group trains	-	++	+	o
Shuttle trains	-	-	++	++
Liner trains	-	+ *	++ *	++ *
++ Very common or suitable + Common or suitable o Possible - Not possible or not suitable * future (expected)				

The main resources are: (1) rolling stock, (2) personnel, (3) infrastructure, (4) energy, (5) train operating principles, (5) yard and terminal operations and (6) the organizational framework. From a modelling point of view train operating principles together with yard and terminal operations play a key role in the design of an activity-based transport cost model. Figure 1 illustrates a number of different train operating principles, which EvaRail is able to handle.

The selection of activities that should be depicted in the model and the decision as to the degree of detail with which they should be depicted, was conducted on the basis of three criteria: (1) Importance/share of the activity/cost item of total costs; separately for different production systems, (2) variability of the cost of the activity/cost item with output, and (3) expected future changes in the input costs (e.g. energy, infrastructure user fees)

As a result of the selection process the following costs together with their main determinants have been included into the model: (1) Capital or rental costs wagons, (2) maintenance and service costs wagons, (3) Capital or rental costs locomotives, (4) Maintenance and service costs locomotives, (5) Capital or rental costs loading units, (6) Maintenance and service costs loading units, (7) Driver costs, (8) Shunting costs, (9) Marshalling costs, (10) transloading costs, (11) Infrastructure user fees and (12) energy costs. The following costs are added as percentage surcharges: (13) administration & planning costs, (14) overhead costs, (15) risk costs, (16) insurance costs and (17) profit margin. If applicable, even feeder transport costs can be added (18). Figure 2 gives a more detailed overview over the calculation model.

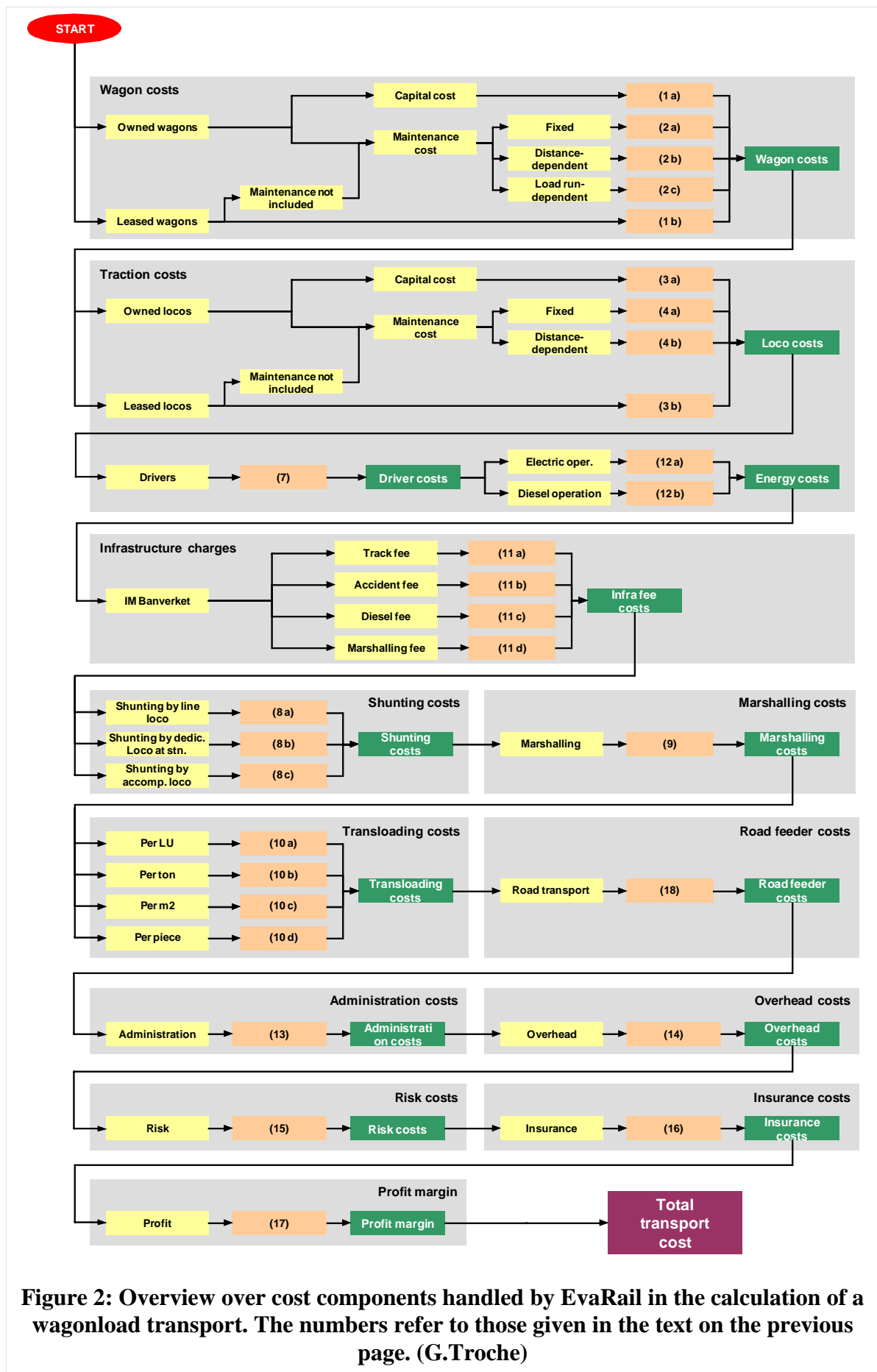


Figure 2: Overview over cost components handled by EvaRail in the calculation of a wagonload transport. The numbers refer to those given in the text on the previous page. (G.Troche)

4. MODEL DESIGN AND OUTPUT

The rail freight system is depicted in EvaRail by three main "levels", which are interconnected to each other:

- the infrastructure-level
- the train services-level
- the freight flow-level

The *infrastructure* and *train service levels* together represent the *supply side* in rail freight, while the *freight flow level* represents the *demand side*.

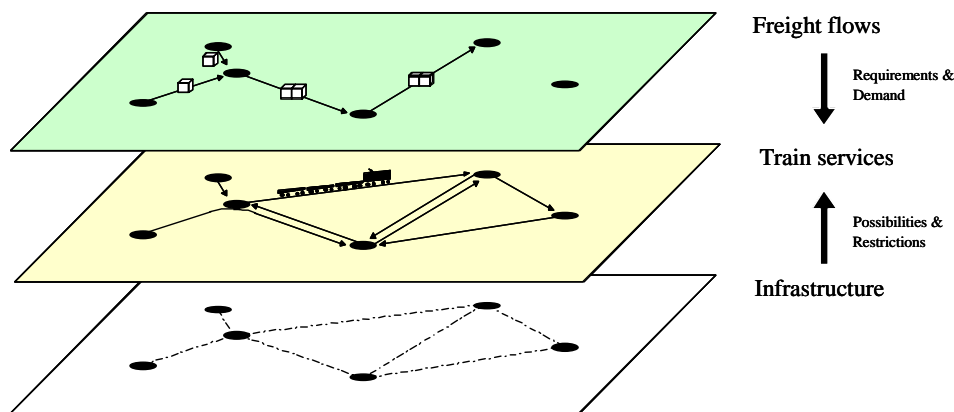


Figure 3: General structure of the model (G.Troche)

The model contains several input-databases: A freight-flow database, a train database, a commodity-database, a vehicle database, a load-unit database and a special cost-database (containing cost-information, which is not contained in other databases, e.g. for personnel, energy, infrastructure access fees, etc.).

Both demand and supply are specified for a whole year with the possibility to vary shipment frequency, shipment size, time windows for loading and unloading, traffic days and a number of other demand and supply parameters over the year. This makes it possible to investigate the effect of weekly as well as seasonal variations on resource utilization and costs.

EvaRail is a computer-based model written in VBA (Visual Basic for Applications). Excel worksheets are used to store input and output data, which facilitates further processing, e.g. for graphical presentation or deeper analyses of the data. EvaRail also already contains some possibilities for graphical presentation.

A calculation can be carried out for a single freight flow or a transport system with multiple flows. EvaRail allocates in a first step shipments (flows) to trains, and in a second step wagon individuals to shipments. Both allocation steps use a route and train choice module, which in the wagon allocation step even is able to generate necessary empty wagon movements. This route choice module is also used to allocate – in a separate process – traction to trains. For Combined Traffic fixed train consists can be specified, since wagon turnrounds here are not linked to specific shipments.

In the final step costs are allocated to all resources and calculated for each shipment. EvaRail delivers detailed data both on system level and for each individual shipment. In the output-database not only the total cost of a transport is saved, but also all cost components separately and for each section of a shipment, as can be seen in the figures below. This allows detailed analyses of the cost structure and where in a transport chain costs occur. Output data can also be presented graphically. In addition to cost data the model also delivers detailed data on transport times and train loading factors.

The following figures give examples of some of the output data for a selected flow and how it can be illustrated graphically. The model has been used in a number of projects [e.g. 3-5]; these applications have allowed to test the model and have formed part its validation.

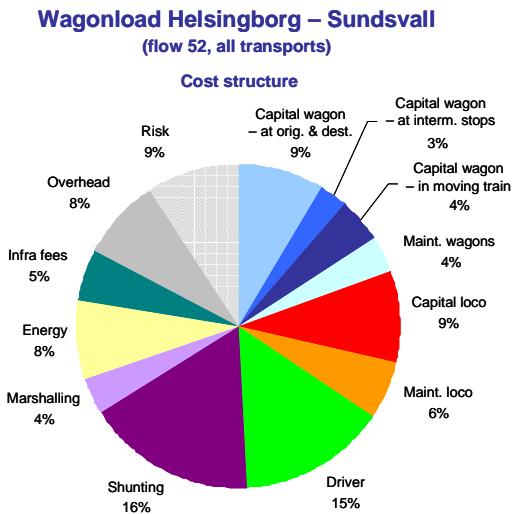


Figure 4: Example of illustration of output data: Cost distribution by cost item in a wagonload flow (EvaRail / G.Troche)

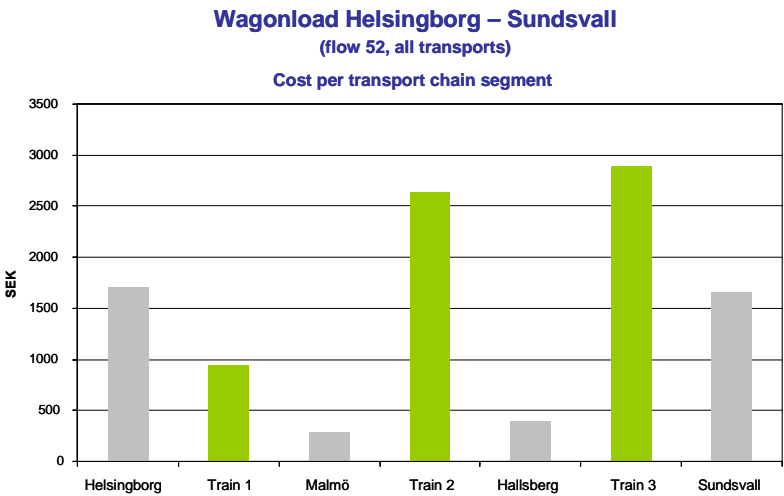


Figure 5: Example of illustration of output data: Cost distribution by location in a wagonload flow (EvaRail / G.Troche)

Wagonload Helsingborg – Sundsvall
(flow 52, all transports)

Cost per transport chain segment, aggregated

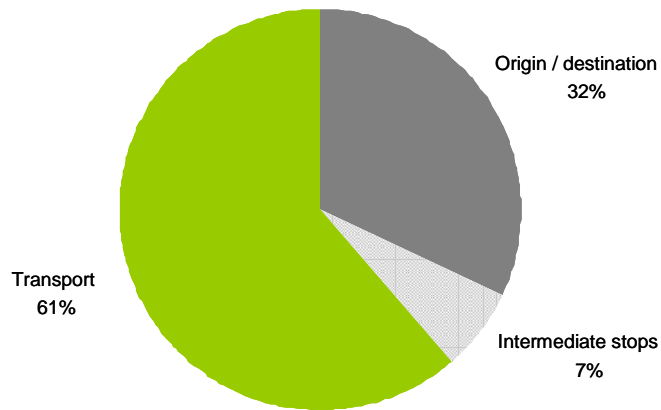


Figure 6: Example of illustration of output data: Cost distribution by location, aggregated, in a wagonload flow (EvaRail / G.Troche)

6. OUTLOOK

A further development of the model will focus mainly on three areas: (1) a better depiction of feeder transport by road in multi- and intermodal transport chains, (2) creation of interfaces to other models to facilitate data exchange, and (3) completion of input-data and minor model adaptations to make the model applicable to more countries in Europe. The model will also form part of a model system for evaluation of intermodal terminal networks, which is currently under development in an international cooperation project.

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