Track Access Charges in Freight Transport

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List of Abbreviations

RU	railway undertakings
IM	infrastructure manager
TAC	track access charges
KPI	key performance indicator
MCB	“market can bear”
CHRISTINE	Charging of Rail InfraSTructure IN Europe (working group)
CIS	Commonwealth of independent states
PPPs	Purchasing power parities
MPI	Maintenance performance indicator
ACEM	Automated and Cost-Effective railway infrastructure Maintenance (project)
CER	Community of European Railways
UNITE	UNIfication of accounts and marginal costs for Transport Efficiency
UIC	Union Internationale des Chemins de fer (International Union of Railways)
CATRIN	Cost Allocation of TRansport Infrastructure cost
PSO	Public service obligation

TSC	Total social costs
TC	(International) Transport Corridor
MU	Markup
BM	Bonus-Malus System
PPP	Public-private partnership
BC	Blockchain
EC	European Commission
CBA	Cost Benefit Analysis

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INTRODUCTION

Rail infrastructure is one of the most important parts of the global economy. Railway infrastructure can provide significant freight volumes, by connecting worldwide production, mining and consuming centres in a less environment-damaging manner than road haulage and avia transport and faster than maritime transport. Therefore, the rational development of a national railway infrastructure, its integration into the international transport system and, consequently, its financing issues are essential in many countries, including in Latvia, where I am from.

Until recently, IMs made their TAC schemes so as to recover their costs either through state financing, or through TAC. IMs are only interested in cost reduction or better capacity utilization if they do not have any state-driven motivation. Bugarinovic and Boskovic stated that the process of requesting additional funding runs automatically if there is no strong regulatory body involved in the governance system.[1] But railway infrastructure and its links to the transport economy represent a very complex organizational, technical-technological, environmental and socio-economic system that is affected by management decisions on different levels of the national and even transnational economy. All the main stakeholders - state authorities, regulatory bodies, IMs and RUs - are disappointed with the performance of others in this system and do not create a synergy effect. However, state authorities, regulatory bodies and RUs usually or commonly misjudge the IM who, in their opinion, lacks transparency of information.

I may only agree that comprehensive information on the operation of the railway infrastructure and its commitment to macroeconomic and microeconomic processes must be prepared, so as to ensure appropriate TAC decisions. But this is a very challenging issue when charging for freight, where (1) the monetary impact of each different transportation unit is different, (2) traffic is much less predictable, and (3) the market mechanism does not encourage competition. At least, these aspects are much more complicated than in passenger traffic, where (1) rolling stock is

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[1] Bugarinovic, M., Boskovic, B. (2015) **A systems approach to access charges in unbundling railways.** European Journal of Operational Research 240, pp.848–860.

more or less coherent, (2) traffic is allocated in advance, and (3) the PSO contracts cover most of the traffic.

As I represent the charging body on a network with freight transportation being dominant, I would like to pass on my knowledge of the freight TAC issue to all involved parties who can contribute to rail freight competitiveness (IMs, rail administrations, logistic companies, freight forwarders, economists, state entities and regulatory bodies) to show the freight TAC development process from the point of view of different stakeholders. I am completely sure that decision makers lack a holistic understanding of rail-related economic interaction processes both at the micro level and the macro level.

In this book, I am going to discuss one by one all aspects of TAC (costs, markups and other charge differentiations) in a comprehensible way. Each of the points is very specific on every network. Although I provide my own insights into the TAC processes, the adoption of a TAC model developed for another network is partially incorrect due to differences in the historical development of the railways, and due to differences in the geographical and climatic situations, the legal requirements and the peculiarities of national development. Therefore, it is rational to create an original TAC methodology for a specific rail infrastructure object, and the role of this book is only to guide the reader through this multidisciplinary charging object, which is what railways are. That is why in this book I consciously avoid using equations, replacing them with a great number of figures and with broad explanations of different philosophies.

The book is based on general theoretical research methods, such as induction and deduction, analysis and synthesis, and draws on a systematic approach to more than five hundred different sources that were investigated in three different TAC-related projects which I participated in.[2] The book is based on the theoretical and methodological foundation of the scientific works of J. Bradley, B. de Borger, F. Calvo, M. Fisher, M. Florian, C. Growitsch, K. Jansson, P. Krugman, S. Maffii, C. Nash, J. de Ona, R. Pittman, J. Preston, S. Proost, F. P. Ramsey, W. Roeger, L. S. Thompson, W. G. II. Waters, H. Wetzel, M. Wickens, C. Woroniuk, Я. А. Дубров, В. Б. Савчук. The substantive hypothesis of my research was as follows: in order to define the optimal railway infrastructure charging system, the

[2] One of them is part of national research program “EKOSOC-LV” project 5.2.1. “Explore the Competitiveness of Latvian Enterprises in Foreign Markets and Make Proposals for its Strengthening” (LR IZM registration No. 02.2-09/13).

interaction of rail-related economic processes at the macro level and the micro level must be considered.

The results presented in this book have been demonstrated at Latvian and international conferences. The results obtained have been used within reports to the European Commission organized working groups, as well as in meetings on rail transport issues with OECD and industry representatives, reports to the Latvian Ports, the Transit and Logistics Council, the working groups organized by the Ministry of Transport, the meeting of the Latvian Transit Business Association, the Latvian Chamber's transport infrastructure committee meeting on the review of the rail development guidelines mid-term, the advisory council meetings of the State Railway Administration, and working groups of the Joint Stock Company "Latvian Railway".

The first part "Costs" discloses a variety of management, technical and technological aspects associated with the costs of services provided on a public-use railway infrastructure. It describes the technical processes of the incurrence of construction, maintenance, renewal and operational costs due to train running. It highlights disadvantages in production factor markets that affect the costs base. It also provides insights into railway infrastructure usage and railway economic features. A description of the cost allocation process closes this part, with my own recommendations on this process.

The second part "Markups" critically analyses the three main approaches used for market segmentation and levying markups, reflecting the advantages, disadvantages and application possibilities. It provides my own reflections on the possibility of merging the provided methodologies into one common system, and suggests algorithms for market segmentation and markup determination.

The third part "Charging scheme" contains an overview of charging and collection schemes' details that are integral. It provides information about possible differentiation instruments that can be used in a charging scheme in order to make it more responsive to different state incentives and market peculiarities. It draws more attention to the issue of the through tariff as a way to encourage intermodal and international transportation, which is a very important topic nowadays.

The fourth part "TAC challenges" tackles the four main topics that aggravate an efficient charging process: complexity of data collection and processing; uncertainty in public funding; lack of robust competition; and missing collaboration in decision making.

The book ends with conclusions and recommendations, where the main call is to quit viewing charging as the allocation of costs only. The charges must be a part of the development of a holistic transport system! For intermodal and international development of rail transport, it is very important to establish an effective negotiation platform, where various economic entities (including, but not only, commercial associations, related ministries and institutions) can officially lobby for the development of rail infrastructure and all related processes, so as to ensure certainty in supply chains. All additional costs that are caused by state requirements and which would not appear in a commercial enterprise must be covered by state funding. To conclude: TACs are not the only competitiveness factor! Charges should be in line with the common rail marketing and development policies, which in turn should encourage RUs and states to be willing to pay for the running of trains.

PART I

COSTS

One of the biggest TAC challenges is to address the optimization of the IM's costs. There is evidence to suggest that costs incurred directly by train operations must be covered by RUs, but other costs must be covered by public funding, as infrastructure contributes to the growth of economy, mobility rights etc. So it is highly important to clarify the causation of costs to apply TAC in a fair way. The best TAC cost base so far is considered to be marginal costs.[3] The main problem with this type of cost application is systematic underfunding of IMs if the freight traffic is not any more a marginal activity, but a dominant or essential market player as set out in transport visions. At least our previously published research demonstrated that studies on the effects of train traffic on track were not consistent when freight became more of a dominant rather than marginal activity.[4] Substantial estimation and systematization of these effects asks for many more factors to be considered.

Systematic understanding of how freight train operation contributes to a cost base is still lacking. Furthermore, researchers who have attempted to evaluate the impact of train operations on European rail infrastructure have primarily covered passenger transportation. Studies on networks with a significant proportion of freight transportation usually cover cases of vertically integrated rail enterprises, where costs incurred by train operation form only a part of the common integrated train tariff. Therefore, the additional investigation of findings made on networks with primarily freight transportation is included in this part.

To understand what drives an IM's costs, the analysis and abstraction of a huge amount of literature sources was done. I also used findings from

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[3] Nash, C. with contributions from partner: UNITE (2003) **Final report for publication**, Funded by 5th Framework RTD programme.

[4] Hudenko J., Ribakova N. (2015) **Costs that are directly incurred as a result of operating the train service: the case of 1520mm rail**. Proceedings of the conference Management Horizons in Changing Economic Environment: Visions and Challenges. – Kaunas, Lithuania, pp. 179–192.

studies organised with my colleagues, where mathematical statistical methods (correlation, grouping, etc.) and empirical research methods (expert surveys) were used.

The central thesis of this chapter is to show that rail infrastructure is not a closed system where costs incurred are limited to the effect of train traffic. The key issues discussed in this part are:

- How does train running incur costs?
- How do costs respond to internal decision making?
- How do costs respond to external factors?
- How may costs be allocated to TAC?

Respectively, this part of the book is composed of four themed chapters. Chapter 1 looks at how the operation of trains incurs network-wide costs in a rail system with a considerable share of freight transportation. Chapter 2 explains how internal IMs' decision-making on choice of maintenance regime affects cost base. Chapter 3 explains how external factors affect both train-track incurred costs and internal decision-making processes. The last chapter of this part summarizes the findings of the previous chapters, with a presentation of how the investigated factors are reflected in the known cost allocation systems. At the end, I also provide my own suggestions for a possible unified costs allocation system that answers the questions raised and which is applicable to freight or mixed traffic networks.

This study cannot cover every factor that incurs IMs' costs. Moreover, I would like to stress that operational circumstances differ on different networks and on different parts of a network. There is a historically formed interrelationship between the investigated categories of factors that incur costs of train operation process: track design; traffic structure; external conditions incurred by nature and by external decision-making; internal engineering, managerial and accounting decision-making. This interrelationship forms a unique operational situation on any network and calls for a customised investigation of each case.

CHAPTER ONE

HOW DOES TRAIN RUNNING INCUR COSTS?

It stands to reason that TAC must be based on the costs that are physically incurred by train running and there is a growing body of literature supporting this issue. The question is whether there are any train running costs that are not related to the operation of trains. This knowledge can help to determine how these costs should be divided among the players in the fairest way. This chapter provides an overview of existing knowledge about costs that arise from ensuring physical track usage. While presenting the factors affecting the infrastructure costs incurred by train running, this chapter focuses mostly on freight train operation.

Zamisljajev emphasises five stages of the infrastructure life cycle:[5]

- track construction (including design works);
- maintenance (regular inspections, including defectoscopy, labour and administrative costs);
- planned renewals (including costs of possession slots);
- failures (out-of-plane renewals, train idle times, possible penalties, unearned revenue);
- track deconstruction and decontamination.

Regarding their functionality, appearance and write-off, the infrastructure costs required for train running may be divided into four main groups: construction and development costs, renewal costs, maintenance costs, and operational and traffic management costs. The costs of liquidation and decontamination presented in Fig.1-1 that are part of life cycle costs are usually not included in train running costs.

[5] Замышляев, А. (2012) **Экономические критерии принятия решений о замене основных средств на основе методологии УРРАН**. Экономика железных дорог. N 12, с. 11 - 22.

During the first years, the maintenance and renewal needs are minimal. Later, wear-and-tear and other factors cause deterioration of the rail quality, thus increasing the need for its maintenance, renewal and replacement.

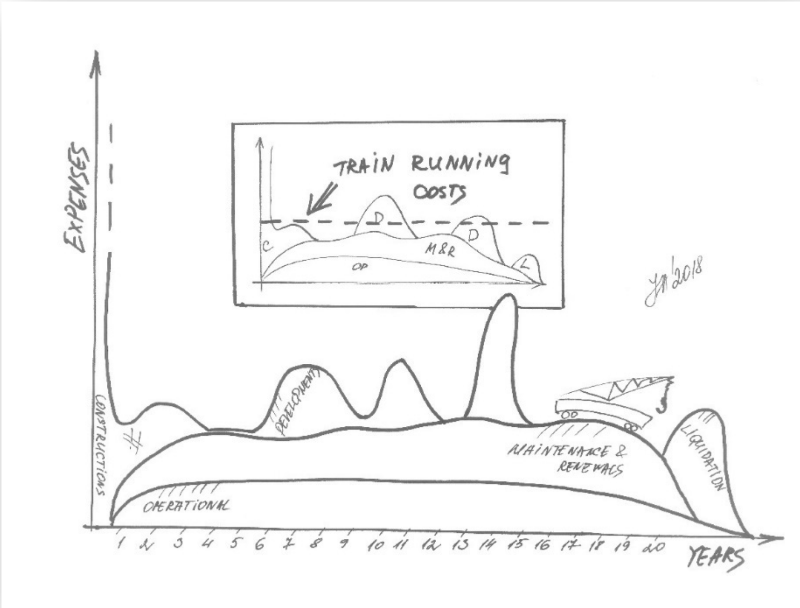

Figure 1-1. Costs incurred by train running, based on Beltukov [6]

Table 1-1 presents the common definitions of these cost groups. The text below explains the processes that affect how costs are incurred in each of the groups.

[6] Бельтюков, В., Симонюк, И., Авдеев, А., Сенникова, А. (2014) **Прогнозирование и оптимизация затрат – основа планирования ремонтов**. Путь и путевое хозяйство. № 2, 11-16стр.

Table 1-1. Classification of train running costs

Cost group	Definition
Construction and development costs	are expenditures on network planning, building and further upgrading of the infrastructure.[7] They are capitalized at the commissioning time, and then depreciated.
Renewal costs	are incurred by the activities related to replacing a rail infrastructure part or object by the same or similar type of rail infrastructure part or object. They are capitalized at the time the replacement is carried out, and then depreciated.[8]
Maintenance costs	are incurred by the processes that keep a rail system in a desired operational state or bring it back into that state, when the existing asset is refurbished but not replaced. The maintenance works consist of e.g. inspection, measurement, servicing or repair. They form a part of annual operating costs.[9]
Operational and traffic management costs	are incurred by the procedures and related equipment that enable coherent operation of the different structural subsystems, both during normal and degraded operation, including training and train driving, traffic planning and management, as well as ensuring the professional qualifications required for carrying out cross-border services.[10] The infrastructure charging is also allocated to the operational activities.[11]

[7] Directive (EU) 2016/2370 of the European Parliament and of the Council of 14 December 2016 amending Directive 2012/34/EU as regards the **opening of the market for domestic passenger transport services by rail and the governance of the railway infrastructure.**
[8] UIC (2004) **Lasting Infrastructure Benchmarking**, UIC.
[9] UIC (2004) **Lasting Infrastructure Benchmarking,** UIC.
[10] Directive 2008/57/EC of the European Parliament and of the Council of 17 June 2008 on the **interoperability of the rail system within the Community.**
[11] Directive (EU) 2016/2370 of the European Parliament and of the Council of 14 December 2016 amending Directive 2012/34/EU as regards the **opening of the market for domestic passenger transport services by rail and the governance of the railway infrastructure.**

Construction and Development Costs

Construction and development costs are the precondition of train running, but cannot be considered as an after-effect of the traffic. Therefore, they are usually covered by the state and appear in TAC only in the form of weighted average costs of the investment capital if a state requires so. Accordingly, two groups of factors - those that affect the amount of investment in the development (costs of assets), and those that affect cost of capital appearance in TAC (rate of return, WACC, depreciation rate etc.) - must be considered. There has been no detailed investigation on the question of the TAC eligible cost of capital, because in most countries it is believed that public capital investments are not the subject of the capital return. However, there are a lot of examples where the costs of capital investments are included in the TAC if they are made using private capital (such as credits).

Investment in development is influenced by several factors. Investigation of the decision-dependent factors (such as quality of materials utilized; financing restrictions etc.) will be covered in Chapters 2 and 3 and Part 4. The following overview examines the decision-independent factors, such as:

- the designed system capacity;
- the landscape profile and the amount of property required;
- local construction costs (purchasing power parity).

The design of the network that is built for dominant freight transportation is different from that built for dominant passenger transportation in a number of respects. The main difference in design of “passenger” and “freight” networks arises from the nature of train movement: passenger trains move using soft suspensions and as close as possible to cities; freight trains need to use rigid suspensions and move far away from urban constraints unless the end point or starting point of the movement is inside the city.[12] “Passenger” networks provide fast point-to-point movement (effective line usage), whereas “freight” networks provide accumulation and classification of the wagons before movement (effective junction usage).[13] This means that “passenger” networks incur higher costs

[12] **Guide to British gauging practice** (2013). Retrieved 02.04.2015 from: http://www.rssb.co.uk/.

[13] Числов, О., Хан. В. (2013) **Метод оценки уровня организации и пропускной способности инфраструктуры железнодорожных узлов**. Известия Петербургского университета путей сообщения. N 4, с. 68 - 78.

in the construction and development of tracks, but “freight” networks ask for investments in junctions and the first/last mile.

Apart from the different nature of movements, the project NEAR² has highlighted several other distinctions of networks developed for dominant freight and for dominant passenger transportation.[14] I have summarised these distinctions in Table 1-2 and have provided comments about their impact on the development and other costs. What stands out in this summary is the high importance of decision making on almost all development issues and its close relation to costs. Consequently, in the case of freight transportation intensification, the previous decisions made for “passenger” exploitation regime and the decisions made in order to ensure mixed traffic cause higher future development or operational costs.

Table 1-2. Main distinctions in “freight” and “passenger” network development, based on NEAR² deliverables[15]

Topics	**Impor-tance to the freight**	**Affected railway infrastructure items**	**Relation to costs**
1	**2**	**3**	**4**
Maxi-mum axle load	+++	Track panel, track bed, track alignment, bridges	An increase of the axle load by 10% reduces the intervals occurring between maintenance works by 30% The track defects are a function of the loads (static and dynamic)

[14] NEAR² (2013). Deliverable D3.8 Concept Document: **Infrastructure and Signalling**. Retrieved 05.04.2015 from: http://www.near2-project.eu/.
[15] NEAR² (2013). Deliverable D3.8 Concept Document: **Infrastructure and Signalling**. Retrieved 05.04.2015 from: http://www.near2-project.eu/.

Table 1-2 continuation

1	2	3	4
Maximum train length	+++	Signalling system, stations track layout, platforms length	Requires longer tracks and platforms in stations and less steep gradients, longer signal spacing, greater traction power
Track gauge	++++	Track, track installations and operation installations	Wider track gauge increases significantly the track construction cost For instance, the construction of a metric line is estimated to cost 30% less than the construction of a standard gauge line
Rolling stock static and dynamic gauge	++	Minimum axial distance between tracks, dimensioning of civil engineering structures	
Max speed	++	Track, track installations and operation	Speed increase requires larger axial distance between tracks, higher track cant, greater length of transition curves in the horizontal alignment, continuously welded and heavier rails, elastic fasteners, thicker track bed, electric signalling, longer signal spacing, slow train overtaking, increased safety measures along the track, bigger tunnel cross-section, higher maintenance needs

Table 1-2 continuation

1	2	3	4
Track capacity of the track sections	+++	The number of tracks available to traffic, the signalling system	Defines the ability of routing additional trains in a rail corridor and affects the itinerary reliability. Requires additional maintenance
Marshalling yards	++++	May not be in scope of TAC, but if included in minimal access package then requires additional constructing and maintenance	
Traction system	No	Diesel trains vs electric trains	Electrification substantially reduces maintenance cost and enables more responsive control Requires high capital cost of providing the energy distribution system
Track, track and operation installations	+++	Track, track and operation installations	Mechanical signs located on the track side are possible for slow freight traffic Electric signalling and operations that are implemented with colour-light signals and messages that are directly displayed on the driver's cab increase traffic speed but require additional construction and maintenance costs
Signalling system	+		

Moving forward to the issue of the land required and probable property expropriation, it should be mentioned that decision making on the rail placement and, consequently, on land investments has a high impact on the construction and future maintenance costs. The factors to be considered include:

- the land value itself;
- suitability for lean construction (minimum of bridges, tunnels, safety walls etc.); and
- future lean operation and maintenance (minimum of crossings, curves, switches etc.).

Additionally, a decision on rail placement influences related costs that may be increased or decreased by three kinds of benefits from the investment:

- the feasibility of transportation itself (the reduction of the capacity scarcity and bottlenecks; streamlined profile etc.);
- increase of land value in places near railways;
- economic effects from connection of different kinds of resources.

The first benefit is investigated in the next chapter when talking about decision making on a combination of the production factors (e.g. capital investments vs staff exploitation), where the main conclusion will be that "chariness" in the development phase causes additional maintenance and renewal costs in the future. Turning to the second, it must be noted that although railways have always been considered prime transit movers, accessibility providers and economic growth boosters, especially in the major cities, examination of the influence of rail placement on land use and value has proven this effect small or inconclusive.[16] The third benefit is connected to the second part of this book, examining the economic choice of the rail beneficiaries, where the main conclusion will be that the success of today's supply chains largely depends on their ability to accommodate global market trends, which all ask for great investments. So, the above-mentioned factors influence construction and development costs, making them dependent on landscape, geology, land value and other factors that differ from place to place.

The construction and development costs are definitely related to the price levels of the state and even to the state region where trains run. When estimating development costs, usually sample costs from different states or regions are compared after having been aligned using purchasing power parities (PPPs) exchange rates. PPPs can also be used as currency conversion rates to convert expenditures expressed in national currencies into an artificial common currency (the purchasing power standard)

[16] Giuliano, G. (2004) **Land use impacts of transportation investments: Highway and transit**. In S. Hanson and G. Giuliano (Eds.), The Geography of Urban Transportation, 3rd Edition. New York: Guilford Press.

eliminating the effect of price level differences across countries.[17] Using this method it is possible to gain a better understanding and level out the differences of construction costs in different countries. There are also other factors that can impact development costs such as demand on construction works, price level of specific materials, costs of transportation of materials and staff to the place of construction, and others.

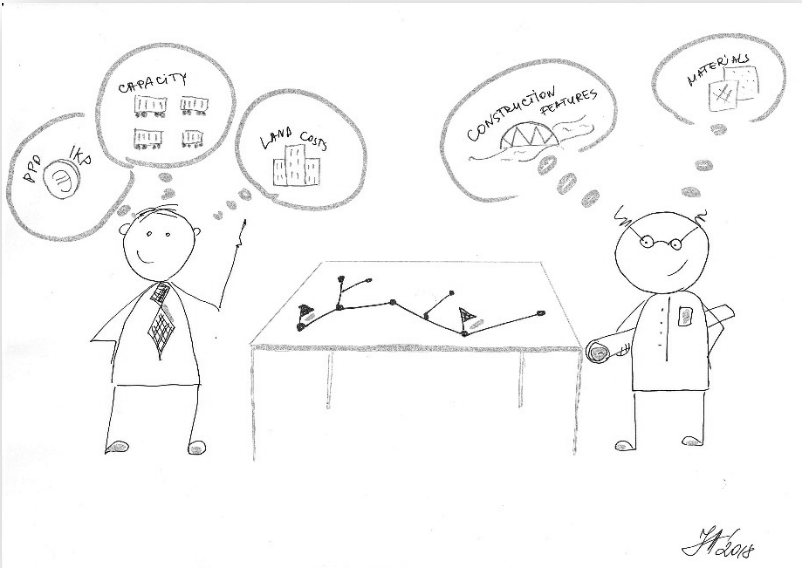

Figure 1-2. Decision-independent factors that affect rail infrastructure development costs

The most obvious finding to emerge from this section is that although these costs are mostly dependent on external factors, such as geographical setting and overall economic conditions, they also are dependent on decision making that affects the amount of RUs' future costs. For example, decisions involving forecasts of future traffic or train running benefits can

[17] Office of Rail Regulation (2013) **PR13 Efficiency Benchmarking of Network Rail using LICB**. Retrieved:
http://orr.gov.uk/__data/assets/pdf_file/0012/5007/pr13-efficiency-benchmarking-of-nr.pdf

have an impact on available capacity and costs that are consequently covered by RUs.

Maintenance and Renewal Costs

Maintenance and renewal costs appear on the same wear-and-tear grounds, which is why I will examine them together. When investigating possible reasons for maintenance and renewal work, I will keep in focus the entity that incurs costs. This is extremely important, so as to ensure that the costs are allocated to the appropriate payer and form a robust base for TAC.

The fission of the maintenance and renewal costs is the most debated topic now. The European charging philosophy is based on an analytical consideration that most maintenance work and a great part of renewal work should be carried out without traffic.[18] But this concept has recently been challenged by several studies demonstrating that cost causation is primarily dependent on train traffic (more than 50%), and that other costs like corrosion, accidents etc. appear laterally.[19] Dorrian et al. have conceptualised four categories of influencing factors that interact with each other:

- the engineering (individual characteristics and abilities);
- the train (conditions, malfunctions, feedback mechanisms, dual engineer interaction),
- the track (track characteristics), and
- the environment (light, temperature, noise, weather).[20]

This recent concept makes the previous studies very contradictory and unable to demonstrate clear proportion of maintenance/renewal works incurred by traffic. The nature of freight wear-and-tear becomes even less clear and demands further investigation.

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[18] Nash, C., Matthews, B. (2002) **British rail infrastructure case study. UNITE (UNIfication of accounts and marginal costs for Transport Efficiency)** Deliverable 10, Annex A4. Funded by EU 5th Framework RTD Programme. ITS, Leeds: University of Leeds. http://www.its.leeds.ac.uk/projects/unite/

[19] Zoeteman, A. (2007) **ProRail's Management of Tracks and Turnouts**, European Railway Review.

[20] Dorrian, J., Roach, G. D., Fletcher, A., Dawson, D. (2006) **The effects of fatigue on train handling during speed restrictions**. Transportation Research Part F: Traffic Psychology and Behaviour, Vol.9, Issue 4, pp. 243-257.