Internalization of External Costs in the EU Transport Sector as an Instrument of Rationalization of the Logistics Supply Chains

Andrzej S. Grzelakowski
Akademia Morska in Gdynia, Poland

Aiming at meeting the general EU transport policy objective, the EC has started promoting very actively the sustainable development of the member states transport systems. Putting into effect common framework and methodology for estimating the external costs of transport activities and specifying how external costs can be internalized in all modes of transport, the EC intends to minimize their negative impact on all spheres of human activity. This strategy needs to apply social marginal cost pricing (SMCP) for the use of transport infrastructure. It could, however, induce significant changes on the EU transport markets and subsequently affect the supply networks and logistics supply chains leading to their rationalization in terms of optimizing transport and inventory costs.
Keywords: external costs, internalization, social marginal costs, supply chain, logistics operator, transport and inventory costs

The main purpose of the article is to identify and analyze an impact of internalization of external costs in the EU transport sector on the operation and development of supply chains in Europe and on a global scale. The external costs produced by any kind of transport activity, have caused many economic, social and environmental burdens as well as drawbacks and nuisances. Due to that, the direct internalization of substantial part of these costs is regarded in the EU as an essential instrument that can enable us to bring into effect the primary goal of the European transport policy set in the EC's White Papers of 1991, 2001 and 2011.

That objective aimed at promoting the sustainable development of member states' transport systems has been carried out for almost twenty years, however, without any expected significant results. The application by the EC in their previous transport policy framework, of mainly indirect and not fully coherent forms and methods of internalization of that transport costs category, predominantly connected with practical application of different fiscal measures, such as dues and fees, various indirect taxes and their other hidden forms, has produced not entirely satisfactory results. Hence, the policy makers strongly supported by researchers in order to bring spectacular effects expected by the EU economies and communities, brought forward, in 2008, partially modified, much more progressive formula for internalization of external transport costs. That dynamic concept is generally based on the idea of accelerating the whole process of internalization, since that time has been strongly oriented on full and direct internalization of external costs, i.e. via the transport market mechanism.

Such concept, which has been gradually put into practice by legal measures since 2008 may, however, cause numerous consequences both in transport systems themselves as well as in other related sectors. Apart from each individual sector such as trade, industry, etc., the majority of implications will be reflected in the network of inter and intra European supply chains connecting the EU with global environment.

1. THE EU TRANSPORT SECTOR – MAIN BARRIERS TO ITS DEVELOPMENT

Sustainable mobility is the main objective of the EU transport policy. A solely efficient transport sector provided with modern infrastructure and effective market mechanisms can guarantee the necessary level of mobility of goods and people. Nowadays, in the age of globalization and highly competitive world economic environment, mobility is becoming essential to the EU's economies and communities. It is key to a higher quality of life and welfare as well as fundamental for enhancing the EU competitiveness and vital to achieving the goals of the EU's ambitious strategies for growth and employment. The mobility, directly connected with the economic expansion (rise of GDP), has been growing in the EU rapidly since the mid-1990s. Freight transport expressed in tonne-kilometres (*tkm*) rose by ca. 2.5% per year (1995-2009), i.e. more dynamically than GDP and passenger transport (by ca. 1.4% per year *in pkm)* in the same period.

As a result, freight and passenger transport grew by 34% and 17% respectively in that time and what is more, this dynamic growth is envisaged to continue in the next decade. Some characteristic trademark of the EU high mobility is, however, a relatively massive share of road transport in the existing modal split. It accounts for 46.6 % of the total freight transport demand (in tkm), whereas rail accounts for 10.5%, inland waterways contribute 3.3% and oil pipelines add another 3.2%.[1] Maritime transport then accounts for 37.3% and air transport for 0.1% of the total traffic (all referring to the EU27 in 2009 in tkm). As a result of the currently formed modal split in the EU's transport sector, and as predicted realistically by 2020, there is no chance for any other shift towards more environmentally friendly modes of transport such as rail and inland waterways. Still rapidly growing transport activity will even diminish the sustainable mobility. Sustainable mobility means disconnecting the mobility from its many harmful effects for the economy, society and environment.

Emissions of hazardous gases and substances seriously threaten human health, lower significantly the local environment quality and make a major and still growing contribution to the worldwide climate changes. The road sector's CO_2 emissions were in the period 2008 -2010 by 30% higher than in 1990 and it is the only transport mode where CO_2 emissions are predicted to increase in the coming years. Bothersome noise emissions, heavy congestions, accidents and many other inconvenient burdens and nuisances, also impose severe costs on the economy and society. All these, so-called, negative externalities (which involve a cost to society, known as external costs) are not directly borne by transport users.

2. EXTERNAL COSTS – NEEDS FOR THEIR INTERNALIZATION AND ITS EFFECTS

Currently, transport users have to pay only the costs that are directly related to the scale of the use of their mode of transport, i.e. fuel costs, insurance, wages, salaries, amortization and other capital costs, etc. Such costs are regarded to be private in the sense that they are borne directly by the users. As opposed to them, the external costs generated by the users as well, such as the costs accompanying any kind of mobility, are borne by communities and economies (states and their citizens). External costs are real, even if they do not always have explicit market values and have been fairly precisely estimated by experts since the end of 1990s and are commonly known in theory and practice.

The sum of the users' direct costs (private ones) and external costs of mobility gives its social costs. In particular, the total social costs generated by the transport users need to constitute the real base for the transport prices. Consequently, incorporating external costs into users' direct costs, i.e. estimating social transport costs, is a keystone for charging in the transport sector. In order to provide grounds for future correct calculations of infrastructure charges, the EU transport policy makers want to create an effective transport pricing system that is more efficient than the exiting one. It should reflect more accurately the true costs involved by the mobility. Such transport charges alone can give the right and optimal price signals to the providers and consumers of transport services and take account of the real needs of the services used as well as the consumption of scarce resources. The new, realistic transport price mechanism is expected to

[1] *Transport in Figures.* Part 3. European Union. European Commission. DG for Energy and Transport. Brussels, 2010

improve the efficiency of infrastructure use, reducing the need for new investments.[2] Strong incentives for users to switch to clean vehicles, speed up technological innovation and use advanced logistics transport solutions should be created. Getting the transport prices right means users will bear the full costs they create, and subsequently will have a clear incentive to change their market behavior and the whole medium and long run decision making process in order to reduce those costs.

3. PREVIOUS INDIRECT FORMS OF INTERNALIZATION OF EXTERNAL COSTS

Transforming this main paradigm of sustainable mobility into practice means that in the EU internalization of external costs has to be effected as soon as possible. Such necessary and unavoidable solutions were indicated not only in the EU White Papers on sustainable transport policy (1992, 1998, 2001), but in many reports, e.g. 2006 mid-term report issued by the EC, its communications, and numerous directives and regulations closely connected with the Community environmental policy. As a result, the transport sector is already exposed to a great deal of regulatory measures.

There is a variety of taxes and charges connected with purchasing vehicles, their ownership and exploitation, e.g. fuel excise, registration fees, etc. In addition to them, there are policy instruments (Euro standards engines in road transport connected with tolls, maximum levels of certain pollutants in fuels such as sulphur and lead, rules to reduce emissions during fuel storage and distribution, and many others). Therefore, some degree of internalization of external costs is already in place. However, all these fiscal and administrative instruments are sometimes not directly related to a particular external costs component and, as such, generally fragmented in their nature. In such form they are not able to compensate properly, even a part of the existing social costs in the transport sector. Consequently, they cannot explicitly tackle the occurring transport market failures caused by the presently used deformed charging system.

The EC is aware of the existing market failures and the huge external costs borne by the society. It is estimated at a minimum of 5% of EU27 GDP (EUR 13.772 bn in 2009). Only road congestion has been estimated to cost around 1.1% of EU GDP per year. That is why, since the mid of the past decade, the Commission has evidently accelerated its efforts to internalize external costs and reach its transport policy goals by making the transport system "greener and more sustainable". But it needs to take broader and much more complex, systematic action in this direction, bearing in mind that:

- demand for transport services, especially for road haulage, is still rapidly growing;
- leaving the existing situation unchanged would mean that the growing level of mobility will continue and even speed up generating external costs; if nothing is done over the next few years, the environmental costs alone (air pollution, CO_2 emissions, etc.) could reach EUR 210 bn by 2020 and cause congestion on more than a quarter of the EU roads;
- the EU is obliged to meet the agreed international commitments as regards greenhouse gases emission (Kyoto protocol) and fulfill many internal undertakings (in 2007 the EC itself set a goal to reduce greenhouse gases by 20% and to increase the use of renewable energy sources to 20% and to reduce energy consumption by 20%, all by 2020) being definitely convinced that a significant reduction of transport externalities will make an important contribution to meet these obligations;
- it was obliged by the EU legislature, i.e. EP and Council in 2006 when amending Directive 1999/62 on charging heavy goods vehicles for the use of infrastructure, to present no later than on 10th June 2008 "…a generally applicable, transparent and comprehensive model for the assessment of all external costs to serve as a basis for future calculations of infrastructure charges." pursuant to the legislature needs, this model shall be accompanied by impact analysis of the internalization of external costs for all modes of transport and a

[2] E. Ponthieu, *Towards an integrated and coordinated sustainable logistics and transport policy for Europe* European Economic and Social Committee (EESC). Rome, 19 June 2008, p. 10

strategy for a gradual implementation of that model for all modes of transport. [3]

The EC fulfilled these obligations in due time, presenting in July 2008 a package of initiatives intended to make the EU transport sector more sustainable and subsequently maintaining both the efficiency and competitiveness of its economies (not to deteriorate them). The new package put forward by the EC, known as "Greening transport" contains numerous initiatives intended to make mobility in the EU greener in the nearest future and all at once more efficient and friendly as well as healthy to the people.[4] It will be transformed into the EU legislation gradually in the present decade.

4. GREENNING TRANSPORT PACKAGE AS A USEFUL STRATEGY FOR EU TRANSPORT MARKET RATIONALIZATION

The essential goal of the EU transport policy is to promote the sustainable development of the member states' transport systems by minimizing their negative impacts on economy, society, environment and spatial order. The already mentioned package (GTP) consists of a few documents and a great deal of initiatives proposed in connection with its main goals.

First, GTP provides a common framework for estimating the external costs of transport activities. It is based on best practices suggesting methodology and producing a handbook with reference values that can be used for the estimation of external costs. This part of the package guides everyone how to use these values at assessing external costs in the transport sector.

Second, there comes a strategy that sets out how external costs can be internalized in all modes of transport. The strategy is both mode and impact specific. It means that the European Commission has taken into account the fact that the level of possible impact on environment and society can vary depending on the transport mode, a particular place and time (like in case of noise and congestion), or stay unlikely of these conditions (e.g. greenhouse gas emissions).

From the EC point of view, internalization of external costs and its direct strong influence on transport prices should give right signals to transport users that they need to change their market behavior. This will result in the reduction of negative externalities such as congestion, environmental damage caused by emissions, accidents, noise and vibration levels. However, this purpose should neither hinder the competitiveness of the EU member states economies nor create any additional burden to transport. Then, in this context, there are some questions, uncertainties and doubts

The formula of charging for the use of transport infrastructure with incorporated external costs proposed in the EU is called the Social Marginal Costs Pricing (SMCP). As a result of such price setting, the process would not lead to overexploitation of resources in the transport sector, but rather to more efficient use of the existing transport infrastructure. As users would incur additional costs they generate for the society, this could also ensure fair treatment of both transport users and non-users and might create a direct link between the use of shared resources on the one hand and payment on the basis of the "polluter pays" and "user pays" principles on the other. Such an approach is obviously possible only if the polluter fails to benefit from any form of compensation that would entirely eliminate the possible effects of internalization. [5]

5. LIMITS AND BARRIERS TO SMCP

The marginal costs approach, however, may have other limitations in practice. It is not only that they sometimes significantly vary according to

[3] *Strategy for the internalisation of external costs.* COM(2008) 435 final,, EC, Brussels 2008,

[4] Ibidem and *Greening Transport*. COM(2008) 433 final, Brussels 8.7.2008, SEC(2008) 2206, *Summary of the Impact assessment on the internalisation of external costs*. Commission Staff Working Document accompanying the Strategy for an internalisation of external costs., SEC(2008) 2209 Brussels 2009,

[5] A. S. Grzelakowski, *Transportation Markets as the Instruments Transportation Systems Regulation and Optimization. Methodological Aspects*.[in:] Contemporary Transportation Systems. Selected Theoretical And Practical Problems. The Development of Transportation Systems. Monograph, Edited by: R. Janecki, G. Sierpiński. Politechnika Śląskia, Gliwice 2010, p.. 34-36

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time and place which makes it difficult to assign their exact level, but the real trouble is that the fixed costs are high and in many cases traffic density is relatively low. In such situations it is not necessarily possible to include infrastructure costs, and certain degree of simplification seems to be inevitable. Generally, in such cases the marginal costs may correspond to the average of the variable costs. If necessary, the marginal costs may be combined with other approaches to make sure that the infrastructure is funded according to the "user pays" principle, and the external costs are internalized according to the "polluter pays" principle.

Furthermore, for the same costs (such as those related to noise), a more pragmatic approach based on average costs may be more feasible, and what is important, better understandable and commonly acceptable.

6. ALL MODES OF TRANSPORT ARE INVOLVED IN INTERNALIZATION

The EU strives to succeed in internalizing the external costs and achieve its transport policy goals by using mainly economic instruments, such as charges, taxes and emission trading schemas. These instruments are regarded to be efficient enough to make all forms of mobility more sustainable. They are strong enough to stimulate transport users to switch to cleaner vehicles and to use more advanced technology as well as less congested infrastructure, and also to avoid traveling at peak hours.

This concept will apply to all modes of transport. In the road sector the EC has launched a proposal on extra infrastructure charges for heavy goods vehicles. The 1999 Directive (Eurovignette), already amended in 2006 to allow different tariffs on heavy vehicles depending on their environmental impact, has been revised in order to apply the social marginal costs charging, i.e. including external costs. The whole revision has focused on three areas:

- application of external costs of air pollution, noise and congestion;
- set-up of community coordination mechanism with the common methodology and limits for the calculation of charges;
- allocation of revenues to the transport sector.

The new proposed model of tolls will differentiate them depending on the vehicle, the kind of route and the carriage time. Payments should be made via electronic toll system in order to eliminate traffic jams at the toll booths.

Because of the subsidiarity principle, the private car transport is not covered by the directive. However, member states are being encouraged by the EC to implement a charging system for all road transport users and not only for heavy goods vehicles. Such an approach would create incentives for all road users to more efficient use of the infrastructure, simultaneously increasing positive effects of internalization. Furthermore, the EC is proposing a reduction of CO2 emissions from new models of vans, a system for tire labeling and revision of the existing car labeling directive.

The rail sector has been addressed mainly to reduce the noise level. Although the EU have already limited noise emissions from the newly produced rolling stock, it is now also focusing on old wagons with the intension to implement new measures for equipping them with low noise brakes. The EC proposal combines noise emissions limits, voluntary commitments and legislation setting financial incentives.

The EC has reviewed the First Railway Package of 2001 carrying into effect legislation under which the quieter railcars will be charged less than the noisier ones. This may provide a kind of payback for the companies which made necessary investments. All the stock should be equipped with low noise brakes by 2015. The 'late birds' will have to deal with higher charges.

The railway directive 2001/14/EC (First Railway Package) already allowed some internalization of external costs in the rail sector. Nevertheless, with the proposal spreading to heavy goods vehicles on roads, new opportunities for internalization of external costs arise for the rail sector as well. The railway package allows internalization only if there is an equivalent internalization revenue increase in the competing modes of transport that is mainly the trucking industry. Hence, enabling internalization on roads will help better internalization for rail.

Meanwhile the EC has put forward a proposal for air transport to include CO2 emissions coming from aviation traffic in the EU Emissions Trading

System (ETS). As a result, aircraft operators will be obliged to surrender allowances to cover their emissions according to "polluter pays" principle, starting from 2011-12. The already-prepared directive concerns not only the intra- EU flights but also all other flights to/from any EU airport. Furthermore, the Commission has recently announced that it intends to deal with air transport NOx emissions with another proposal coming up by the end of 2008. Moreover, the Commission may take further actions by revising the existing directive on aircraft noise at the airports. All these initiatives will be reflected in airport charges. A due proposal introduced in January 2007 was warmly welcomed by both the European Council and the European Parliament. The suggested amendments included differentiated charges, depending on the extent of the environmental damage.

The European Council addressed the problem of greenhouse gas emissions produced by maritime transport already in March 2007. The Commission intends to include this transport sector in the post-2012 agreement on preventing climate change, and has enforced the International Maritime Organization to develop a series of measures in 2009 to reduce greenhouse gas emissions. If the IMO fails to make sufficient progress in this area, the Commission is determined to propose taking action on the European level. One of the considered options is the inclusion of maritime transport in the EU Emissions Trading System. It is therefore crucial that the strategy for maritime sector be developed in line with the new European integrated maritime policy.

As the EC envisages internalizing external costs for all modes of transport, the NAIADES (Integrated European Action Program for Inland Waterway Transport) provides it also for inland waterways. This approach might truly revitalize inland waterways by gathering the necessary funds for infrastructure projects in this sector. Moreover, the inland waterways should considerably benefit from a general intermodal transport policy promoted by the EC recently.

7. INTERNALIZATION – A MULTIDENSIOMAL APPROACH TO ITS EVALUATION

The efforts aimed at internalizing external costs must not only be multidimensional but also must be implemented on the EU member states level. The main issue that has been unequivocal, still under development, seems to be the proper use of the revenues generated by internalization of external costs. In this context the EC started to review its existing policy on the TEN-T (Trans-European Network -Transport) program in 2009 and has already prepared the action plan on Intelligent Transport Systems (ITS). It has been included in the long term scenarios for the EU transport policy development for the next 20-40 years which the EC presented in its 2009 special report. It has followed up the current White Paper which is coming to end in 2011.

In this context, apart from revenues and their proper allocation within the transport sector, serious problems arise as regards the general assessment of economic, social and environmental effects resulting from implemented by the EC internalization of external costs in the transport sector. There is no doubt that internalization method, based on SMCP formula, besides generating financial gains for transport infrastructure managers, will bring many positive effects in the transport sector, significantly contributing to the improvement of transport market mechanism due to the rationalization of market choices by consumers of transport services. However, the problem is, whether these effects will be transformed, and if any, to what extent, to other actors of the existing supply chains and supply networks as contemporarily the most developed form of organization of economic activity in Europe.

8. TRANSPORT COSTS AND ITS ROLE IN THE SUPPLY CHAIN MANAGEMENT

Transport refers to the movement of products from one location to another as it makes its way from the beginning of a supply chain to the customer's handle. Transport services are required in the whole production processes, from manufacture to delivery to the final consumers and returns. Only a good coordination between each component would bring benefits to the maximum.

In this sense, transport system, which joints the separated activities, is the key element in a logistics chain. Hence, transport and in much broader concept transport markets play a very important role in each supply chain.[6] It is a real driving force influencing its effectiveness and elasticity as well as determining ability to survive under turbulent conditions, e.g. economic and financial crisis, what one could observe in recent years.

In fact, any supply chain success is closely linked to the appropriate use of transport, i.e. suitable choice of transport mode and transport operator. It is a general guideline commonly known by each logistics supply chain operator who needs to use in the most effective way the responsive transport systems on the European or world scale in order to lower their overall costs.[7] Transport is a vital component of their globally oriented strategy which lays down that the supply chain goal is to minimize the total cost while providing the desired level of responsiveness to customers. Transport occupies one-third of the amount in the logistics costs, and hence, transport systems influence the performance of logistics system hugely.[8]

Besides, transport system is the most important economic link among the components of the business logistics systems. Around one third to two thirds of the expenses of enterprises' logistics costs are nowadays spent on transport, storage, warehousing and parallel services. Hence, transport system which makes goods and products movable and provides timely and regional efficacy to promote value-added under the least cost principle, affects the results of logistics activities and, of course, influences the production and sale.

In the logistics system, transport cost could be regarded as a restriction of the objective market.[9] The value of transport services varies with different products and industries. For those products with small volume, low weight and high value, transport cost simply occupies a very small part of sale and is less regarded; for those big, heavy and low-valued products, transport occupies a very big part of sale and affects profits more, and therefore it is more regarded.[10] The value of transport services is a derived unit of transport costs which in turn depend on the structure and elements in SCM frame. It displays the details of the whole processes from purchasing, management, production, and distribution to customers. The product flow that proceeds through the whole production processes from material supply via manufactories till providing the finished products to consumers, serviced by various transport modes, determines the transport costs. Its character (type of product), intensity and forms of proceeding (direct flow, storage, etc.) affect the total transport costs as well as their structure. Such relations existing between the use of different transport modes and the two main transport related cost elements are reflected in figure 1.

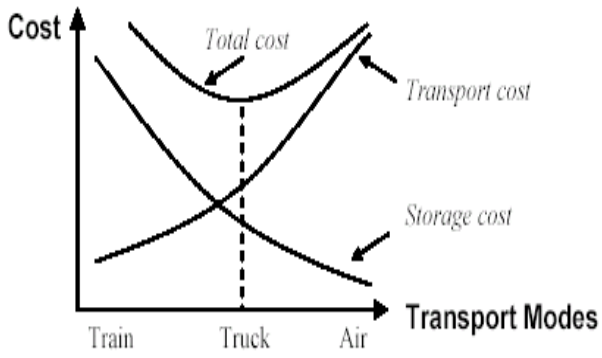

Figure 1. Transport costs relating to the logistics supply chain transport patterns.

Source: Y.H Chang, *Logistical Management*. Hwa-Tai Bookstore Ltd., Taiwan. 1998, p. 49

Figure 1 shows the principle of the transport cost matters with different transport modes. Airfreight is generally much more expensive than both indicated land transport but the storage cost

[6] This issue has been presented in a very comprehensive and theoretically interested way by: S. Chopra and P. Meindl, *Supply Chain Management; Strategy, Planning, and Operation.* Fourth Edition. Pearson, 2010, p.380-383,

[7] http://www.citehr.com/135411-role-transportation-supply-chain.com [07.09.2011]

[8] Y. Tseng, W. L. Yue, M.A. P. Taylor, *The role of transportation in logistics chain.* Proceedings of the Eastern Asia Society for Transportation Studies, Vol. 5, 2005, pp. 1662 - 1663,

[9] J. Mangan, Ch. Lalwani, T. Butcher, *Global Logistics and Supply Chain Management.* John Wiley& Sons.Ltd. London, 2008, p. 132-134,

[10] Y. Tseng, W. L. Yue, M.A. P. Taylor, *The role of*...Op. cit., s,

might here be lower Thus, in terms of total cost, airfreight for the supply chain logistics operator might be the most reasonable transport mode for a particular transport purpose, for example, transport of manufactured goods with high value and small volume or particularly fresh products with relatively high value per unit, e.g. cargo tone.

As regards the total transport costs and their numerous components within a logistics supply chain as well as their function and role in SCM optimizing, especially while taking into account scheduled in the EU, for this decade, internalization of transport external costs by implementing social marginal costs (*SMCP formula*) pricing for transport infrastructure, a great deal of new problems arise. They refer to key economic relations existing between transport costs regarded as significant part of total logistics costs generated by supply chain and generally speaking time factor which plays a decisive role in a smooth and efficient proceeding with all transport operations within the product flow. These relations are closely connected with the level of intensity of the traffic flows as a reaction of the transport system to the demand for transport services which subsequently determines ratio of vehicles flow by the existing throughput of transport infrastructure and the total price incurred by consumers of transport services. Such correlation which reflects the existing level of congestion in the transport infrastructure system as well as obtained condition of transport market (demand and supply side), is presented in figure 2.

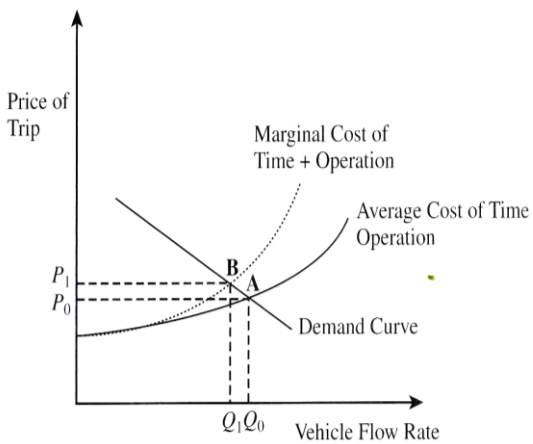

Figure 2. Fluctuation of marginal and average cost of time and operation of transport vehicle flow (train, track) as a result of changing effective demand – potential supply constellation on transport market

Source: S. Chopra, P. Meindl, *Supply Chain Management…,* op.cit., p. 392

Figure 2 presents clearly the market oriented behavior of any transport operators adapting typical types of vehicles using public transport infrastructure who need to bear the cost reflecting the level of congestion on transport network and payment for access to infrastructure they use. Marginal cost curve measures the marginal increase in total transport cost as a result of additional traffic flow and consequently growing density of vehicles flow.

This cost curve is higher than the average cost curve, which means that the marginal impact of any individual vehicle (presence of a new transport operator) on total cost is much higher than its or their share of this impact (on the traffic flow). From the marginal cost perspective (fig. 2), especially bearing in mind the upcoming EU SMCP formula, transport operators (vehicles) should be charged a higher toll: $P_1 - P_0$ so that the cost they bear by such vehicle flow rate is the true cost they are imposing on the transport infrastructure subsystem, e.g. highway, railway network, etc.[11]

The toll lowers the vehicle flow rate when it falls down to Q_1 level. All these relations are closely connected with the demand price elasticity, existing potential supply of transport services limited by maximal throughput of relating infrastructure network and holding applied methodology of payment for access to transport infrastructure.

Summing up the absence of congestion toll and scarcity charges results in:

1. uncontrolled growing demand for services provided by transport infrastructure and consequently causes significant overuse of such scarce public capital-intensive re-sources,
2. growing congestion costs which have to be incurred by all infrastructure users, irrespec-tive of their character and frequency of use of transport infrastructure component or traffic intensity,
3. rising or even escalating of external costs especially these related to time factor – total time needed to satisfy mounted up demand for transport services,

[11] A. E. Branch, *Global Supply Chain Management and International Logistics.* Routledge Taylor & Francis Group. New York and London, 2009, p. 82-84

4. downfall in efficiency, effectiveness and elasticity of product flows in logistics supply chains as well as supply network in global scale, which generates additional logistics costs for SC operators and involved businesses.

Moreover, application of quasi-market prices for the use of transport infrastructure or methodologically incorrectly calculated on the basis of realistically generated costs by transport users might also cause serious economic, social and environmental problems.

Such constructed tolls like nowadays in the EU result in higher prices at peak locations and hours and lower prices otherwise. Consequently, they can not only lower the effectiveness of product flows in logistics supply chains but also distort to some extent the processes of optimal resources allocation on the macro as well as global scale.

9. CRITERIA OF OPTIMAL TRANSPORT MODE SELECTION IN LOGISTICS SUPPLY CHAIN

The product flow, which efficient and smooth proceeding is determined by transport operations and processes, links the whole supply chain from supplier and manufacturer to consumer. Unimpeded product flow supported by information flow could increase the operation accuracy for costs saving and promote the competitiveness of firms involved in logistics supply chain. Hence, transport operations and transport costs which reflect the usage of certain transport mode with all its pros and cons constitute a decisive factor determining the supply chain performance.

That problem refers directly to the so-called trade-offs in transport design in logistics supply chain and is connected with the appropriate, from the logistics point of view, selection of transport mode.[12] In concise form this issue is presented in table 1.

Table 1. Ranking of transport modes* in terms of supply chain performance (1-worst; 6 – best)

Size	Lot Inventory	Safety Inventory	In-Transit Cost	Transportation Time	Transportat Cost
Rail	5	5	5	2	5
TL	4	4	4	3	3
LTL	3	3	3	4	4
Package	1	1	1	6	1
Air	2	2	2	5	2
Water	6	6	6	1	6

* as far as" Size "(1stcolumn) is concerned, categories: 1. TL (truckload freight or full track load), 2. LTL (less than truckload or partial truck load) and 3. Package (parcels, smaller products and wrapped items) refer directly to road transport – motor freight.

Source: S. Chopra, P. Meindl, *Supply Chain Management…*op.cit., p.394

Table 1 shows the impact of using different modes of transport on the most important elements determining the final supply chain performance, i.e. inventories, response time and costs. Each transport mode is ranked along various dimensions, with 1 being the worst and 6 being the best. With regard to the ranking of transport modes presented in table 1, following remarks could be listed:

- faster modes of transport are preferred for products with a high value – to - weight ratio for which reducing inventories is important,
- cheaper modes of transport are preferred for products with a small value – to – weight ratio, for which reducing transport costs is important,
- apart from the cost of transport, the selection of transport mode needs to take into account cycle, safety and in-transit inventory costs.

A general remark concerning an appropriate choice of transport mode by shipper or supply chain logistics operator can be formulated in the form of a guideline indicating that ignoring inventory costs when making transport decision always results in choices that worsen the performance of the supply chain.

[12] S. Chopra, P. Meindl, *Supply Chain Management…, o*p. cit., p.393-394

10. CONCLUSIONS

Any decision made by shippers or logistics operators in a supply chain network needs to take always into account its potential impact on inventory costs, facility and processing costs as well as the cost of coordinating all operations and the level of responsiveness provided to customers. As regards transport costs and their optimization in the supply chain, shippers and logistics operators need to evaluate different transport options connected with the choice of transport mode in terms of various costs and revenues. Then they should rank these options according to coordination complexity and then, as a result of such evaluation, the appropriate transport decision might be taken. Making such a complex transport decision with regard to transport mode selection, any shipper/operator or company manager involved in SCM has to consider the following trade-offs:[13]

- transport and inventory costs trade-off ,
- transport costs and consumer responsiveness trade-off.

Selecting a transport mode supply chain operator or shipper has to balance both transport and inventory costs. Otherwise for some modes of transport they can not optimize transport and logistics costs for it may result in relatively low transport cost which do not necessarily lower the total costs for a supply chain. Cheaper modes of transport usually have longer operation times (longer production cycles) and larger minimum shipment quantities, both of which result in higher level of inventory in the logistics supply chain. In turn, transport modes that allow for shipping in small quantities might lower inventory levels but they tend to be more expensive in terms of time and operation costs.14

However, such operational and market choices made nowadays almost commonly by logistics supply chain operators and shippers, do not take into account the real existing transport and inventory costs. These costs, being a subject of calculation and evaluation of transport processes, are almost exclusively private costs. i.e. they do not incorporate external costs in their full extent. As a result, such choices and decisions are in fact not optimal both from micro- as well as macroeconomic point of view. They can not bring expected value added to consumers and other entities involved in the supply chain operations. What is more, they hamper the whole process of enhancing the supply chain management (SCM) towards the more efficient form of cooperation among its partners.

The EC-proposed direct internalization of external costs in transport sector along with the launch of the new, based on SMCP method, model of charging for the use of transport infrastructure, can substantially change currently existing distorted pattern of transport mode selection. New charging system, based on tolls directly linked to all factors determining external costs, such as time, type of vehicle, form of infrastructure usage, etc., will provide logistics supply chain operators and shippers via transport markets with appropriate signals with regard to full social costs attributed to each mode of transport and vehicle. As a result, new pricing mechanism in transport sector will create new system of preferences as far as the selection of particular transport modes is concerned. These strongly market oriented preferences can significantly change the traditional ranking of transport modes based on criteria closely linked to the supply chain performance (see table 1). Hence, such system of preferences which is not fully in line with the interests of road and air transport operators as well as petrol industry, has been strongly hampered since the very beginning of launching that idea by the EC.

Therefore, under the new transport market (price) regime, supply chain logistics operators and shippers aimed at optimizing transport costs will be enforced to reconsider a new distribution pattern of costs and revenues while evaluating different transport options. Due to the implementation of SMCP model they predominantly need to take into account after all new dimension and assessment of transport and inventory costs and their trade-offs. Consequently, rationalization of supply chain operation and development will be launched and in the aftermath nowadays existing modal split will be reshaped and a new one will be established. A new modal split shall reflect not only the criteria set by the EU transport policy oriented towards promoting the

[13] Ibidem, p.394

[14] See: J. Mangan, Ch. Lalwani, T. Butcher, *Global Logistics and Supply Chain Management.* Op. cit., p. 132-135 and A. E. Branch, *Global Supply Chain Management and International Logistics*. Op. cit. p.83,

sustainable mobility but also the prerequisites of the supply chain logistic operators aimed at optimal selection of transport mode.

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Andrzej Grzelakowski
Akademia Morska w Gdyni
hamagh@neostrada.pl