ASSESSING THE IMPACT OF TRANSPORT POLICY INSTRUMENTS ON ROAD HAULAGE ENERGY EFFICIENCY

by

Olivera M. MEDAR, Vladimir D. PAPIĆ, Aleksandar V. MANOJLOVIĆ**, *and Snežana M. FILIPOVIĆ

Faculty of Transport and Traffic Engineering, University of Belgrade, Belgrade, Serbia

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This paper focuses on elements of transport policies affecting energy efficiency of road haulage. The purpose is to present a tool developed to support decision making during the policy making process, at the stage of formulating the elements of transport policies. The paper describes a model developed to assess the impact of policy instruments on fleet energy efficiency by multi-criteria ranking applying the Analytical Network Process. The paper describes the possibilities to employ the defined model giving the example of international road haulage in the Republic of Serbia. The application led to a proposal for policy instruments which could have the highest impact on the increase of energy efficiency in this sector and which will be considered further in detail during the policy formulation process.

Key words: *energy efficiency, transport policy, road freight transport, multi-criteria decision-making, analytical network process*

Introduction

Road transport is deemed important for economic development and it represents a predominant mode of freight transport. Though it is evident that road transport contributes to overall economic and social performance, much more attention is devoted to its negative effects (consumption of limited resources, emission of gases causing air-pollution and contributing to climate changes, *etc*.) in comparison to its efficiency. This is especially pronounced as it is expected that the growth of transport volume and negative effects arising there from will prevail against the results achieved through the application of technical innovations, such as fuel-efficient vehicles or better utilization of transport capacities. This suggests the need for improved efficiency in energy use.

Energy efficiency has become a highly important global goal in the past years. The EU action plan for energy efficiency [1] identifies transport sector as an essential sector to achieve energy savings, as it is the fastest growing sector in terms of energy use and heavily dependent on fossil fuels. Out of energy efficiency measures defined in the action plan, only a few are applicable in road freight transport, such as developing markets for cleaner vehicles, maintaining proper tire pressures and promoting co-modality (*i. e.* efficient use of transport modes on their own and in combination), which is also emphasized in the EU's transport policy [2]. Nowadays, in addition to instruments aimed at direct decrease of road transport volume, national transport policies also develop instruments to improve efficiency of road transport. These policy instruments are additionally aimed at reducing pollution, congestion and other negative effects of

* Corresponding author; e-mail: a.manojlovic@sf.bg.ac.rs

road transport, as well as at fuel economy. The practice shows both negative and positive examples with regard to employment of transport policy instruments. Some of the instruments employed, such as increase in maximum allowed gross weight for lorries in the UK, had much better results than expected [3]. The opposite example when government goals were not accomplished was the increase in the cost of fuel in UK [4].

Modern conditions are characterized by openness and exposure of transport system and policies to numerous influences where upon there is a strong need to systematically comprehend and manage the processes of developing and pursuing certain policies. The need for higher-quality management and models to support decision-making process is even more pronounced if one takes requirements to shorten policy cycles in consideration. The purpose of this paper is to develop a tool to support decision-making at early stages of the policy making process, especially when developing elements of transport policy to be used for finding a convenient solution to make transport energy-efficient. The key research question is: how to identify policy instruments which have the highest impact on the fleet energy efficiency by balancing governmental, economic, environmental, and social concerns as well as business concerns?

Possibilities to manage fleet energy efficiency

Fleet energy efficiency can be improved by taking various measures, starting from those related to vehicle and engine technologies to those related to better matching of truck capacities to load and better transport activity management. While improving fuel economy of individual vehicles is very important, large reductions in trucking energy use and emissions will come from better logistics and driving, higher load factors, and better matching of truck capacity to load [5]. It has been shown that energy efficiency of vehicles can be significantly improved by increasing the load factor [6]. This means the use of the most favourable vehicle in terms of its freight load and cargo compartment capacity in relation to the weight and volume of the cargo that is to be transported. The trucks are, however, very rarely loaded to maximum weight, mainly because the loads are limited by volume or because the desired delivery frequency does not enable full loads [7]. Empty running is a characteristic feature of road freight transport as the possibilities for backhauls are often very limited [7]. More back-loading could produce significant economic and environmental benefits [8].

All the above measures can be classified at different levels [9]:

– Logistic efficiency, with the aim of increasing the load factor.
– Vehicle efficiency, with improvements in fuel consumption efficiency.
– Driver efficiency, with training or assistance from on-board units.
– Route efficiency: various information can help to optimise routing.

In addition to measures that are applied as based on decisions made by fleet operating companies, energy efficiency is at the national level managed by the public sector. The role of governments is to provide policies complementary to decisions made by the economy and to minimize negative effects to society. It is required to create preconditions and favourable climate for the implementation of the above measures through the application of policy instruments in various spheres. Government uses energy policy to define the desired levels of energy efficiency and instruments to achieve it. However, an energy policy for transport does not replace a transport policy [10]. Transport policies are used to define instruments to achieve the desired performance of transport systems, with energy efficiency being one of them. If one can achieve the co-ordination and integration of policies, the implementation of transport policy instruments virtually means the accomplishment of goals of energy policies related to transport system. Most strategies for national transport policies include goals such as "environmental protection" or "tackle climate change" with internal goal to cut greenhouse emissions by policies and instruments setting the frameworks and incentives that will foster the promotion of energy efficiency. It is also necessary to point out that the development of an energy policy should take into account that fuel consumption without considering the direct rebound effect may be overestimated, as may be the increase of energy efficiency [11].

In the late 1970s, the environmental issue became increasingly important in national transport policies, while in the 80s and 90s this issue climbed the priority agenda and transport policies faced the challenge of finding a solution thereto. France can be cited for examples of instruments employed during these years to improve energy efficiency [12]: in the 1970s, the government action was first aimed at informing customers via awareness campaigns, and regulatory measures were introduced including speed limits and the display of test fuel consumption, while in the 80s, focus was on support for R&D in vehicle manufacture to bring more energy-efficient vehicles to market, and a direct policy incentives was instituted and direct investment grants allocated to transport businesses. Three types of procedure were set up: energy audits, company commitment charters, and subsidies for energy efficient equipment. Afterwards, direct investment subsidies were withdrawn, except for combined transport. Energy management action was redeployed along four lines: improving the performance of road vehicles; modifying modal distribution by encouraging the development of combined rail-road transport; creation of tools for the analysis of traffic; programme for the development and promotion of alternative vehicles and fuels. Since efficiency is a ratio between output and input, higher efficiency can lead to both, lower input or higher output. Efficiency change has been initially employed to reduce fuel economy, and later on to increase vehicle performances [13].

The analysis of national transport policies in more than 20 European countries was used to identify and systematize goals, policies and instruments of the environment domain [14]. Policy instruments are classified according to directions of strategic action (policies) and desired directions (goals) as anticipated in highest level strategic documents of national transport policies. Table 1 presents instruments which may affect energy efficiency. With regard to national transport policy instruments employed in practice there are both positive and negative experiences. The following sections give examples of results of evaluation of policy instrument application in the UK and in the Republic of Serbia. The results of policy instrument implementation in the UK have been achieved by activities strategically planned and implemented towards the attainment of pollution reduction goals and energy efficiency increase, while the case of Serbia exemplifies application of policy instruments due to a need to regulate closely access to international haulage market.

Increase of maximum vehicle gross weight permitted in the UK

Great Britain's Sustainable Distribution strategy from 1999 [15] marks the beginning of identification of measures that can be used to influence changes in behaviour, and decision making, of hauliers in order to reach sustainability of their activities in both economic and social terms, as well as in terms of environmental protection. As an instrument for the implementation of Sustainable Distribution strategy and in order to reduce negative effect of transport to the environment and to increase road haulage efficiency, starting from February 2001, the UK Government increased maximum permitted vehicle gross weight from 41 t to 44 t.

The implementation of these instruments showed results that were better than anticipated in the analyses prior to the implementation. The first report by the Commission for Integrated Transport [16] stated that this measure would result in "small, but important" economic and environmental benefits. The following savings were foreseen in the report: 100 million ve-

Table 1. Elements of national transport policies affecting energy efficiency

Goal	Policy	Measure/instrument
Reduction of fuel consumption	Improvement of energy efficiency of vehicles	Fuel taxes
		Fiscal and technical support for the use of vehicles with lower fuel consumption
		Improve vehicle design and weight
		Support to management system certification according to ISO 14000
		Support to training programs to professional drivers for energy-efficient driving
		Support to fleet renewal
		Control of vehicle technical condition
		Build awareness of best practice examples
		Allocate funds for programs of distribution-related cost reductions and efficiency increase
Increasing the share of renewable fuel	Stimulate the use of renewable fuel	Financial incentives to manufacture and procure renewable fuel vehicles
		Support research on possibilities to use new fuels in road transport
Reduction of greenhouse gas emissions	Internalization of all external transport costs	Vehicle ownership taxation system
		Variable fees (insurance, registration, licences, infrastructure use)
		Establish appropriate regulations at the international level
	Intermo	Analyze ways of cooperation between operators of different transport modes
		Support hauliers to extend their activities to other modes of transport
		Produce maps with all freight terminals drawn in
		Support transport companies to adopt new technologies
		Studies for more rational use of road transport and its interaction with other modes
		Funding the elaboration of as-is analyses, promotion plans, performance and training monitoring in companies
	Support initiatives to increase efficiency of operators' business performance	Develop tools to calculate savings in both costs and pollution
		Analyze possibilities to change maximum permitted vehicle weights and dimension
		Introduce new areas for best practice examples
		Change the fleet structure in favour of vehicles fit for purpose and heavier vehicles
		Develop efficient logistics systems to reduce total transport operations
		Promote eco-driving
Reduction of particulate matter and exhaust emissions	Introduce higher standards for fuel and vehicles	Standards of fuel quality and standards for emissions and noise
		Financial incentives to old vehicles replacement
		Stimulate the use of vehicles with engines complying with highest emission standards
	Support initiatives to reduce emissions	Voluntary reduction of environmental impact
		Introduce modern systems for vehicle navigation and positioning

hicle-kms, £ 60-80 million in costs of hauliers and 80-100 thousand tonnes of CO_2 emissions. The results of analysis of the three-year application period (2000-2003) show that annual savings are around one third higher than the estimates: 134 million km, £ 110 million in costs and 136 thousand tonnes of CO_2 emissions [3]. The analysis estimated that in 2006-2007 the savings would be around 27% higher than in the first three years of application. Although the benefits are higher than expected, many companies do not fully utilize capacities of vehicles registered for 44 t. These vehicles on average transport 17.9 t of load which is significantly lower than the maximum carrying capacity of 29 t. Maximum carrying capacities were operated at only 30% of the laden vehicle-kms. Data also shows that on 37% of the laden vehicle-kms the capacity was limited by load volume, not by weight. This implies that, as average load density decreases, more benefit can be derived from increasing maximum vehicle dimensions.

Renewal of international road hauliers' fleets in Serbia

Numerous national transport policies anticipate incentives for fleet renewal. Various instruments can be used: fuel taxing systems, abolishment/decrease of import customs duties for new vehicles *etc*. Fleet renewal in Serbia was stimulated by governing the system for accessing the international road haulage market.

The access to international road haulage market for hauliers from Serbia was limited by quota permits (bilateral and ECMT permits). Quotas distributed to Serbia are allocated according to the prescribed criteria. The method for quota allocation until 2002 – subjective establishment (by a commission) of the number of quotas belonging to each single operator at the end of the month for the month to follow-provoked high incertitude and disenabled long-term business and development planning. Criteria for allocation were only defined in principle, therefore, it was concluded that access to the market must be regulated in more detail. Thus, in 2003, provisions that precisely develop and quantify criteria were passed and mathematical models were used to determine relations between the number of permits granted and the scope and quality of operator's performance. The method thereby established enabled planning an annual level. This allowed hauliers to make better plans not only for the engagement of their transport capacities and further development, but also to make procurement-related decisions in line with their possibilities to access the market, based on their plans.

One of the criteria for the distribution of permits is the transport operator fleet quality. This criterion is measured by the number of points given for each vehicle (vehicle combination) depending on the category, body type, payload and ownership type. For example, according to current criteria [17], a Euro V safe vehicle combinations with payload higher than 20 t shall be given 8 points; Conventional vehicles less than 15 years old shall be given 1 point, while Conventional vehicles older than 15 years will be given only 0.5 points. This method to establish the number of points was prescribed in order to stimulate operators to improve quality of their fleets, which has created assumptions to supply larger permit contingent for hauliers from Serbia, and it represents one of the instruments for implementation of policies to develop a more efficient system to govern access to the market, to increase vehicle energy efficiency and to increase road safety.

Hauliers from Serbia stimulated in the above way started revitalizing their fleets, thereby decreasing the average fleet age: in 2005 average fleet age was 8.66, in 2007 it was 7.28, and in 2009 it was 6.96 [14]. Such fleet renewal rate had a significant impact upon vehicle environmental class (fig. 1). While in 2001 fleets were mostly composed of conventional vehicles (75%), already in 2005 the situation was the opposite – 73% of vehicles met some of the norms. The data about vehicles and their characteristics are obtained from the author database made

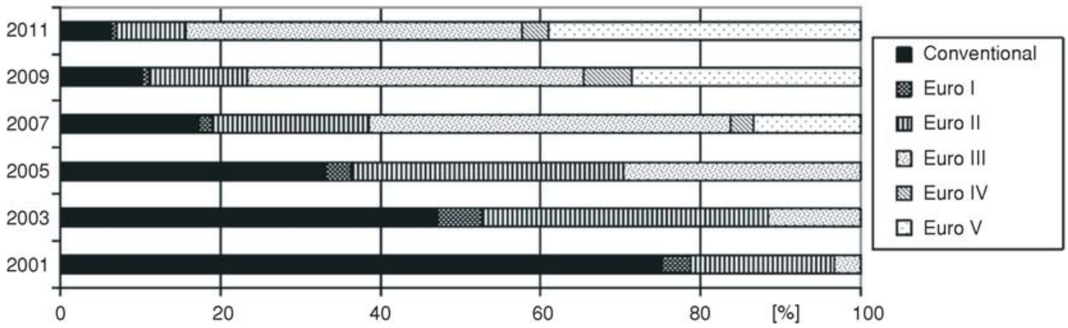


Figure 1. Fleet structure by environmental class, based on [18]

upon data published in Annual Distribution Plans at the end of each year (the last one was for the 2012 [18]).

The reason for this change in fleet structure has been primarily the fact that market access was limited by the number of bilateral and multilateral permits and the increase of this number was possible first for environmentally friendly vehicles. A survey on the attitudes of hauliers conducted in 2007 [14] covering 38.5% of operators, established that for 69.2% of operators permits were the motive to procure more modern vehicles.

In order to estimate environmental effects of this instrument, the authors calculated pollutants' emission and energy consumption for heavy duty trucks, articulated vehicles with gross weight of 34-40 t, using the COPERT 4 model [19-21]. For the emission calculation COPERT 4 uses a set of categorized input data, including the number of trucks according to emission levels, the average annual mileage, the average speed of trucks in urban, rural and highway traffic conditions, the average monthly temperature, and the average monthly air pressure. The input data and emission factors are adopted based on the survey that was completed during the project [20] realization.

The authors chose articulated vehicles with 34-40 t gross weight because such vehicle account for more than 80% of fleets operated by international road hauliers from Serbia. Calculations were made for the years 2002, 2007, and 2011, when fleets comprised of 3003, 5419, and 6349 articulated vehicles, with average annual mileage of 110, 120, and 115 thousand km respectively. Results for the pollutants' emission and energy consumption are presented in tab. 2.

Table 2. Pollutants' emission and energy consumption

Pollutant	Pollutants' emission, total [t]			Pollutants' emission [g/vehicle-km]		
	2002	2007	2011	2002	2007	2011
1	2	3	4	5	6	7
CO	739	270	287	2.23	1.95	1.76
CO_2	283496	521735	573224	858	802	785
NO_x	3348	4665	3990	10.13	7.17	5.46
HC	168	201	147	0.51	0.308	0.20
PM	134	150	124	0.41	0.23	0.17
Energy consumption	[TJ]			[TJ/ g/vehicle-km]		
	2107062	3877754	4260436	0.00638	0.00596	0.00584

In the period observed, total emission of CO, HC, and PM was reduced, while total energy consumption and total CO_2 and NO_x emissions were increased. Emissions of all pollutants and energy consumption per vehicle-kilometer were reduced. These results were achieved without deploying instruments which imply spending funds from the state budget or any change implemented in the taxing system. Effects would have probably been even better had some other policy instruments for accomplishing goals of environmental protection and increase of energy efficiency been applied.

Research framework and methodology

Complexity of transport systems with all their aspects (technical, socio-economic, and environmental) and the need to vertically and horizontally link policies (various administrative levels and interdependency with other systems), but also different interests of various parties included, indicate how difficult strategic transport planning is. Implementation of transport policies demands joint action of various executive authorities. The central idea of an integrated transport policy, given out by the EU-Commission, is being rhetorically propagated. In Germany, just like in all the other European countries, ambitions and reality of the strategies of transport policy are far apart [22]. Without the change of policy and a policy making process, the transport development will go further on in an energy inefficient manner. Energy efficiency policies world-wide fail to accomplish the desired objectives in terms of energy consumption reduction [23]. Policy instruments are created autonomously, and stakeholders do not participate to a sufficient degree, most often approximate and incomplete data are used, and actual capacities of institutions are not taken into consideration.

A special problem poses the fact that there is no application of methods for support to policy making processes and implementation of policy goals and instruments; moreover, neither methods for ex-ante and ex-post evaluation of policy *vs.* goals set, nor methods for impact assessment to analyze effects of policy instrument application in certain areas are applied. Impact assessment applied during policy instrument formulation process is mostly only on a formal level, while its vertical and horizontal integration and integration into a decision making process is insignificant. It is evident that there is a need to provide support to decision making at a policy planning stage. Therefore, a methodology for transport policy impact assessment on road transport of goods was developed [14] and it is employed in order to structure and support development of policies and instruments thereof. This methodology is based on both the existing models, modified in the function of studying and analyzing policy directions and impacts which will result in a successful activity, and on a newly-developed model for policy instrument impact assessment by multi-criteria ranking. It covers early stages of the policy making process, and it includes situation analysis, definition of goals and instruments, selection of indicators and impact assessment by multicriteria ranking. This paper focuses on the last segment and its application with a view to increasing road transport energy efficiency.

The process of defining the impact assessment framework starts from goals. The goal is used to define outcomes which will embody the progress. The increase of the international road haulage energy efficiency, which is given as an example in this paper, has been set as a goal to be attained by accomplishing the desired outcomes: better vehicle utilization, reduction of time losses, and reduction of fuel consumption. Outcomes are then linked to intermediate outcomes which reflect changes in the road haulage. Finally, outputs and inputs are established. Figure 2 shows the framework.

Since this paper does not deal with monitoring of policy instrument implementation but with an assessment of their impact to energy efficiency, results and inputs were not consid-

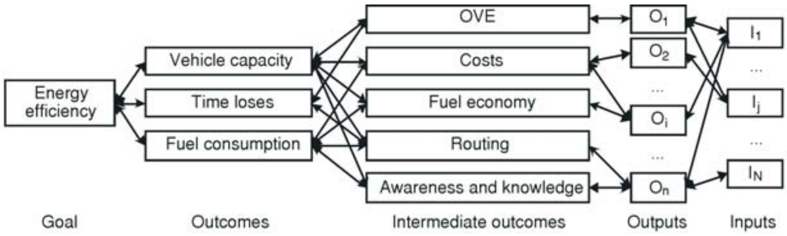


Figure 2. Framework for efficiency impact assessment

ered in detail. Monitoring of overall vehicle effectiveness (OVE) allows one to look at improvements in the process of service provision, *i. e.* vehicle operation process. OVE [24] is a single operational measure of total vehicle performance. OVE can contribute to monitoring the efficiency of road transport on a national level, and it can also indicate profitability of hauliers as its monitoring may lead to cost savings [24]. Since OVE is an indicator of how effective the use of resources planned is (time and vehicle capacities), for its definition it is important to identify the activities that do not add value to transport (losses) in order to assess their relative relation to value-adding activities with a view to eliminate losses. Application of OVE in each single case requires that one considers and identifies losses specific to road transport services in question. In general, the following losses can be defined for international road haulage: excessive loading/unloading time, delays at border crossings and inner customs, legislated driver breaks taken during a journey, speed losses, fill losses (vehicle is not fully loaded), empty running, and quality delays (inconsistencies with the plan, inconsistency of goods and losses due to mistakes made by drivers or other operators).

As OVE considers only losses incurred in provision of transport services, but in order to view the changes outside this process as well, the following were defined as intermediate results: costs which do not occur during a journey, fuel economy, routing and level of awareness and knowledge. This definition level is sufficient for the assessment of instrument impact to energy efficiency dealt within this paper. If the instruments representing options for decision making would be more precise or a more detailed assessment would be elaborated for these instruments, then attention to details would have to be higher.

The desired goal and established outcomes can be achieved by implementing the instruments of transport policy presented in tab. 1. An analysis of their effects on the goal and outcome accomplishments should be used to select options for decision making. In order to assess the impact of selected instruments on fleet energy efficiency, and in order to rank instruments according to their impact, it is required to apply one of the methods of multi-criteria ranking. For this purpose Analytical Network Process (ANP) was chosen as a method which allows modelling of complex dependence similar to the one faced in problems which deal with policy issues.

Theoretical foundations of ANP

ANP is a generalization of Analytic Hierarchy Process, in cases when there are various forms of dependence and feedbacks, *i. e.* when interaction between elements forms a network [*cf.* 25, 26]. ANP is a method based on network-like representation of a decision making process, on mathematical theory for assessment of impact and importance between large number of elements *i. e.* their pair-wise evaluation according to certain scale of relative significance and vector representation of priorities between elements. ANP method belongs to the class of multi-criteria methods. Specific to this method is the application of clusters and existence of several different relations between them. In ANP, clusters are comprised of groups of elements with similar characteristics and connected in a network. Clusters are defined in order to detect and assign value complex effects between them or their elements bearing in mind that there is a possibility that some ambiguities may occur in the process of their comparison. The main feature of such structuring is relatively easy and intuitive investigation of functional dependence of system elements at the same hierarchy levels along with the possibility to use qualitative and quantitative information.

Application of the ANP method can be simple, with one network, or complex, with the base network and two or more layers of sub-networks. One of the most often complex networks applied is the so-called BOCR network (network with control hierarchies of Benefits, Opportunities, costs, and risks). ANP models with BOCR network have strategic criteria for the assessment of contribution attained by priority decisions from each of the control hierarchies. Benefits, Opportunities, Costs and Risks are connected with sub-networks which include control criteria that are again most often connected to sub-networks of the following layer. The lowest level covers decision-making networks with alternatives. Number of levels and sub-networks is theoretically not limited.

Development of ANP model

The increase of energy efficiency in the international road haulage sector has been set as a goal to be attained by accomplishing desired outcomes: better vehicle utilization, reduction of time losses and reduction of fuel consumption. Firstly the decision making options are defined – the policy instruments enabling the achievement of the goal set are selected. Once the options for decision making are defined, the BOCR network is formed. Each BOCR network (Benefits, Opportunities, Costs and Risks) contains two control criteria each having their own sub-networks (decision networks, fig. 3) with options to be decided and clusters with defined elements. Criteria are primarily based on identified stakeholder goals, not on impacts of the very instrument effects, which are more often applied in multi-criteria analyses. Control criteria of the benefit network are selected based on desired outcomes and intermediate outcomes. Control criteria of the opportunities network are determined based on the goals of national transport policy (NTP) and goals of international road transport of goods (IRTG), as these can be implemented through the accomplishment of goals. Control criteria of the costs network are defined as costs of instruments to be borne by executive authorities, as well as costs which hauliers shall have. Control criteria of the risks network are risks to accomplish NTP goals and barriers that pose a risk to successful application of instruments.

Having established control criteria, clusters and cluster elements, internal and external relations between clusters have been determined and comparison of cluster pairs and pair wise comparison of elements should be done on the basis of Saaty' scale [25] so as to identify priorities in BOCR networks set. Once the pair wise comparisons have been completed the priority of the element is obtained by calculating eigenvalues and eigenvectors. The determination of global priorities in the network system follows by the formation of supermatrix. ANP involves three kinds of supermatrix, *i. e.* un-weighted supermatrix, weighted supermatrix, and limit supermatrix [*cf.* 25]. At the end a ratings model for the identified strategic criteria shall be created. Finally, results for the whole model shall be synthesized and this gives final alternative priorities, *i. e.* final ranking of options for decision making.

Numerical example in case of Serbia

This section deals with a numerical example of the developed ANP model in the case of Serbia. An analysis of possibilities of their impact on accomplishment of outcomes defined was used to select options for decision making. Besides that, attention was paid to capacities for

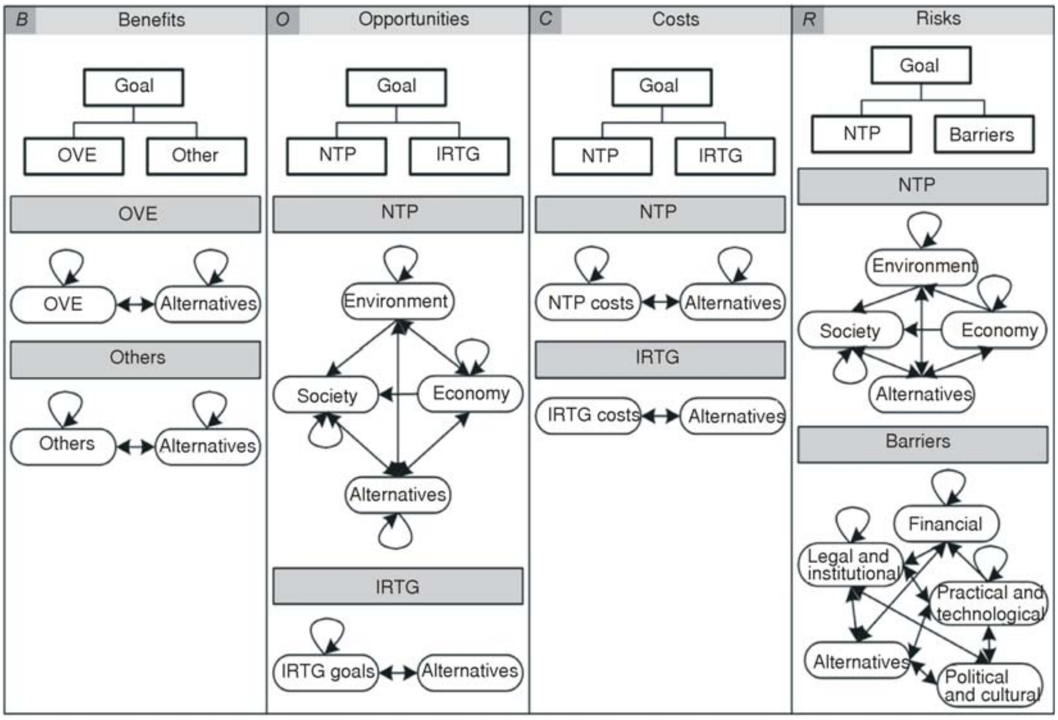


Figure 3. Decision sub-networks with clusters and nodes for each of the BOCR

the policy instruments implementation as Gvozdenac [23] states, as the main reason why the policies world-wide fail to accomplish the desired objectives in terms of reduction of energy consumption, undeveloped, insufficient and inappropriate capacities for the implementation of ambitious objectives that have to be achieved. The following four options were formed, *viz*.:

A1. support to fleet renewal,
A2. incorporation of eco-driving into regulations on mandatory training for professional drivers,
A3. support to hauliers to adopt new technologies, and
A4. efficient technologies for customs procedures and controls of loads and vehicles.

Once the options for decision making are defined, the complete ANP model structure has been established, with options to be decided on and clusters with defined elements (tab. 3).

Ranking of alternatives in networks and sub-networks

Having established control criteria, clusters and cluster elements, pair wise comparison was done based on the knowledge and experience of experts and based on the opinion of competent authorities and hauliers. When pairs in each of the defined networks have been compared, results are synthesized in order to set the ranking of alternatives. The calculation of supermatrices and ranking of priorities was done by applying the Super Decision Software* version 2.2.2 software package. Super decision software package provides a display of results in three ways: (1) list of priority alternatives defined in relation to the instrument with highest pri-

* Super Decision-Software for decision-making, http://www.superdecisions.com

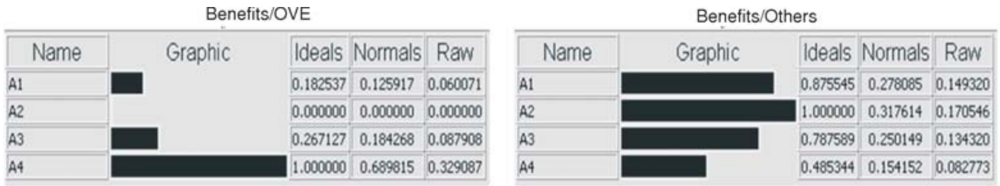
Table 3. Clusters in the decision networks and elements in the clusters

BOCR	Control criteria	Clusters	Elements
Benefits	OVE	OVE	Vehicle fill, empty running, border crossings delays, inner customs delays
	Others	Others	Fuel economy, routing, costs, awareness, and knowledge
Opport.	NTP	Society	Population satisfaction, Safety for all road users
		Environment	Fuel consumption, green-house gas emissions, particulate and exhaust gas emissions
		Economy	Competitiveness and productivity of national economy, competence of national hauliers on national and international markets, quality of transport services
	IRTG	IRTG goals	Efficient business performance, service quality, corporate image
Costs	NTP	NTP Costs	Elaboration/amendments of regulations, enforcement of regulations, cutting down the budget revenues
	IRTG	IRTG costs	Set-up costs, training
Risks	NTP	Society	Population satisfaction, safety for all road users
		Environment	Fuel consumption, green-house gas emissions, particulate and exhaust gas emissions
		Economy	Competitiveness and productivity of national economy, competence of national hauliers on national and international markets, quality of transport services
	Barriers	Legal and institutional	National policies are not harmonized, distribution of powers between various competent institutions, lack of co-ordination between competent institutions
		Financial	Insecure funding, no links between policies and budget
		Political and cultural	Corruptive practices, impact of certain groups on the government
		Practical and technological	Lack of skills and competencies, problems in monitoring and managing the instrument implementation
All networks		Alternatives	Fleet renewal, eco-driving, New technologies, procedures and control

ority ranking (Ideals), (2) priority vector in a normalized form (Normals), and (3) alternative priority vector resulting from synthesis of all impacts and the calculation of a limit matrix (Raw).

Combining the outcomes from the OVE and Others decision subnets (fig. 4) for the benefits model produces the results shown in fig. 5. The normalized values show that efficient technologies for customs procedures and controls of loads and vehicles (A4) offers greatest benefits, and by significant amount, at 32%. The results for the opportunities network are obtained by combining the results of NTP and IRTG sub-networks. The final synthesized results for opportunities are shown in fig. 5. Values of normalized priorities show that support to fleet renewal (A1) can provide best possibilities by around 37%.

With costs and risks networks, one should bear in mind that highest ranking priority is the most expensive one *i. e.* with highest risks. Combining the results of NTP and IRTG sub-networks gives results for the costs network, while combining of NTP and barriers sub-networks gives results for the risks network (fig. 5). Support to fleet renewal (A1) represents the alternative with highest priority in both networks.



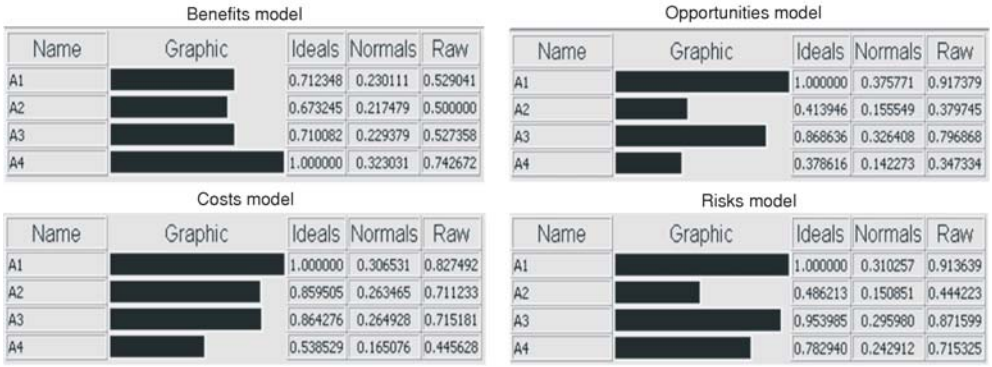
Benefits/OVE

Name	Graphic	Ideals	Normals	Raw
A1		0.182537	0.125917	0.060071
A2		0.000000	0.000000	0.000000
A3		0.267127	0.184268	0.087908
A4		1.000000	0.689815	0.329087

Benefits/Others

Name	Graphic	Ideals	Normals	Raw
A1		0.875545	0.278085	0.149320
A2		1.000000	0.317614	0.170546
A3		0.787589	0.250149	0.134320
A4		0.485344	0.154152	0.082773

Figure 4. Alternative rankings from the benefits/OVE and benefits/others subnets



Benefits model

Name	Graphic	Ideals	Normals	Raw
A1		0.712348	0.230111	0.529041
A2		0.673245	0.217479	0.500000
A3		0.710082	0.229379	0.527358
A4		1.000000	0.323031	0.742672

Opportunities model

Name	Graphic	Ideals	Normals	Raw
A1		1.000000	0.375771	0.917379
A2		0.413946	0.155549	0.379745
A3		0.868636	0.326408	0.796868
A4		0.378616	0.142273	0.347334

Costs model

Name	Graphic	Ideals	Normals	Raw
A1		1.000000	0.306531	0.827492
A2		0.859505	0.263465	0.711233
A3		0.864276	0.264928	0.715181
A4		0.538529	0.165076	0.445628

Risks model

Name	Graphic	Ideals	Normals	Raw
A1		1.000000	0.310257	0.913639
A2		0.486213	0.150851	0.444223
A3		0.953985	0.295980	0.871599
A4		0.782940	0.242912	0.715325

Figure 5. Synthesized result for the benefits, opportunities, costs and risks models

Strategic criteria definitions and BOCR Rating

Once the network structure is defined, pair wise comparison made and priorities in BOCR networks set, strategic criteria shall be determined. Since the goal is to assess the impact to fleet energy efficiency in IRTG, the above mentioned desired policy outcomes are selected as strategic criteria: better utilization of vehicles, reduction of time losses and reduction of fuel consumption. Afterwards, the ranking model is formed (tab. 4) in which benefits, opportunities, costs, and risks represent highest ranking alternatives in these networks. For strategic criteria, a scale was developed to assess the degree of accomplishments (for benefits and opportunities) and level of impact (in case of costs and risks) on strategic criterion of the highest priority alternative. The scale used in this model ranges from poor to excellent with priorities set by pair wise comparison (lowest row, tab. 4). For example, benefits from efficient technologies for customs procedures and controls of loads and vehicles (A4) were rated as poor against reduction of fuel consumption, while opportunities arising from support to fleet renewal were rated as excellent. final priorities for benefits, opportunities, costs, and risks are given in the last column of tab. 4.

Table 4. BOCR ratings and priorities

	Vehicle capacity 0.285714	Time losses 0.571429	Fuel consumption 0.142857	Priorities
Benefits	Poor	Excellent	Poor	0.477179
Opportunities	Average	Poor	Excellent	0.212887
Costs	Below average	Average	Poor	0.175426
Risks	Average	Below average	Poor	0.134507
Excellent (0.463), Above average (0.307), Average (0.142), Below average (0.058), Poor (0.030)				

Synthesized model results and discussion

Following the priorities set for BOCR, results for the whole model shall be synthesized and this gives final alternative priorities, *i.e.* final ranking of options for decision making (fig. 6). The first solution was reached by applying the multiplicative BO/CR formula, which means that the priority vector product of benefits and opportunities is divided by priority vector product of costs and risks. This method produces marginal values, therefore these results are considered short-term. For the second solution additive $bB + oO\text{-}cC\text{-}rR$ formula was used, with b, o, c, and r values being the priorities from the ranking model (tab. 4), while B, O, C and R are calculated in the same manner as in the previous solution. Results obtained in such a way are considered more long-term.

As based on the results presented (fig. 6) one can infer that in both short-term and long-term solution efficient technologies for customs procedures and controls of loads and vehicles (A4) is the highest priority ranking alternative, *i. e.* the alternative with highest impact on increase of energy efficiency, while incorporation of eco-driving into regulations on mandatory training for professional drivers (A2) is the alternative with lowest priority ranking. Alternatives A2 and A3 have different ranking depending on the calculation method used. A recommendation for further decision making in the policy process can be twofold. The instrument with highest ranking can be recommended for further analyses, or it can be recommended to consider all four instruments and to use results obtained with regard to allocation of resources for each of the instruments.

Multiplicative *BO/CR* formula

Name	Graphic	Ideals	Normals	Raw
A1		0.793288	0.235466	0.641948
A2		0.742643	0.220433	0.600965
A3		0.833088	0.247279	0.674155
A4		1.000000	0.296822	0.809224

Additive $bB + oO - cC - rR$ formula

Name	Graphic	Ideals	Normals	Raw
A1		0.707613	0.240507	0.179691
A2		0.531277	0.180574	0.134912
A3		0.703276	0.239033	0.178590
A4		1.000000	0.339886	0.253940

Figure 6. BOCR model: overall synthesized results

Instrument impact assessment on energy efficiency is employed to rank instruments. The proposed policy instruments strongly depend on quality and range of options used as input and tested during this process. It is important to identify options to be short-listed further on for the following phase – ranking. Results are practically applied in the process of preparing options for formal assessment processes, especially in such conditions when the impact is estimated and decision made based on incomplete and unreliable data. The developed decision making process at transport policy defining stage and results obtained using the ANP method show that a developed procedure could possibly reduce the risk in decision making regarding transport policies and similarly achieve higher level of energy efficiency in the road transport.

Conclusions

A decision with regard to road transport which is made at the national level exerts considerable impact on the business climate in which service providers operate and on achieving the efficiency and sustainability of road transport. In the area of transport policies, the support to decision making is mostly directed toward the development of concrete models and methods for the purpose of seeking optimal solutions to problems, most often comparing the effects of possible options with the criteria adopted. Both literature and practice direct mush less attention to support the decision making process within strategic planning.

The paper assumed the need to provide harmonized, interactive decision making during policy planning and a possibility to develop a tool for support to decision making in the sphere of transport policy implementation, especially in the part when transport policy elements related to international road haulage are being developed and implemented.

In tool development, higher quality of management conditioned the application of systemic consideration and management of the process of creating and realizing certain functions. The existing approaches in managing road transport of goods have been analysed by applying the today's particularly used criteria – energy efficiency and protection of environment. The research conducted helped develop a tool which, through the impact assessment of the defined instruments of transport policy, makes it possible to determine those instruments whose application will have positive effect on energy efficiency of road transport of goods. Case studies have proven practical applicability of the method developed in addition to which it was significant to define the structure of the model and determine the range of alternatives relying on the experts' knowledge and experience.

The developed model enables us to generate options for formal decision making with instrument impact assessment more simply and it can be employed in policy making practice. The model formulates instrument proposals for further decision making with regard to policy options. The main contribution of this research is the promotion of application of newly-developed tools in the process of establishing instruments of transport policy when goals are set. The research was under time constraints and conducted with respect to a single case. The results achieved were not practically applied in the preparation of instruments of transport policy. Also, the impact of knowledge, experience and training of experts for the participation in the research conducted was not examined. Further research needs to determine the quality of results and confidence in results obtained.

The research conducted confirmed the possibility and applicability of ANP model in the process of applying instruments of transport policy. The options have been created for further research in a very important area where exact methods have so far been of minimal use. A tool was developed for practical application in the process of transport policy drafting. The participants in the establishment of transport policy are focused on a more complex approach to their work, better anticipation of consequences of their work and potential engaging in the anticipation of rebound effect upon examining energy efficiency of road transport of goods.

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