THE BALTIC JOURNAL
OF ROAD AND BRIDGE ENGINEERING

2012
7(1): 60–67

POLICY INSTRUMENTS FOR MANAGING EU ROAD SAFETY TARGETS: ROAD SAFETY IMPACT ASSESSMENT

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Abstract. The Directive 2008/96/EC of European Parliament and of the Council requires the establishment and implementation of procedures relating to road safety impact assessments, road safety audits, the management of road network safety and safety inspections by the Member States. Directive aims to develop procedures with the aim of increasing safety of road infrastructures. Road Safety Impact Assessment (RSIA) is an initial part of road infrastructure safety management systems. This article describes the scope of RSIA procedures, provides detailed recommendations on qualification of auditors, implementation and execution of procedures for the EU Member States. Road safety should play an important role when routes are being selected and safety awareness should be included in the decision making during the designing/planning stage. RSIA is a very beneficial tool that could increase transparency and availability of information, consequently, it leads all parties concerned to well-informed decisions.

Keywords: road safety impact assessment, road safety, road safety measures, infrastructure project, initial planning or design stage.

1. Introduction

BALTRIS is a project within the European Union's Baltic Sea Region Programme 2007–2013 that promotes regional development through transnational cooperation. *BALTRIS* is led by Lithuanian Road Administration and the project partners are Lithuanian Road Administration, Estonian Road Administration, Swedish Transport Administration, Vilnius Gediminas Technical University, Tallinn University of Technology, Lund University and Riga Technical University. The specific objective of *BALTRIS* is to develop tools and build capacity/competence for a better safety management of road infrastructure in the Baltic Sea Region. The project focuses on the exchange of experiences, knowledge and joint development of road infrastructure safety management procedures, i.e.:

– road safety impact assessment (RSIA);
– road safety inspections and road safety audits (RSA);
– evaluation of high accident concentration sections.

Some European Union (EU) members already possess the well functioning road infrastructure safety management systems, in particular RSIA. *Directive 2008/96/EC Road Infrastructure Safety Management* aims to develop procedures in order to increase safety of road infrastructures in all EU countries and stimulates the exchange of knowledge and best practices between the Member States. RSIA is carried out for all infrastructure projects which are part of the trans-European road network. By the regulations of European Parliament the Member States may also apply the procedures, as a set of good practices, to national road transport infrastructure, not included in the trans-European road network which was constructed using Community funding in whole or in part.

ISSN 1822-427X print / ISSN 1822-4288 online
doi: 10.3846/bjrbe.2012.09
http://www.bjrbe.vgtu.lt

RSIA is a strategic comparative analysis of the impact of a new road project or a substantial modification to the existing network on the safety performance of the road network. The purpose of RSIA is to demonstrate, on a strategic level, the implications for road safety of different designing/planning alternatives of an infrastructure project. Road safety should play an important role when routes are being selected and safety awareness should be included in the decision making during the designing/planning stage. RSIA shall indicate the road safety considerations which contribute to the choice of the proposed solution. It shall further provide all relevant information necessary for a cost-benefit analysis of the different options assessed. Thus, this article aims to present BALTRIS project, accumulated experience and framework of RSIA procedure.

2. Overview of the EU policy and best practices

The need to reduce the number of injuries and fatalities on the roads has been recognized by the United Nations and its Member States. The first global ministerial conference on road safety organised by the UN resulted in the Moscow Declaration which will lead to a range of activities within the area of global road safety. The Moscow Declaration was presented and adopted by the United Nations General Assembly in March 2010. The declaration designates the period 2011–2020 as the "Decade of Action for Road Safety", with the aim of reducing global road deaths by 2020 (according to the *Program Friends of the Decade of Action for Road Safety 2011–2020*). Road traffic safety is a major concern for the 27 Member States of the European Union. The European Commission has recognized that "Road safety is a major societal issue" and concluded that "In 2009, more than 35 000 people died on the roads of the European Union, i.e. the equivalent of a medium town, and no fewer than 1 500 000 persons were injured. The cost for society is huge, representing approx 130 billion EUR in 2009". The Commission adopted a Road Safety Program which aims to cut road deaths in Europe by 2020. The western part of Europe, especially the Nordic countries, have developed some tradition in a science-based road safety work which is indicated by a positive development placing them among the countries with the lowest accident levels (e.g. Sweden and Denmark). Other parts of Europe and the world need to develop such kind of systematic work to improve their road safety situation. The demand for road traffic safety specialists in developing countries is even more urging as road "unsafety" has taken a devastating proportion in those countries.

Sweden. Regulations of the Swedish Transport Administration already require RSIA to be carried out in all feasibility studies on state road investment projects to be assessed according to the Swedish Road Act. The regulations also require cost-benefit analysis with monetary comparisons of road user, safety and environment effects with investment and maintenance costs and estimates of safety effects in terms of the saved fatalities and the severely injured as well as travel times and environmental effects. The RSIA is an integrated part the initial feasibility study which is a part of the general planning process. The feasibility study includes discussions about deficiencies, problems and needs. Environmental issues, road safety, accessibility, transport quality, regional development, and gender equality among other areas, are covered in the feasibility study. This also the case for the next step, the preliminary road design step, where the requirements are consistent with the requirements in the first stage.

Belgium. RSIA procedure of the Traffic Safety Directive shall be implemented in short terms for all the projects requiring a building license for TEN-roads, however the country apply the procedures as a set of good practices for the regional roads. RSIA in Belgium considers different planning possibilities in traffic safety for a road project. The road safety element is one of the assessment elements of the project.

Cyprus. The information of the RSIA report is presently contained within Techno-Economical Study of each project in Cyprus. The standard stages for "initial planning" are the inclusion of a proposed project in the State Budget and the preparation of a Techno-economical Study and a Traffic Modelling/Impact Assessment Study. Hence, RSIA is implemented at the same time as the other assessments (Data collected by questioning participants during the seminar "Safety Management of Road Infrastructure – Implementation of *Directive 2008/96/EC*").

France. There is no specific procedure laid down for the moment for the RSIA report in France. Road safety like other criteria, such as environmental issues, cost of fatalities, cost of accident are calculated and used in the socio-economic cost-benefit analysis. Hence, in the process of assessment the traffic and accident data is used.

Portugal. A Road Safety Impact Assessment Manual has been elaborated to be applied for the national road projects in Portugal. RSIA means a strategic comparative analysis of the impact of a new road or a substantial modification to the existing network on the safety performance of the road network. The standard stages for "initial planning", at which RSIA is implemented in the process, are Base Program and Preliminary Study.

Iceland. RSIA procedure is mandatory for TERN-roads in Iceland. For other national roads RSIA should be performed if the cost of the road project exceeds a certain amount. In addition, RSIA should be performed if the project in question is very important from the view of traffic safety. The project manager (design manager) decides which remarks of the RSIA-team will be taken into account in further design of the project and present to the RSIA team. If the members of the RSIA-team decide that some of the remarks that will not be taken into account are extremely important they can send information on the matter to the general director of the project (Data collected by questioning participants during the seminar "Safety Management of Road Infrastructure – Implementation of *Directive 2008/96/EC*").

Ireland. The information for the RSIA report is presently contained within the Scheme Constraints Study. The traffic and road safety information will be extracted separately to form the RSIA. It will also act as a source of information for the independent stage of RSA. Therefore, the RSIA will be part of the larger Constraints Study for the scheme which will include documents on archaeology, environment, economic issues and all other factors and will be evaluated on cost-benefit basis (Information given by the National Roads Authority of Ireland).

3. General requirements and recommendations concerning RSIA procedures

RSIA procedures are intended to be applied at the initial design/planning stage with the major aim to prepare definite plan or design of the road network scheme. Procedures should cover two major aspects:

– to evaluate the impact of planned/alternative network schemes on road safety at the strategic level in the existing network of certain geographical area (entire affected for traffic in finite network);
– to evaluate road safety impact of the existing road network on alternative/planned road network schemes.

Ideally, the RSIA could be prepared in parallel to a strategic feasibility study. Usually, such feasibility studies cover traffic forecast, traffic pattern and engineering solutions (route selection, major technical details). The results of Road Safety Impact Assessment should improve the quality of such feasibility study and decision-making: provide all relevant road safety information necessary for a cost-benefit analysis of the different alternatives assessed.

If such strategic studies are not the subject, extra efforts will be needed for the RSIA. Deeper and advanced analysis of alternatives might reveal road safety synergies or anti-synergies, however such analysis requires very high skills and expensive tools, i.e. transport modelling, statistical analysis or multi-criteria analysis. Requirements concerning such methodologies may be regulated at national level. For instance, a very detailed RSIA can be performed under favorable circumstances, when such transport models are already running for national/certain territories, or when detailed local studies describe the local road safety conditions and its relations to various safety factors.

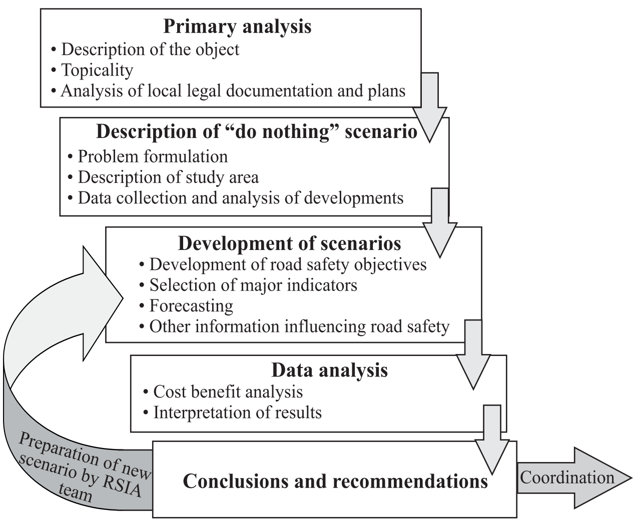

Fig. 1. Flow chart of the focal RSIA procedures

The initial steps of RSIA procedures (Fig. 1) start from the short description of plans, topicality of the object including its role in the trans-European network and analysis of local documentation if such exists (comprehensive, special, detail plans).

"Do nothing" scenario is an outline for most plausible series of events in the absence of different design/planning alternatives of an infrastructure project. Road safety objectives could be formulated on the basis of cost-benefit analysis indicators (i.e. cost-benefit ratio, Internal Rate of Return) if there are national methodologies or guidelines. In such way, the projects with highest economic indicators would have highest priority (such study covers just a part of feasibility study and indicators).

The RSIA should include at least 2 scenarios (including "do nothing"). Scenarios could originate in the design/planning team (at least one "do project") or in RSIA team. Prognosis of changes in road safety elements could be forecasted by using various methodologies (expert-based, analytical, multi-criteria analysis).

Data analysis covers cost-benefit analysis for different scenarios, data evaluation and interpretation.

Final part covers data summarization and interpretation of cost-benefit analysis (different scenarios). RSIA team has a right to propose a new scenario after RSIA process (if the results are not meeting the raised objectives) and evaluate this new scenario among the provided scenarios. Similarly, it is possible to construct a new scenario involving strengths of the already evaluated scenarios and to evaluate this new scenario among the provided scenarios.

4. Primary analysis

All in all, the designer/planner is responsible for data provision, i.e. all initial and essential data needed for the RSIA should be supplied by the designer/planner to the auditor. Additional data should be collected by using all feasible local sources, i.e. GIS-based systems, local statistical data, etc. RSIA auditors should characterize the following aspects:

– geographical area;
– description of client and possessor;
– What is the preliminary schedule of the initial design/planning stages? (description of the RSIA project time-plan and integration into local design/planning stages);
– What are the constructional plans concerning the infrastructure project? (reconstruction of existing road infrastructure, construction of a new road infrastructure);
– prepare maps with initial technical specifications of infrastructure project such as category/type/function, length, width, rough investments.

RSIA auditors should describe the following topicality aspects:

– Does the infrastructure object belong to trans-European network? ("trans-European road network" means the road network identified in *Decision 661/2010/EU* of the European Parliament);

– Member States may also apply the provisions of *Directive 2008/96/EC*, as a set of good practices, to national road transport infrastructure, not included in the trans-European road network that was constructed using Community funding in whole or in part. In such case the auditors should describe the national reasons and legal base of audit;
– What is the relevance of the object? (more detailed description of corridor, spatial connectivity, modal interactions).

Although the RSIA must be included in the initial planning/design stages, the existing long-term planning documentation and plans could be very beneficial. Analysis of local documentation, if such exists (comprehensive, special, detail plans), would be helpful to describe the transport and land-use interaction and collect more detailed information concerning the infrastructure project, to validate the project's compliance with local transport policy.

5. Description of "do nothing" scenario

In most cases we assume that road safety could be improved. Therefore, a problem formulation could be in the form of question: What would road safety be in the existing ambient infrastructure after certain period of time in the absence of major infrastructure projects? A problem formulation can be in the form of hypothesis: the road safety will be improved in a certain geographical area after implementation of the infrastructure project.

A new road infrastructure could generate negative impact on local road safety: generate additional traffic flows and risk factors. In such case RSIA study will not cover all cost-benefit aspects and the problem could be formulated as follows: how road safety can be maximized if major infrastructure projects are implemented?

Later on, the existing affected network/territory must be defined and geographical data should be collected and visualized. The boundaries of the RSIA object (affected network/territory) could be defined on the basis of traffic or road safety risk factors (regulated by the National Road Authority):

– certain rate of influence of the infrastructure project on traffic;
– certain rate of influence of infrastructure on risk factors.

For instance, RSIA procedure should be implemented in such cases:

– new construction of infrastructure projects;
– reconstruction of the infrastructure dealing with:
  – increase of capacity;
  – new entrances or exits;
  – reorganization of traffic scheme;
  – substantial road safety improvements (reconstruction of intersections, crossings, installation of road safety improvement packages such as safety barriers, lighting etc.).

The RSIA will take place at an early design/planning stage to allow the results of the assessment to influence the further design or planning process, as in the case of environmental impact assessment. Land use plans and the pattern of land use in an area can affect the number of accidents by influencing traffic volume, the modal split of traffic, how traffic is distributed between various roads and the accident rate for each road or each mode of transport. Moreover, they will be carried out for all transport policy measures having influence on road safety, including e.g. infrastructure investments, standardization, pricing etc.

The RSIA means a strategic comparative analysis of the safety performance of the road network and, therefore collection of additional data may vary for "new construction of infrastructure" and "reconstruction of existing infrastructure" cases:

– "new construction of infrastructure projects" – data collection should concentrate on study area including existing ambient infrastructure, i.e. no historical data are available concerning new infrastructure project;
– "substantial modification/reconstruction of existing infrastructure" – data collection should concentrate on study area including all existing infrastructure, i.e. historical data concerning road safety situation on reconstructed object are available.

Analysis of national or local territorial planning, national strategies and plans, and legal documentation concerning road design/planning in the selected area should be done at the first step. Data on road importance in trans-European road network, category of road and analysis of spatial and functional partitioning should be collected.

More detailed description of the "do nothing" scenario in terms of topicality should be accomplished: linkage to TEN or national transport corridors, analysis of national road network development programme, description of project objectives (traffic accident rate reduction, reduction in travel time, etc.). Describing the needs of the project, the following aspects should be elaborated:

– analysis of road function and features;
– accidents;
– traffic patterns, volume and categorization;
– road users (including vulnerable users);
– seasonal and climatic conditions;
– seismic activity (where it is applicable);
– other information influencing road safety assessment.

Data on land use and future land use developments is very essential for the forecast of future spatial interactions in the territory. A spatial interaction is a realized movement of people, freight or information between origin and destination. Data on land use should include at least the most important socio-economic variables pertaining to the area under investigation, such as population, employment, income level, commercial activity, etc. Such data is used to estimate or calibrate the amount of travel generated and attracted (origin and destination), however further forecast could be based on various methods (expert-based forecasting, simple calculations or traffic modelling).

Auditors should pay attention to intermodal or multimodal interaction in the territory if such exists or is foreseen. Many economic and transport activities as generally located at hubs, including distribution, warehousing, finance and retailing. Intermodal and multimodal interactions could cause the need of special infrastructure and generate additional transport needs and flows. With economic development, the addition of new activities and transport infrastructures, spatial interactions have a tendency to change very rapidly as flows adapt to a new spatial structure.

6. Development and evaluation of scenarios

The RSIA should include at least 2 scenarios (Fig. 2).

Scenario "do project" in most of the cases will originate in the design/planning team, but RSIA team has a right to propose a new scenario after evaluation if the results do not meet the raised objectives and evaluate this new scenario among the provided scenarios. Similarly, it is possible to construct a new scenario involving strengths of the already evaluated scenarios and to evaluate this new scenario among the provided scenarios. All the scenarios must be calculated with the same method.

There are a number of methods how to evaluate performance of transport infrastructure: cost/efficiency, cost-benefit, life-cycle, least cost planning, multi-criteria analysis and combined adaptations of such methodologies. Cost benefit analysis for life-cycle of infrastructure project is one of the most common analysis and normally based on local adaptations. Three separate measures are usually obtained from a cost benefit analysis to aid decision making:

Net Present Value (NPV): It is obtained by subtracting the discounted costs and negative effects from the discounted benefits. A negative NPV suggests that the project should be rejected because the society would be worse off.

Benefit-cost ratio: It is derived by dividing the discounted costs by the discounted benefits. A value greater than 1 would indicate a useful project.

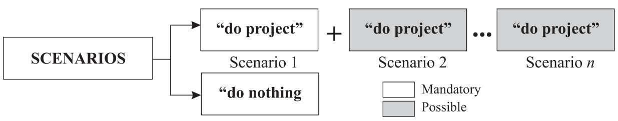

Fig. 2. Mandatority of the proposed scenarios

Internal Rate of Return (IRR): The average rate of return on investment costs over the life of the project.

In such way, projects with highest economic indicators would have highest priority (RSIA study most likely will cover just a part of feasibility study and its indicators).

Studies dealing with strategic aspects should deal with long term periods such as 15–30 years horizon. However, amendment to the horizon could be based on local methodologies.

The effects of road safety elements which are hard to express in monetary terms could be evaluated on the basis of selected indicators. Primary traffic indicators could be:

– passenger kilometers;
– vehicle kilometers;
– ton kilometers.

These indicators could be selected considering available information. Later on, they should be calculated as relative indicators:

– effect of road safety element/passenger kilometer;
– effect of road safety element/vehicle kilometer;
– effect of road safety element/ton kilometer.

The effect of road safety could be measured by decrease in the number of fatalities, accidents, risk factors or even monetary expressions of these and other benefits.

Most of the European countries have already prepared or are preparing methodologies concerning accident forecasting.

Basic methodologies used to predict future developments are (Elvik 2009; Stipdonk *et al.* 2010):

1. Expert opinion is based on expert's experience concerning influence of infrastructure project on road safety;
2. Analytical methodology is based on simple mathematical calculations of road accidents (per road type and traffic volume) on existing roads and use of such data to predict future situations on designed/planned infrastructure;
3. Statistical modelling is based on statistical road accident analysis and development of accident prediction models considering road type, traffic volume, speed limit and etc. Use of the Bayesian method is recommended as the best practice;
4. Multi-criteria decision making is based on in-depth analysis of road safety criteria/elements and their interaction.

Table 1. Major steps of analytical methodology

Step 1 Basic data analysis at national level	Step 2 Research of certain geographical/ study area in reference year	Step 3 Research of certain geographical/ study area in future year
Categorizing a road network; Road safety indicators per type of road*; Relationship between road safety indicators and primary traffic indicators; Distribution of road safety indicators; Development of road safety indicators.	Roads per road type; Traffic volumes per road type*; Accidents per road type*; Road safety indicator per road type; Comparison of national and regional road safety indicators.	Road network per road type and estimations of traffic volumes; Estimations of road safety indicators; Estimation of road safety effects.

* (i.e. average of 5 years).

Assessment by experts is a simple procedure and will definitely guaranty the outcome, however validity and reliability are questionable. By the Wegman or European Transport Safety Council the national analytical methodology could consist of the following major steps (Wegman *et al.* 1994):

Statistical modelling gives mathematical formula describing the relation between the safety level of existing roads and variables that explains this level. Ripcor-Iserest projects deliverable "*Accident Prediction Models and Road Safety Impact Assessment: Recommendations for Using These Tools*" describes a modern accident forecast model as (Eenink *et al.* 2008):

$$E(\lambda) = \alpha Q_{MA}^{\beta} Q_{MI}^{\beta} e^{\sum \gamma_i x_i}. \quad (1)$$

The estimated expected number of accidents, $E(\lambda)$, is a function of traffic volume, Q, and a set of risk factors, x_i $(i = 1, 2, 3, \ldots, n)$. The effect of traffic volume on accidents is modelled in terms of an elasticity that is a power, β, to which traffic volume is raised. For intersections volumes for the major and minor road are included. The effects of various risk factors that influence the probability of accidents, given exposure, is generally modelled as an exponential function, that is as e (the base of natural logarithms) raised to a sum of the product of coefficients, γ_i, and values of the variables, x_i, denoting risk factors.

Practical tools have been developed to standardise and simplify accident evaluations. One example of them is TARVA – a tool for evaluating reliably the existing safety situation as well as expected effects of various safety measures. It uses local road and traffic information together with international best practice information about the results of road safety studies. An accident model TARVA has originally been developed for Finnish roads (database and language), but even the English version with Lithuanian road data base and accident models has been produced (TARVAL). Because of simple evaluation algorithms, the programme can easily be converted to any other country that has some basic database about roads, traffic and accidents (Ratkevičiūtė 2010). The safety effects of infrastructure improvements can be evaluated easily and using the same data and definitions for all the roads in the database. The minimum input is: i) what is the measure and ii) where it is implemented. In Finland, there are almost 100 predetermined measures in the programme and own measures can be defined by the user if needed. Also the implementation costs can be entered but the average costs for measures (per km or per measure) are used, if these values are not entered.

The estimation of safety effects of road improvements in TARVA is a four-phase process (Peltola 2000):

1) For each homogeneous road segment the most reliable estimate of the accident number is combined from the number of accidents in the past, vehicle mileage and the average accident rate in corresponding conditions. Accident information is combined in a formula which takes into consideration the model's goodness of fit and the random variation in the number of accidents. The weight of the accident model compared to the weight of the accident history is the bigger the more there is random variation in the accident count.
2) To make prediction of the number of accidents without road improvements the most reliable estimate of the number of accidents is corrected by the growth coefficient of the traffic. Also the effects of fundamental changes in land use on the forecasted accident number can be taken into consideration by the coefficient.
3) The effects of measures on injury accidents are then described in terms of impact coefficients. The impacts coefficients have been obtained from the research results of all the relevant countries taking into consideration the differences in traffic regulation and road user behaviour.
4) Road improvement measures can affect also the severity of the accidents remaining on the road after the improvement. These effects can also be taken into consideration in TARVA by using severity change coefficients.

Using evaluated injury accident reduction percentage and knowledge about the average severity (deaths/100 injury accidents) and its change, TARVA gives an estimate of yearly-avoided accidents. TARVA uses different models for junctions and road sections. For road sections, the accident prediction model is based on the number of accidents per vehicle mileage and for junctions on the number of accidents per incoming vehicles. Model calculates three separate types of accidents (those involving motor vehicles only, involving pedestrians and bicyclists and involving animals). These are used because road improvements can have very different effects on those accident types.

Using the estimates of yearly avoided injury accidents and fatalities due to road improvements, one can easily calculate savings in accident costs. When knowing also the costs of the measures, it is easy to calculate what kind of measures is the most effective regarding safety and where those measures pay off most effectively.

There are also other more evaluation tools/models of such kind, like the ones for analysing the accidents in more details – an example of this is ONHA-tool (Lithuanian and Finnish accident databases in the Lithuanian, Finnish and English languages). Another kind of tool would help in evaluating the safety effects of different kinds of road safety measures when preparing national road safety plans – again an example of this if instance TEPA – used in Finland and ONHA. All these tools are useful for national evaluations, but extra benefit can be achieved from the possibility to carry out international comparison.

Multiple-criteria decision making or multiple-criteria decision analysis refers to making decisions in the presence of multiple criteria. Application of multiple-criteria decision making methods in planning is not a new thing. As an example, under the *European Union Road Safety Action Programme 1997–2001* a multi-criteria analysis of the various safety actions was followed by a cost-effectiveness analysis leading to the definition and ranking of short- and medium-term road safety priorities in the European Union.

Nowadays, a multi-criteria decision making framework for road safety research aims at incorporating advanced statistical methods (such as optimization algorithms) into a new multi-criteria decision making framework in order to enable road safety decision makers to make better informed choices. Given the complexity of the road safety phenomenon and the increasing attention paid to an extended set of road safety indicators (in which not only the number of fatalities are included, but also risk factors, policy efforts and descriptive characteristics), evaluation based on multiple indicators is required. Consequently, to measure the multi-dimensional concept of road safety which cannot be captured by a single indicator, the exploration of a composite road safety index is attractive and desirable. Compared to other fields such as environment, economy, and society, the development of a composite index for road safety is relatively new and promising (Elvik 2011; Qiong *et al.* 2010; Wang 2011).

RSIA study requires transportation forecasting. Transportation forecasting is the process of estimating the number of vehicles or people that will use a specific transportation facility in the future. For forecasting some countries use a fixed time traffic growth rate expressed in units or percents per year. As it was mentioned, RSIA could be prepared in parallel to a strategic feasibility study. Usually, such feasibility studies cover route choice and traffic patterns, volume, categorization, aspects. In the case of the absence of such feasibility studies, transport modelling software (i.e. Emme/2, Cube, PTV VISION etc.) can be used for transport forecasting and data analysis. Thus, RSIA study should answer such questions for each "do project" scenario:

– Does a new infrastructure project make influence on route choice and traffic patterns?
– How much does a new infrastructure project make influence on route choice and traffic patterns?
– What would the distribution of traffic volumes in the whole network be after implementation of infrastructure project?
– What would the influence of new infrastructure project on the structure of traffic be (vehicle categories)?
– The "do nothing" scenario after a certain period of time should be also described by expected traffic volumes and vehicle categories.

RSIA study could evaluate smaller details if there is information on road safety elements. Changes in the traffic volumes and infrastructure require more detailed analysis of such aspects:

– possible effects on the existing network elements (e.g. exits, intersections, level crossings);
– road users, including vulnerable users (e.g. pedestrians, cyclists, motorcyclists);
– seasonal and climatic conditions;
– presence of a sufficient number of safe parking areas;
– seismic activity (where it is applicable);
– other information influencing road safety.

The RSIA should give clear recommendations what effects of local conditions should be covered/tackled in further planning and design stages.

7. Data analysis

In spite of some of the discussions on the cost-benefit analysis (Elvik 2001; Elvik 2010; Veisten 2010) it is determined by the regulations of European Commission and Directorate General Regional Policy that data analysis should be conducted according to the valid local methodologies or guides to cost-benefit analysis. Major steps of the cost-benefit analysis are:

– description of each scenario;
– define cost and benefit elements for further analysis;
– define measurement units and monetize such units;
– define discount rate;
– calculation of yearly benefits and costs (i.e. 15–30 years);
– calculate net present value, benefit-cost ratio, internal rate of return;
– define elements which are hardly expressed in terms of money;
– perform sensitivity analysis;
– prepare results (graphs, tables, matrices, summary).

Interpretation is an art that one learns through practice and experience. It should be stressed that much prudence is needed in the interpretation of the analysis results. It is advisable, before embarking upon final conclusions, to consult the auditing team members who will not hesitate to point out omissions and errors in logical argumentation. Eventually, the team leader must give reasonable explanations of proposals and present proposals to all parties concerned (client and designer/planner). The results of the study should meet the raised objectives and consider all relevant factors affecting the problem to avoid false generalization.

8. Formulation of conclusions and recommendations, coordination of the recommendations

This part covers summarization and generalization of the cost-benefit analysis data and other elements of the RSIA (including all different scenarios). RSIA team has a right to propose a new scenario after RSIA process (if the results do not meet the raised objectives) and evaluate such new scenario among the provided scenarios. Similarly, it is possible to construct a new scenario involving strengths of the already evaluated scenarios and to evaluate this new scenario among the provided initial scenarios.

The proposals of the auditing team should be presented (provide report and/or prepare oral presentation) to the designer/planner and client in order to find the final consensus concerning infrastructure project. Designer/planner and client have a right to submit comments in written or oral form. The report of auditors could be updated and adjusted after the meeting with other parties. However, the client makes final decision whether recommendations are to be adopted or not. The written response to the audit report from the client is a part of the RSIA project documentation.

9. Recommendations concerning the use of RSIA procedures

1. The RSIA is a tool that could increase transparency and awareness of decision making during initial design or planning process. It is a useful tool to develop and compare policy options, though it requires high quality databases, preferably based on latest technologies such as GIS.

2. RSIA procedures is an integral part of the design or planning process of the infrastructure project at the stage of initial designing or planning in the EU Member States. Some EU members already possess the well functioning road infrastructure safety management systems. These countries are permitted to continue using their existing methods, in so far as they are consistent with the aims of Directive 2008/96/EC.

3. The prepared RSIA procedures are recommendatory and should be adapted to local conditions and peculiarities.

4. The structure of RSIA report should consist of such key sections: Primary Analysis, Description of "Do nothing" Scenario, Development of "Do project" Scenarios, Data Analysis, Conclusion and Recommendations. Hence, various methods can be used during preparation of these sections, therefore the prepared recommendations provide short overview of methodologies that are useful for the countries starting up with the RSIA.

5. National road accident forecast models are a part of RSIA methodology and such models should be developed for different road types. Simple road accident models estimate dependency between the number of accidents and traffic volume. More sophisticated models evaluate safety effects of various road infrastructure improvements; however such models require significant need for data, know-how and financial recourses.

6. Development of national road accident forecast models is a responsibility of national entities (i.e. road authorities). It is evident that cooperation between national authorities and research organizations is a prerequisite for the development of sophisticated models.

Acknowledgement

BALTRIS is a project within the European Union's Baltic Sea Region Programme 2007–2013, a programme that promotes regional development through transnational cooperation. The aim of the programme is to make the Baltic Sea region an attractive place to invest, work and live in. The BALTRIS project is expected to lead to improved safety of road infrastructure as well as possibilities to choose cost-effective engineering solutions. Safer road infrastructure will result in improved overall road safety.

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Received 10 January 2012; accepted 30 January 2012