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Abstract: This report includes a detailed cost benefit analysis of the integrated traffic & mobility management and traveler information systems that were developed in the framework of SEE-ITS. The overall benefits and costs from a future implementation of the aforementioned systems are being computed for Albania.

EXECUTIVE SUMMARY

This report includes a detailed cost benefit analysis of the integrated traffic & mobility management and traveler information systems that were developed in the framework of SEE-ITS. The overall benefits and costs from a future implementation of the aforementioned systems are being computed for Albania.

The adequate techniques for the transformation of qualitative criteria (environmental, social) are also being identified and applied for the computation of the external effects. The computation of costs and benefits follows the analytical CBA procedure, namely the analysis is composed by three different perspectives: the user perspective, the operator's perspective and the government's perspective. The overall welfare of the society for Slovenia is the sum of the three separate perspectives. The output of this activity is the analytical recording of all costs and benefits, along with the overall impact to social welfare for each demo case like it could be realized in Albania.

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- Current ITS status in Albania.
- Description of 2010/40/EU ITS Directive
- Brief description of ITS project inventory in Albania
- Cost-Benefit Analysis for ITS projects

1.1. Objective of the Study

This study is conducted at the framework of the project entitled "Intelligent Transport Systems in South East Europe" (SEE-ITS) and is incorporated within Work Package (WP) 7 and specifically for Activity 7.1.

The study's objective is related to the goals of the activity 7.1, which is specifically the development of a Cost-Benefit Assessment regarding the implementation of Intelligent Transport Systems (ITS) in Albania. During this study, the total benefits and total costs arising from the implementation of ITS in Albania are quantified based on the experience gained by other countries which are partners in project "SEE-ITS". To quantify benefits and costs, well-established techniques will be used in order to convert qualitative criteria (e.g. environmental, social) to quantifiable indicators and to internalize all relevant external factors. The calculation of costs and benefits is undertaken by following the detailed Cost-Benefit Assessment methodology; so the analysis is formulated by various factors: the needs of transport service providers, the needs of the decision makers and the needs of transport users.

The current study is based significantly on data already developed by the project SEE-ITS and are related to the experience gained by other countries of South-East Europe.

1.2. Brief Description of SEE-ITS project

SEE-ITS is a transnational project aiming to stimulate cooperation, harmonization and interoperability between isolated Intelligent Transport Systems (ITS) in South East Europe. SEE-ITS focuses on setting the framework for ITS deployment in the field of road transport and for interfaces with other modes of transport based on the guidelines of the European Union's Directive (2010/40/EU) dealing with ITS deployment.
The scope of the project is to enhance the interoperable use of ITS for traffic monitoring and control along road transport networks at transnational, regional and local (urban/peri-urban) levels. The project results will set a long-term sustainable strategic and operational framework for institutional and operational integration of ITS in South East Europe countries.

The main areas to be covered within the SEE-ITS project are:

- optimal use of road, traffic and travel data
- continuity of traffic and freight management ITS services
- ITS road safety and security applications
- linking the vehicle with the transport infrastructure

The SEE-ITS consortium consists of eight (8) core partners coming from seven (7) European Countries namely Greece, Austria, Italy, Romania, Hungary, Bulgaria and Slovenia and five (5) Associated Strategic Partners coming from Italy, Greece, Hungary, Croatia and Albania.

1.3. Current Status of ITS in Albania

The recording of the existing ITS status in Albania, which is drafted in the Deliverable D3.1.9 of the SEE-ITS project, revealed that ITS applications and services for road transport are currently in an early deployment stage. Albania was focused in the last twenty years, on the reconstruction of the current road infrastructure and on the construction of new roads. As a result, the application of ITS services weren't a priority for Albania. At present, after significant investments in the road transport, the interurban transportation network is improved. On the other hand, due to several reasons (migration of population and urban development, poor parking infrastructure, not satisfactory development of public transport), in the cities and especially in Tirana, the traffic congestion creates unfavorable conditions for the mobility of cars, vehicles and people.

So, since there are quite limited possibilities for new infrastructure construction and there is need for effective urban traffic management, the potential of ITS services and application is becoming a significant area for investment. In addition, the fact that a part of Albanian transport network belongs to the "Comprehensive Core Network of South East Europe" provides the opportunity to develop ITS technologies for monitoring and controlling cross-border traffic.

The review of the existing ITS status in Albania showed that there is not an ITS-dedicated legislative framework. There are laws that are related to road transport in general, containing some ITS aspects. Regarding the existing ITS projects, there are few on-going systems under development and only some sub-systems have already been finalized.
The on-going ITS projects in Albania are the following:

- Tirana Urban Traffic Control Management System (T-UTC)
- The implementation of Digital Tachograph in Albania
- On-line fleet management - Installation of GPS in the urban busses
- Tirana Public Transportation Terminal (TPTT)
- SEE-ITS

Concerning the funding of the projects, only the SEE-ITS project uses European funds while all the rest are financed from national funding and from private institutions.

1.4. Summarized Description of EU Directive 2010/40/EU

The increase in the volume of road transport in the Union associated with the growth of the European economy and mobility requirements of citizens is the primary cause of increasing congestion of road infrastructure and rising energy consumption, as well as a source of environmental and social problems. The response to those major challenges cannot be limited to traditional measures, inter alia the expansion of the existing road transport infrastructure. Innovation will have a major role to play in finding appropriate solutions for the Union. So, in 6/8/2010 published at the Official Journal of the EC "DIRECTIVE 2010/40/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL" on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport.

The following 4 priority areas are defined within 2010/40/EU Directive:

- Optimal use of road, traffic and travel data,
- Continuity of traffic and freight management ITS services,
- ITS road safety and security applications,
- Linking the vehicle with the transport infrastructure.

Moreover, the 2010/40/EU Directive states "to ensure a coordinated and effective deployment of ITS within the Union as a whole, specifications, including, where appropriate, standards, defining further detailed provisions and procedures should be introduced."

Moreover, the adoption of specifications, the issuing of mandates for standards and the selection and deployment of ITS applications and services shall be based upon an evaluation of needs involving all relevant stakeholders, and shall comply with the following basic principles:

- Be effective – make a tangible contribution towards solving the key challenges affecting road transportation in Europe (e.g. reducing congestion, lowering of emissions, improving energy efficiency, attaining higher levels of safety and security including vulnerable road users);
- Be cost-efficient – optimise the ratio of costs in relation to output with regard to meeting objectives;
- Be proportionate – provide, where appropriate, for different levels of achievable service quality and deployment, taking into account the local, regional, national and European specificities;
- Support continuity of services – ensure seamless services across the Union, in particular on the trans-European network, and where possible at its external borders, when ITS services are deployed. Continuity of services should be ensured at a level adapted to the characteristics of the transport networks linking countries with countries, and where appropriate, regions with regions and cities with rural areas;

- Deliver interoperability – ensure that systems and the underlying business processes have the capacity to exchange data and to share information and knowledge to enable effective ITS service delivery;
- Support backward compatibility – ensure, where appropriate, the capability for ITS systems to work with existing systems that share a common purpose, without hindering the development of new technologies;
- Respect existing national infrastructure and network characteristics – take into account the inherent differences in the transport network characteristics, in particular in the sizes of the traffic volumes and in road weather conditions;
- Promote equality of access – do not impede or discriminate against access to ITS applications and services by vulnerable road users;
- Support maturity – demonstrate, after appropriate risk assessment, the robustness of innovative ITS systems, through a sufficient level of technical development and operational exploitation;
- Deliver quality of timing and positioning – use of satellite-based infrastructures, or any technology providing equivalent levels of precision for the purposes of ITS applications and services that require global, continuous, accurate and guaranteed timing and positioning services;
- Facilitate inter-modality – take into account the coordination of various modes of transport, where appropriate, when deploying ITS;
- Respect coherence – take into account existing Union rules, policies and activities which are relevant in the field of ITS, in particular in the field of standardization.

1.5. Prioritization of ITS Projects in Albania

At the framework of the study “Proposals for Long-term Investment Plans in Albania regarding Intelligent Transportation Systems”, based on existing ITS conditions in Albania and on the requirements of EU Directive 2010/40/EU, an ITS project inventory was developed for Albania.

A brief description of the proposed ITS projects in Albania for short and medium- term deployment is presented below:

1.5.1. Project 1: Development of Traffic Management Information System in the city of Tirana

This system will be combined with the Tirana Urban Traffic Control Management system and will have as a scope to provide traffic related information to the users of the network. The information will be provided via roadside infrastructure (Variable Message Signs-VMS), and through the internet – mobile applications. VMS will provide real time travel times for important routes, traffic condition description and information regarding incidents. Through the internet and the mobile applications routing services, traffic related information, and information concerning the public transport means and the possible multimodal choices will be provided. The implementation of the services will require the installation of roadside equipment (VMS, traffic counters), the processing of traffic data (routing algorithms, traffic models) and the provision to the final users (VMS, web, mobile applications). The scale of this project will be regional.

1.5.2. Project 2: Development of Public Transport Information System in the city of Tirana

This system will be based on the “On-line fleet management” project. The system will use the trajectories derived from the GPS equipped buses and will provide real time on-trip passenger information services. These services will be the display of on-board information and the display of bus arrival information at roadside equipment (smart bus stops). Information will be also available through the web and mobile applications. The scale of this project will be local.

1.5.3. Project 3: Development of Advanced Traffic Management System in Tirana - Durres

This project will get advantage of the technological background and the experience gained from the “Tirana Urban Traffic Control Management” project and will establish a highway traffic management system. The functions of the system will be the traffic monitoring, the collection of real time traffic data and the incident detection. The scale of the project will be regional. The Advanced Highway Traffic Management system that will be assessed will the Tirana – Durres motorway.

1.5.4. Project 4: Development of the e-Call system

This project will get advantage of the experience gained from the “Digital Tachograph” project and will implement the e-Call system. In case of a crash, an e-Call-equipped car automatically will call the nearest emergency center. The project could install, as a first step, the e-Call system in commercial cars. Moreover the implementation requires the creation of emergency centers. The scale of the project will be national.

Based on this previous study findings and prioritirization, this study will evaluate the projects considered for short-term implementation in Albania. More specifically, the projects under socio-economical evaluation are the following:

- Project 1: Development of Traffic Management Information System in the city of Tirana
- Project 3: Development of Highway Traffic Management System in the inter-urban road axis Tirana – Dirres

2. Cost-Benefit Analysis of ITS

The appraisal of a transportation project seeks to evaluate the value for money of this project. Investments on the transportation sector usually affect many different parties (i.e. public transport agencies, transport users, businesses, land owners etc.). Each of these parties is interested in quantifying the impacts of a transportation project from his/her viewpoint. However, an economic analysis that is conducted within the context of a transport project appraisal aims to identify the social benefit of the transport project.

In this present document a framework is proposed for the conduct of such an economic analysis. The proposed framework approach is a cost-benefit analysis (CBA). A CBA compares costs and benefits (in monetary units) of an application incurred in a specific time period and spatial dimension (e.g. highway corridor). As a comparative tool CBA assesses the difference between project alternatives (i.e. capital investment alternatives) and a Base Case Alternative (i.e. “Do minimum” alternative). A “Do minimum” alternative should be the most plausible yet efficient utilization of the stock of capital resources that is likely to be available over the life of the proposed project, without additional investment.

Transportation projects normally require large initial investments and are expected to generate benefits extending far into the future. Thus, a need is created to compare benefits and costs that occur at different points in time. Since money has a time value, the same amount of money at different times does not have the same value. Therefore, it is important to convert costs and benefits (i.e. “cash flows”) into equivalent values when conducting a CBA.

2.1. Overview of CBA in Transport

The primary goal of an economic assessment of a transport project is to quantify the magnitude of the economic impact resulting from an investment in the transportation sector. The cumulative economic impact is a function of the change in transport user benefits (i.e. consumer’s surplus), the change in system operating costs and revenues (i.e. producer surplus), the change in cost of externalities (i.e. environmental costs, accidents, etc.), and finally the investments costs.

Monetizing the abovementioned changes is a rather demanding task, since it is necessary to consider:

- The scope of the analysis in terms of mode, study area and range of impacts;
- The definition of the alternatives – particularly the “Do minimum” alternative;
- The estimation of transport user benefits (consumer surplus);
- The estimation of impacts on transport providers and the government (includes producer surplus and investment costs);
- Monetization of time and safety;

- Consideration of environmental impacts and other externalities;
- The mechanics of the process including inputs, project life, discounting, aggregation of benefits and costs, unit of account.

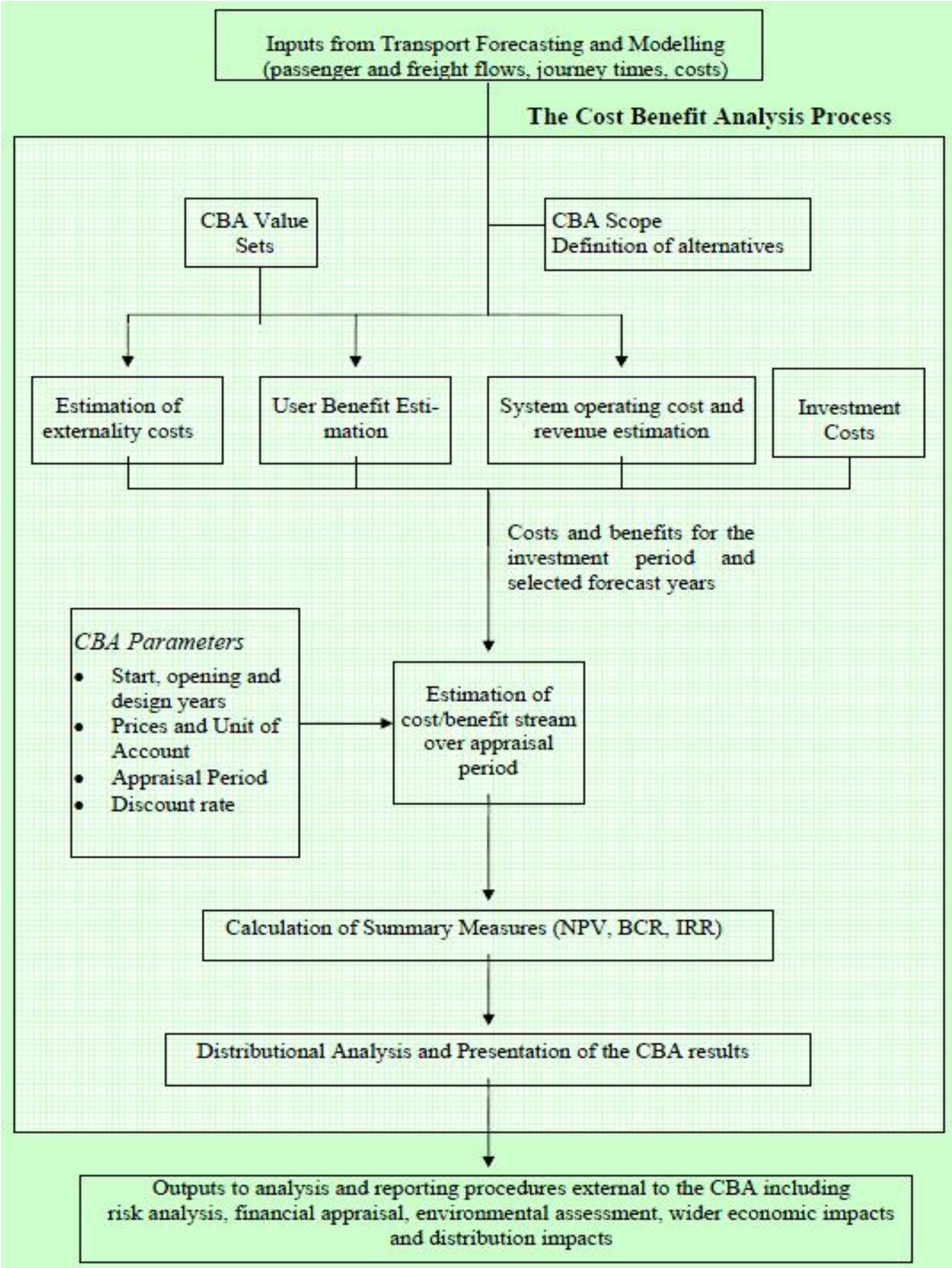

Figure 1: Flowchart of Transport Economic Appraisal (*Source: HEATCO D5 [1]*)

2.2. Scope of the CBA

In order to define the scope of a CBA it is critical to delineate the study area, determine the modes of transports that should be considered in the analysis, and identify the impacts of the transport project. Regarding impacts, the estimation of changes in producer and consumer surplus demands the measurement of benefits, revenues and costs to transport operators and users. These should at least include the investment cost and changes in infrastructure and system maintenance and operating costs, travel times, safety, user charges and operator revenues. As far as the modes of transport are concerned, those should be considered that will use the new infrastructure, along with those from which demand may be abstracted. Finally, the study area should be small enough to facilitate the estimation of accurate results.

2.3. Estimation of consumer's surplus and travel time savings

Monetization of transport user benefits requires the quantification of consumer's surplus. Consumer's surplus has been defined as the excess of consumer willingness to pay over the cost of a trip. Normally, what is of interest is the change in consumer surplus occurring from some change in the cost of travel incurred by an improvement in transport conditions. However, in the transportation field, money costs are only a part of the composite travel cost. In reality the cost of travel also encompasses the time spent by the users, access time to public transport, discomfort, perceived safety risk and other elements. Thus, price alone is not an accurate estimate of the cost of travel of the consumer's willingness to pay, instead generalized cost is used.

Generalized cost is an amount of money representing the overall cost and inconvenience to the transport user of travelling between a particular origin and destination by a particular mode. In practice, generalized cost is usually limited to a number of impacts which when added constitute the components of user benefit:

1. Time costs (Time in minutes * Value of Time in €/minute);
2. User charges (e.g. fares/tolls); and
3. Operating costs for private vehicles.

It is critical though to mention that the components of generalized cost differ among the different transportation modes. Thus, there is a substantial difference in the reported user's benefits for users of different modes. Moreover, it should be noted that Value of Time varies between individuals and even for the same individual, depending for example on the trip purpose. Thus, there is no unique willingness-to-pay for travel time savings.

Given the significance of the Value of Time in the estimation of the generalized cost of travel and in consequence the consumer's surplus, it is recommended that local values should be used whenever possible, provided that they have been produced according to a coherent and well justified methodology. In the case that no such values exist, then default values obtained from international analyses of value of time studies should be used (e.g. Developing Harmonized European Approaches for Transport Costing and Project Assessment [1]). In the abovementioned study different valuation methods of Value of Time have been used for different trip purposes.

2.4. Estimation of Producer's Surplus

Since CBA is concerned about the social welfare and not only the consumer's surplus, the producer's surplus should be estimated as well. Producer's surplus is defined simply as the total revenue minus total costs. However, regarding producer's surplus, it should be emphasized at this point that if the additional demand for this service is associated with reduced consumption of some other goods or services elsewhere in the economy, those goods and services are being priced at marginal cost, so that there is no offsetting or additional change in producer surplus elsewhere.

2.5. Investment Costs

The investment costs for transport infrastructure projects are normally dictated from engineering design studies and estimates. However, necessary adjustments have to be applied to these engineering cost estimates before they can be considered for the economic analysis. Adjustments should account for **Inflation** (between year of the engineering cost estimate and price base of the appraisal).

No adjustments are required for the method of the project financing. The investment costs are the same whether or not the project is financed directly by the government or through some form of private sector involvement (i.e. public private partnerships). Moreover, it is important that user benefits reflect any travel time and cost delays during construction, although they cannot be directly accounted as investment costs.

2.6. Maintenance and Operating Costs

Appropriate estimates are also necessary for the costs of infrastructure and services operation, which are mode and country-specific. The main costs are commonly:

- The costs of infrastructure operation;
- Maintenance costs;
- Changes in the vehicle operating costs of public transport services.

Additionally, any disruption to transport users that occurs during periods of routine maintenance should be reflected in the appraisal as a user benefit impact.

2.7. Safety related Benefits

Safety is not treated like the other components of user benefit. Instead of being considered as a component of generalized cost per trip, accidents and casualties are typically treated as random, occasional costs arising from the transport system. These costs are estimated by applying unit values per accident and per casualty. The calculation is a simple multiplication of forecasted accident numbers (by severity) with the costs of accidents (by severity). This approach is similar to that of externalities (e.g. the environment).

Accidents costs are comprised by direct economic costs, indirect economic costs, costs of material damage, and a value of safety per se:

- Value of safety per se: willingness to pay for protecting human life based on stated preference studies carried out in the country concerned.
- Direct and indirect economic costs (mainly medical and rehabilitation cost, administrative cost of legal system, and production losses).
- Material damage from accidents: cost values for the average damage caused by accidents in the country under assessment.

Estimates for the value of safety per se, direct and indirect economic costs, and material damage can be found in the following project report “Developing Harmonized European Approaches for Transport Costing and Project Assessment [1]” regarding EU member countries.

2.8. Environmental Impacts of a Transport Project

Investments on ITS technologies and infrastructure can possibly generate significant benefits regarding the surrounding environment (i.e. natural and man-made). Within the context of a CBA analysis attention is being placed on the assessment of environmental effects such as air pollution, noise and global warming. Monetary measures are proposed below for the valuation of these environmental impacts. In order to quantify the positive effects of the transport project on air pollution the following calculation procedure is recommended:

Step 1: quantification of change in pollutant emissions (NOx, SO2, NMVOC, PM2.5/PM10) due to a project, measured in tonnes, using state-of-the-art national or European emission factors.

Step 2: classification of emissions according to local environment (urban – outside built-up areas).

Step 3: preparation of the cost factor table by increasing the cost factor according to the assumed country-specific GDP per capita growth for each year of the analysis.

Step 4: calculation of impacts (multiplication of pollutant emissions by impact factor) and costs (multiplication of pollutant emissions by cost factor).

Step 5: reporting of impacts and costs.

The monetization of noise costs should be obtained according to the subsequent estimation procedure:

Step 1: quantification of the number of persons exposed to certain noise levels (should be available from noise calculations) for the Do-Minimum case and the Do-Something case.

Step 2: preparation of the cost factor table by increasing the cost factor according to the assumed country-specific GDP per capita growth for each year of the analysis.

Step 3: calculation of impacts (multiply percentage of highly annoyed persons by number of persons exposed) and costs (multiply cost per person by number of persons exposed) for both cases.

Step 4: subtraction of total costs for the Do-Something case from Do-Minimum case

Step 5: reporting of costs and impacts (change in number of people highly annoyed).

Accordingly, the estimation of costs due to the emission of greenhouse gases (usually expressed as CO2 equivalents) is conducted by multiplying the amount of CO2 equivalents emitted with a cost factor. The calculation steps are the following:

Step 1: quantification of change in greenhouse gas emissions (i.e. CO2) due to a project measured in tonnes.

Step 2: multiplication of CO2 equivalents with cost factor for year of emission.

Step 3: reporting of emissions and costs.

Values for the corresponding emission and noise cost factors can be obtained from the following project report “Developing Harmonized European Approaches for Transport Costing and Project Assessment [1]” regarding EU member countries.

2.9. Evaluation Criteria

Costs and benefits have to be converted into equivalent present values prior to the estimation of the evaluation criteria on which the project assessment will be based. Thus, the base year of the evaluation has to be initially determined. All past investment costs have to be converted into present values (with respect to the base year of the valuation) according to the inflation rate of the corresponding country where the investment is taking place. All future costs (i.e. operation and maintenance) and benefits have to be converted into equivalent present values according to the present value formula:

$$P = F*(1+r)-N \qquad \text{(Eq. 1)}$$

where P is the present value, F is the future amount, r is the social discount rate, and N is the project lifetime.

The abovementioned conversions require the knowledge of the project lifetime (i.e. typically ranges between 5 – 10 years for ITS projects), the inflation rate as well as the social discount rate. The social discount rate represents the way money now is worth more than money later. It determines by how much any future amount is discounted or reduced, to make it correspond to an equivalent amount today. It is generally specified as a constant rate over time (i.e. reference social discount rate is 5.5% for EU transport projects [2]).

There are three evaluation criteria that can be used for the economic assessment of a transport project:

- Net Present Value (NPV);
- Benefit-Cost Ratio; and
- Internal Rate of Return (IRR)

The net present value is defined as the difference between benefits and costs. NPV focuses attention on quantity of money, which is what the evaluation is ultimately concerned with. However, it only provides a good comparison between projects when they are strictly comparable in terms of level of investment or total budgets. Benefit-cost ratio is a non-dimensional index of economic evaluation. It allows the comparison of projects on a common scale and provides an easy mean to rank objects in order of relative merit. However, since values changes depending on how costs and benefits are counted, there has been frequently observed a tendency to manipulate the data. Finally, the internal rate of return is the discount rate for which the net present value of a project is zero. The internal rate of return introduces the notion of “return on investment” and the project with the highest IRR is ranked as top. The advantages of the IRR is that it eliminates the need to argue about the appropriate discount rate and that rankings cannot be manipulated by the choice of the discount rate. On the other side, such an evaluation could possibly lead to two or more solutions; one cannot really tell what the IRR is.

3. COST-BENEFIT ANALYSIS OF ATIS IN TIRANA

3.1. Brief Project Description

The project relates to the development of an Advanced Travelers Information System (ATIS) in the city of Tirana.

According to 2011 census, Tirana population is estimated to 321.546 citizens.

Note that Tirana today has established a Traffic Management Control Centre (TMCC) providing modern and adaptive traffic signaling system functionalities. So, it is expected that the current ITS project under evaluation will be hosted in the existing Traffic Management Control Centre.

The project relates to the development of an Advanced Travellers Information System (ATIS) in the city of Tirana. The ATIS in Tirana is expected to include the development of the following systems:

- Procurement and installation of traffic detectors for the real time acquisition of traffic data such as traffic flows, traffic speed, occupancy and traffic classification.
- Procurement and installation of CCTV/PTZ cameras for visual monitoring of pertaining traffic conditions at critical road segments or intersections in the road network of Tirana.
- Procurement and installation upon intersections of Bluetooth detectors for estimating travel times at specific predetermined paths.
- Procurement and installation of Variable Message Signs (VMS) at strategically located sites of the road network in order to provide real-time information regarding traffic conditions (e.g. congestion levels, travel times) and traffic incidents.
- Supplementary hardware equipment for the existing TMCC where the ATIS is expected to be hosted. The supplementary equipment relates to the acquisition and installation of servers and workstations.
- Integration activities to the existing Traffic Signalling Management system in order to acquire the traffic data collected close to traffic signalized intersections.
- Development and configuration of a central ATIS software platform receiving on-site data and providing advanced capabilities to the operator for monitoring and processing the collected traffic data. Moreover, via the software platform the processed data can be sent to the available communication channels (such as VMS, web-portal). The central ITS software platform is expected to provide at least the following functionalities:
    - Traffic data collection and data processing via advanced traffic modelling techniques

  - Visual monitoring of traffic conditions via processed data and by cameras
  - Cameras management functionality
  - Detailed reporting of traffic conditions via maps, graphs and tables
  - Hardware diagnostic functionalities for the on-site equipment
  - Manual insertion of traffic events into the system
  - Variable Message signs management functionality
- Development of web-portal with 2 basic functionalities:
  - Provide dynamic information regarding traffic conditions, travel times within the city, traffic incidents and routing and navigation capabilities
  - Provide advanced and dynamic multi-modal travel options with public transport and bicycles (e.g. travel times, navigation capabilities); this requires the collection and processing of public transport available data (e.g. bus stops, description of bus lines, description of bicycle routes, e.t.c)

The project includes the preparation of an implementation study before the initiation of works, some period for system testing after the installation of ATIS and extensive training to Authority's personnel.

It is assumed that 3 years period guarantee period is provided for all sub-systems of ATIS.

3.2. Project Costs

At the framework of this study, a preliminary cost evaluation was undertaken based on the following bill of quantities.

Table 1: Preliminary Bill of Quantities for ATIS

Description	Quantity	Type
Variable Message Signs	14	items
CCTV/PTZ monitoring cameras	15	items
Traffic Detectors	50	items
Bluetooth devices for travel time estimation	22	items
Servers	2	items
Workstations	2	items
Integration to traffic signal system for traffic data acquisition	2	m/m
ITS Central Platform (including all sw)	1	items
Web-portal for real-time traffic information	1	items
Multi-modal journey planner	1	items
Collection and processing of PT data	4	m/m

Configuration activities	3	m/m
Traffic Calibration Activities	3	m/m
Project management	5	m/m
Training	1	m/m
Implementation study	1	m/m
System testing	2	m/m

3.2.1. Investment Costs

The investment project cost is estimated to 1.580.925 euros (in 2014 constant prices). The relevant analysis is provided on the following table:

Table 2: Analysis of ATIS Investment Costs

Description	Quantity	Type	Cost/Item	Cost
Variable Message Signs	14	items	40.000	560.000
CCTV/PTZ monitoring cameras	15	items	7.000	105.000
Traffic Detectors	50	items	7.000	350.000
Bluetooth devices for travel time estimation	22	items	3.000	66.000
Servers	2	items	5.000	10.000
Workstations	2	items	750	1.500
Integration to traffic signal system for traffic data acquisition	2	m/m	15.000	30.000
ITS Central Platform (including all sw)	1	items	80.000	80.000
Web-portal for real-time traffic information	1	items	15.000	15.000
Multi-modal journey planner	1	items	20.000	20.000
Collection and processing of PT data	4	m/m	10.000	40.000
Configuration activities	3	m/m	10.000	30.000
Traffic Calibration Activities	3	m/m	15.000	45.000
Project management	5	m/m	15.000	75.000
Training	1	m/m	15.000	15.000
Implementation study	1	m/m	15.000	15.000
System testing	2	m/m	10.000	20.000
Non foreseen (7%)				103.425
Total				1.580.925

3.2.2. Maintenance & Operating Costs

Within the operating costs, the telecommunication costs and the personnel costs are quantified. The operating costs are expected to occur within the entire evaluation period, after the delivery of the system.

The telecommunication costs are calculated based on the number of hardware equipment on-site. A value of 8€ per hardware equipment per day is considered as realistic.

Although, ATIS is expected to be hosted in existing TMCC of Tirana, except of the existing personnel, additional personnel is expected to be involved with ATIS. So, 3 persons are expected to be hired.

The maintenance costs relate to all systems ATIS maintenance. An average cost of 100€ per day is considered as realistic. Since 3 years guarantee period is expected for ATIS, then for first 3 years of the system operation, the maintenance costs are excluded for the analysis.
The following table summarizes the expected annual maintenance and operating costs in 2014 constant prices.

Table 3: Estimated ATIS Annual Maintenance & Operating Costs

Description	Cost (€)
Telecommunications	9.888 €
Personnel	36.000 €
Maintenance	10.500 €
Total	56.388 €

3.3. Project Benefits

The ATIS of Tirana project is expected to bring benefits by reduction of trips travel time, by reduction of vehicles CO2 emissions, and by the reduction of vehicles fuel consumption. Benefits to safety are not expected. The pre-mentioned benefits are quantified in monetary terms, by using the Report "Developing Harmonised European Approaches for Transport Costing and Project Assessment (February 2006)".

3.3.1. Travel Time Savings

ATIS will provide real-time traffic information pre-trip via web-portal and on-trip via VMS at the road network and mobile phones. So, it is expected that travellers will optimize at some degree their trip routes resulting in reduction of trip travel times.

Since several trip and car ownership data within city of Tirana were not available, the following assumptions were made in order to estimate number of trips and number of total vehicles-hrs:

- Registered vehicles in Albania, according to National Statistics (Institute of Transport of Albania), are 445.956 for the year 2013. In year 2014, the registered vehicles are assumed to remain identical. The total number of cars, motorcycles and buses is 374.031 vehicles.
- To estimate the car ownership level to Tirana, based on internet-search, it is found that Tirana accounts for 41% of private car ownership of the entire country; this can be considered realistic since it Tirana is the capital and the most modern city and the other cities present low population (except Durres where population is 200.000 citizens). Therefore, the number of registered vehicles in Tirana is estimated to 153.053 vehicles.
- To estimate the annual trips in Tirana, it is assumed that each registered vehicle will be used 40% within 365 days of a year and will undertake on-average 2 trips per day. Therefore, the annual total number of trips for 2014 within the city of Tirana is 44.778.991.
- A mean trip time of 20 minutes was assumed in order to be at conservative side, i.e. the total annual vehicles-hrs for 2014 in Tirana is estimated to 14.926.330.

To be on conservative side, 2% reduction of total vehicles-hrs per year is forecasted due to the implementation of ATIS (note that another pilot has shown that the benefits due to multi-modal journey planner can reach up to 20%). Moreover, it is assumed that total annual vehicles-hrs will increase annually by 2.5% within the evaluation time period, so the annual time savings of ATIS in absolute values will increase correspondingly.

To quantify the benefits from the reduction of vehicles-hrs, the Value of Time for Albania is obtained by Table 0.3 from the report "Developing Harmonised European Approaches for Transport Costing and Project Assessment (February 2006). The value of time for 2014 is estimated by using GDP/capita growth (source: World Bank), as shown in the following table:

Table 4: Estimation of Value of Time

Year	Annual Growth Rate of GDP/capita	Value of Time (€/hr)
2002		11,58
2003	0,084	12,55
2004	0,011	12,69
2005	0,055	13,39
2006	0,05	14,06
2007	0,059	14,89
2008	0,077	16,03
2009	0,033	16,56

2010	0,084	17,95
2011	0,061	19,05
2012	0,013	19,30
2013	0,013	19,55

3.3.2. Emissions

To quantify in monetary terms the CO2 emissions, the CO2 cost factor (€/tonne) should be determined and the relevant reduction of CO2 vehicles emissions in the city of Tirana.

The CO2 cost factor emissions are obtained by Table 0.16 from the report "Developing Harmonised European Approaches for Transport Costing and Project Assessment (February 2006); the CO2 cost factor for the period 2010 – 2019 is obtained as 26 €/tonne.

To estimate the reduction of CO2 emissions in the city of Tirana the following assumptions were made:

- In 2008, CO2 emissions at Albania were estimated to 2Mt (according to web-site: knoema.com). The CO2 emissions, within period 2002 – 2008, have shown significant annual variation within the range of -20.91% and 32.53%. So, within the period 2008 – 2014, a 5% annual increase on CO2 emissions is assumed, i.e. in 2014 the CO2 emissions of Albania are estimated to 2.68Mt.
- To estimate the CO2 emissions at Tirana: (a) the split of registered vehicles in Tirana and Albania is estimated, and (b) the split is multiplied by the CO2 emissions of Albania for the year 2014. So, the CO2 emissions of Tirana for the year 2014 are estimated to 1.1Mt.

To be on conservative side, 2% reduction of CO2 emissions per year is forecasted due to the implementation of ATIS. Since, it is assumed that there will be annual increase of 2.5% in vehicle-hours within the entire evaluation period, and then corresponding increase is applied for the CO2 emissions.

3.3.3. Fuel Consumption

To quantify fuel consumption reduction in monetary terms, petrol and diesel current local market prices were identified by internet-search. So, for November 2014, the local market prices for petrol and diesel are 1,413€/liter and 1,335€/liter respectively.

To estimate the petrol and diesel fuel road transport consumption in Albania the World Bank portal is used (http://data.worldbank.org/).

In order to estimate the reduction of petrol and diesel road transport consumption the following assumptions were made:

- In Albania for 2011, the road transport consumption of petrol and diesel was 38.5 kg per capita and 262 kg per capita (note that 1kg = 1 liter), according to the World Bank portal. Since significant variations are observed within 2005 and 2011, the road transport fuel consumption was assumed to remain identical.
- According to census 2011, the population of Albania is 2.821.977. In year 2014, the Albania population is assumed to remain identical.
- So, the annual petrol and diesel consumption in Albania for the year 2014 is estimated to 108.646 liters and 739.358 liters respectively.
- To estimate the petrol and diesel consumption at Tirana for road transport: (a) the split of registered vehicles in Tirana and Albania is estimated, and (b) the split is multiplied by the relevant estimated fuel consumption of Albania for the year 2014. So, the petrol and diesel road transport consumption of Tirana for the year 2014 are estimated to 44.545 and 303.137 respectively

To be on conservative side, 2% reduction of petrol and diesel consumption per year is forecasted due to the implementation of ATIS. Since, it is assumed that there will be annual increase of 2.5% in vehicle-hours within the entire evaluation period, and then corresponding increase is applied for the fuel consumption.

3.4. Results

Based on the figures presented in section 3.2 and 3.3, the CBA results for ATIS in Tirana are presented into this section.

Significant parameters to the CBA evaluation are the following:

- The evaluation time period is 2013 – 2020. The deployment of the system is undertaken in the year 2014. Seven (7) is considered the life cycle of the system which is considered a realistic time period for ITS.
- The social discount rate is taken as 7%.
- The discounted values are obtained by Equation 1.

The infrastructure cost is 1.580.925€. The Present Value of maintenance operating costs for the period 2014 – 2020 is 276.336€. Therefore, the Present Value of Total Costs within the CBA evaluation period is 1.857.261€.

The operating/ maintenance costs are shown in the following Table.

Table 5: ATIS Maintenance/ Operating Costs

Year	2014	2015	2016	2017	2018	2019	2020
Cost (€)	45888	45888	45888	56388	56388	56388	56388
Discounted Values (€)	42886	40080	37458	43018	40204	37574	35116

The Present Value of total benefits, i.e. vehicles-hour reduction, reduction of CO2 emissions and reduction of fuel consumption, is estimated for the entire evaluation period to 37.039.913€. The detail presentation of benefits within period 2014 – 2020 is shown in the following Table.

Table 6: Annual ATIS Benefits within the Evaluation Period 2014 – 2020

Year	2014	2015	2016	2017	2018	2019	2020	PV
Travel Time Savings								
Reduction of Veh-Hours (veh-hours)	298.527	305.990	313.640	321.481	329.518	337.755	346.199	
Value of Travel Time (€/hour)	19,55	19,55	19,55	19,55	19,55	19,55	19,55	-
Benefit from Travel Time Savings	5.835.651	5.981.543	6.131.081	6.284.358	6.441.467	6.602.504	6.767.567	
Discounted Values (€)	*5.453.880*	*5.224.511*	*5.004.789*	*4.794.307*	*4.592.677*	*4.399.527*	*4.214.500*	*33.684.191*
Emissions								
CO^2 Emission Reduction (in tonnes)	21.978	22.527	23.090	23.667	24.259	24.866	25.487	
Cost Factor (€/tonne)	26,00	26,00	26,00	26,00	26,00	26,00	26,00	-
Benefit from reduction of CO^2 Emissions	571.417	585.702	600.345	615.353	630.737	646.506	662.668	
Discounted Values (€)	*534.034*	*511.575*	*490.060*	*469.450*	*449.707*	*430.794*	*412.677*	*3.298.297*
Fuel Consumption								
Reduction of Consumed Petrol (in liters)	891	913	936	959	983	1.008	1.033	
Petrol Price (€/liter)	1,41	1,41	1,41	1,41	1,41	1,41	1,41	
Benefit (€)	1.259	1.290	1.323	1.356	1.390	1.424	1.460	
Reduction of Consumed Diesel (in liters)	6.063	6.214	6.370	6.529	6.692	6.859	7.031	-
Diesel Price (€/liter)	1,34	1,37	1,40	1,44	1,47	1,51	1,55	
Benefit (€)	8.094	8.503	8.934	9.386	9.861	10.361	10.885	
Benefit from Reduction of Fuel Consumption (€)	9.353	9.794	10.257	10.742	11.251	11.785	12.345	
Discounted Values (€)	*8.741*	*8.554*	*8.372*	*8.195*	*8.022*	*7.853*	*7.688*	*57.425*
Discounted Values (€)								*37.039.913*

Therefore, the Cost-Benefit Ratio is calculated to 19,94; i.e. for each 1€ invested, the corresponding socio-economic benefit will be 19,94€.

Moreover, the Net Present Value is 35.182.652€ > 0 and the Internal Rate of Return (IRR) = 372% > 7% (social discount rate).

So, the ATIS project can be considered in socio-economical terms as very beneficial for deployment, since all socio-economic indicators are very positive.

4. Cost-Benefit Analysis of ATMS

4.1. Brief Project Description

The project relates to the development of an Advanced Traffic Management System (ATMS) in motorway Tirana – Durres.

The motorway Tirana – Durres is connecting the most significant cities of Albania; Tirana and Durres have population of 421.286 and 200.000 respectively. The motorway has two traffic lanes per traffic direction and each traffic direction is separated by islands. The total motorway length is 34.9 km.

It is assumed that the ATMS will be incorporated within the existing Traffic Management Control Centre (TMCC) which provides modern and adaptive traffic signaling system functionalities. However, significant infrastructure investment will be required within the existing TMCC in order to host the ATMS functionalities.

The development of an Advanced Traffic Management (ATMS) in the motorway Tirana – Durres will include the following activities:

- Procurement and installation of incident detection cameras in order to record in real-time the pertaining traffic incidents. Moreover, via the incident detection cameras the existing traffic levels will be detected. The incident detection cameras will cover the entire motorway length.
- Procurement and installation of traffic detectors for the real time acquisition of traffic data such as traffic flows, traffic speed, occupancy and traffic classification.
- Procurement and installation of CCTV/PTZ cameras for visual monitoring of pertaining traffic conditions at critical road segments or intersections of the motorway.
- Procurement and installation of hardware within the existing TMCC of Tirana in order to host adequately the new ATMS. New servers, new workstations and new monitors are foreseen to be acquired for the ATMS.
- Development and configuration of a central ATMS software platform receiving on-site data and providing advanced capabilities to the operator for monitoring and processing the collected data. Moreover, via the software platform the processed data can be sent to the available communication channels (such as VMS). The central ATMS software platform is expected to provide at least the following functionalities:
    - Traffic data collection and data processing via advanced traffic modelling techniques
    - Automatic traffic incident collection and monitoring, as well as manual validation options
    - Visual monitoring of traffic conditions via processed data and by cameras

- Advanced Cameras management functionalities
- Detailed reporting of traffic conditions and incidents via maps, graphs and tables
- Hardware diagnostic functionalities for the on-site equipment
- Manual insertion of traffic events into the system

- Variable Message signs management functionality.

The project includes the preparation of an implementation study before the initiation of works, some period for system testing after the installation of ATMS and extensive training to Authority's personnel.

It is assumed that 3 years period guarantee period is provided for all sub-systems of ATMS.

4.2. Project Costs

At the framework of this study, a preliminary cost evaluation was undertaken based on the following bill of quantities:

Table 7: Preliminary Bill of Quantities for ATIS

Description	Quantity	Type
Variable Message Signs	8	items
Incident Detection Cameras	70	items
Traffic Detectors	10	items
CCTV/PTZ monitoring cameras	10	items
Servers	4	items
Workstations	4	items
Large Monitors	4	items
Control Centre supplementary spares)	1	item
ITS Central Platform (including all sw)	1	items
Configuration activities	4	m/m
Project management	6	m/m
Training	2	m/m
Implementation study	2	m/m
System testing	3	m/m

4.2.1. Investment Costs

The investment project cost is estimated to 1.860.730 euros (in 2014 constant prices). The relevant analysis is provided on the following table:

Table 8: Analysis of ATMS Investment Costs

Description	Quantity	Type	Cost(€) /Item	Cost (€)
Variable Message Signs	8	items	55.000	440.000
Incident Detection Cameras	70	items	10.000	700.000
Traffic Detectors	10	items	7.500	75.000
CCTV/PTZ monitoring cameras	10	items	7.000	70.000
Servers	4	items	5.000	20.000
Workstations	4	items	1.000	4.000
Large Monitors	4	items	10.000	40.000
Control Centre supplementary spares)	1	item	50.000	50.000
ITS Central Platform (including all sw)	1	items	120.000	120.000
Configuration activities	4	m/m	10.000	40.000
Project management	6	m/m	15.000	90.000
Training	2	m/m	15.000	30.000
Implementation study	2	m/m	15.000	30.000
System testing	3	m/m	10.000	30.000
Non foreseen (7%)				121.730
Total				1.860.730

4.2.2. Maintenance & Operating Costs

Within the operating costs, the telecommunication costs and the personnel costs are quantified. The operating costs are expected to occur within the entire evaluation period, after the delivery of the system.

The telecommunication costs are calculated based on the number of hardware equipment on-site. A value of 8€ per hardware equipment per day is considered as realistic.

Although, ATMS is expected to be hosted in existing TMCC of Tirana, except of the existing personnel, additional personnel is expected to be involved with ATMS. So, 10 persons are expected to be hired since 24-hr system operation will be required.

The maintenance costs relate to all systems ATMS maintenance. An average cost of 100€ per day is considered realistic. Since 3 years guarantee period is expected for ATMS, then for first 3 years of the system operation, the maintenance costs are excluded for the analysis.

The following table summarizes the expected annual maintenance and operating costs in 2014 constant prices.

Table 9: Estimated ATMS Annual Maintenance & Operating Costs

Description	Cost (€)
Telecommunications	9.792

Personnel	120.000
Maintenance	10.400
Total	140.192

4.3. Project Benefits

The ATMS project in the Tirana – Durres motorway is expected to bring benefits mainly by reduction of accidents but also by reduction of trips travel time, by reduction of vehicles CO2 emissions, and by the reduction of vehicles fuel consumption. Benefits to safety are not expected. The pre-mentioned benefits are quantified in monetary terms, by using the Report "Developing Harmonized European Approaches for Transport Costing and Project Assessment (February 2006)".

4.3.1. Travel Time Savings

ATMS will provide real-time traffic information on-trip via VMS at the road network and mobile phones. So, it is expected that travelers may choose alternative routes when traffic congestion or traffic incident is apparent, i.e. some improvement on travel times is foreseen.

Since no traffic data were available, the following assumptions were made in order to estimate number of trips and number of total vehicles-hrs:

- The peak-hr traffic level is assumed to be 3,200 vehicles per hour per traffic direction
- Traffic surveys in Greece in interurban road network have shown that peak hour traffic is between 13% and 17% of the daily traffic. Since, the motorway distance is short and the motorway connects the most two significant cities in Albania, it is assumed that peak hour is 13% of the daily traffic, i.e. the peak hrs are more smoothed
- For 2014, the annual traffic levels in the motorway section Tirana – Durres is estimated to 17.969.231 (for both directions of traffic)
- A mean travel time of 28 minutes is estimated between Tirana and Durres, i.e. an average speed of 75km/hr

To be on conservative side, 0.5% reduction of total vehicles-hrs per year is forecasted due to the implementation of ATMS. Moreover, it is assumed that total annual vehicles-hrs will increase annually by 2% within the evaluation time period.

To quantify the benefits from the reduction of vehicles-hrs, the Value of Time for Albania is obtained by Table 0.3 from the report "Developing Harmonized European Approaches for Transport Costing and Project Assessment (February 2006). The value of time for 2014 is estimated by using GDP/capita growth (source: World Bank), as shown in the following table:

Table 10: Estimation of Value of Time

Year	Annual Growth Rate of GDP/capita	Value of Time (€/hr)
2002		11,58
2003	0,084	12,55
2004	0,011	12,69
2005	0,055	13,39
2006	0,05	14,06
2007	0,059	14,89
2008	0,077	16,03
2009	0,033	16,56
2010	0,084	17,95
2011	0,061	19,05
2012	0,013	19,30
2013	0,013	19,55

4.3.2. Accidents

To quantify in monetary terms the benefits from accidents, the cost factors (e.g. €/severe injury) per accident fatality should be determined, as well as the reduction of accidents due to implementation of ATMS in the motorway Tirana – Durres.

The cost accident factors per type of accident are obtained by Table 0.10 from the report "Developing Harmonized European Approaches for Transport Costing and Project Assessment (February 2006); cost accident factors per accident type is estimated by using GDP/capita growth in Albania (source: World Bank), as shown in the following table:

Table 11: Estimation of Cost Accident Factors

Year	Annual Growth Rate of GDP/capita	Fatality	Severe Injury	Slight Injury
2002	-	836.000	109.500	8.400
2003	0,084	906.224	118.698	9.106
2004	0,011	916.192	120.004	9.206
2005	0,055	966.583	126.604	9.712
2006	0,05	1.014.912	132.934	10.198
2007	0,059	1.074.792	140.777	10.799
2008	0,077	1.157.551	151.617	11.631
2009	0,033	1.195.750	156.620	12.015
2010	0,084	1.296.193	169.777	13.024
2011	0,061	1.375.261	180.133	13.818
2012	0,013	1.393.139	182.475	13.998
2013	0,013	1.411.250	184.847	14.180

To estimate the number of accident for fatal, serious injuries and slight injuries the following assumptions were made:

- According to Institute of Transport of Albania, the national fatal and injuries accidents in 2013 were 295 and 2,075 respectively. The accidents in Albania within the last decade in overall show an increase. To be on conservative side the 2014 road accidents remain identical to 2013 statistics.
- From 2,075 non-fatal accidents, it is assumed that 55% are slight injuries and 45% are serious injuries, since in the motorway the speeds tend to be high.
- It is assumed that 4% of the total Albania accidents are occurring in the motorway section Tirana – Durres.

To be on conservative side, 25% and 35% reduction on the total number of fatal accidents and accidents with injuries are assumed respectively due to the implementation of ATMS. Note that the number of accidents for the entire evaluation period is assumed to remain identical.

4.3.3. Emissions

To quantify in monetary terms the CO2 emissions, the CO2 cost factor (€/tonne) should be determined and the relevant reduction of CO2 vehicles emissions in the motorway section Tirana – Durres.

The CO2 cost factor emissions are obtained by Table 0.16 from the report "Developing harmonized European Approaches for Transport Costing and Project Assessment (February 2006); the CO2 cost factor for the period 2010 – 2019 is obtained as 26 €/tonne.

To estimate the reduction of CO2 emissions for the ATMS in the motorway section Tirana – Durres, the following assumptions were made:

- In 2008, CO2 emissions at Albania were estimated to 2Mt (according to web-site: knoema.com). The CO2 emissions, within period 2002 – 2008, have shown significant annual variation within the range of -20.91% and 32.53%. So, within the period 2008 – 2014, a 5% annual increase on CO2 emissions is assumed, i.e. in 2014 the CO2 emissions of Albania are estimated to 2.68Mt.
- To estimate the CO2 emissions at the motorway Tirana - Durres: (a) the split of annual number of vehicles in the motorway and Albania is estimated, and (b) the split is multiplied by the CO2 emissions of Albania for the year 2014. So, the CO2 emissions of the motorway Tirana - Durres for the year 2014 are estimated to 0.44Mt.

To be on conservative side, 0.5% reduction of CO2 emissions per year is forecasted due to the implementation of ATMS. Note that since 2% annual increase in vehicles-km is forecasted within the evaluation time period, the CO2 emissions annual increase is expected to follow identical pattern.

4.3.4. Fuel Consumption

To quantify fuel consumption reduction in monetary terms, petrol and diesel current local market prices were identified by internet-search. So, for November 2014, the local market prices for petrol and diesel are 1,413€/liter and 1,335€/liter respectively.

To estimate the petrol and diesel fuel road transport consumption in Albania the World Bank portal is used (http://data.worldbank.org/).

In order to estimate the reduction of petrol and diesel road transport consumption the following assumptions were made:

- In Albania for 2011, the road transport consumption of petrol and diesel was 38.5 kg per capita and 262 kg per capita (note that 1kg = 1 liter), according to the World Bank portal. Since significant variations are observed within 2005 and 2011, the road transport fuel consumption was assumed to remain identical.
- According to census 2011, the population of Albania is 2.821.977. In year 2014, the Albania population is assumed to remain identical.
- So, the annual petrol and diesel consumption in Albania for the year 2014 is estimated to 108.646 liters and 739.358 liters respectively.
- To estimate the petrol and diesel consumption at the motorway of Tirana - Durres: (a) the split of annual number of vehicles in the motorway and Albania is estimated, and (b) the split is multiplied by the relevant estimated fuel consumption of Albania for the year 2014. So, the petrol and diesel road transport consumption upon the motorway for the year 2014 are estimated to 17.875 and 121.645 respectively

To be on conservative side, 0.5% reduction of petrol and diesel consumption per year is forecasted due to the implementation of ATMS. Note that since 2% annual increase in vehicles-km is forecasted within the evaluation time period, the transport fuel consumption annual increase is expected to follow identical pattern.

4.4. Results

Based on the figures presented in section 4.2 and 4.3, the CBA results for ATMS in the Tirana – Durres motorway are presented into this section.

Significant parameters to the CBA evaluation are the following:

- The evaluation time period is 2013 – 2020. The deployment of the system is undertaken in the year 2014. Seven (7) is considered the life cycle of the system which is considered a realistic time period for ITS.
- The social discount rate is taken as 7%.
- The discounted values are obtained by Equation 1.

The infrastructure cost is 1.860.730€. The Present Value of maintenance operating costs for the period 2014 – 2020 is 728.242€. Therefore, the Present Value of Total Costs within the CBA evaluation period is 2.588.972€.

The operating/ maintenance costs are shown in the following Table.

Table 12: ATMS Maintenance/ Operating Costs

Year	2014	2015	2016	2017	2018	2019	2020
Cost (€)	129792	129792	129792	140192	140192	140192	140192
Discounted Values (€)	121301	113365	105949	106952	99955	93416	87305

The Present Value of total benefits, i.e. vehicles-hour reduction, accidents reduction, reduction of CO2 emissions and reduction of fuel consumption, is estimated for the entire evaluation period to 52.188.566€. The detail presentation of benefits within period 2014 – 2020 is shown in the following Table.

Therefore, the Cost-Benefit Ratio yields to 20,16; i.e. for each 1€ invested, the corresponding socio-economic benefit will be 20,16€.

Moreover, the Net Present Value is 49.599.594€ > 0 and the Internal Rate of Return (IRR) is 431% > 7% (social discount rate).

So, the ATMS project can be considered in socio-economical terms as very beneficial for deployment, since all socio-economic indicators are very positive.

Table 13: Annual ATMS Benefits within the Evaluation Period 2014 – 2020

Year	2014	2015	2016	2017	2018	2019	2020	PV
Travel Time Savings								
Reduction of Veh-Hours (veh-hours)	41.928	42.767	43.622	44.495	45.384	46.292	47.218	
Value of Travel Time (€/hour)	19,55	19,55	19,55	19,55	19,55	19,55	19,55	-
Benefit from Travel Time Savings	819.620	836.012	852.733	869.787	887.183	904.927	923.025	
Discounted Values (€)	*766.000*	*730.206*	*696.084*	*663.557*	*632.549*	*602.991*	*574.814*	*4.666.200*
Fatalities								
Reduction of Fatalities	3	3	3	3	3	3	3	
Cost Factor (€/fatality)	1.411.250	1.411.250	1.411.250	1.411.250	1.411.250	1.411.250	1.411.250	-
Correction Factor	1,02	1,02	1,02	1,02	1,02	1,02	1,02	
Benefit from reduction of fatalities	4.318.426	4.318.426	4.318.426	4.318.426	4.318.426	4.318.426	4.318.426	
Discounted Values (€)	*4.035.912*	*3.771.880*	*3.525.122*	*3.294.506*	*3.078.978*	*2.877.549*	*2.689.298*	*23.273.245*
Severe Injuries								
Reduction of Severe Injuries	17	17	17	17	17	17	17	
Cost Factor (€/severe injury)	184.847	184.847	184.847	184.847	184.847	184.847	184.847	-
Correction Factor	1,25	1,25	1,25	1,25	1,25	1,25	1,25	
Benefit from reduction of severe injuries	3.927.994	3.927.994	3.927.994	3.927.994	3.927.994	3.927.994	3.927.994	
Discounted Values (€)	*3.671.022*	*3.430.862*	*3.206.413*	*2.996.648*	*2.800.605*	*2.617.388*	*2.446.157*	*21.169.095*
Slight Injuries								
Reduction of Slight Injuries	18	18	18	18	18	18	18	
Cost Factor (€/slight injury)	14.180	14.180	14.180	14.180	14.180	14.180	14.180	-
Correction Factor	2,00	2,00	2,00	2,00	2,00	2,00	2,00	
Benefit from reduction of slight injuries	510.481	510.481	510.481	510.481	510.481	510.481	510.481	

Discounted Values (€)	*477.085*	*445.874*	*416.705*	*389.443*	*363.966*	*340.155*	*317.902*	*2.751.129*
Emissions								
CO^2 Emission Reduction (in tonnes)	2.205	2.249	2.294	2.340	2.387	2.434	2.483	
Cost Factor (€/tonne)	26,00	26,00	26,00	26,00	26,00	26,00	26,00	-
Benefit from reduction of CO^2 Emissions	57.326	58.472	59.641	60.834	62.051	63.292	64.558	
Discounted Values (€)	*53.575*	*51.072*	*48.685*	*46.410*	*44.242*	*42.174*	*40.203*	*326.362*
Fuel Consumption								
Reduction of Consumed Petrol (in liters)	42	43	44	45	45	46	47	
Petrol Price (€/liter)	1,41	1,41	1,41	1,41	1,41	1,41	1,41	
Benefit (€)	59	61	62	63	64	66	67	
Reduction of Consumed Diesel (in liters)	289	295	301	307	313	319	325	-
Diesel Price (€/liter)	1,34	1,34	1,34	1,34	1,34	1,34	1,34	
Benefit (€)	386	394	401	409	418	426	434	
Benefit from Reduction of Fuel Consumption (€)	445	454	463	472	482	491	501	
Discounted Values (€)	*416*	*397*	*378*	*360*	*344*	*328*	*312*	*2.534*
Discounted Values (€)								*52.188.566*

5. CONCLUSIONS

Albania is a country in which ITS for road transport are in an early stage of deployment. The adoption and the implementation of ITS applications and services in the cities and especially in Tirana could be a cost effective solution to get deal with urban traffic congestion that creates unfavorable conditions. In addition, the fact that a part of Albanian transport network belongs to the "Comprehensive Core Network of South East Europe" provides the opportunity to develop ITS technologies for monitoring and controlling cross-border traffic and to enhance road safety and security.

The promotion of ITS in Albania could have several positive effects that can be analyzed in terms of their thematic framework. By taking into account the on-going ITS projects, the needs of the country and the conditions created regarding the European perspective and previous deliverable of the project SEE-ITS for Albania, the implementation of two projects in short-term horizon is concluded:

- Advanced Travelers Information System in the city of Tirana. The project relates to the development of an advanced system including permanent traffic detectors, CCTV/PTZ monitoring cameras, VMS, web-portal and the development of an advanced central ITS platform. The system is expected to be hosted in the existing TMCC of Tirana. The total estimated infrastructure cost is estimated to 1.58m €.

- Development of an Advanced Traffic Management System in the motorway Tirana – Durres. The project relates to the development of an advanced system including incident detection cameras to cover the entire motorway, permanent traffic detectors, CCTV/PTZ monitoring cameras, VMS, and the development of an advanced central ITS platform. The total estimated infrastructure cost is estimated to 1.86m €.

According to CBA results, both projects are accepted and useful in socio-economic terms since they yield very promising socio-economic indicators. The socio-economic results per project are summarized in Table 14.

Table 14: Synopsis of CBA results

Socio-Economic Indicators	ATIS (Tirana)	ATMS (Motorway Tirana - Durres)
Costs PV (€)	1.857.261	2.588.972
Benefits PV(€)	37.039.913	52.188.566
C/B	19,94	20,16
NPV (€)	35.182.652	49.599.594
IRR(%)	372%	431%

The composition of each benefit category to the total Present Value of benefits for ATIS in Tirana is shown in Figure 2. As shown, travel time savings are the major contributor of the total ATIS benefits (about 91%).

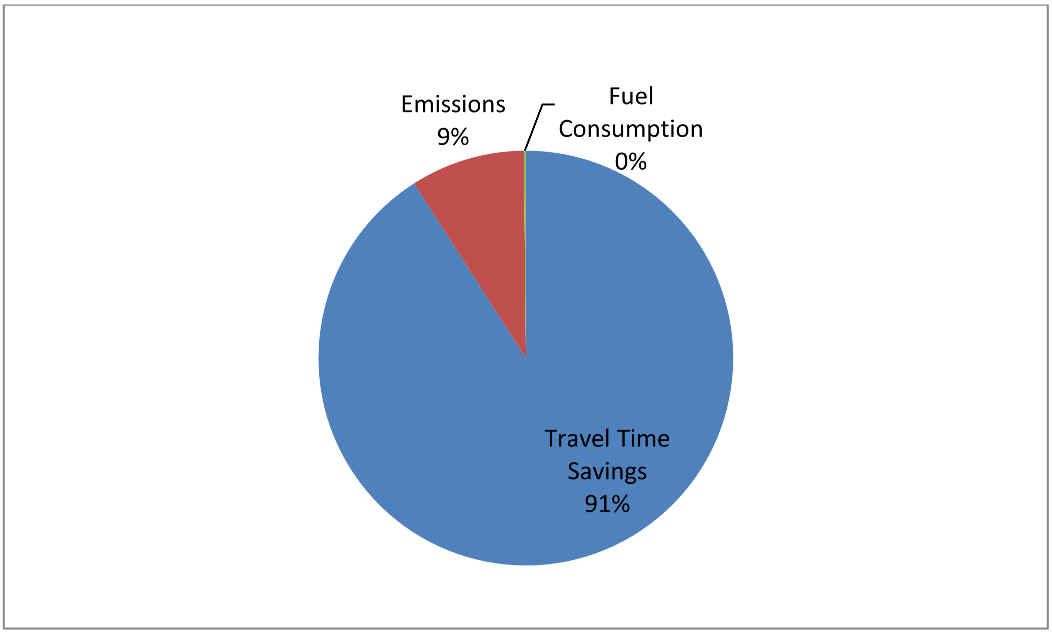

Figure 2: Benefit Category Contribution to the Total PV of Benefits for ATIS

The composition of each benefit category to the total Present Value of benefits for ATMS in Tirana – Durres motorway is shown in **Error! Reference source not found.**. As shown, reduction of accidents are the most significant benefits since fatalities and severe injuries reduction account for 44,6% and 40,5% of the total PV of benefits. Note that travel time savings are estimated to 8,9%.

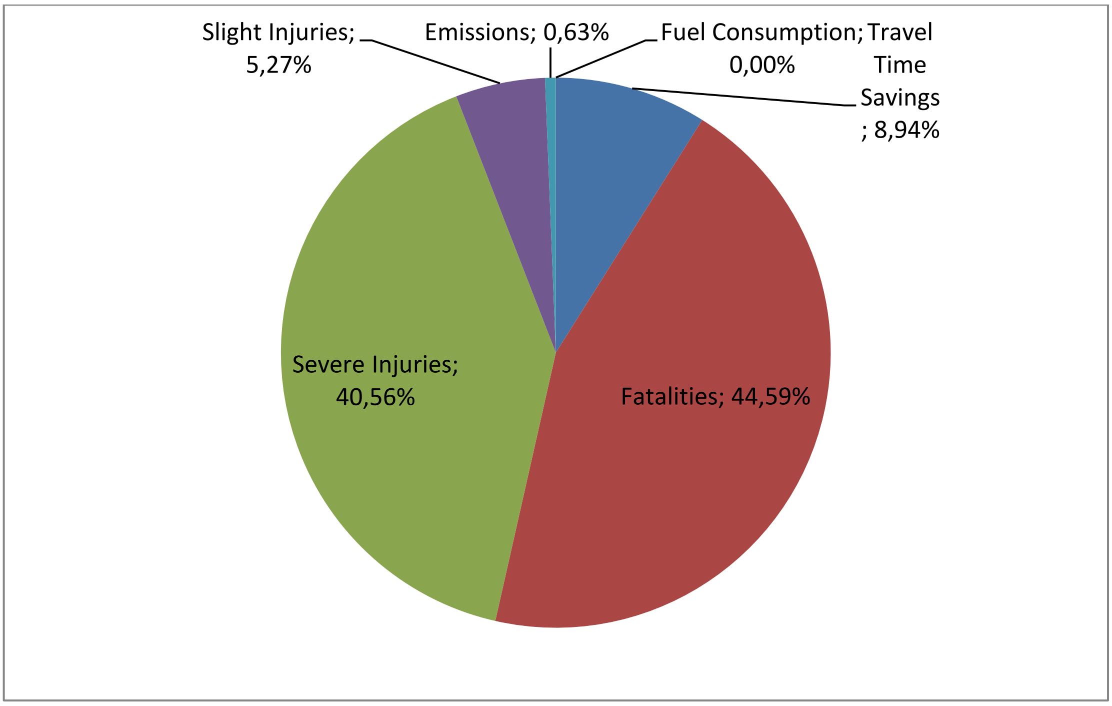

Figure 3: Benefit Category Contribution to the Total PV of Benefits for ATMS

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