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Liikennetelematiikkahankkeiden arviointiohjeet

Tiivistelmä

Raportti sisältää ohjeet liikennetelematiikkahankkeiden arvioimiseen siten, että telematiikka-hankkeita voidaan vertailla vaikuttavuudeltaan ja taloudellisuudeltaan keskenään ja muihin hankkeisiin. Ohjeet koskevat sekä etukäteis- että jälkiarviointia. Ohjeet on päivitetty edellisten, TETRA-ohjelmassa kehitettyjen ohjeiden käyttökokemusten perusteella. Tuloksena on järjestelmällinen menettelytapa muun muassa vaikutusten käsittelemiseksi niin, että hankkeissa kartoitetaan päätöksenteon kannalta olennaiset seikat. Hankkeen tuloksena syntyvät arviointiohjeet perustuvat YHTALI-kehikkoon ja arvioinnin YHTALIn mukaiseen esitystapaan. Raportti tehtiin osana liikennetelematiikan rakenteiden ja palveluiden tutkimus- ja kehittämisohjelmaa FITS.

Ohjeissa esitetään tarkistuslista vaikutuksista, joita erilaisilla telemaattisilla järjestelmillä voi olla liikennejärjestelmään ja sen käyttäjiin sekä logistisen järjestelmän eri osapuoliin. Yleisimmät vaikutusindikaattorit ja niiden mittaamismenetelmät esitetään seitsemälle eri vaikutusalueelle: 1) Verkko ja sen kustannukset, 2) kalusto ja sen kustannukset, 3) saavutettavuus, 4) aika, täsmällisyys, 5) onnettomuudet, 6) melu, päästöt ja energia sekä 7) arvostukset ja mukavuus. Erikseen suositellaan joidenkin keskeisten indikaattorien käyttöä.

Hankkeiden kannattavuusanalyysi voidaan tehdä hyötykustannuslaskelman tai liiketaloudellisen kannattavuuslaskelman avulla, minkä lisäksi hankkeiden vertailussa on syytä käyttää monikriteerianalyysia ja sanallisia arvioita. Liikennetelematiikkahankkeiden toteutettavuuden tarkasteluun esitetään tarkistuslistat markkinoiden, teknisen toteutettavuuden, teknisen, käyttöliittymän, rahoituksellisen, lainsäädännöllisen ja organisatorisen arvioinnin osalta.

Logistiikkahankkeiden arviointiperiaatteissa korostuu hankkeiden päätavoite teollisuuden ja kaupan kilpailukyvyn parantamiseksi. Arvioinnissa käytetty Du Pont -malli on tarkistuslista hankkeiden vaikutuksille ja tuottaa samalla arvion vaikutusten suuruudesta.

Arviointiohjeiden helppokäyttöisyyden lisäämiseksi tarkastellaan lisäksi neljän eri telematiikkahankkeen arviointia ohjeiden mukaisella tavalla. Esimerkkijärjestelmät olivat liikenteen ja kelin seuranta, ajoituksen hallinta tavarantoimituksissa satamasta tukkukauppaan, linja-autojen liikennevaloetuudet ja multimodaalinen reittipalvelu.

Lopuksi raportissa esitetään arviointiohjeiden, -menetelmien ja yleensä arvioinnin jatkokehitystarpeet.

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Liikenne, logistiikka, telematiikka, vaikutukset, arviointi, ohjeet

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Guidelines for the evaluation of ITS projects

Abstract

This report contains the guidelines for the evaluation of ITS projects for the purpose of comparing ITS projects to one another and to other transport projects with regard to their impacts and economic feasibility. The guidelines deal with both pre- and post-evaluations. The report has been updated from the version developed in the TETRA programme three years earlier. The guidelines present a systematic method for evaluating the projects so that all essential factors for decision making are investigated. The guidelines are based on the YHTALI framework generally used in Finland for project appraisal, and they apply the YHTALI template for presenting the results. The guidelines were developed as a part of the Finnish National R&D Programme on ITS Infrastructures and Services FITS.

The guidelines present extensive checklists of the possible impacts of ITS systems on the transport systems and their users as well as all the actors linked to logistics systems. Lists of indicators and their estimation methods cover seven different impact categories: 1) transport network and its costs, 2) fleet and its costs, 3) accessibility, 4) time and predictability, 5) safety, 6) noise, emissions and energy, and 7) valuations and comfort. The use of specific primary indicators is recommended.

The economic feasibility analyses can build on a cost benefit analysis or a profitability calculation. In addition, multi-criteria analyses and verbal assessments should be used. For studying the feasibility of the implementation of the projects, the guidelines present checklists for market assessment, human-machine interface analyses, and technological, technical, financial, legal and organisational aspects.

The guidelines for the evaluation of logistics projects emphasise the main objective of these projects, which is to enhance the competitiveness of the companies. The Du Pont model applied acts as an impact checklist while at the same time it produces an estimate of the magnitude of the impacts.

To make the use of the guidelines as easy as possible, examples of their application are given for four ITS projects. The example projects deal with 1) traffic and road weather monitoring, 2) timing management in the delivery of goods from ports to wholesale stores, 3) signal priorities for buses, and multimodal route guidance. As a conclusion, the report lists the further development needs for evaluation in general, and especially for evaluation guidelines and methods.

The study has been granted European Community financial aid in the field of Trans-European Networks - Transport.

Keywords

Transport, logistics, telematics, impacts, evaluation, assessment, guidelines

Miscellaneous

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FOREWORD

The objective of programme area 2 of the Finnish R & D Programme on ITS Infrastructures and Services FITS is to determine the transportational, socio-economic and other essential impacts of trials of new ITS systems, applications and services in a reliable and consistent way, so that the wide-range implementation of corresponding systems can be evaluated objectively.

In order to ensure the consistent evaluation of the projects, the management group of programme area 5 decided first to have guidelines drawn up for evaluating ITS projects. The task was given over to a research consortium consisting of VTT Building and Transport, Strafica Oy, SysOpen Oyj and Traficon Oy.

The drawing up of the evaluation guidelines was directed by the management group of programme area 2 of the FITS Programme, led by Petri Jalasto of the Ministry of Transport and Communications. The members of the management group were Heidi Hirvonen of the Finnish Rail Administration (RHK), Jari Kauppila, Sabina Lindström and Katariina Myllärniemi of the Ministry of Transport and Communications, Pentti Karvonen and Olli Penttinen of the Finnish Road Administration (Finnra), Hannele Luukkainen of the Traffic League, Mauri Heikkonen of the Ministry of the Environment, Kari Sane of the City of Helsinki and Kimmo Sinisalo of the Helsinki Metropolitan Area Council (YTV).

The evaluation guidelines were prepared by Risto Kulmala, Juha Luoma and Pirkko Rämä of VTT Building and Transport, Hannu Pesonen of Strafica Oy, Jukka Lähesmaa and Hanna Pajunen-Muhonen of SysOpen Oyj, and Tomi Ristola of Traficon Oy.

Quality assurance of the report as part of the FITS Programme was carried out by Pentti Karvonen of the Finnish Road Administration (not Chapter 5) and by Jari Gröhn of the Ministry of Transport and Communications (Chapter 5 in particular). The report was translated into English by Jenna Horko, and the translation was checked by Nigel Kimberley.

The project has been granted European Community financial support in the field of Trans-European Networks - Transport.

Helsinki, March 2002

FITS Programme, area 2

Head of management group, Director Petri Jalasto

TABLE OF CONTENTS

FOREWORD 5

TABLE OF CONTENTS 7

1 INTRODUCTION 11
- 1.1 Objectives and scope 11
- 1.2 Framework for project evaluation 11
- 1.3 Use of guidelines 15

2 IMPACT MECHANISMS OF TRANSPORT TELEMATICS 18
- 2.1 General 18
- 2.2 Target of impacts 18
- 2.3 Main impacts 19
- 2.4 Transport and information society policy objectives 19

3 IMPACT EVALUATION 28
- 3.1 Indicators and evaluation methods 28
  - 3.1.1 General 28
  - 3.1.2 Transport network and its costs 28
  - 3.1.3 Fleet and its costs 29
  - 3.1.4 Accessibility 30
  - 3.1.5 Time and its predictability 32
  - 3.1.6 Traffic safety 33
  - 3.1.7 Noise, emissions and energy 35
  - 3.1.8 Valuations and comfort 37
- 3.2 Study design 38
- 3.3 Impact evaluation of subsystems 39

4 SOCIO-ECONOMIC EVALUATION 41
- 4.1 Characteristics of ITS projects 41
- 4.2 Project description 42
- 4.3 Impact descriptions 42
- 4.4 Profitability assessment 43
  - 4.4.1 General 43
  - 4.4.2 Cost items and their allocation 43
  - 4.4.3 Benefit/cost ratio 45
  - 4.4.4 Sensitivity analysis 46
  - 4.4.5 Impacts on private economy 46
- 4.5 Impact analysis 47
- 4.6 Evaluation of feasibility/implementation 48
  - 4.6.1 General 48

4.6.2 Market assessment 49
4.6.3 Evaluation of technical feasibility 50
4.6.4 Technical evaluation 51
4.6.5 Evaluation of human machine interface and interaction 52
4.6.6 Evaluation of financial issues 55
4.6.7 Legal and institutional evaluation 56
4.7 Summary and documentation of project evaluation 58

5 APPLICATION OF FRAMEWORK IN LOGISTICS ITS PROJECTS 59
5.1 Characteristics of logistics ITS projects 59
5.2 Project classification 60
5.3 Impact assessments 62
5.3.1 Project evaluation framework 62
5.3.2 Allocation of impacts to various factors 63
5.3.3 Order/delivery process analysis 63
5.3.4 Function analysis 66
5.3.5 Impact analysis 68

6 EXAMPLE PROJECTS 73
6.1 General 73
6.2 Development of traffic and road weather monitoring 73
6.2.1 Introduction 73
6.2.2 Summary 74
6.2.3 Project description 74
6.2.4 Impact descriptions 74
6.2.5 Socio-economic analyses 75
6.3 Timing management in the delivery of goods 76
6.3.1 Introduction 76
6.3.2 Project description 76
6.3.3 Allocation of impacts to various actors 76
6.3.4 Impact assessment 77
6.3.5 Summary 78
6.4 Signal priorities and passenger information for public transport 79
6.4.1 Introduction 79
6.4.2 Summary 79
6.4.3 Project description 80
6.4.4 Impact descriptions 80
6.4.5 Socio-economic analyses 80
6.5 Multimodal routing service 81

7 FOLLOW-UP ACTIONS 82

BIBLIOGRAPHY 83

APPENDICES

1 Summary of project assessments

1.1 Traffic and road weather monitoring
1.2 Improvement of timing management in delivery chain
1.3 Signal priorities for buses and public transport passenger information systems
1.4 E-NYSSE multimodal routing service

2 Logistics functions by target

1 INTRODUCTION

1.1 Objectives and scope

The objective of the project was to draw up guidelines for the impact assessments of ITS (Intelligent Transport Systems) projects, thus enabling the comparison of ITS projects to one another and other investment projects from the point of view of impacts and economic feasibility. These guidelines are an updated version of the guidelines published earlier (Kulmala et al. 1999). Matters learnt using the old guidelines during the TETRA Programme (e.g. Kulmala, Karhunen et al. 1999 and Lehtonen & Kulmala in press) were used in drafting the updated guidelines.

The guidelines present a systematic method for dealing with impacts, which ensures that all projects cover the essential points for decision-making. The evaluation guidelines are based on the YHTALI framework and they apply the YHTALI template for presenting the results (Ministry of Transport and Communications 1994, Niskanen et al. 1998, Pesonen et el. 2000).

Owing to the novelty of ITS projects, the guidelines present extensive checklists of the possible impacts of ITS on the transport system and its users (end users, operators, authorities, etc.) as well as on all the actors linked to logistics systems. The guidelines apply to all modes of transport.

1.2 Framework for project evaluation

The evaluation of transport infrastructure projects has been guided by the Ministry of Transport and Communications (MinTC) so-called YHTALI report "Harmonisation of assessment of transport infrastructure projects" (Ministry of Transport and Communications 1994). The development needs of project evaluations have been further defined in the Ministry's reports "Development needs of project assessment in the transport sector" (Niskanen et al. 1998) and "General guidelines for project evaluations" (Pesonen et al. 2000), which, among other things, outline amendments to the YHTALI framework.

The development of and drawing up of a framework for the evaluation of great investment projects is taking place in the Ministry of Transport and Communications. Transport infrastructure administrations have also helped develop and then apply the evaluation framework. The framework is a more detailed continuation of the framework drawn up by the MinTC and is meant to be a tool used in drawing up project evaluations. The MinTC framework confirms the unit values (vehicle operating, time, accident and environmental costs) for road and railway projects used in the calculations.

The project evaluation framework is designed for use in evaluating extensive, government-funded development projects, but its principles can also be applied to the evaluation of smaller projects and actions.

The guidelines for the evaluation of ITS projects are compatible with MinTC's evaluation framework, providing additional information for and commenting on the application of the framework to ITS projects.

Since decision making on ITS projects is different from decision making on extensive investment projects, and since ITS projects also often have significantly smaller budgets, the MinTC framework should be only loosely applied to the evaluation of ITS projects. The MinTC framework for project evaluation, its principles and the framework on the values to be used in the calculations can also be used as the basis for evaluating ITS projects, but the size and significance of the project have to be taken into consideration, e.g. in the case of impact descriptions, the depth and thoroughness of the calculations and analyses, and the mode of presentation.

The general framework given in Figure 1 can also be used in ITS project evaluations.

The general framework is used to analyse and guide impact evaluations so that the essential impacts regarding the project evaluation are sufficiently taken into account. The framework is primarily intended for evaluating extensive new and supplementary investments, but its principles can also be applied to the evaluation of other transport projects.

The "General guidelines for project evaluations" report also outlines models for the presentation of a summary of a project assessment.

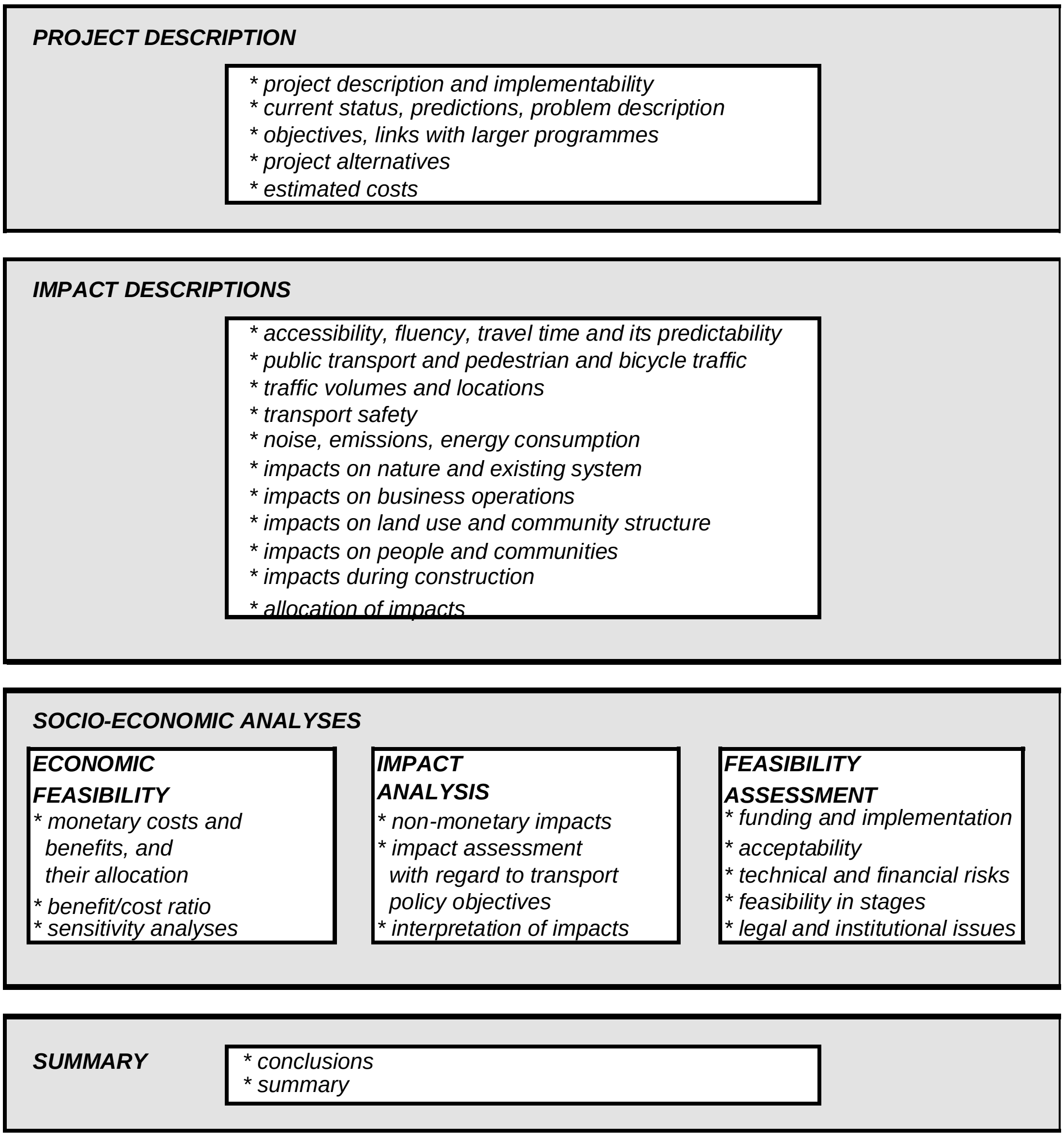

Figure 1. General framework for project evaluation (Pesonen et al. 2000).

An important part of project evaluations are the social objectives the projects should help realise. The transport policy objectives of the Ministry of Transport and Communications (2000) correspond to Table 1. Since ITS projects are closely associated with the development of information technology, ITS projects should correspond not only to the transport policy objectives, but also to the objectives set for the development of an information society (Table 2).

Table 1. Transport policy objectives (Ministry of Transport and Communications 2000)

Target area	Objectives
Transport system level of service and costs	Safe, high-quality and reasonably priced movement and transport. A guaranteed basic level of service for traffic across the country. Guaranteed ease and reliability of both national and international passenger and goods transport. Reliable, easy-to-use real-time transport information. Cost-effective transport system development and management. Efficient, competitive passenger and goods transport markets. Competitive domestic passenger and goods transport service provision that can also compete on the international market.
Safety and health	A traffic environment that promotes health. No-one should be killed or seriously injured in traffic incidents.
Social sustainability	An equal and fair division of the benefits and disadvantages of transport among the various population groups. Special attention paid to the needs of disadvantaged groups in traffic. Citizens able to participate in and influence the planning of transport solutions.
Regional and community development	A transport system that supports national land and region use objectives and regional development strategies. A transport system that supports objectives associated with community structure and urban quality. Harmonised planning of transport and land use. Pleasant environments for moving and transport that are considered safe. No alteration of the urban or cultural landscape without proper justification.
Detriments to the environment	Minimal global and local detriments to the environment. Minimal use of natural resources (such as energy, land area, extractable land resources etc.).

Table 2. Information society objectives (Government of Finland 1999, Ministry of Transport and Communications 2000)

Target area	Objectives
Information society	Finland will be made into an information society, where knowledge and know-how are part of the culture and the main productive resource. Finland must be a forerunner in technology policy. Finland wants to be a forerunner in the creation of a humane and sustainable information society. This means, e.g. the development of easy-to-use, safe electronic services and their cultural and information content for all to use via computers, digital television and mobile communication systems. Transport users, service systems, vehicles and infrastructure will utilise the full potential of intelligent technology.

1.3 Use of guidelines

The report first outlines the overall basis for project evaluations and examines the basis this provides for the evaluation of ITS projects. In addition, the field of ITS projects is examined. The main impact mechanisms of ITS systems are outlined and the factors that should be taken into consideration during impact analyses are defined. Finally, the report provides guidelines for the application of the framework to the evaluation of various ITS projects, and information on which assessment methods are best suited for the various types of projects. Examples are given for the assessment of three different types of projects. The structure of the report is shown in Figure 2.

The evaluation guidelines utilise previous assessments and evaluation guidelines of European transport telematics projects (Bobinger et al. 1991, European Commission 1997, Lind 1997). On the other hand, the guidelines aim to be as specific and applicable as possible.

The guidelines do not, however, provide a complete framework for the retrospective evaluation of the impacts of individual ITS projects. Special guidelines have been published, though, in Finland for impact evaluation of variable speed limit systems (Kulmala & Rämä 1998), road transport information services (Penttinen et al. 1998) and public transport ITS (Ministry of Transport and Communications 1998).

The evaluation guidelines include a guideline and instructions for the application of the general evaluation framework (YHTALI) and do not include detailed instructions for the use of specific methods, such as cost-benefit analysis. The guidelines are meant for use in conjunction with the rest of the project evaluation framework and are therefore not independent guidelines but rather help more closely define the rest of the framework.

The guidelines provide recommendations on carrying out assessments and should not be applied as is to every project. The depth and scope of the assessment should correspond with the project . Projects with wide-ranging impacts – which, one assumes, are carried out frequently – should usually be assessed in depth. Smaller, less frequent projects should be assessed less extensively, with the evaluation focusing on the bare essentials. These essentials can be found by looking at the figures and tables included in the report. Even with smaller projects, the assessment is best carried out and the findings presented in accordance with the provided framework to ensure the compatibility and applicability of the findings. The assessment of a small project can usually be given as a one-page summary.

Project pre-evaluations are usually carried out before it is even certain that the project will be carried out. The pre-evaluation is usually done or commissioned by the party funding the project.

Project post-evaluations are closely connected with project follow-ups. Assessments of project implementation (how the project came about, was the implementation different from the plan, and why, etc.) can often be carried out as part of the project. Post-evaluations of the project's impacts should usually be carried out a minimum of twelve months after the project, in which case the evaluation is usually no longer part of the project.

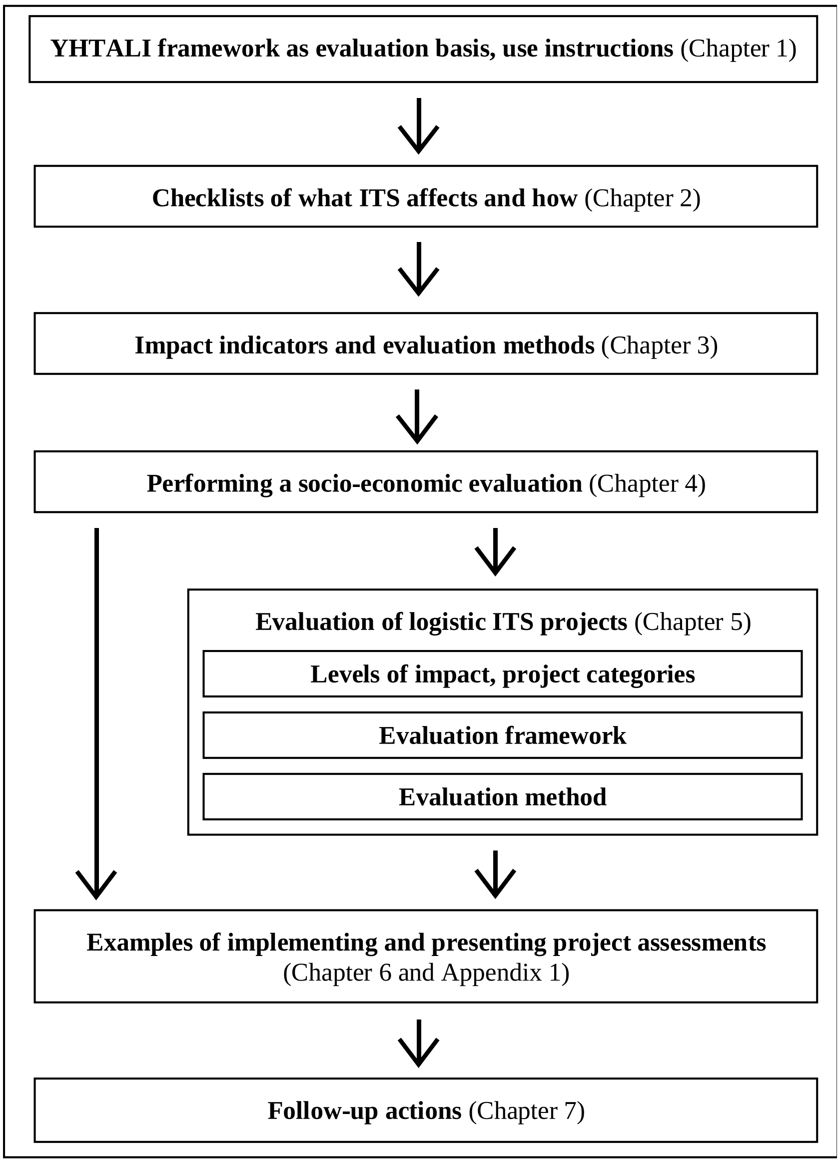

Figure 2. Report structure.

Impact post-evaluations are best funded by the parties that fund the projects, since post-evaluations are supposed to be part of the quality management system for operations. The Ministry of Transport and Communications and its administrative offices and institutions are also interested in investigating the project impacts associated with attaining the set transport and information society policy objectives, and are therefore willing to fund post-evaluations.

The guidelines do not cover the assessment of the project implementation process. This assessment can be carried out while the project is being implemented and utilised in the development and modification of the system before the system is introduced. The guidelines can, however, be applied so that the suggested assessments are carried out when applicable during the project's planning stages and possibly repeated during post-evaluation.

2 IMPACT MECHANISMS OF TRANSPORT TELEMATICS

2.1 General

Tables 3a–3g on the following pages examine the impact mechanisms of various ITS functions. The approach is outlined in Figure 3 on page20.

The impact mechanisms of different ITS functions are studied separately by first determining the functions' main targets, or what factors the functions will attempt to affect. The main impacts of the functions are defined next. Finally, the transport policy objectives the impacts are aimed at are examined.

Tables 3a–3g consist of the ITS functions (rows of the tables), whose impacts are under examination. The columns describe (1) which targets can be affected with transport telematics, (2) what main impacts the telematics will have, and (3) what transport and information society policy objectives the ITS function in question serves. The tables use

- a darker tone to indicate an ITS function's most important impact mechanisms, on which the impact examinations should primarily focus.
- a lighter tone to usually indicate less significant impact mechanisms that should still be considered during impact examinations.

An ITS function can also have other impact mechanisms, but their significance is usually small from the point of view of the total impacts of the ITS function. The tables presented hereinafter as a whole attempt to describe the directness and significance of the impacts that are considered to be essential in these guidelines. These tables are intended as instructive and advisory to the user rather than binding the user to the mechanisms given in them.

For instance, the impact mechanisms of ITS functions *Information on alternative transport modes (INF1)* and *Public transport fleet management (F1)* are examined below in order to facilitate the understanding of the tables.

2.2 Target of impacts

The ITS function *Information on alternative transport modes* primarily affects the *choice of transport mode,* but also the *amount and distribution of demand*, *travel timing* and the *choice of route*. The *Public transport fleet management* primarily affects *transport system maintenance* by facilitating the operating and planning of public transport, but often also affects *traffic behaviour,* e.g. through the monitoring of drivers' adherence to timetables.

2.3 Main impacts

The provision of information on alternative transport modes results in changes in the use of the transport network, the need for further construction and the cost of network maintenance (*network and its costs*). In addition, information services affect the need for and use of the transport fleet (*fleet and its costs*). Information services are used to try to improve the *accessibility* and image of a transport mode (*valuations, comfort, image*).

Public transport fleet management primarily affects the efficiency and costs of using the fleet (*fleet and its costs*) as well as the travel time and accuracy of the timetables (*time and its predictability*). Fleet management also affects the *quality* and *accessibility* of public transport services.

2.4 Transport and information society policy objectives

The impacts of information on alternative transport modes are especially significant for companies that operate transport services. In addition to this, e.g. changes in the utilisation of infrastructure have a direct impact on social economy, and thus on the *transport system level of service and costs* as well as on the *information society* during the creation of new information services. Improvements in accessibility affect social sustainability.

Public transport fleet management primarily has an effect on the public transport operator's private economy and indirectly on social economy, i.e. the *transport system level of service and costs*. The fleet management system produces much information that can be utilised, e.g. in content services, which in turn promotes the creation of an *information society*.

It should be noted that the approach used is rough and based on a notion of an ITS function's traditional implementation method. The function's objectives and impacts can naturally differ even significantly from the norm in individual implementations. The impact evaluation should always be tailored to the individual characteristics of each project. In addition, the tables are filled out under the assumption that the transport system will be as it is currently, e.g. that the state or municipalities will maintain the roads.

When discussing transport policy objectives, it is good to keep in mind that the effects on the objectives overlap one another somewhat. The detriments to people and the environment are, shown as a monetary impact on the costs of the transport system, for example.

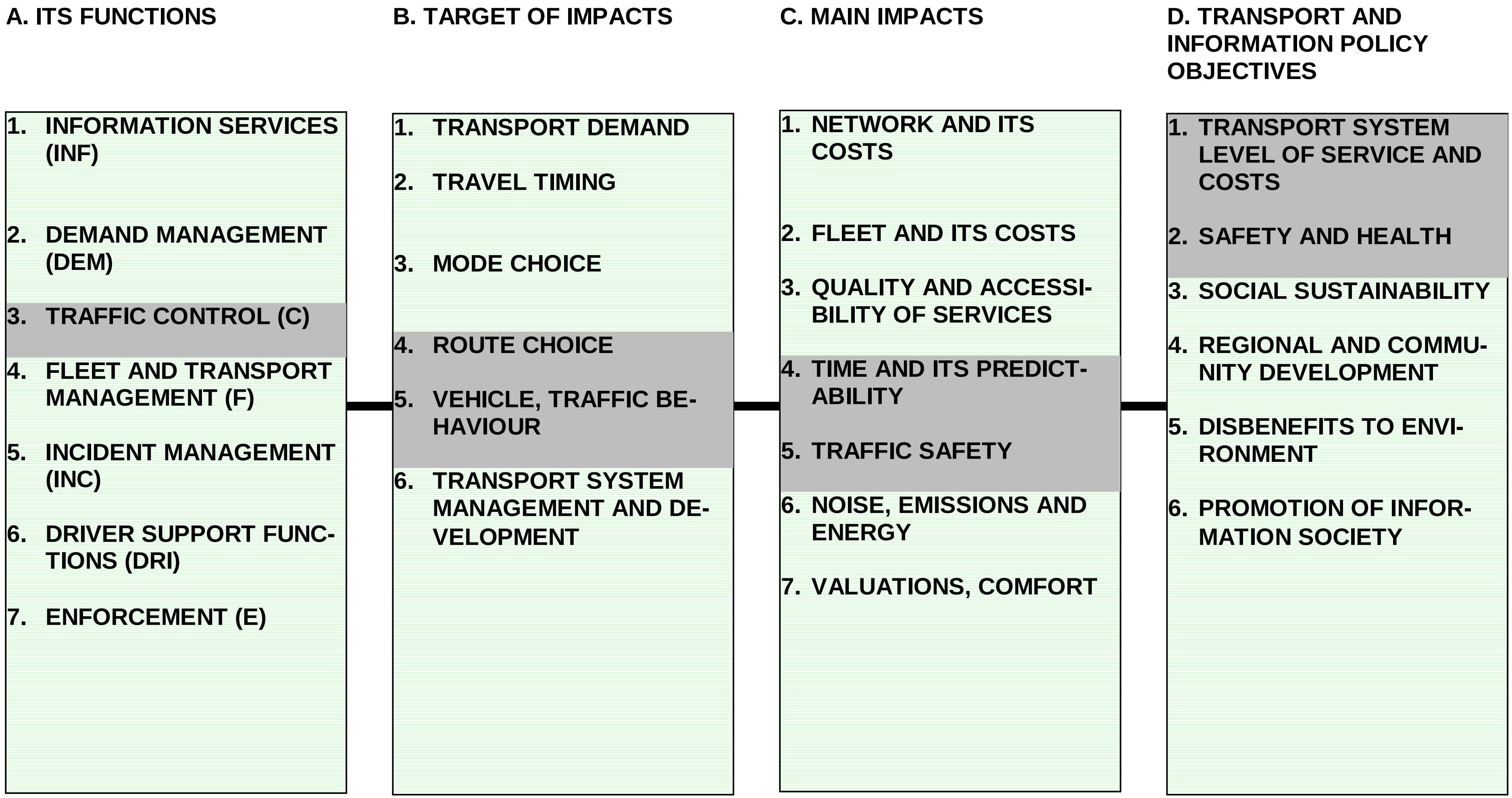

Figure 3. ITS impacts. The potential impacts of traffic control are shown with a dark background.

Table 3a. Impact mechanisms of ITS functions. Information services.

No.	ITS function	TARGET OF IMPACTS						MAIN IMPACTS							TRANSPORT AND INFORMATION SOCIETY POLICY OBJECTIVES					
		Transport demand	Travel timing	Mode choice	Route choice	Vehicle, traffic behaviour	Transport system man. & dev.	Network and its costs	Fleet and its costs	Accessibility	Time and its predictability	Traffic safety	Noise, emissions, energy	Valuations, comfort	Transport system service level & costs	Safety and health	Social sustainability	Regional and community development	Detriments to environment	Information society
1.	INFORMATION SERVICES (INF)																			
INF1	Information on alternative transport modes																			
INF2	Information on traffic fluency, incidents and road works																			
INF3	Information on weather and road surface condition																			
INF4	Information on routes and (travel) services																			
INF5	Information on presently available parking places																			
INF6	Information services for public transport users																			

Table 3b. Impact mechanisms of ITS functions. Demand management.

No.	ITS function	TARGET OF IMPACTS						MAIN IMPACTS							TRANSPORT AND INFORMATION SOCIETY POLICY OBJECTIVES					
		Transport demand.	Travel timing	Mode choice	Route choice	Vehicle, traffic behaviour	Transport system man. & dev.	Network and its costs	Fleet and its costs	Accessibility	Time and its predictability	Traffic safety	Noise, emissions, energy	Valuations, comfort	Transport system service level & costs	Safety and health	Social sustainability	Regional and community development	Detriments to environment	Information society
2.	DEMAND MANAGEMENT (DEM)																			
DEM1	Park-and-ride system operation																			
DEM2	Demand responsive public transport																			
DEM3	Combining trips																			
DEM4	Car pooling																			
DEM5	Introducing general road tolls																			
DEM6	Introducing congestion pricing or area tolls																			
DEM7	Access control																			
DEM8	Public transport payment system																			
DEM9	Integrated payment system (several services)																			

Table 3c. Impact mechanisms of ITS functions. Traffic control.

No.	ITS function	TARGET OF IMPACTS						MAIN IMPACTS							TRANSPORT AND INFORMATION SOCIETY POLICY OBJECTIVES					
		Transport demand.	Travel timing	Mode choice	Route choice	Vehicle, traffic behaviour	Transport system man. & dev.	Network and its costs	Fleet and its costs	Accessibility	Time and its predictability	Traffic safety	Noise, emissions, energy	Valuations, comfort	Transport system service level & costs	Safety and health	Social sustainability	Regional and community development	Detriments to environment	Information society
3.	TRAFFIC CONTROL (C)																			
C1	Junction and link control using traffic signals																			
C2	Network control using traffic signals																			
C3	Traffic signal priority functions																			
C4	Local warnings with variable message signs (VMS)																			
C5	Condition controlled variable speed limit																			
C6	Direction to alternative routes																			
C7	Control of lane use																			

Table 3d. Impact mechanisms of ITS functions. Fleet and transport management, Incident management.

No.	ITS function	TARGET OF IMPACTS						MAIN IMPACTS							TRANSPORT AND INFORMATION SOCIETY POLICY OBJECTIVES					
		Transport demand	Travel timing	Mode choice	Route choice	Vehicle, traffic behaviour	Transport system man. & dev.	Network and its costs	Fleet and its costs	Accessibility	Time and its predictability	Traffic safety	Noise, emissions, energy	Valuations, comfort	Transport system service level & costs	Safety and health	Social sustainability	Regional and community development	Detriments to environment	Information society
4.	FLEET & TRANSPORT MAN. (F)																			
F1	Public transport fleet management																			
F2	Goods transport fleet management																			
F3	Hazardous goods transport management																			
F4	Freight management																			
F5	Maintenance fleet and operations management																			
5.	INCIDENT MANAGEMENT (INC)																			
INC1	Private transport incident detection																			
INC2	Private transport incident management																			
INC3	Public transport incident detection																			
INC4	Public transport incident management																			

Table 3e. Impact mechanisms of ITS functions. Driver support functions.

No.	ITS function	TARGET OF IMPACTS						MAIN IMPACTS							TRANSPORT AND INFORMATION SOCIETY POLICY OBJECTIVES					
		Transport demand	Travel timing	Mode choice	Route choice	Vehicle, traffic behaviour	Transport system man. & dev.	Network and its costs	Fleet and its costs	Accessibility	Time and its predictability	Traffic safety	Noise, emissions, energy	Valuations, comfort	Transport system service level & costs	Safety and health	Social sustainability	Regional and community development	Detriments to environment	Information society
6.	**DRIVER SUPPORT FUNCTIONS (DRI)**																			
DRI1	**Autonomous cruise control**																			
DRI2	**Intelligent Speed Adaptation**																			
DRI3	**Instructions on safe following distance**																			
DRI4	**Automatic maintaining of safe following distance**																			
DRI5	**Collision avoidance** (incl. Vulnerable road users and animals)																			
DRI6	**Lane keeping support**																			
DRI7	**Vision enhancement**																			
DRI8	**Driver condition monitoring**																			
DRI9	**Navigation and route guidance**																			
DRI10	**Emergency services**																			

Table 3f. Impact mechanisms of ITS functions. Enforcement systems.

No.	ITS function	TARGET OF IMPACTS						MAIN IMPACTS							TRANSPORT AND INFORMATION SOCIETY POLICY OBJECTIVES					
		Transport demand	Travel timing	Mode choice	Route choice	Vehicle, traffic behaviour	Transport system man. & dev.	Network and its costs	Fleet and its costs	Accessibility	Time and its predictability	Traffic safety	Noise, emissions, energy	Valuations, comfort	Transport system service level & costs	Safety and health	Social sustainability	Regional and community development	Detriments to environment	Information society
7.	ENFORCEMENT SYSTEMS (E)																			
E1	Automatic speed enforcement																			
E2	Automatic enforcement of signal compliance (red light running)																			
E3	Monitoring of hazardous goods transportation																			
E4	Load weight enforcement (WIM)																			
E5	Automatic lane use enforcement																			

Table 3g. Impact mechanisms of ITS functions. Data collection and management systems.

No.	ITS function	TARGET OF IMPACTS						MAIN IMPACTS							TRANSPORT AND INFORMATION SOCIETY POLICY OBJECTIVES					
		Transport demand	Travel timing	Mode choice	Route choice	Vehicle, behaviour	Transport system man. & dev.	Network and its costs	Fleet and its costs	Accessibility	Time and its predictability	Traffic safety	Noise, emissions, energy	Valuations, comfort	Transport system service level & costs	Safety and health	Social sustainability	Regional and community development	Detriments to environment	Information society
8.	DATA COLLECTION AND MANAGEMENT SYSTEMS (CM)																			
CM1	Traffic monitoring																			
CM2	Monitoring of weather and road surface conditions																			
CM3	Monitoring of environmental conditions																			
CM4	Traffic management and information centres																			
CM5	Support systems for centre operators																			

In Tables 3a-3g above, the data collection and management systems as well as the incident situation detection systems (INC1, INC3) do not have any direct impact on the users of the transport systems, but do have an indirect one through the ITS functions and planning that utilise these systems. Therefore, the maintenance and enabling of the transport system and functions connected with it are the target, while the social economy, through which the systems' indirect impacts can usually be illustrated, is the transport policy objective of these systems. The systems also affect the development of an information society by producing information content for various content services. The impacts on the users of the transport systems are visible in the tables under the ITS functions that utilise the systems.

3 IMPACT EVALUATION

3.1 Indicators and evaluation methods

3.1.1 General

Chapter 2 outlined the ITS mechanisms on the basis of which the main impacts to be examined are determined. This chapter outlines the indicators and evaluation methods that should be used to evaluate the main impacts.

The most important indicators and evaluation methods of the main ITS impacts are listed in Tables 4–10. The indicators can help assess the targets and quantity of ITS impacts. The evaluation method describes how the indicator's value is determined in post-evaluation. The pre-evaluation methods are examined in the text connected with the tables.

For instance, the impact mechanism tables in Chapter 2 show that the main impacts of the ITS function *condition controlled variable speed limits* are directed at *time and its predictability* and *traffic safety*. The table in Section 3.1.6 of this chapter shows that one of the indicators of the main impact *traffic safety* is the *number of fatalities in traffic accidents*, which is monitored through before-and-after analysis, using police accident reports and accident statistics based on hospital reports.

The choice of indicator depends on the type and characteristics of the ITS project. The impacts of an individual project cannot always be assessed by directly measuring the desired indicator. For example, the impacts of a regionally limited ITS project on the number of injuries and fatalities cannot usually be measured during a few years' follow-up time. It is then necessary to use some other indicators to describe the safety impacts. The most important indicators, at least one from each group of which should be used in every evaluation, are written in bold face to aid the harmonisation of the impact evaluations.

The tables contain similar or related indicators. One must therefore be careful not to add up the same impacts two or more times.

3.1.2 Transport network and its costs

Table 4 presents the indicators of impacts directed at the transport network and its costs, along with the indicators' evaluation methods.

The most important indicator for the network and its costs is the change in the vehicle-kilometres travelled within the network, caused by ITS systems. Transport telematics can, however, also affect the utilisation of the network in other ways, e.g. by improving the utilisation of the network's capacity. The changes in network utilisation affect the need for investments in infrastructure as well as the network's maintenance costs.

Table 4. Assessment of the main impact "Network and its costs". The most important indicators are written in bold face.

INDICATOR	EVALUATION METHOD
Network utilisation (change in vehicle-kilometres travelled or the use of a particular area)	**Traffic counts, field studies, simulation**
Change in network's investment or maintenance costs	**Cost monitoring, project comparison**
Change in the time in which traffic demand exceeds network's capacity	Automatic traffic monitoring, simulation
Change in average speed during peak hours	Automatic traffic monitoring, simulation
Number of incident situations caused by insufficiency of network capacity	Field studies, monitoring of incident situations
Time loss caused by insufficiency of network capacity	Field studies, traffic monitoring, monitoring of incident situations, simulation
Changes in contents and timing of network maintenance measures	Monitoring of maintenance measures, surveys
Necessity for and urgency of constructing additional network capacity	Surveys

Transport telematics systems often also have a direct impact on the network maintenance costs, which is not determined by the change in the vehicle-kilometres travelled, e.g. when maintenance becomes more effective through the use of monitoring systems. Transport telematics then also have an impact on the fleet and its use, e.g. the timing of the use of the maintenance fleet (cf. Table 5).

When measuring or estimating the costs of the network and its utilisation, it is essential to draw up a model which describes the current network status and how transport telematics can change the situation. It may describe, for example, the changes in the vehicle-kilometres travelled on various streets caused by a park-and-ride system and whether this change will affect the need for investments in road infrastructure. Pre-evaluations of ITS impacts on the vehicle-kilometres travelled or the utilisation of network capacity have to be carried out on the basis of the results of previous studies and as expert assessments.

3.1.3 Fleet and its costs

Table 5 presents the indicators of impacts directed at the fleet and its costs, along with the indicators' evaluation methods.

The evaluation of the main impact *fleet and its costs* should be started by describing the changes in fleet utilisation caused by ITS systems. This will assist in judging whether the utilisation of ITS systems will change the size of the required fleet or the costs of fleet utilisation. These two indicators are the most important ones of this main impact. The planning, driving and maintenance costs are operating costs that can be examined case by case.

Table 5. Assessment of the main impact "Fleet and its costs". The most important indicators are written in bold face.

INDICATOR	EVALUATION METHOD
Fleet size	**Monitoring of fleet size, analyses of financial statements**
Fleet utilisation rate	**Monitoring of business operations**
Fleet investments	**Monitoring of business operations, analyses of financial statements**
Costs of fleet utilisation (personnel and vehicle operating costs)	Monitoring of business operations, analyses of financial statements, simulation
Changes in planning of fleet utilisation (ease, use of time)	Work monitoring, surveys
Need for additional equipment	Surveys
Changes in fleet maintenance	Work monitoring, surveys
Changes in timing of fleet use (size of fleet required during peak hours, time of fleet utilisation below capacity)	Monitoring of business operations
Number of complaints due to fleet use	Monitoring of complaints

During pre-evaluation, the impacts of ITS systems on fleet utilisation are estimated on the basis of previous experience or in the form of expert statements.

In order for the actual impacts to be determined, the monitoring of business operations has to be arranged in a way that allows the impacts of transport telematics to be identified. This means that monitoring is concentrated on the operations and cost components that have been determined during pre-evaluation to possibly be pervious to ITS systems. An assessment of which other factors besides transport telematics could have changed the fleet's status during the follow-up time should also be drawn up while monitoring these operations and cost components. The impact evaluation of logistics ITS projects as they affect companies and business life is outlined in Chapter 5.

3.1.4 Accessibility

The indicators of impacts directed at accessibility, along with the indicators' evaluation methods are given in Table 6.

The main indicator of accessibility is the number of users. The examination can focus on either a specific site or region (e.g. village, tourist attraction) or a transport service (e.g. service line). The evaluation can usually be realised through simple field studies, for instance by using automatic monitoring equipment. The aforementioned equipment can be a part of the implemented ITS system.

Table 6. Assessment of the main impact "Accessibility". The most important indicators are written in bold face.

INDICATOR	EVALUATION METHOD
Number of visitors or users (e.g. in the centre, at a terminal, in a shop)	**Field studies, automatic traffic monitoring**
Range of impact zone	**Trip diaries, interviews, surveys**
Average length of transports	**Statistics, field studies**
Average length of trip	**Field studies, trip diaries**
Ratio of traffic-weighted trip lengths to distances as the crow flies (accessibility)	Trip diaries, field studies
Revenue of companies using transport services	Statistics
Public transport's share of all trips or person-kilometres travelled	Field studies, interviews, surveys
Range of public transport service zone (number of inhabitants within 500 metres of the stop)	Field studies, data from location data system
Supply of public transport services (buses/inhabitant)	Timetables, statistics
Use of low floor buses	Field studies, trip diaries
Number of trips taken by the disabled	Field studies, trip diaries
Disabled people's share of all passengers	Field studies
Ease of travel	Interviews, surveys
Total travel time in comparison with trip taken by private car	Field studies
Availability of services at different times	Surveys

During pre-evaluation, accessibility can be evaluated, e.g. by examining the number of users who live within a certain distance or travel time.

The accessibility of various modes of transport can be evaluated through the quantity and distribution of the supply of transport services and by comparing the total travel times of different transport modes.

The number of trips and the share of all trips taken by different passenger groups reflect their access to transport services.

3.1.5 Time and its predictability

Table 7 presents the assessment of the main impact *time and its predictability*.

Table 7. Assessment of the main impact "Time and its predictability". The most important indicators are written in bold face.

INDICATOR	EVALUATION METHOD
Travel time (mean and standard deviation)	**Licence plate method, floating car method, car following, driving in instrumented cars, driver's logs and trip diaries, tachographs, automatic monitoring, simulation**
Total door-to-door travel time	**Trip diaries**
Travel time predictability (deviations from expectations)	**As above, surveys**
Waiting time (terminal, stop, junction etc.)	**Field studies, trip diaries**
Additional travel/delivery time caused by incidents	**Tachographs, driver's logs and trip diaries, interviews, surveys, simulation**
Public transport's deviations from timetables	**Field studies, trip diaries, interviews, surveys**
Spot speed (mean and standard deviation)	Automatic traffic monitoring
Vehicle-kilometres travelled in congestion (passenger km, vehicle km, ton km, person h, ton h)	Driver's logs and trip diaries, tachographs, automatic traffic monitoring, simulation
Stability of traffic flow (number of changes in speed)	Car following, tachographs, driving in instrumented cars
Incident proneness of traffic flow (share of short headways or TTC values) cf. "Traffic safety"	Automatic traffic monitoring
Capacity of link/junction	Field studies, automatic traffic monitoring
Need for overtaking	Field studies, automatic traffic monitoring
Number of delays	Interviews, surveys, automatic monitoring
Perceived fluency	Interviews, surveys
Success of incident information services	Interviews, surveys
Transfer possibilities and information about them	Field studies, interviews, surveys
Maximum transfer time	Field studies, trip diaries
Availability of public transport timetables	Field studies, interviews, surveys
Public transport service frequency	Field studies, interviews, surveys
Barrier effect of traffic	Interviews, surveys

The main indicator is the travel time along with its contributory factors, the most significant ones for users being unexpected time loss, waiting times and delays owing to incidents and other such reasons. Measuring travel times is often difficult and demands a lot of resources, although the increasing use of telematics systems in vehicles and public transport offers new possibilities for automatic monitoring with little need for additional resources.

In general, automatic monitoring (passage times, speeds and following time headways of individual vehicles, vehicle types, travel times between stops etc.) using loop detectors or similar equipment enables several impacts to be monitored while gathering background information essential for the study design. Large quantities of data can thus be collected at low cost, and data concerning unusual circumstances can easily be collected along with other data. Other methods of collecting data on unusual circumstances, the better control of which is often the aim of ITS functions, have proven to be highly difficult and time consuming.

Travel times are connected with and correlate with several indicators that describe the performance and incident proneness of the transport infrastructure or a transport service. Traffic fluency and the punctuality of transport services are also subjective issues that are viewed very differently by different users and parties (e.g. Luoma 1998). This factor speaks for the need to examine the perceptions and expectations of the users of transport services.

During pre-evaluation, the impacts on travel times and the transport system's incident proneness can be assessed through modelling and simulations (European Commission 1997, Ojala 1997).

3.1.6 Traffic safety

Traffic safety's main indicators are the number of injuries and fatalities that have occurred in traffic accidents (Table 8). However, it is often futile to measure these on the basis of traffic accident statistics because only a small number of accidents takes place within the ITS project's limited impact zone. Therefore, research has to rely on indirect indicators, such as conflicts and driving speeds. Speeds are examined according to the established connection between accidents and the seriousness of the injuries incurred in them and the mean speeds (e.g. Ranta & Kallberg 1996). The choice of a suitable indicator depends essentially on the ways in which an ITS project is expected to affect safety, for instance by refocusing of driver's attention or by decreasing speeds.

Table 8. Assessment of the main impact "Traffic safety". The most important indicators are written in bold face.

INDICATOR	EVALUATION METHOD
Number of traffic accident fatalities	**Before-and-after analysis using accident statistics based on police or hospital reports**
Number of injuries incurred in traffic accidents	**Before-and-after analysis using accident statistics based on police or hospital reports**
Number of accidents	**Before-and-after analysis using accident statistics based on police or hospital reports**
Number of conflicts (near accidents)	**Traffic conflict studies**
Traffic volume	Traffic counts
Vehicle-kilometres driven	Transport studies, driver's logs, origin-destination studies, models
Person-kilometres travelled (number of person hours or passenger kilometres)	Transport studies, driver's logs, origin-destination studies, models
Goods tons transported (ton-kilometres)	Driver's logs, tachographs, models
Mean and standard deviation of spot speeds	Automatic traffic monitoring, radar studies, simulation studies, simulation
Mean and standard deviation of travelling speeds	License plate study, floating car technique, car following, tachographs, driving in instrumented cars, simulation
Number of traffic violations	Police statistics and accounts, interviews, surveys
Number of drunken-driving offences	Police statistics and accounts
Alertness	Measuring reaction times in an instrumented car, simulator or laboratory, interviews, operational errors
Focus of attention	Eye movement recordings in an instrumented car, simulator or laboratory, errors in perception, interviews
Share of short accepted time gaps	Field studies, driving in an instrumented car or simulator
Short (under 0.5 seconds) following time headways' share of all platooning headways	Automatic traffic monitoring, driving in an instrumented car or simulator
Share of short (under 1 second) TTC[1] values	Automatic traffic monitoring
Number of crimes committed in vehicles and terminals	Police/security company statistics and accounts, interviews, surveys
Feeling of safety	Interviews, surveys

[1] TTC or Time-To-Collision is calculated between two consecutive vehicles when the velocity v_B of the second vehicle B is greater than the velocity v_A of the first vehicle A at a certain cross section of the road as follows: $TTC_{AB} = [(t_A-t_B)v_A]/(v_B-v_A)$, in which t_A and t_B are the times when the vehicles passed the examined cross section.

The number of traffic accidents is often described as the product of the accident risk and exposure, which is why an ITS project's safety impacts can be evaluated by examining the project's impact on the accident risk (e.g. the accident rate) and exposure to accidents (vehicle-kilometres travelled or driven) separately.

If a project does not have a significant impact on the accident risk, the safety impacts can be evaluated through the changes in the amount of exposure or the distribution of this exposure (transport mode, route, timing).

During pre-evaluation, the impacts on the accident risk are especially difficult to evaluate in other ways than on the basis of expert statements and previous impact examinations, although models do exist for simulating conflicts (Ojala 1997). The current transport and simulation models should merely be used in predicting the changes in accident exposure and its distribution.

3.1.7 Noise, emissions and energy

The assessment of environmental impacts is given in Table 9.

The main indicators of environmental impacts consist of the number of people being exposed to environmental hazards in various ways. Besides monitoring, the assessment emphasises the utilisation of location data systems as well as simulation and other models. An increase in traffic usually causes an increase in environmental hazards, which is why the traffic volume and the number of vehicle-kilometres travelled can be useful indicators for assessing the allocation of environmental impacts. Interview and survey methods have to be used to assess the impacts on scenic and valuable natural sites.

Applying noise and emission models to the results of traffic and simulation models is the main working method during pre-evaluation.

Table 9. Assessment of the main impact "Noise, emissions and energy". The most important indicators are written in bold face.

INDICATOR	EVALUATION METHOD *)
Number of inhabitants affected by traffic noise	**Noise studies + location data analysis, traffic counts + noise models + location data analysis**
Number of people exposed to exhaust emissions	**Exhaust emission measurements, models, simulation, location data analysis**
Air quality indices of urban districts	**Air quality measurements**
Number of people suffering from illnesses directly or indirectly caused by emissions	**Interviews, surveys**
CO_2 emissions	Traffic counts and transport studies + emission models, simulation
Use of salt	MAINTENANCE STATISTICS + LOCATION DATA ANALYSIS
Transport energy consumption	Traffic counts or automatic traffic monitoring (speed distribution) + specific fuel consumption models, simulation
Range of area affected by traffic noise	Noise studies, traffic counts + noise models
Number of animals exposed to traffic noise	Noise studies, traffic counts + noise models along with a nature survey
Number of people disturbed by traffic noise	Interviews, surveys
Traffic volume	Traffic counts, models
Vehicle-kilometres driven	Transport studies, driver's logs, origin-destination studies, models
Person-kilometres travelled (number of person hours or passenger-kilometres)	Transport studies, driver's logs, origin-destination studies, models
Goods tons transported (ton-kilometres)	Driver's logs, tachographs, origin-destination studies, models
Mean and standard deviation of spot speeds	Automatic traffic monitoring, radar studies, simulation studies
Amount of traffic exhaust emissions	Traffic counts and transport studies + emission models
Damage caused to valuable natural sites	Interviews, expert statements
Safety of hazardous goods transportation	Hazardous goods tons transported + accident models, location data analyses
Hazardous goods-tons transported	Corporate interviews and surveys, location data analyses
Impact of transport infrastructure on the landscape	Interviews, surveys

*) "+" signs denote that the evaluation methods in question should be used in combination.

3.1.8 Valuations and comfort

All positive impacts indicated by the system's users are also expressions of valuations. For instance, if a service is thought to improve safety or have a positive impact on behaviour, these opinions can be considered examples of the system's valuations. Assessments of changes in valuations include examinations of service valuations as is (e.g. the number of users or uses) but also examinations of any changes in attitudes towards the various transport modes, e.g. people's willingness to use private cars or public transportation. Assessments of changes in valuations usually involve specific, well-defined targets of examination rather than general changes in attitude with no point of reference.

The construction of telematics systems can cause changes in the organisations that use the systems. Consequently, changes in valuations can also be examined from an institutional perspective. The status or role of the organisation can change in a way to suggest improved valuations for the organisation. This can be measured using surveys of organisational atmosphere or interest group and customer surveys. Improvements in valuations can appear as improved resources and visibility for the unit in charge of the system.

Table 10 presents the indicators and methods used to evaluate valuations and comfort. It can be very difficult, if not in fact impossible, to examine the direct impacts of a system or service. This may be because of, e.g. the large number of external factors involved, which can make it impossible to separate the impacts of various factors from one another. Surveys and interviews can give direct feedback during both pre- and post-evaluation about the value of the systems and services from users, which can help assess the magnitude of the actual impacts or compare different systems with one another.

Questions about the users' willingness to pay for a service can help researchers make assessments about the profitability of a system. It should, however, be noted that the indicated willingness to pay is very doubtful. The transferability of the results from one situation to the next should especially be viewed with great reservation. However, the willingness to pay can usually be used to compare the different services being studied.

Sometimes, the objective of an ITS project is to improve the users' attitudes towards a transport service's (e.g. public transport) general quality standard, or in other words, the image of a transport service. User interviews are then a direct method of evaluating how well the objective has been reached. Questions can, for instance, be asked about the users' notions of the characteristics of various transport modes and the differences before and after project implementation can be compared. The users' attitudes towards an ITS system or service can also be asked directly. Penttinen et al. (1998) have designed guidelines for carrying out user interviews in connection with traffic information services.

The number of users of a service is an indicator that can be directly measured and one that reflects the users' valuations.

Table 10. Assessment of the main impact "Valuations and comfort".

INDICATOR	EVALUATION METHOD
Number of uses	**Survey, census, registration**
Opinion of system and its characteristics	**Interviews, surveys, user feedback**
Willingness to pay (service)	**Interviews, surveys**
Willingness to pay (mobility)	Interviews, surveys
Users' attitudes towards transport system	Interviews, surveys
Users' attitudes towards different transport modes	Interviews, surveys
Travel comfort experienced by users	Interviews, surveys
Feeling of personal security	Interviews, surveys
Number of users of a service	Statistics, census
Number of users of a transport service	Statistics, census
Organisation/unit image	Measurements of customer satisfaction and surveys of organisational atmosphere

3.2 Study design

The design describes the way a study and the associated data collection are arranged. The design should allow the examination of the impacts of an ITS project objectively, free of any intervening factors. Table 11 outlines the basic design for examining the impacts of, e.g. variable speed limits.

Table 11. Basic design for studying the impacts of variable speed limits (Kulmala & Rämä 1998).

	Before	After 1 (immediate impacts)	After 2 (permanent impacts)
Control road section			
Actual road section			
Neighbouring road section			
Alternative routes			

During the before-phase, the actual road section is presumed to have a standard system of fixed speed limits, where the road section may have a lower speed limit during the winter period than during the rest of the year. The data for the after-phase is collected during precisely the same times of the year as the data for the before-phase in order to ensure that the trip purpose distributions and other related characteristics of the examined road users are as identical as possible. Data for the 'After 1' phase is usually collected as soon after the system's implementation as possible. If desired, tentative estimates can be made of the system's impacts, e.g. in order to modify the system's functions. The permanent impacts of the system are only discovered during the 'After 2' phase, for which the collecting of data can start one year after the system has been implemented at the earliest.

In addition, the material should usually be arranged according to the different prevailing circumstances. In the analysis of variable speed limits, such circumstances include weather and road surface conditions, daylight and the various conditions controlling the system of speed limits. Exceptional situations, such as large public events, that do not appear in similar study conditions in both the before- and after-phases may have to be eliminated from the material. (Kulmala & Rämä 1998.)

A similar design is well-suited for most impact assessments of ITS projects. The most difficult part of the post-evaluation of the impacts is usually assessing what would have happened at the site if the ITS project had not been implemented. For this reason, it is usually very important to follow up on the developments of the control site.

The objective of impact assessments is to assess a system's impact as reliably as possible. In order to separate the system's impacts from the impacts of other factors, the changes are evaluated according to the design of Table 11 and other controls.

Impact evaluation also concerns the testing of the correctness of the research hypotheses on the system's impacts, and the statistical significance of the observed changes. Significance testing is not dealt with separately in this report. The procedures associated with the testing of significance can be found in statistical literature (e.g. Milton & Arnold 1990).

3.3 Impact evaluation of subsystems

Some of the ITS functions given in Chapter 2 do not have direct primary impacts on the transport system's end users. These functions include, e.g. *traffic monitoring systems* and *traffic management and information centres*. These functions are subsystems in the production of services for end users, and their operation is therefore an absolute prerequisite for the implementation of the functions that affect the end users.

There are two ways to evaluate ITS functions that have no direct impacts on end users:

- Evaluating the impacts of the greater group of systems to which the subsystem in question belongs.
- Assessing how well the subsystem in question is fulfilling its own role in the system as a whole.

The functions that affect the end users and that are implemented with the help of the subsystems are defined while studying the greater whole. After this, the impacts of these functions are assessed. The impacts can be allocated to various subsystems on a case-by-case basis. However, one usually should not allocate the numerical values of the impacts to the various subsystems, since the result is always forced and artificial.

When a subsystem is evaluated separately, its objectives and end products have to be defined. For instance, the end product of the traffic monitoring system is information on the traffic situation. The end products of the traffic centre include, e.g. operative decisions concerning the use of variable speed limits.

After the subsystem's objectives and end products have been defined, assessment is made of how well the function in question fulfils its mission. The questions to be asked at this point include, e.g. Does the end product correspond with the objectives on quantity, accuracy and reliability, and how much resources are required for realising the desired end product? It is assessed, for instance, whether the traffic information to be produced is reliable enough and whether it has sufficient geographical coverage according to which variable speed limits can be controlled.

4 SOCIO-ECONOMIC EVALUATION

4.1 Characteristics of ITS projects

ITS projects are typically heterogeneous. The projects differ more from one another insofar as user groups and technical solutions are concerned than do traditional transport infrastructure projects. This is caused somewhat by the novelty of the field and the lack of standard solutions. The impact mechanisms and extent of the impacts of ITS projects are also different from those of traditional transport infrastructure projects. Thus, project evaluation must be flexible and the application guidelines given below should be interpreted according to the situation.

The main division (project description, impact descriptions, socio-economic profitability analysis, summary) of the project evaluation framework is well-suited for the assessment of ITS projects, but a more detailed division should better bring out the points of view that emphasise the special characteristics of ITS projects. The implementation of ITS projects may also be based on a research or piloting motive used for improving the knowledge of decision makers with regard to implementation decisions.

In ITS projects, it is important to define the evaluated project and subprojects. Individual subprojects (e.g. monitoring) often do not have impact mechanisms of their own. The impacts are created by a greater whole. On the other hand, a subproject can serve several wholes, thus making the allocation of impacts more difficult.

The ITS projects' point of comparison is also the so-called alternative 0, which represents the predicted state of the transport system in case the project is not implemented. This comparison should not include steps that may replace the project. Instead, this possible so-called alternative 0+ should be analysed in a similar way to the ITS project being examined.

In some cases, the ITS project can, in itself, be part of the alternative 0+, which is used to avoid or postpone investments in infrastructure. Then the impact assessments should also discuss the costs and impacts of the investment options as well as present an estimate of how well an ITS project can be used to replace or postpone investments.

An ITS project can also be a temporary solution, e.g. when investments in infrastructure are not possible until later, but the severity of the problems calls for speedy improvements in the situation.

Telematics can also form part of a primary investment, e.g. in transport infrastructure. The project evaluation would then follow the guidelines and principles set for the evaluation of infrastructure projects. These guidelines can be applied to the impact assessment of telematics applications, even though the impacts of the projects are being examined as a whole. The same goes for projects and alternatives, where the ITS solution also affects the physical implementation (e.g. road with lanes for changing directions).

4.2 Project description

The project description first outlines what the project is about (the nature and location of the project, and the quantitative data, etc.). The project description can be illustrated with a figure outlining the location of the project or the principle for reaching a solution. The various project alternatives should be outlined briefly.

After this, the problem the project attempts to solve is outlined, along with how the problem is expected to develop if the project is not implemented. The demand for and predicted development of the project are also described at this point.

It is especially important to outline what can or will have to be done, if the project is not implemented, and what these actions will cost. If the project is part of a larger whole or programme, this will be mentioned. The project description should also outline the ITS project's role as part of a long-term transport system solution.

It is typical for ITS projects to consist of subprojects that only together produce the desired function and its impact. If the evaluation concerns an individual subproject that has no impact mechanism of its own, the evaluation can, however, be limited to the project description in a way that brings out the project's pros and cons when possible. If the target in question is a whole project, the subprojects are also described.

The project's costs are presented with the most important cost components and subprojects specified. The estimated annual operating and maintenance costs are shown along with the actual cost of investment. In addition to this, any possible financial considerations and the allocation of costs to various actors are shown.

The project description also outlines the project's planning status and readiness for implementation.

4.3 Impact descriptions

The impacts of ITS projects are evaluated according to the same principles as those of other transport projects. The project's impacts on traffic are usually examined, as are the safety and environmental impacts when the nature of the project calls for it. The impact descriptions are descriptive in nature, and do not comment on the utility or harmfulness of the project as a whole.

The impacts are primarily evaluated quantitatively. If quantitative data is not available, the impacts are outlined verbally.

The impacts on passenger and freight traffic are at least analysed, as are any significant impacts on the costs and profits of transportation market operators. The most significant impacts on equality (e.g. impacts for various regions and population groups) are also discussed.

4.4 Profitability assessment

4.4.1 General

If a project's impacts can be evaluated in terms of money, a cost-benefit analysis should also be drawn up. The objective of a cost-benefit analysis is to investigate how productive a project is, taking into account all of the project's significant socio-economic impacts. A cost-benefit analysis can be used both while deciding on future projects and during the post-evaluation of a project's socio-economic impacts.

If only approximate estimates of the impacts of a project exist, the cost-benefit calculation is also rough. The calculation can indicate the range of profitability, e.g. by using the minimum and maximum values of the impacts.

If there are no specific impact assessments of the project available, there are no grounds for drawing up a cost-benefit analysis. Then the project's cost efficiency can be evaluated, e.g. by proportioning its costs with the number of expected users or those who will benefit from the project.

In accordance with YHTALI, the cost-benefit calculation should be just one part of a total socio-economic profitability analysis, which is clearly a wider concept than cost-benefit analysis.

4.4.2 Cost items and their allocation

The benefits of ITS projects vary according to the project type. Table 12 outlines some of the cost components that should be examined during cost-benefit analyses.

All cost-benefit analyses of ITS projects should at least take any significant changes in driving costs and the project's implementation and maintenance costs into consideration. The maintenance costs include, e.g. equipment operating costs, labour costs and the cost of normal system maintenance. If a project has a significant impact on travel time predictability, the examination should also include the time savings caused by later departure. The calculation is carried out in accordance with the specific guidelines (Ministry of Transport and Communications 1994, Niskanen et al. 1998). The calculation of driving costs is usually based on the set values. Taxes are included according to the valid evaluation principles of transport sector. At the time of writing, the costs used in the calculation did not include taxes.

Table 12. Cost components used in cost-benefit analysis.

Project's implementation and maintenance costs*
Impacts on driving costs. Transport economy-related impacts with specified shadow prices
accident costs*
time costs*
vehicle operating costs*
environmental costs* (e.g. exhaust emission and noise costs)
Market-price impacts. Impacts in monetary terms that can be estimated / calculated
on the economic status of private persons (e.g. changes in service prices)
on corporate economy
on costs – not project-related – of transport infrastructure operators (e.g. savings in infrastructure maintenance costs due to transport telematics)*

* costs should primarily be included in the basic estimate

The market-priced cost components that are chosen for the cost-benefit analysis are those which the examined project affects. The choice of components depends on the nature of the project, for instance, on whether or not commercial enterprises are involved in the ITS implementation. The choice also depends on the examination level. It is, for instance, not expedient to estimate the impact that implementing a passenger information system on one line will have on unemployment. Chapter 3 outlines the most important impact mechanisms of various ITS functions. They can be used as the basis for determining the cost components that should be taken into consideration during investment calculations. When examining the impacts on costs that affect the economic status of private persons, companies and the public sector, double counting should be carefully avoided. The same impacts should not be calculated twice, e.g. as benefits of both private persons and the national economy.

The allocation of costs and benefits should be outlined. The normal division is as follows: transport system or infrastructure manager (state or municipality), transport service providers (e.g. operators, transport operators), transport users and other parties (e.g. when it comes to accident and environmental costs). The costs and benefits of passenger and freight transport are also usually shown separately.

As the figures used in the calculations are usually various kinds of estimates, it would generally be expedient to give an estimate of the level of uncertainty associated with each cost component. These uncertainty estimates can be used later on during sensitivity analyses. If a project's economic impacts are highly uncertain, it would be better to examine them by using multi-criteria analysis or a verbal description rather than to give them an unreliable monetary value.

The cash flow showing the costs and income created during an investment's economic lifetime is drawn up. The estimation also takes note of the investment's possible residual value. Figure 4 presents an example of the timing of the expenses and revenue of an ITS project.

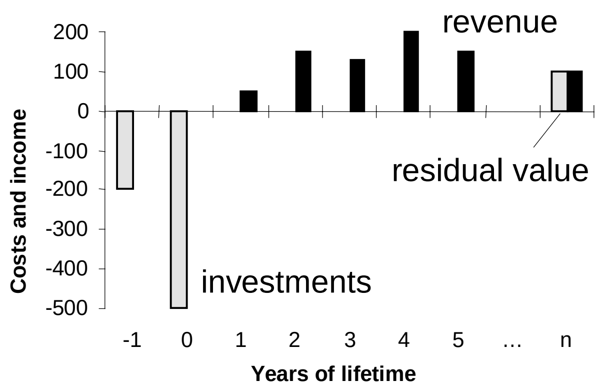

Figure 4. Example of the timing of the expenses and revenue of an ITS project.

The lifetime of an ITS investment is significantly shorter than that of an infrastructure investment, usually 10 years or less. For instance, the usual lifetime of computer hardware and software is 3–5 years. The residual value of ITS equipment is lower than that of equipment used in infrastructure projects. So far, no commonly defined lifetimes or residual values exist.

4.4.3 Benefit/cost ratio

In Finland, transport sector investment calculations utilise the *benefit/cost ratio*, which should also be calculated during the socio-economic profitability analyses of ITS projects. The benefit/cost ratio is calculated using the net principle, as seen in Formula 1. The net principle means that the overall socio-economic impact is divided by the investment costs. The system's maintenance costs are thus subtracted from the overall benefits, and the residual value is seen as profit.

$$\text{Benefit/cost ratio} = \frac{\text{socio-economic benefits} - \text{maintenance costs}}{\text{investment costs}} \qquad (1)$$

To calculate the benefit/cost ratio, a project's cash flow is discounted in order to find out its value at a specific time, usually the time of implementation. Transport sector profitability calculations use the imputed interest set by the Ministry of Transport and Communications, which was 5% in 2001 (Pesonen et al. 2000).

In addition to the benefit/cost ratio, other parameters such as the return rate for the first year of the project and the return rate of invested capital for various years of the project can be shown.

While calculating the benefit/cost ratio, the various components' impacts on costs should be shown individually. This means presenting the numerical values of the various cost components, such as the investment, accident and time costs. This helps the decision maker to have an idea of the factors that have affected the final result and the impact these factors have had. It would be expedient to show the actual impacts that the monetary values are based on along with the numerical values of the driving costs.

If the cost-benefit calculation includes any unusual cost items, several benefit/cost ratios should be presented. The basic calculation includes the cost components outlined in Table 12, the main components to take into consideration in transport sector profitability calculations. An example of an unusual cost component is the willingness to pay for services that are provided for free.

4.4.4 Sensitivity analysis

A sensitivity analysis should be made of the main uncertainty factors of the benefit/cost ratio. These uncertainty factors include traffic forecasts, the budget and any uncertainty associated with impact evaluations. Sensitivity analyses also have to examine the risks involved with the realisation of cost components, such as the financing risk. Sensitivity analyses are often especially necessary within ITS projects, because similar projects have not been implemented before, making the uncertainty associated with the impacts particularly great.

During sensitivity analysis, the value of a factor that affects the project's profitability is changed (increased and decreased) from the presumed value, and the consequent changes in the benefit/cost ratio are examined. During sensitivity analysis, it is usually expedient to change the value of only one cost component at a time, because otherwise it will be more difficult to examine the results. The cost-benefit analysis can present an estimate of the critical uncertainty factors, when the results of the sensitivity analysis are combined with an earlier estimate of the level of uncertainty associated with each factor.

4.4.5 Impacts on private economy

The objective of the method of evaluating the economic impacts is to show an ITS project's economic impacts on commercial and industrial enterprises as well as companies and public organisations that provide logistics services. Evaluations of impacts on private economy are best done when these impacts are significant. The method, presented later, was developed primarily for evaluating the impacts of logistics ITS projects, but can also be used to assess the impacts of other ITS projects on private economy. The method for evaluating impacts on private economy is outlined in greater detail in Chapter 5.

4.5 Impact analysis

The project impact analysis is based on impacts outlined in the impact descriptions. During analysis, the impact assessments are connected to values, as the quality and significance of the impacts are evaluated. The objectives corresponding with Tables 1 and 2 in Chapter 1, published by the Ministry of Transport and Communications (2000), provide the basis for these value connections.

The project's impacts should be compared with these objectives. In practice, it is expedient during project assessments to examine the impacts more extensively than just from the point of view of individual objectives. The following categories should be used:

1. Transport system level of service and costs
2. Safety and health
3. Social sustainability
4. Regional and community development
5. Detriments to environment
6. Development of information society.

The impacts of ITS projects should be analysed from the point of view of these six target areas. The significance and impacts of the project should also be divided by target area. It is essential to outline and prove the project's impacts on each target area. It should also be examined whether the impacts on each target area are included in whole or in part in the possible profitability calculation.

A graphic summary, similar to Figure 5, can be made of the impact analysis.

Project's main impacts and their allocation to the transport and information society policy objectives	Information society	Transport system level of service and costs	Safety and health	Social sustainability	Regional & community development	Detriments to environment
Decreased car traffic and increased PT lowers environmental and safety hazards		☺	☺	☺	☺	☺
Less need for transport infrastructure investments		☺			☺	
Creation of private value-added services around the service	☺					
Increased pedestrian and bicycle traffic		☺	😐	☺	☺	☺
Use of the service provides information on information systems' development needs	☺	☺				
Use of service via mobile communication devices increases driver workloads			☹			

Figure 5. Example of summing up the findings of an impact analysis (e-Nysse project, Appendix 1.4).

4.6 Evaluation of feasibility/implementation

4.6.1 General

ITS projects are often forerunners when it comes to technology and implementation concepts. This also causes the projects to entail significant risks concerning feasibility, along with other factors that should be discussed as visibly as the other project analyses.

Insofar as ITS projects are concerned, other factors essential for the project's feasibility are defined along with impact and profitability evaluations. These factors may include, e.g. the following:

- technical feasibility and user interface associated with the project
- evaluation of the market for a project and the technology developed within it
- technical feasibility-related risks
- need for and value of data produced during a trial project
- budget-related risks
- viewpoints connected with project financing
- user acceptance
- social acceptance
- legal and organisational factors
- data security and protection issues
- possibilities for implementation in phases.

4.6.2 Market assessment

Table 13 presents a checklist of the factors that should be examined during market assessments.

The results obtained by analysing the attitudes of service users towards an ITS service are usually needed to form the basis of the market evaluation, e.g. when the objective is to improve a company's position as regards competition by improving the image of the quality of the provided services. These results are obtained, e.g. through market research and user surveys. It is often necessary to pay special attention to the needs of special groups, such as the elderly and the disabled.

The size of the market can be evaluated, e.g. from the point of view of an equipment vendor or operator. In the first alternative, the equipment vendor attempts to estimate the overall demand for a system or piece of equipment and to proportion his investments in development to the expected sales. The operator on the other hand is interested in the significance of the investments for the creation of a service.

Table 13. Market evaluation checklist. The most important indicators are written in bold face.

MARKET EVALUATION	
Matter under examination	**Example**
Estimation of market size (demand)	Overall demand for elk warning systems in Finland
Market development	Does the project create new market opportunities
Satisfying the user needs	Need for system and requirements of system characteristics indicated by market research or user survey
Taking notice of the needs of special groups	Possibilities for the disabled to use the system
Encouraging competition	The risk of the creation of a monopoly as the project is implemented
Improving footing as regards competition	The impact of developed information services on the competitiveness of public transport services
Staying in touch with technological developments	Creation of facilities associated with the development of company operations
Taking care of information services	Information service plan
Exploiting the results	Result exploitation plan

The project may further an operator's chances to develop his operations, though it may not have any direct impact on the operations themselves. There may also be a need to try new solutions to determine the market.

Competitiveness should usually be encouraged, especially when implementing projects in the public sector, so that a single company or the public sector itself is not given better footing as regards competition than others.

The systematic management of information services and exploitation of the results is significant for a project's full utilisation.

4.6.3 Evaluation of technical feasibility

Table 14 presents a checklist of the factors that have to be examined during the evaluation of technical feasibility.

Development projects often apply the latest technology, the functioning of which has not been tested in practice. The risks associated with this must be clearly outlined during pre-evaluation.

Implementing a project in phases decreases the risks associated with the project's technical feasibility. When a project is implemented in phases, the solutions that are not functioning properly can be replaced before much money has been wastefully invested. The risks are increased on the other hand by a project's dependence on the existence and faultless performance of other systems.

Table 14. Checklist for evaluation of technical feasibility. The most important indicators are written in bold face.

EVALUATION OF TECHNICAL FEASIBILITY	
Matter under examination	**Example**
Risks associated with technical solution	Compatibility of equipment from different vendors
Compatibility and common system architecture	Interchangeability of subsystems, the need to rely on standards
Availability and development stage of necessary technology	Do sufficiently reliable sensors exist and are more developed models currently coming on the market?
Dependence on other systems	Does the project call for the implementation of other projects or can it be implemented independently?
Implementation in phases	Can a pilot project be carried out first as part of a larger system?
Risks associated with commitment	Does the implementation bind the operator to a specific system vendor?

Questions about the users' willingness to pay for a service can help researchers make assessments about the profitability of a system. It should, however, be noted that the indicated willingness to pay is very doubtful. The transferability of the results from one situation to the next should especially be viewed with great reservation. However, the willingness to pay can usually be used to compare the different services being studied.

Sometimes, the objective of an ITS project is to improve the users' attitudes towards a transport service's (e.g. public transport) general quality standard, or in other words, the image of a transport service. User interviews are then a direct method of evaluating how well the objective has been reached. Questions can, for instance, be asked about the users' notions of the characteristics of various transport modes and the differences before and after project implementation can be compared. The users' attitudes towards an ITS system or service can also be asked directly. Penttinen et al. (1998) have designed guidelines for carrying out user interviews in connection with traffic information services.

The number of users of a service is an indicator that can be directly measured and one that reflects the users' valuations.

The risks associated with technical feasibility are increased by a commitment to a certain form of technology and a specific equipment or system vendor. This is one of the reasons why the implementation of ITS systems aims for modularity and subsystem compatibility. This calls for solutions that correspond with the commonly accepted system architecture. Compatibility, therefore, should be one of the principles taken into consideration especially during pre-evaluation.

4.6.4 Technical evaluation

Table 15 presents a checklist of the factors examined during a technical evaluation.

Table 15. Technical evaluation checklist. The most important indicators are written in bold face.

TECHNICAL EVALUATION	
Matter under examination	**Example**
Technical functioning	Does a system or piece of equipment work as planned?
Reliability	Number of failures
Operating speed	Duration of payment transaction
System maintenance	Need for and duration of maintenance procedures

Technical evaluation is emphasised during the post-evaluation of new types of systems, one task of which is to find out which technical solutions are usable and working.

The difference between a technical and a functional indicator is not always clear. When examining a public transport payment system, the time spent at stops is clearly a functional indicator, while the payment-card reading time is an indicator associated with technical evaluation. The operating speed mentioned in the above checklist can be considered an intermediate form between technical and functional evaluations.

During post-evaluation, one important task of the technical evaluation is to give background information on the type of system the evaluation has been about. If the system has experienced technical difficulties during the trial period, it is presumable that these difficulties will affect the results of the impact evaluation and they should therefore be reported.

4.6.5 Evaluation of human machine interface and interaction

The human machine interface as a concept is quite close to usability specification, but the two concepts are not identical, as usability is a term defined for information technology (ISO 9241-11:1999), and as such is not applicable to transport telematics.

Interface evaluations focus on the point of view of the users during system development or implementation. During system development, the objective is to improve the ergonomics of the interface by considering the needs of users. During system implementation, the evaluation focuses on whether the interface can be approved for use in traffic or in a comparison test of alternative interfaces.

The standards set for human machine interfaces used in transport are exceptionally high for several reasons. First of all, problems with the interfaces can endanger traffic safety. Secondly, the situations and environments where the interfaces are used vary and can be highly demanding, especially if the system is used while driving. Thirdly, the system – especially if it is used in road transport – has to be suitable for a wide variety of users with varying degrees of knowledge, skills and experience (cf. Häkkinen & Luoma 1991). The systems must suit the young and the old, the experienced and inexperienced, professional and others, etc.

The human machine interface literally connects the human user with the machine system. Interface evaluation will next be examined from the aspect of user actions, seen as a sensing-perception-decision-action chain (e.g. Häkkinen & Luoma 1991). To ensure expedient actions, the system must be visible and easy to understand, there has to be efficient human machine interaction, and the system has to produce the desired reactions and minimise errors.

The examined aspects can be assessed using a variety of methods and techniques. The most common ones are various operational tests, monitoring, user interviews and surveys and expert assessments. Careful assessment usually calls for the use of multiple methods and a sufficient range of different users and uses. More superficial assessments are often used while the systems are still under development.

The bases for the evaluation are the interface legislation with its application and design guidelines, international standards and recommendations (e.g. European Commission 1998), and pre-standards. However, many regulations merely provide a general basis for the expert evaluation, the main stages of which will be outlined.

A checklist of the factors examined during an interface evaluation is given in Table 16.

Table 16. Checklist for evaluation of human machine interface.

EVALUATION OF HUMAN-MACHINE INTERFACE	
Matter under examination	**Example**
Visibility, conspiquity, detectability, identifiability	Legibility of visual information, volume level of auditory information
Comprehensibility	Interpretation of the meaning of the message for one's own actions in the prevailing environment
Structuring of information	Chances of getting confused in the menu
Compatibility of information with rest of the system	Compatibility of the information provided by variable message signs and the in-vehicle terminal
Controls	Distance, mode of operation, operational reliability in different circumstances
Interaction between user and system	Sufficiency of feedback, performance in error situations
Impact on driving and driver workload	Eye movements, vehicle control, use of controls
Acceptance	Considering properties to be useful
Installation and connections with other systems	Placement of the display
Supplementary information and instructions for use	How understandable user instructions are

One of the basic requirements of the system is that the interface and some main parts of it can be detected and identified . Many systems produce visual stimuli. Their important properties include legibility, the size of symbols and markers, contrast, luminance, resolution and colour. The messages should usually be visible in different lighting conditions. The most important properties of voice and audio messages are sound volume and clarity, the possibility of message repetition and the control of possibly distracting external sounds. One can also study whether incoming new messages and information are indicated clearly, e.g. a preceding signal in an in-vehicle terminal. Visual stimuli in the surrounding environment should also be conspicuous and visible from a suitable distance.

Comprehensibility means that the user interprets the meaning of the message as it applies to his own actions within the current context and environment. For instance, the clarity of the symbols, numbers and abbreviations used must be assessed to ensure the correct interpretation. Comprehensibility is one of the most important evaluation criteria for messages.

Assessments of the information structure examine if the information has been presented in such an order (e.g. on the display or in a menu) as to make its reading and comprehension as efficient as possible. It can be examined whether one can move from one topic to the other and comprehend the topic hierarchy easily and without error, whether the user can “get lost” in the menu etc.

Assessments of the compatibility of the information with the rest of the system include whether the information provided by the interface corresponds to the prevalent conditions and other information provided by the surrounding environment.

If the interface has controls, their ergonomics should be assessed: are the controls close enough, easy to understand and manipulated in a uniform way (turn, push etc.), identifiable in different lighting conditions, properly colour coded, possible to use without fault in a shaking vehicle etc.?

One must assess whether the optimal display methods and functions have been chosen for the interface, whether the system provides sufficient feedback if the user makes a mistake, and how the feedback system works for the user. The interface must provide sufficient information on the system status, but it must not give information that may lead to dangerous behaviour.

If the telematics system is being operated while driving (or moving), it is essential to assess what kind of impacts the interface will have on the performance of the driver’s primary task, which is to keep the vehicle on the proper part of the road and avoid hitting obstacles or other road users. The system must support the user, not to distract. The impacts of the interface can be assessed by analysing the user’s eye movements, consideration for the traffic situation and other road users, vehicle control, use of the controls, etc.

In addition to the visual/auditory properties of individual stimuli, one must also assess the overall amount of information per unit of time, the timing of information provision and the type of reaction the system calls for (the user cannot for instance be expected to react within a limited time frame).

User acceptance is connected to a knowledge and understanding of the system’s properties and considering these properties to be good and useful. As systems become more complex, it may be essential to evaluate how well the user understands the operational and management principles of the system. In the case of implemented systems, the number of uses and willingness to pay are often signs of acceptance.

Installation includes, e.g. the assessment of the placement of the in-vehicle terminal from the point of view of visibility and accessibility as well as other controls and parts of the system. The interface must not cover up any other equipment or hinder visibility. On the other hand, the display has to be placed as close as possible to the driver's normal line of sight. Reflections and lighting conditions will also need to be examined.

The clarity, brevity, comprehensibility and ease of use of the supplementary information are also assessed.

4.6.6 Evaluation of financial issues

Table 17 is a checklist of the factors that are examined during the evaluation of financial issues.

Investments in ITS systems can be a way to replace or postpone more extensive investments in transport infrastructure. Postponing a major investment decision has its own value, since profitability calculations for new investments always contain many uncertainty factors.

Table 17. Checklist for evaluation of financial issues. The most important indicators are written in bold face.

EVALUATION OF FINANCIAL ISSUES	
Matter under examination	**Example**
Budgetary economy	Funding available for a single investment
Arranging financing	Certainty of funding
Financing risk	Reliability of forecasts for the future development of transport problems
Financial actors	Commitment of all actors to the costs, agreeing on the distribution of the costs
User fees	Can users be charged for using the systems?

The budgetary economy sets great limitations on the implementation of investments. Budgetary limitations can postpone the implementation of even highly profitable projects. ITS investments often have quite limited costs, allowing the improvement measures to cover most of the transport network. (Leviäkangas & Lähesmaa 1999.)

Usually, the more long-term the investment is, the greater the risk involved. This makes road improvements and investments in ITS systems a more feasible alternative than new road investments.

Funding can also be taken care of by charging system users and other parties that benefit from the system for using the system. The possibilities for collecting user fees and the possible size of the fees should be examined before project implementation.

4.6.7 Legal and institutional evaluation

Tables 18 and 19 present checklists of the factors that should be examined during legal and institutional evaluations.

Legislation usually reacts very slowly to the challenges introduced by technological development. Statutes directly linked with transport telematics will only be introduced later on, when the number of controversial cases that appears creates a need for legislative regulations. Until then, the implementation of ITS systems adheres to the general statutes concerning traffic, procurement, privacy and data protection, and product liability.

Table 18. Legal evaluation checklist. The most important indicators are written in bold face.

LEGAL EVALUATION	
Matter under examination	**Example**
Protection of privacy	Making records of registration numbers; registration of driver behaviour in accidents
Data security and protection	Confidentiality of information associated with company product development
Compliance with standards etc.	Complying with regulations concerning existing standards and e.g. the code of practise for Human-Machine Interfaces
Implementation in accordance with traffic law	Signs and displays that follow the traffic sign act
Other laws and statutes associated with the implementation method	Following statutes concerning public procurements
Insurance in case of failures in ITS system	Compensation of damages to the system and to outsiders
Operation obligation and other regulations set for parts of ITS system	Obligatory use of tachographs in heavy vehicles
Need for new standards etc.	Wide-range implementation of the system can call for standardisation of certain components
Taking notice of factors associated with the product liability act	Accepting responsibility in accidents or when false information has been issued
Defining the user's responsibilities	Informing users of their responsibilities when using the system

Table 19. Institutional evaluation checklist. The most important indicators are written in bold face.

INSTITUTIONAL EVALUATION	
Matter under examination	**Example**
Responsibilities and powers of public actors	The borderlines of powers between various authorities and against companies
Powers of private actors	Is the actor authorised to collect data on the transport system
Delegation of responsibilities	All actors are aware of the delegation of responsibilities as well as their own responsibilities
Agreements between all actors taking part in the implementation	Written agreement on data transfer and the delegation of responsibilities as regards the quality of the data
Organisation plan in the implementation stages	Commonly accepted plan to organise the system
Organisation of system operation	Commonly accepted plan to organise the operation of the ITS system
Organising the maintenance and service of the system	Maintenance and service contracts
International connections and integration	Forming an international consortium, if the project is feasible as an international project

The utilisation of ITS systems emphasises compliance with standards related to the sector as well as common codes of practice agreed upon, especially on the EU level. An example of these is the code of practice for designing Human-Machine Interfaces for in-vehicle devices, the first draft of which was published by the European Commission in the spring of 1998, followed by an expanded version in late 1999 (European Commission 1998 and 2000).

Institutional issues usually turn out to be the most difficult issues concerning ITS systems. Such issues include, e.g. the question of who has the right to sell data that was collected as a co-operative effort and data that was partly collected using tax funds. Institutional issues are closely connected with legal issues, as statutes and regulations are often connected with the way an organisation's functions or the operations connected with an ITS project are controlled by special regulations.

Project implementation may slow down if there are no common ground rules on service or system implementation and maintenance, and the associated allocation of responsibilities between the public and private sector. The European Commission has made recommendations, e.g. on the legal and commercial issues associated with transport information services. The project evaluation will assess how well the project complies with or promotes this and other EU and national recommendations and regulations.

It is best to make written agreements on powers and the delegation of responsibilities during the various stages – planning, implementation and utilisation – of the project. With this in mind, the EU has had model contracts drawn up, for instance, in connection with the transfer of data between various operators.

Implementing projects on a national or international level depends on the objectives, scope and other details of the projects. International implementations and reliance on international programmes demand additional attention especially to institutional issues.

4.7 Summary and documentation of project evaluation

An evaluation's need for documentation depends on the extent of the project and the evaluation. A *document* at its most extensive is a separate evaluation report that also includes impact descriptions. At its shortest it is, e.g. a one-page summary that also includes the contact information for the person who wrote the evaluation. The significant information and bases for the calculation must always be available so that interested parties can, if they want, do their own assessment or calculation.

The documentation of ITS project evaluations should correspond with the extent and costs of the actual project. The documentation can often be less thorough as that of traditional infrastructure investments. The impacts and calculations just have to be documented as objectively as possible.

The way an ITS project evaluation *summary* is drawn up depends on the extent of the project and its evaluation and the purpose of the summary. If the project is an important investment project, the summary should be thorough and compliant with these guidelines. In the case of smaller projects, the summary can be, e.g. a one-page abstract of the various parts of the evaluation framework. The following structure, used widely in project evaluations, is the recommended summary structure:

- abstract (if the summary has four pages)
- project description (e.g. objectives, significance, problems to be solved, physical description, budget and readiness for implementation)
- impacts divided by target area
- profitability calculation and its sensitivity analyses
- feasibility evaluation.

The summary should include a date and contact information.

The project evaluation summaries of some example projects are included as appendices in this report.

5 APPLICATION OF FRAMEWORK IN LOGISTICS ITS PROJECTS

5.1 Characteristics of logistics ITS projects

In the supply networks and logistics processes, the impacts of ITS development projects (Figure 6) transcend corporate and organisational limits. ITS projects can directly or indirectly (through other levels) affect the following levels:

- transport system infrastructure
- logistics services and authority-provided services
- business life.

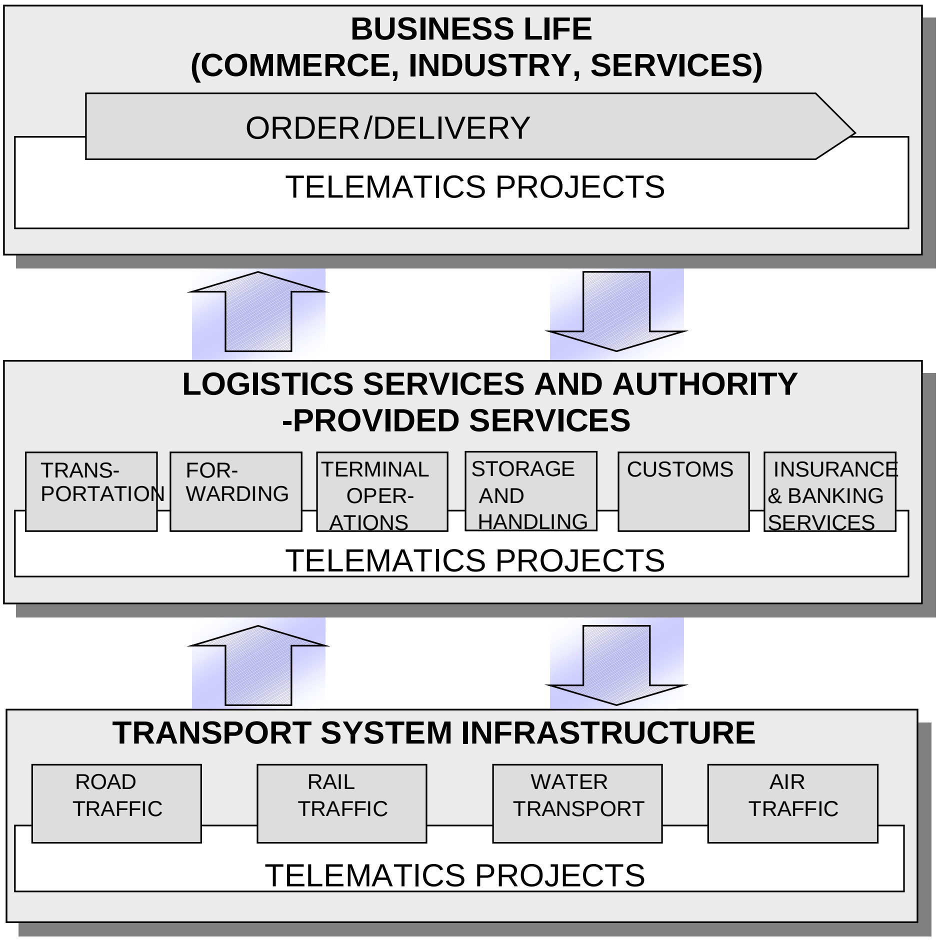

Figure 6. Logistics impact levels in telematics development projects

ITS development projects of the transport system infrastructure create the foundation for the development of transport system management and are beneficial for logistics services and authority-provided services as well as business life. Companies that provide such services (including the public sector) develop and increase the efficiency of their own operations and enhance the competitiveness of their own customers, while furthering the management of the transport system infrastructure. Commercial and industrial projects can similarly create preconditions for efficient operations and the development of services in companies that provide logistics services.

The realisation of a logistics ITS project can take place on many levels in various enterprises and organisations or be entirely focused on one company. The evaluation method outlined in this chapter covers both individual and multilayered project assessments.

5.2 Project classification

ITS development projects affect the different parts of logistics processes in different ways. Here, ITS development projects are examined from the viewpoint of the *order/delivery process* in a supply chain (Figure 7).

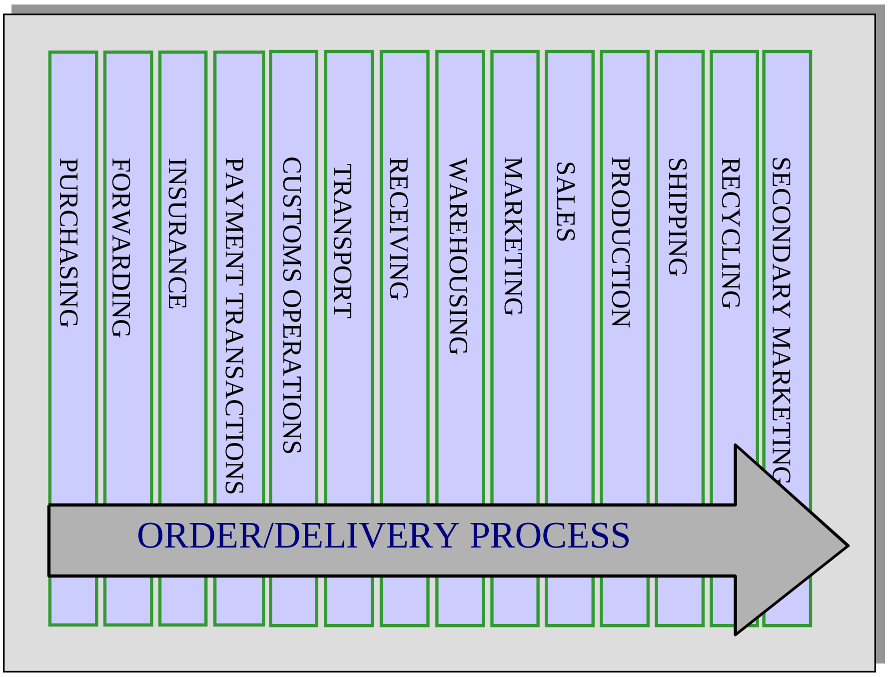

Figure 7. Order/delivery process.

In the order/delivery process, logistics ITS projects can be divided into seven project categories according to how and what parts of the processes they affect (Table 20). A project can belong to several project types simultaneously.

Table 20. Categories of logistics ITS projects[2].

Project	Focus	Description
K1	EDI (electronic data interchange)	Development projects making the electronic data interchange between organisations more effective (e.g. transmission of transportation documents)
K2	Tracking and tracing of shipments, units and vehicles	Development projects contributing to the management of transportation and handling of goods (e.g. development of satellite positioning)
K3	Delivery control	Development projects contributing to delivery time control and supply chain data management (e.g. delay control and variation announcement)
K4	Risk management	Development projects contributing to the management of damage, spoilage, loss and environmental risk (e.g. control of transportation circumstances)
K5	Marketing and transmission	Development projects contributing to the marketing and transmission of logistics services (e.g. development of supply of logistics services via the Internet)
K6	Planning and control of logistics functions	Development projects contributing to the planning and control of logistics functions in order/delivery processes (e.g. the development of individual enterprises' operative planning and management systems, projects associated with enhancing the efficiency of transport companies (e.g. choosing the least expensive route by utilising digital transport infrastructure data and driving simulation))
K7	Planning and control of functions in the management of transport infrastructure	Development projects contributing to the planning and control of functions in the management of transport infrastructure (e.g. the development of ice breaking and piloting, congestion information

The objective of the logistics ITS project's evaluation method is to show the logistics ITS project's

- economic impacts on commercial and industrial enterprises as well as companies and public organisations that provide logistics services
- qualitative impacts that are converted by the evaluation method into indirect economic impacts and which affect commercial and industrial enterprises and companies that provide logistics services
- socio-economic impacts.

[2] The project types K1 and K2 create the basis for the value added services in types K3 - K6.

The evaluation method of logistics ITS projects has been constructed to enable the status of the networking of the logistics operational environment and the main and secondary effects of the ITS development project on participants of the order delivery process to be taken into account (Figure 8). Owing to the 'multi-formity' of the operational environment one should always pay careful, case-by-case attention to the associated parties and their functions. The described method presents a preliminary model for function analysis within the most important target companies. There is an attempt to describe the economic and qualitative impacts in such a way that allows the utilisation of the Du Pont model, which proportions the impacts to the profitability of an enterprise or branch, in analyses concerning private economy.

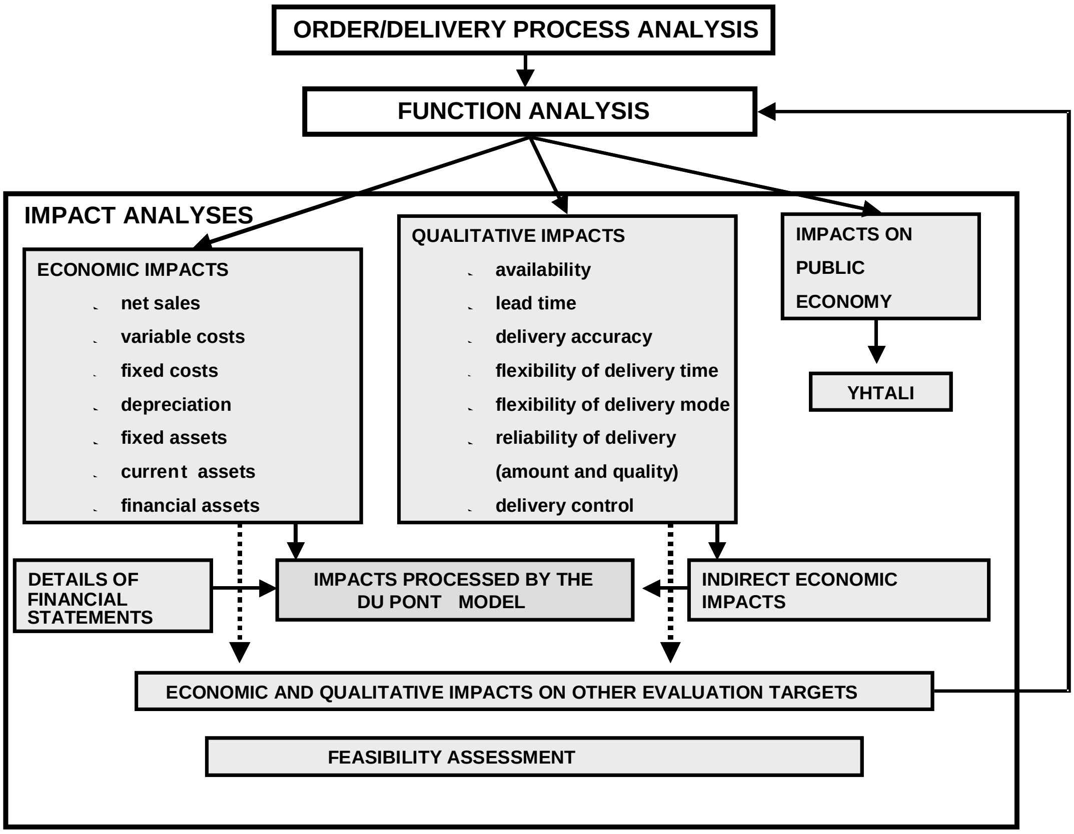

Figure 8. The evaluation method of logistics ITS projects.

5.3 Impact assessments

5.3.1 Project evaluation framework

The impact evaluation of logistics ITS projects is based on a project evaluation framework (project description, impacts, economic analyses, summary) that corresponds with the impact evaluation guidelines given here. The method outlined in Chapter 4 should generally be followed when carrying out project descriptions, feasibility and implementation evaluations, market assessments, technical feasibility and technical evaluations, and usability assessments. In the impact evaluation methods used, it is expedient to better bring out viewpoints that emphasise the special characteristics of the logistics ITS projects.

During the evaluation of logistics ITS projects, the projects are compared to the so-called alternative 0, which describes the predicted state of a logistics operational environment in case the project is not implemented. This comparison does not include steps that may be used to replace the project.

In some cases, ITS projects are used to try to prevent other needs for investment. These needs can include the need for additional storage space for transport units and goods or additions to the transport fleet and handling equipment. The impact examinations should then also examine the costs and impacts of alternative investments, and estimate how well an ITS project can be used to replace, reduce or delay investments.

5.3.2 Allocation of impacts to various factors

When it comes to logistic ITS projects, it is important to define the project being examined and its structure. In addition to direct economic and qualitative impacts, the project will have indirect economic and secondary impacts on the various parties involved in the logistics process. Defining the allocation of the impacts is therefore essential for assessing the impacts of logistics ITS projects. Assessing the allocation of the impacts of logistics ITS projects utilises the order/delivery process and function analyses.

The order/delivery process analysis is descriptive in nature, and does not comment on the usefulness or harmfulness of the impacts. Instead, it indicates whether the project will have economic, socio-economic or qualitative impacts on the various parties.

The function analysis identifies those functions of the order/delivery process that are affected by the development project in question in each company or organisation. The function analysis also indicates whether the project has a positive or negative impact on the functions of the participants.

5.3.3 Order/delivery process analysis

The order/delivery process analysis outlines the main and secondary impacts of ITS development projects on the participants in the process. The projects’ impacts can be economic or qualitative.

ITS development projects related to the order/delivery processes can also have socio-economic impacts (the so-called YHTALI impacts), which should also be taken into consideration.

The order/delivery process analysis is presented as a table (Table 21)[3], which illustrates all of the companies and organisations involved in the order/delivery process (20 in all).

Table 21. Order/delivery process analysis of a logistics ITS project in the example project "Control of damage risks within the delivery chain". The column on the left shows the participants of the development project in the darkened cells, and the top row shows all the participants in the process.

IMPACT AREA ANALYSIS	Seller	Buyer	Storage and handling	Forwarding	Road transport	Rail transport	Air transport	Shipping	Stevedor	Port	Insurance	Bank	Customs	Finnra	Finnish Rail Adm.	CAA Finland	Finnish Maritime	Statistics	Police, fire & rescue services	Frontier & product
Seller																				
Buyer																				
Storage and handling																				
Forwarding	E,Q	E,Q		E,Q							E									
Road transport																				
Rail transport																				
Air transport																				
Shipping								E,Q	E,Q								S		S	
Stevedor								E,Q	E,Q	S									S	
Port																				
Insurance																				
Bank																				
Customs																				
Finnra																				
Finnish Rail Administration																				
CAA Finland																				
Finnish Maritime Administration																				
Statistics																				
Police, fire & rescue services																				
Frontier & product																				

The column on the left shows the companies and organisations involved in the process. The participants involved in the implementation of the project can be identified by the darkened cells in which they are written. The row at the top of the table shows all the participants in the process, and the impacts of the development project on these parties are marked in the table as follows:

- The dark colour represents the most significant *impacts* of the ITS development project, on which the impact analyses should primarily focus.
- The lighter colour represents the other *impacts* of the ITS development project, which should also be noted during impact analyses
- The light colour represents the less important *impacts*, which are described, but not noted during impact analyses.

The nature of the impacts is described with the letters:

[3] Table 21 illustrates the impact area analysis of the logistics ITS project "Control of damage risks within the delivery chain" as an example.

E = Economic impacts on the party in question
Q = Qualitative impacts on the party in question
S = Socio-economic impacts

If a project has socio-economic impacts, the project should, in addition to a logistic impact analysis, also be submitted to an assessment of its socio-economic impacts, based on the YHTALI method, which is described in greater detail in Chapter 4. This also includes the secondary impacts that changes in logistic operating methods have on society[4].

If a project causes or promotes socio-economically significant changes in logistic operating methods, these impacts should be evaluated using the following scale:

- minor (no significance)
- moderate (causes some secondary impacts and need for change)
- significant (causes a number of secondary impacts and much need for change).

The changes in operating methods include:

- additional deliveries as sizes of delivery units are reduced (e.g. reduction in order sizes, increase in direct deliveries to customers)
- change in delivery routes as shipments are increasingly delivered through terminals or directly to clients
- change in transport mode distribution owing to changes in the modes' footing as regards competition.

All assessments of the moderate and significant impacts of changes in operations and operating methods should be done verbally in accordance with the Tables 3a–g (pages 21–27) in the target of impacts (main impacts and transport policy objectives).

In the order/delivery process analyses, it is important to pay attention to any special cases and future benefits. For instance, if the project belongs to the project types (Section 5.1, Table 20) EDI or the Tracking and tracing of shipments, units and vehicles, it creates a foundation for the value-added services that are developed later (the other project types). The project may therefore not create immediate economic or qualitative benefits, and may even appear to increase costs at the time of implementation when examined separately. In such cases, the order/delivery process analysis should include estimates of the future benefits brought by new possible value-added services to the various participants.

[4] If a project has significant socio-economic impacts, the size of the impacts is assessed in accordance with the YHTALI template. The impact mechanisms of the functions of Tables 3d (No. F2 - F4) and 3f (No. E3-E4) should especially be checked, if they are connected with the project.

5.3.4 Function analysis

The functions of the order/delivery process that are affected in each company or organisation by the development project in question should be identified to assess the size of the economic and qualitative impacts' effect on costs. The effect on these functions should also be identified (positive impact / negative impact).

As shown in Figure 8, a logistics ITS project can have economic impacts within companies or organisations on the net sales, variable costs, fixed costs, depreciation, fixed assets, current assets and financial assets. A logistics ITS project can also have qualitative impacts within companies or organisations on the availability, lead time, delivery accuracy, delivery time flexibility, delivery mode flexibility, delivery reliability in connection with quantity and quality, and delivery control.

The targets of economic and qualitative impacts are defined in greater detail later on (cf. Section 5.3.5).

Function analysis is illustrated in Table 22[5], which outlines the functions of the order/delivery process for those companies that were allocated *significant impacts* (darkened cells) or *other impacts* (lighter cells) during impact area analysis.

[5] Table 22 illustrates the function analysis of the logistics ITS project "Control of damage risks within the delivery chain", examined in the previous order/delivery process analysis, from the viewpoint of a transport company and seller as an example.

Table 22. Function analysis of the example project “Control of damage risks within the delivery chain” for those participants that have been marked with a darker colour in accordance with the order/delivery process analysis. [6]

FUNCTIONS BY TARGET		Economic impacts							Qualitative impacts							
		Net sales	Variable costs	Fixed costs	Depreciation	Fixed assets	Current assets	Financial assets	Availability	Lead time	Delivery accuracy	Delivery time flexibility	Delivery mode flexibility	Del. reliability (amount)	Del. reliability (quality)	Delivery control
Buyer and seller	Management of sales			++											++	+
	Man. of puchase order			++											++	+
	Payment transactions															
	Planning & control of production															
	Inventory man.						+									
	Def. of transport demand															
	Analysis of transport supply															
	Transportation schedules															
	Cargo clearance															
	Shipping & loading of goods															
	Receiving & unloading of goods			+												
Forwarding	Control of transport orders / bookings															
	Handling/transfer of B/L data															
	Advising	+			-	-									+	+
	Receiving forwarding, freight etc. bills															
	Transmitting forwarding, freight etc. bills															
	Sending customs declaration															
	Receiving clearance decision															
	Payment of taxes & tariffs															
	Drawing up Intrastat & VAT notifications															
Marine transport services	Transport supply & schedules															
	Freights & freight offers															
	Receiving transport orders / bookings															
	Booking & timing of marine transport															
	Timing of vessel traffic at the port															
	Timing & control of stevedoring															
	Timing & control of pilotage operations															
	Timing & control of ice breaking operations															
	Receipt at port															
	Port handling & loading onto ship		+		-	-									+	+
	Ship departure															
	Liner service				-	-									+	+
	Tramp vessel service															
	Ship arrival		+		-	-									+	+
	Unloading & port handling															
	Delivery of goods															
	Draw up & transmit of documents															
	Draw up & transmit of freight bills															
	Paying & transmitting fairway, piloting… bills															
	Paying & transmitting port dues															

The left side of the table outlines the functions of the order/delivery process for each company or organisation. The following columns represent the economic and qualitative impacts (listed above, c.f. definitions in Section 5.3.5). The impacts of the project under examination on the functions of each party are marked here as follows:

- “+” sign represents positive impacts.
- “–”sign represents negative impacts.
- “E” represents impacts that cannot be classified as positive or negative.

[6] Advising refers to the goods or cargo notice of arrival.

The number of "+" and "–" signs (1–3) illustrates the quantitative intensity of the impact on a scale of 1) minor impact, 2) moderate impact and 3) significant impact. While drawing up a function analysis, it should be noted that the impacts of the functions can vary by target, depending on the type and nature of the ITS project being examined, and some functions are not necessarily affected at all.

Appendix 2 outlines the essential functions of the logistics process in relation to the following parties:

- buyer and seller (deliverer and supplier of goods)
- provider of storage and handling services
- forwarding
- road transport services
- rail transport services
- maritime transport services
- air transport services
- customs services.

The functional descriptions needed for the evaluation are drawn up on the basis of these functions while making the required modifications. The functional descriptions can also be combined. For instance, in a detailed analysis, forwarding can form part of the deliverer's (seller's) own processes.

5.3.5 Impact analysis

Impact analysis defines the economic, qualitative and indirect economic impacts of a logistics ITS project. These impacts are described in such a way that changes in them can be analysed using the Du Pont model (Figure 9) (Uusi-Rauva et al. 1999). The model allows the description of each project's impacts on private economy, which includes, e.g.:

- the change in profit percentage
- the change in capital turnover rate
- the change in capital return rate
- capital needs and costs.

The Du Pont model requires as its foundation details of the enterprises' financial statements. The model can be applied to individual enterprises or whole branches that compile financial statistics. The model proportions the specific costs and savings to the overall profitability of a whole enterprise or branch, and furthers, e.g. the evaluation of socio-economic projects that increase the costs of enterprises.[7]

[7] An Excel application of the Du Pont model was drawn up for the old version of the guidelines. The application is based on material that corresponds with the Central Bureau of Statistics' audit report from 1995 (1997). Example descriptions were drawn up for 9 different fields (Kulmala et al. 1998).

The qualitative impacts are first given as a verbal estimate, after which their size is evaluated quantitatively. Finally, there is an attempt to estimate the impacts as indirect economic impacts measured in money.

If a project has significant secondary impacts on other parties, the size of the impacts can be estimated by carrying out a new round of estimates in these targets. These secondary impacts include, e.g. changes in service charges resulting from increased operational efficiency, or a decrease in current assets made possible by the increased efficiency of operations management.

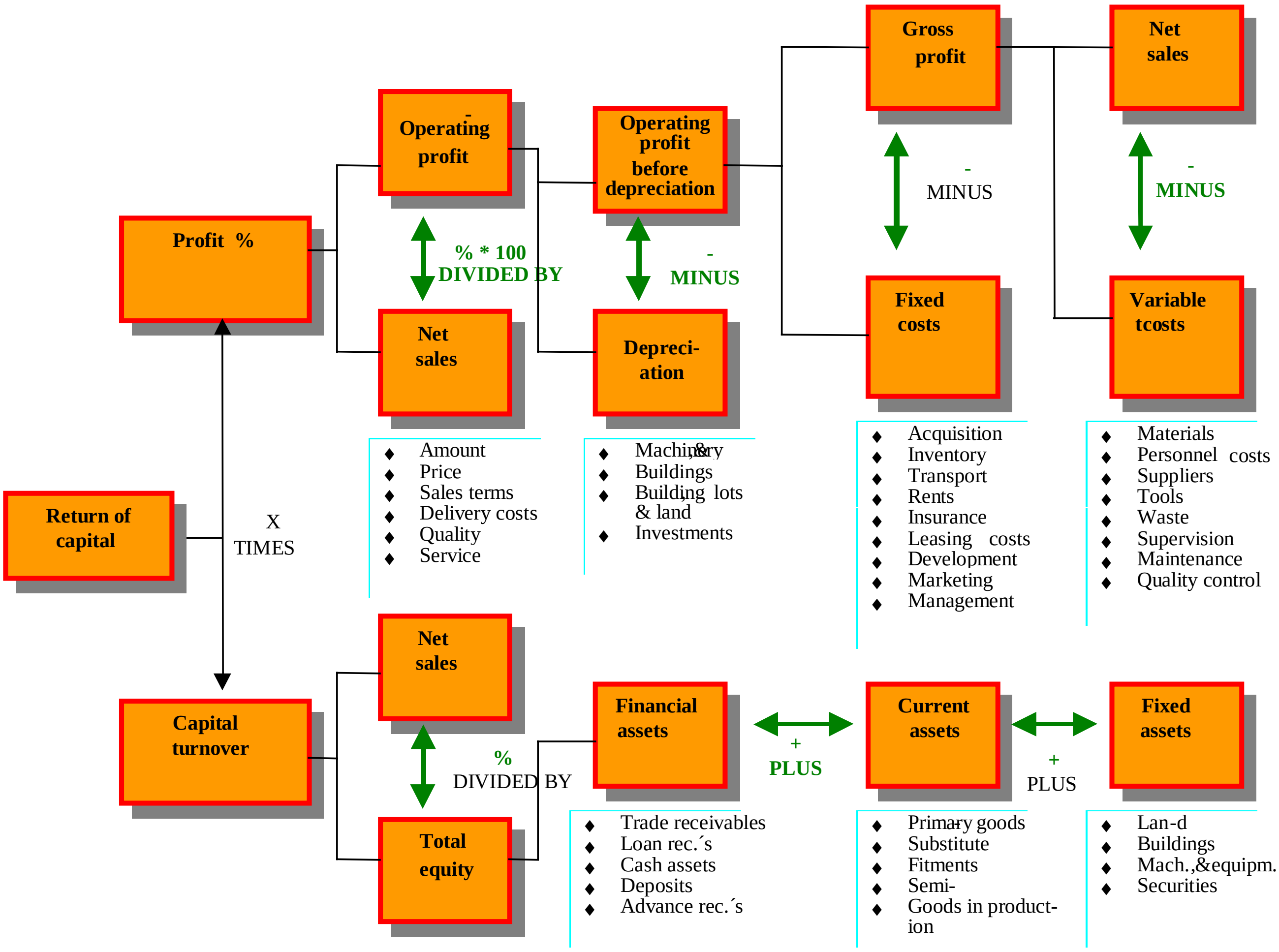

Figure 9. Du Pont model

Economic impacts

A logistics ITS project can have an economic impact on net sales, variable costs, fixed costs, depreciation, fixed assets, current assets and financial assets within companies or organisations (Table 23).

Table 23. Allocation of economic impacts

Target	Definition
Net sales	*Net sales* are obtained during actual business operations and calculated by subtracting the sales adjustment items from the sales proceeds.
Variable costs	*Variable costs* depend on the number of goods manufactured or sold. In industrial enterprises these costs include the acquisition of primary goods and equipment, production wages and indirect employee costs, fuels, and the maintenance and upkeep of machinery.
Fixed costs	*Fixed costs* are not dependent on the number of goods manufactured or sold. They are divided into salaries, rents and other fixed costs.
Depreciation	*Depreciation* means the calculated reduction of acquisition costs due to the cost of buildings and structures, machinery and equipment, intangible assets and other expenses with long-term effects.
Fixed assets	*Fixed assets* are articles, individually transferable assets and other commodities that are meant to yield a profit for more than one financial year.
Current assets	*Current assets* are commodities that are meant to be transferred or consumed as such or after processing.
Financial assets	*Financial assets* consist of money, receivables and financial assets that are temporarily not in the form of currency.

Qualitative impacts and indirect economic impacts

A logistics ITS project can have an impact on availability, lead time, delivery accuracy, delivery time flexibility, delivery mode flexibility, delivery reliability and delivery control within companies or organisations (Table 24). These are called qualitative impacts.

Table 24. Allocation of qualitative impacts

Target	Definition
Availability	*Availability* means whether a deliverer of goods or the inventory can provide goods or services to satisfy demand if necessary.
Lead time	*Lead time* is the time from the receipt of the order until the moment the client receives the product.
Delivery accuracy	*Delivery accuracy* refers to the predictability of the delivery time, or how probable it is that there will be no changes to the time of delivery given to the client.
Flexibility of mode of delivery	*Flexibility of the mode of delivery* refers to the chances the client has to affect delivery policy and the ability of the delivery mode to react to changes and incident situations.
Reliability of delivery	*Reliability of delivery* means the probability of the correct amount of the correct product reaching the client undamaged.

Qualitative impacts are first shown quantitatively (function analysis) and then as indirect economic impacts that can be measured in money.

Overall impacts on private economy

During the evaluation of the impacts on private economy, the overall economic, qualitative and indirect economic impacts on private economy caused by the logistic ITS project are determined.

The overall impacts on private economy are assessed by utilising the results of the function analysis and the assessment sheet (Figure 9), which also functions as the basic data sheet for the Du Pont application. The impact can be assessed in the sheet as a change either directly in Euros or as a percentage. The assessment in Euros is suitable, e.g. for assessments of changes in additional investments and fixed assets (e.g. the required size of the transport fleet being reduced by five vehicles). Assessments concerned with current assets are usually easier to make with the change shown in percentages.

The numbers are then fed into the Du Pont application, which gives the results in Euros or percentages for

- the change in profits
- the change in capital turnover rate
- the change in capital return rate.

ECONOMIC IMPACTS IN THE DU PONT MODEL	Direct economic impacts		Indirect economic impacts		TOTAL	
	1,000 €	%	1,000 €	%	1,000 €	%
Purchases during financial year						
Change in inventory						
External services						
Salaries						
Other personnel costs						
Other variable costs						
Total variable costs						
Salaries						
Other personnel costs						
Leasing costs						
Other rents						
Other fixed costs						
Total fixed costs						
Total depreciation						
Land						
Buildings						
Machinery, equipment						
Securities						
Total fixed assets						
Primary goods						
Substitute parts						
Equipment						
Semi-manufactured goods						
Goods in production						
Total current assets						
Trade receivables						
Loan receivables						
Cash assets						
Deposits						
Advance receivables						
Total financial assets						

Figure 10. Assessment sheet for impacts on private economy.

6 EXAMPLE PROJECTS

6.1 General

This chapter gives examples of the application of the evaluation guidelines in four example projects:

1 The development of traffic and road weather monitoring
2 Timing management in the delivery of goods between ports and wholesalers
3 Signal priorities for buses
4 Multimodal routing service

These example projects were chosen to represent different types of projects and assessments. Project 3 is a post-evaluation, whereas the others are pre-evaluations. Project 1 examines a system that functions as a subsystem for several others. Project 2 is a logistics ITS project evaluation, Project 3 affects both private and social economy, and Project 4 is a short evaluation of a minor project.

6.2 Development of traffic and road weather monitoring

6.2.1 Introduction

The traffic and road weather monitoring system consists of roadside equipment for monitoring road weather and traffic conditions, data transfer from the roadside to a traffic management and information centre, and the hardware and software used to analyse the data in the centre. This example outlines how a project evaluation of the monitoring system can be carried out in order to make an investment decision concerning a single location. A four-page summary of the project evaluation, corresponding with the YHTALI framework, is included in Appendix 1.1.

The impacts and profitability of the monitoring system are evaluated by studying the end services that utilise the data provided by the monitoring system. These services include variable speed limits, transport information and increasing the efficiency of winter road maintenance. The impacts of these services, e.g. on traffic flow and safety can be assessed, and these impact assessments can then be used to calculate the service's impact on social economy. The costs caused by the monitoring system are divided amongst these services and taken into consideration during profitability calculations.

The monitoring system has no direct impacts on traffic flow, even though the data obtained through the system is an essential precondition for the implementation of end services. Evaluations of the monitoring system should therefore pay close attention to evaluating the system's technical performance and how well the system serves the objective of providing data for end services.

However, the following example shows how it is theoretically possible to allocate some of the end services' impacts on the monitoring system and thus calculate the system's benefit/cost ratio. This example is partly based on material from an ITS analysis carried out in the Finnish Road Administration's Kakkois-Suomi Region (Lähesmaa et al. 1998).

6.2.2 Summary

The project summary based on the YHTALI framework begins with a short abstract outlining the project and its main impacts. The profitability and feasibility of the project are also discussed. The discussed factors include, e.g. whether the impacts of the ITS system are sufficient to realise the project objectives and whether telematics can remove the current problems associated with a road section. In addition, the abstract can indicate any technical difficulties that may jeopardise the entire project or should be solved before project implementation.

It is expedient to sum up the main impacts and their allocation to the transport and information society policy objectives in a table.

6.2.3 Project description

The project description introduces both the location that has been chosen as the site of the implementation of the traffic and road weather monitoring system and the system itself, along with its objectives and investment and maintenance costs. The description outlines the area and the problems that are to be tackled. In addition to this, background information needed for carrying out the impact assessments is given on the before-situation, including traffic volumes, speeds and accidents.

6.2.4 Impact descriptions

The impacts of the traffic and road weather monitoring systems come about owing to increases in the efficiency of winter road maintenance services, transport information services and variable speed limits. The impacts of these operations are then evaluated.

The description begins with a definition of the targets of the examined ITS functions and the main impacts that the description should focus on assessing, made by using the tables in Chapter 2, Impact mechanisms of transport telematics. For instance, the function *condition controlled variable speed limit* (C5) especially affects *time and its predictability* and *traffic safety*.

The indicators of the examined main impacts are defined next according to the tables in Chapter 3, Impact evaluation. For instance, *travel time* and the *stability of the traffic flow* can be used as the indicators of the main impact *time and its predictability* in connection with variable speed limits. The *number of accidents* is used as an indicator of the main impact *traffic safety*.

These impacts are assessed during pre-evaluation on the basis of previous research results or expert statements. If the impacts of an implemented system were being examined, the methods outlined in the tables and/or other indicators could be used.

6.2.5 Socio-economic analyses

The cost-benefit analysis utilises the cost components defined in Section 4.4, Profitability assessment, which are essential to the project in question. The impacts that were assessed within the example concerning the traffic and road weather monitoring system and allocated through calculations to the system are transformed into changes in costs related to private economy (e.g. accident, time and vehicle operating costs). In addition to this, the savings obtained through the improvement of the timing and planning of winter road maintenance operations are noted as a benefit. The benefit/cost ratio is calculated by comparing the overall obtained benefits with the system's investment and maintenance costs.

In this project, the socio-economic analysis does not have to include an impact analysis, as the project under evaluation is a single minor improvement project with no extensive impacts on the realisation of the transport policy objectives. Owing to the example purposes, the project evaluation summary does, however, include a verbal assessment of the impacts.

The checklists shown in the tables in Section 4.6.3, Evaluation of technical feasibility, are consulted when evaluating the factors associated with project feasibility. When going through the checklists, it is considered whether or not the listed factors have an essential impact on project feasibility. The project evaluation summary that corresponds with the YHTALI framework contains those factors that are essential to the examined project. *System maintenance* is a significant issue, for instance, in connection with the implementation of the traffic and road weather monitoring system, but the Finnish Road Administration does not have to worry about improving its *footing as regards competition*.

6.3 Timing management in the delivery of goods

6.3.1 Introduction

The example used of the implementation of the logistics ITS projects' impact evaluation method is a project that aimed at *improving timing management* within the delivery chain between the port and wholesaler. The aim is especially to increase the efficiency of the management of the port and land transport stages as well as the wholesaler-related unloading and loading stages.

The ITS project can help, e.g. improve stowage timing management, make the time-related advising (notices of arrival) during the other phases of the delivery chain more accurate, improve information services on possible changes in the transport conditions, and increase the efficiency of the functions in the port and land transport stages as well as the functions associated with wholesalers. The project also provides predictions that make it possible to plan the other stages of the delivery chain.

The logistics ITS project's impact assessment during pre-evaluation is examined. The imaginary project drawn up for this evaluation could be connected, for instance, with the FITS Programme.

A four-page summary of the project impact assessment, corresponding with the evaluation framework, is presented in Appendix 1.2.

6.3.2 Project description

The project description outlines a logistics ITS project's

- current status and objectives
- description and project classification
- links to other projects
- implementation method, participants and schedule
- estimated costs and financial plan
- ITS solution.

The description of both the project's operational environment and the ITS solution are best clarified with figures illustrating the principles of the project. The financial plan can be presented as a separate appendix if needed.

6.3.3 Allocation of impacts to various actors

The allocation of impacts is described using the *impact area analysis* (cf. Section 5.3.3), which illustrates by using a dark colour the direct and significant economic (marked with the letter E) and qualitative (marked with the letter Q) main impacts on the various participants of the order/delivery process. This example project has an impact on the following parties:

- buyer
- forwarder
- road transport company
- stevedore.

The other impacts of the ITS development project that should be noted during impact examinations are illustrated using a slightly lighter colour. The example project has no such impacts.

Finally, the significant indirect or less significant direct economic and qualitative impacts are illustrated with a light colour. These kinds of impacts affect the following parties during the example project:

- port
- insurance.

The project also has less significant qualitative impacts on the following parties:

- customs
- statistics
- frontier and product supervision.

The following function analysis (cf. Section 5.3.4) identifies those functions of the order/delivery process that are affected (positive impact (+) – negative impact (-)) within each company or organisation by the development project in order to assess the economic and qualitative impacts' effects on costs. The function analysis is illustrated as a table, which presents all of the functions of the order/delivery process that are essential for impact evaluations for those companies that were seen during impact area analysis to be allocated important impacts (darkened cells) or other impacts (lighter cells).

The example then presents the functions of the order/delivery process for the buyer, forwarding, road transport services and marine transport services in the left-side column of the table. The following columns present the economic and qualitative impacts of the examined project on the functions of each participant.

6.3.4 Impact assessment

Impacts on private economy

The assessment of the impacts on private economy defines the total private economy-related impacts caused by the logistics ITS project, which consist of economic, qualitative and indirect economic impacts. The total private economy-related impacts are assessed using the results of the functional analysis and the assessment sheet (Appendix

3). The sheet also functions as the Du Pont application's input data sheet. An impact can be evaluated on the sheet as a change either directly in Euros or in percentages.

The Du Pont model has been used to assess the project's private economy-related impacts on the stevedore, transport company, forwarder and wholesaler.

The results of Du Pont calculations that can be brought up in the result section include

- the change in profit percentage
- the change in capital turnover rate
- the change in capital return rate
- costs and need for capital.

During the example project's impact evaluation, the result section has shown

- the capital return rate prior to the implementation of the ITS project
- the capital return rate after the implementation of the ITS project
- the change in capital return rate.

Feasibility evaluation

The project's feasibility is evaluated as described in Section 4.6. The checklists connected with feasibility evaluation are examined and the most important factors in the lists are discussed in the project evaluation summary. It is also important at this stage to discuss the project's possible impacts on companies' competitiveness and relative positions as regards competition. This is especially important if the project causes inequality between groups (e.g. large companies – small and medium-sized firms) or fields.

6.3.5 Summary

The four-page project evaluation summary discusses the most important conclusions reached during the project evaluation in its first-page abstract.

The project and the need for its implementation (project objectives, deficiencies and problem areas in the current system, results of development) are briefly outlined.

The most important results of the project evaluation are outlined in the section on the project's impacts on private economy. The project's impacts on all parties are summarised and the impacts on the competitiveness of the companies participating in the project are discussed.

The most important changes that illustrate the impacts on private economy and that can vary according to the nature of the development project are outlined. At this stage, the example project outlined the following as regards all project participants:

- size of investments
- changes in capital return rate

- changes in net sales
- changes in overall capital
- changes in variable and fixed costs.

The most important factors connected with project feasibility, including the technical, operational and financial risks associated with project implementation, are discussed at the end of the summary.

6.4 Signal priorities and passenger information for public transport

6.4.1 Introduction

The system of signal priorities for buses consists of changes in junctions' lane and detector arrangements, the timing of the traffic signals, in-vehicle equipment in buses and data transfer between the vehicle and signal devices.

The impacts and profitability of signal priorities for buses should be assessed on the basis of the impacts on public transport users, transport operators, other modes of transport and the environment.

The example is the post-evaluation of an implemented system of public transport signal priorities on one bus and one tram route in Helsinki. The example target is the "423" system in Helsinki, which includes both public transport signal priorities and real-time passenger information services. The example is based on an impact study conducted during the TETRA Programme, but the summary has been amended to correspond with the new model being used. A four-page summary of the project evaluation is presented in Appendix 1.3.

6.4.2 Summary

The summary outlines the most important impacts and factors that affect project implementation and it discusses the significance of these factors in relation to the transport policy objectives. For instance, it is discussed whether or not the impacts of the priority arrangement have been sufficient to realise the objectives of the project and whether or not the system can improve public transport's footing as regards competition. The summary can also outline the technical solutions and starting points that have been essential to the success of the project and that have included problems that will diminish the desired benefits.

6.4.3 Project description

The implemented priority solution, and its objectives and investment and maintenance costs are outlined in the project description, as is the site where the priority arrangements have been implemented. The site and the problems to be solved are both outlined. The background information given consists of the conditions during the before-situation that are essential for drawing up the impact assessments, such as traffic volumes, the number of passengers and accidents, the delays in public transport and vehicle traffic and adherence to timetables. The connections with more extensive priority, information and fleet management systems and their objectives are also outlined.

6.4.4 Impact descriptions

Public transport signal priorities increase the efficiency of public transport services, fleet management and transport information services. The priority arrangements usually also have an impact on the other vehicle traffic and vulnerable road users at the site, which should be taken into consideration while presenting the impact descriptions.

The description is begun by defining the targets of the project's functions and the main impacts that the description should focus on by using the tables given in Chapter 2, Impact mechanisms of transport telematics.

The traffic signal priority function (C3) is mainly used to affect the *choice of transport mode.* The signal priority project should focus on assessing the main impacts *fleet and its costs, time and its predictability, noise, emissions and energy* and *valuations and comfort*. *Traffic safety* may also be an important impact factor. The priority may significantly shorten the green light given to other directions, which must be taken into consideration in the study.

Next, the indicators of the main impacts are defined on the basis of the tables given in Chapter 3. *Transport fleet investments* and *costs of fleet utilization* are here used as indicators of the main impact *fleet and its costs*. *Travel time*, *delays due to incidents* and *deviations from schedule in public transport* can be used as indicators of the main impact *time and its predictability.* The *number of accidents* is used as an indicator of the main impact *traffic safety*. *Transport energy consumption* can be used as an indicator of the main impact *noise, emissions and energy.*

6.4.5 Socio-economic analyses

The cost-benefit analysis utilises the cost components defined in Section 4.4 that are essential to the project in question.

The impacts measured and estimated in the example on signal priorities for buses are used to assess the changes in transport economy-related costs, such as accident, time and vehicle operating costs. The savings obtained through the improvements in fleet management are also noted as a benefit. The benefit/cost ratio is calculated by comparing the total benefits with the system's investment and maintenance costs.

The project evaluation summary includes a verbal assessment of the project's impacts on the realisation of the transport policy objectives.

When evaluating factors associated with project feasibility, the checklist tables in Section 4.6, Feasibility evaluation, are examined and it is discussed whether or not these factors have an essential impact on project implementation. The summary includes the factors that are essential for the project. For instance, when implementing signal priorities for buses, *technical performance and reliability* are essential issues, while *ergonomics* has almost no significance, unlike in transport information systems.

6.5 Multimodal routing service

The project on multimodal routing services is based on a service trial designed for use in Tampere by VTT Building and Transport. The trial was drawn up as an example for discussion (Lehtonen 2001) for an event held at the then VTT Automation in Tampere in November 2001. Owing to the limited extent of the project, all essential data on the project can be found in the summary in Appendix 1.4.

7 FOLLOW-UP ACTIONS

The most important follow-up action is the utilisation of the guidelines in all ITS project evaluations both beforehand to support decisions made on project implementation and afterwards to help assess the project's impact. It should be emphasised that the extent of the evaluation should correspond with the extent of the evaluated system and its expected implementation. The updated guidelines should be used in both small and more extensive evaluations. The Ministry of Transport and Communications encourages the systematic use of the evaluation guidelines.

The findings of project evaluations should be given in a minimum 1-4 page summary as seen in the Appendices. The project evaluation summaries can be compiled into an impact assessment database, or used in transport information services.

Following these guidelines during both pre- and post-evaluations makes it possible to compare the projects in a consistent manner. This consistency is especially increased if the parties that utilise the guidelines all use the recommended parameters for each impact in their impact descriptions.

It is sensible to examine the applicability and possible deficiencies of the evaluation guidelines while implementing them. The guidelines will probably have to be amended and developed constantly as ITS systems develop and more information is gathered during system evaluations. It should be fairly easy to further develop the evaluation guidelines, as the guidelines are based on the utilisation of easily amendable checklists. Individual evaluation guidelines will probably have to be drawn up for the most common types of systems, as is already done in the case of variable speed limits and transport information services. These individual guidelines should be based on the evaluation framework given in this report.

In Finland, the goal should continue to be the systematic investigation of the impacts of trials and implementations of ITS systems and services, until the impacts of transport telematics in different conditions and operational environments have been assessed reliably. The best design for this task is a before-after design with controls to ensure reliability.

Within transport sector project evaluations, the need for further development is mainly connected with the development of cost-benefit analyses and multi-criteria analyses. Cost-benefit analyses should be developed to take into consideration the projects' impacts on budgetary constraints and the life spans of ITS projects, which are shorter than those of traditional investment projects. Multi-criteria analyses should aim to develop consistent application guidelines to ensure the comparability of project evaluations.

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PROJECT DESCRIPTION

SUMMARY OF IMPACTS

The road section between Pyhtää and Kotka on highway 7 (E18) is part of Finland's most important road connection with Russia. This road section is more difficult to operate than the rest of the road is, due to the large share of international and heavy traffic, the mixture of long-distance and local traffic and the traffic volume frequently exceeding the road's capacity.

A traffic and road weather monitoring system is an absolute precondition for the future implementation of a system of variable speed limits, transport information services and enhanced winter maintenance. The monitoring system has no direct impact on the traffic situation. Instead, the effects are caused by the implementation of the aforementioned services.

Owing to the use of variable speed limits, the average speed on the road section is increased by 0.5 km/h and the travel time for an average vehicle is cut by two seconds. The traffic situation is also stabilised and merging becomes easier. The number of accidents remains the same as it was during the before-situation. The enhanced transport information services and winter maintenance are estimated to reduce the number of injury accidents by 2 and the number of property-damage-only accidents by 4 in five years. All of the implemented services have a positive impact on the level of comfort experienced by road users. Better information services enable the timing and scale of winter maintenance to be improved and create annual savings of about 70,000 Finnish marks in winter road maintenance costs.

PROFITABILITY AND FEASIBILITY OF THE PROJECT

Theoretically, some of the savings in driving costs obtained through the aforementioned services can be allocated to compensating for the costs of the monitoring system and other costs caused by the implementation of the service. The monitoring system was thus calculated to create savings of 1.9 million FIM in accident costs, FIM 420,000 in time costs, and FIM 210,000 in vehicle operating costs. Also, winter maintenance costs are cut by FIM 370,000 within ten years. When these savings are compared with the costs of investment in the system (FIM 1.9 million) and operating costs for the first ten years (FIM 1.1 million), the benefit/cost ratio is calculated to be 0.97, which means that the benefits created by the project approximately cover the costs.

The planned system does not involve any great operational risks. However, the defects in the new type of ROSA weather station have to be fixed before the monitoring system can be implemented. The planned system can be used to produce the necessary data for the system of variable speed limits, transport information services and more efficient winter road maintenance.

Contacts
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Project's main impacts and their allocation to the transport and information society policy objectives	Information society	Transport system costs & service level	Safety & health	Social sustainability	Regional & community development	Detriments to environment
Precondition for system of variable speed limits, transport information services and control of winter road maintenance. Impacts caused by the implementation of services	☺					
Average speed increased by 0.5 km/h due to use of variable speed limits		☺				
Presumed stabile traffic situation and easier merging		☺	☺			
Number of injury accidents cut by 2 and the number of property-damage-only accidents cut by 4 on the road section within 5 years			☺			
Road users feel safer and more often feel like they are driving at optimal speeds (their target speeds)		☺	☺			
More efficient implementation of and lower cost for winter road maintenance		☺				

ROAD SECTION

A two-lane road on highway 7 (E18) between Pyhtää and Kotka. The road section is 10 km long and has an average traffic volume of 9,900 veh./d. (15 % heavy vehicles). The traffic volume increases by 4 % annually. The speed limit varies between 60/80/100 km/h.

CONDITIONS

- busy traffic, a lot of heavy vehicles and international traffic
- few places for overtaking, many junctions
- exceptional road surface conditions due to proximity of sea

TRAFFIC AND SPEEDS

During the summer, the average speed for cars and vans is 87 km/h, while that of heavy vehicles is 83. During the winter, the corresponding figures are 83 km/h for cars and vans and 80 km/h for heavy vehicles. The figure below illustrates the variation in traffic volume and average hourly speeds.

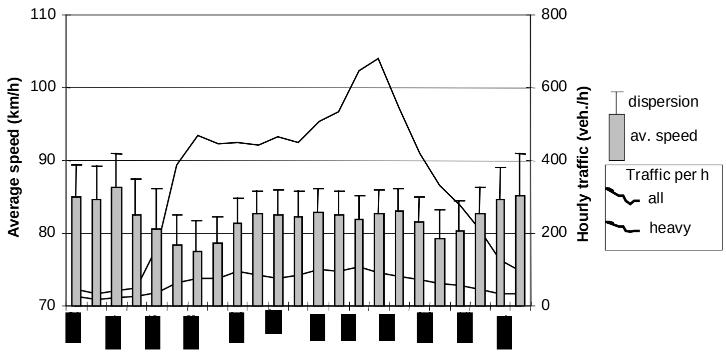


Figure. Average hourly traffic volume and average speeds of all vehicles and heavy vehicles from Monday to Thursday 9.-12.3.1998

ACCIDENTS

There have been 63 accidents on the road section between 1993 and 1997, 18 of which have been injury accidents. 12 of these accidents have involved a heavy vehicle. An estimated 23 % of the accidents have taken place in freely flowing traffic (<200 veh./h) while 7 % have taken place during busy traffic (>700 veh./h). Twice as many accidents have occurred when the road surface has been wet than on average on public roads. The accident types do not differ significantly from the accident types on public roads in general.

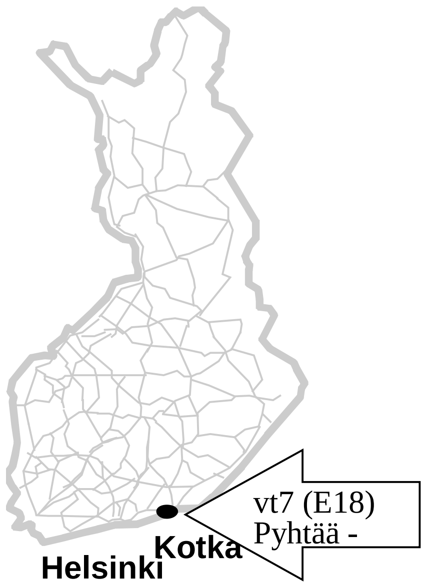


Figure. Location of project on traffic monitoring system on vt7 (E18) Pyhtää - Kotka.

TELEMATICS SOLUTION

Three road weather stations and six automatic traffic monitoring stations are positioned on the road section. Fixed cabling is used to organise data transfer and electrification by the road side. Data is transmitted from the technical building by the side of the road to the traffic management centre through a commercial net. The traffic management centre has systems for analysing the data. The software used to analyse road weather and traffic data has to be adapted.

The monitoring system's investment costs are estimated to be about FIM 1.9 million and the annual operating costs, including communication, electricity and service costs, are estimated to reach FIM 150,000. The operating costs do not, however, include the work time costs of the personnel maintaining the system.

IMPACTS

IMPACT DESCRIPTIONS

The data obtained through the monitoring system is used on the road section to control variable speed limits on the basis of both the weather and road surface condition and the traffic situation, to distribute transport information before and during trips, and to increase the efficiency of winter road maintenance operations. The impact descriptions assess the impacts of these services.

VARIABLE SPEED LIMITS

- The average speed for all traffic increases slightly, by about 0.5 km/h. Vehicles can travel at higher speeds in good road surface conditions and slow traffic. In busy traffic and bad road surface conditions the average speed decreases, the road's capacity is presumably slightly improved, traffic becomes more stable and merging becomes easier.
- As regards traffic safety, the situation is nearly the same as with a fixed 80 km/h speed limit. Raising the speed limit to 100 km/h increases the number of accidents, but the use of fibreoptic 80 km/h speed limit signs and the use of the 60 km/h speed limit decrease the number of accidents by a corresponding amount.
- Road users consider variable speed limits to be a good service, thus increasing driver comfort.

TRANSPORT INFORMATION

- Transport information can be used before a trip to learn about congested hours and can thus change trip timing accordingly. During the trip, transport information services increase the drivers' sense of comfort, but it is usually too late to choose alternative routes then.
- The impact of transport information on travel times was estimated to be slight. Information obtained prior to a trip may shorten travel times for certain road users. Information on the weather and road surface condition may decrease speeds and lengthen travel times for some drivers. The change in travel time could not be given an estimated numerical value.

Weather and road surface condition data improves driver preparedness for adverse road surface conditions, especially when there is hard-to-detect slipperiness, and increases the drivers' sense of comfort. Within five years, transport information is estimated to result in a reduction of one injury accident and two property-damage accidents.

ENHANCED WINTER MAINTENANCE

- The costs of winter maintenance will become lower as the data obtained through road weather stations will help improve the timing and scale of the maintenance operations. The number of maintenance operations may, however, increase, resulting in an increase in costs. The combined impact of this is an estimated annual decrease of FIM 70,000 in costs.
- As winter maintenance improves, the condition of roads during the winter becomes better, thus improving traffic safety. This is estimated to result in a reduction of one injury accident and two property-damage-only accidents in five years.

COMBINED IMPACTS

• Owing to the use of variable speed limits, the average speed will increase by 0.5 km/h
• Traffic flow will presumably become more stable and merging will become easier
• Within five years there will be 2 fewer injury accidents and 4 fewer property-damage-only accidents on the road section

Road users will feel safer and feel that they are driving at their target speed more often

SOCIO-ECONOMIC PROFITABILITY ANALYSIS

ALLOCATION OF BENEFITS

In order to do a profitability calculation, it has to be estimated which of the aforementioned impacts can be allocated to the monitoring system. Theoretically, this can be done by dividing the impacts by the costs of the monitoring system and the implementation of other user services.

The costs of the monitoring system are about
– 1/3 of the costs of the entire system of variable speed limits
– 1/2 of the costs of the system's transport information
– 2/3 of the costs of the road weather system utilised in winter road maintenance

COST COMPONENTS

Savings in driving costs FIM 2.63 M/10 years

- The monitoring system is calculated to result in a reduction of 1.2 injury accidents and 2.3 property-damage-only accidents in five years. Savings of FIM 1.97 million in accident costs are reached during the ITS investment's 10-year lifetime.
  (discount rate 5%)
- Due to the use of variable speed limits, the average speed is increased by 0.5 km/h on the road section, resulting in time savings of approximately two seconds per vehicle. One third of this impact is attributed to the monitoring system. Within 10 years, the time costs decrease by FIM 440,000 and the vehicle operating costs decrease by FIM 220,000.

Benefits to infrastructure operator FIM 0.38 M/ 10 years

- The current value for the savings in winter maintenance reached within 10 years is FIM 380,000.

Total benefits FIM 3.01 M/ 10 years

Investment and maintenance costs

- System investment costs are FIM 1.9 million
- Maintenance costs for 10 years are FIM 1.15 million

Total costs FIM 3.05 M/ 10 years

The monitoring system's transport policy-related imputed savings and the savings in winter maintenance and maintenance costs are equal to the monitoring system's investment costs

VAIKUTUSTEN ANALYYSI

The monitoring system is an absolute precondition for the implementation of variable speed limits, transport information services and enhanced winter maintenance operations, systems which help realise transport policy objectives as follows:

- increased traffic safety
- improved traffic flow on a nationally and internationally significant road section

increased efficiency in the implementation of maintenance operations and a decrease in the operations' costs

SENSITIVITY ANALYSES

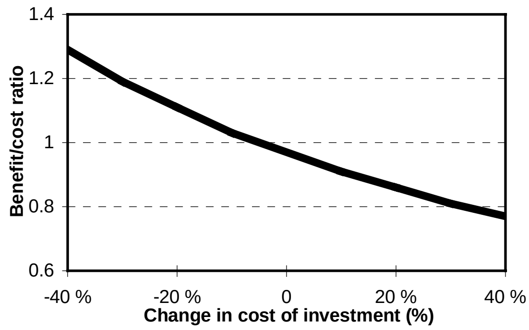


Figure. Benefit/cost ratio as the cost of investment changes.

FEASIBILITY EVALUATION

- Road weather stations give reliable data on the existing road surface conditions.
- Automatic traffic monitoring stations are able to monitor traffic flow in its entirety, but cannot detect anomalies involving individual vehicles. This would demand a much more extensive network of traffic monitoring stations and video or radar tracking. The monitoring of individual vehicles is, however, not considered to be essential for traffic control or information services on this road section.
- In the future, it will be possible to monitor traffic or the road surface condition from a moving vehicle. The amount of fixed tracking equipment on the road side can then be decreased, thus decreasing the cost of investment. These methods are, however, still in their experimental stages.

Road weather stations and automatic traffic monitoring stations have been used for a long time, which makes the system technically reliable. The new ROSA weather stations have, however, experienced software problems.

Reports drawn up on the project:

–

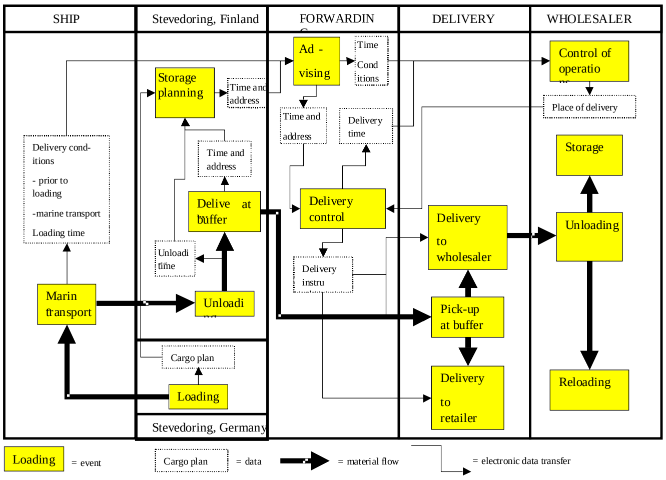
PROJECT DESCRIPTION

ABSTRACT

The objective of the project is to improve timing management within the delivery chain between ports and wholesalers. The aim is especially to increase the efficiency of the management of the port and land transport stages as well as the loading and unloading stages involving wholesalers. The current system has clear shortcomings, e.g. in delivery supervision and the way clients are informed of deviations, a matter connected with delivery time management.

ITS projects can help improve, e.g. the management of stowage timing, advising concerning other stages of the delivery chain, information services on qualitative deviations in the delivery conditions, the management of operations during the port and land transport stages and operations involving wholesalers. The project also enables the drawing up of predictions for planning the various stages of the delivery chain.

The project has a positive effect on the competitive capacity of all the enterprises participating in the project, and increases their capital return rate. The project's budget is 0.6 M€. The project is technically feasible, and the planned system involves no great operational risks.



Additional information:

SysOpen Oyj, Hanna Pajunen-Muhonen
tel. (09) 1344 5402, hanna.pajunen-muhonen@sysopen.fi

PROJECT'S IMPACTS ON PRIVATE ECONOMY

The project has direct, significant economic and qualitative impacts on the wholesaler, forwarder, transport company and stevedore. It also has indirect or less significant economic and qualitative impacts on the port and insurance companies, as well as less significant qualitative impacts on customs, statistics and frontier and product supervision. The project has no socio-economic impacts, nor does it cause or promote socio-economically significant changes in logistics modes of operation.

Party	Investment (€)	Change in capital return rate (%)	Change in net sales (€)	Change in overall capital (€)	Changes in fixed and variable costs (€)
Stevedore	67,320	+ 5	+ 60,250	+ 67,320	+ 11,780
Transporter	50,490	+ 29	+ 669,950	+ 50,490	+ 39,215
Forwarder	103,510	+ 37	+ 1,520,740	+ 103,510	- 274,240
Wholesaler	-	+ 105	+ 30,413,195	- 1,363,290	+ 454,430

NEED FOR AND OBJECTIVES OF PROJECT

The basis for the project is *improving timing management* within the delivery chain between the port and wholesaler. The objective is especially to increase the efficiency of the port and land transport stages and the wholesaler's unloading and loading phases.

The objective of the project is
- to improve stevedoring timing management
- to increase the consistency of time advising during the transport chain and to provide data on qualitative deviations in the delivery conditions
- to increase the efficiency of operation management within the port and land transport stages
- to increase the efficiency of wholesaler operations
- to make predictions to be utilised in the planning of the other stages of the delivery chain.

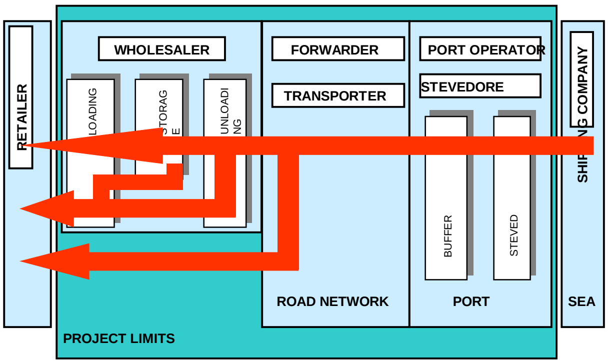


Figure. Material flow within the transport chain between the port and wholesaler and the project limits

PROJECT DESCRIPTION AND CATEGORISATION

The project is a development project connected with the identification of shipments and combining the associated data.

The project results in the following data being available for use in operation management systems:
- data on the location of goods in the delivery chain
- data on timing
- data on cargo
- data on trailers
- data on transport conditions.

The project belongs to the project categories K1, K2, K3, K4 and K6.

LINKS WITH OTHER PROJECTS

The project works as an example. It could be connected with the Ministry of Transport and Communications' (LVM) FITS Programme.

IMPLEMENTATION, PARTIES AND SCHEDULE

The project is implemented as a pilot project used to develop and do trial runs of various identification methods and principles associated with goods shipments.

The project concerns Wholesaler NN, Forwarder NN, Transport company NN and Stevedore NN. The project also involves Shipping company NN, the costs entailed to which are paid by the forwarder. The project also includes the LVM.

The project can commence in March 2002 and it will end in November 2003.

BUDGET

The project's overall budget is €0.6 M.

ITS SOLUTION

In the ideal situation resulting from the project, timing management in the delivery chain works as follows:
- Loading units have electronic identifiers, and temperature-controlled trailers also have sensors and electronic identifiers, which periodically record the time, temperature and humidity.
- The data in the identifiers can be analysed at various points along the delivery chain so that replacing measures can be taken immediately after an accident occurs (e.g. cargo is spoiled during a food delivery).
- Tracking data gathered by the stevedore is automatically transmitted to the forwarder responsible for controlling and advising the deliveries.
- The transport company receives real-time data on the arrival of the shipment, the exact pick-up address on the port buffer zone and the delivery address of the wholesaler.
- The system provides the wholesaler (and retailers) with data on the arrival of shipments and deviations from the delivery plan.

The main principles of the project's ITS solution are shown in the figure on the first page. The system is based on the following technical solutions:
- Trailers are equipped with an electronic identifier (read only) containing the identification code.
- Temperature-controlled trailers are also equipped with sensor technology and an electronic identifier, which can periodically record the time, temperature and humidity.
- Identifier data can be accessed and the data transmitted to the forwarder through a reading system on the ship while unloading.
- The tugmasters that handle trailers at the port are already equipped with radio terminals and GPS positioning devices. Additional electronic identifier reading devices allow the identification of trailers when unloaded from the ship and when left at the buffer. The GPS system is already used to manage the buffer area address set.
- Tracking data is electronically transmitted from the stevedore to the forwarder in charge of advising and transport planning.

IMPACTS

IMPACT ALLOCATION

The order/delivery process analysis for the ITS project ”Improving timing management within the delivery chain between ports and wholesalers” is shown in the figure below.

IMPACT AREA ANALYSIS	Seller	Buyer	Storage and handling	Forwardi	Road transport	Rail transport	Air transport	Shipping	Steved	Port	Insurance	Bank	Cust	Finnra	Finnish Rail Adm.	CAA Finland	Finnish Maritime	Statistics	Police, fire & rescue services	Frontier & product
Seller																				
Buyer		E,Q																		
Storage and handling																				
Forwardi		E,Q		E,Q	E,Q				E,Q		E,Q		Q					Q		Q
Road transport					E,Q															
Rail transport																				
Air transport																				
Shipping																				
Steved									E,Q	E,Q										
Port																				
Insurance																				
Bank																				
Cust																				
Finnra																				
Finnish Rail Adm.																				
CAA Finland																				
Finnish Maritime																				
Statistics																				
Police, fire & rescue services																				
Frontier & product																				

Figure. Project impact area analysis

The project has direct, significant economic and qualitative impacts on the following participants in the order/delivery process:

- buyer
- forwarder
- road transport company
- stevedore.

The project has indirect or less significant economic and qualitative impacts on the following parties:

- port
- insurance.

The increased optimisation of stevedoring operations has economic and qualitative impacts on ports, e.g. by enabling the more efficient use of space. The utilisation of delivery condition enforcement operations, simplifying the handling of losses and damages within the delivery chain, provides insurance companies with economic and qualitative benefits. However, the impacts will only become significant through wide-range implementation of the system. The impacts are therefore not taken into consideration in the pilot project’s impact evaluations.

The project also has less significant qualitative impacts on the following parties:

- customs
- statistics
- frontier and product supervision.

The lorries used to move trailers are equipped with radio terminals, through which they are given data on pick-up and delivery addresses and schedules from the forwarder.

FUNCTION ANALYSIS

Function analysis (figure) outlines the functions associated with the order/delivery process that are essential for impact evaluations in relation to the following parties:

- buyer (wholesaler)
- forwarding
- road transport services (transport company)
- marine transport services (stevedore).

FUNCTIONS BY TARGET		Economic impacts							Qualitative impacts							
		Net sales	Variable costs	Fixed costs	Depreciat	Fixed assets	Current assets	Financial assets	Availability	Lead time	Delivery accuracy	Delivery time flexibility	Delivery mode flexibility	Delivery reliability (amount)	Delivery reliability (quality)	Delivery control
Buyer	Management of sales															
	Man. of purchase order			++											+	++
	Payment transactions															
	Planning & control of production															
	Inventory man.						+									
	Definition of transport demand															
	Analysis of transport supply															
	Transportation schedules															
	Cargo clearance															
	Shipment & loading of goods			+					+		++					
	Receiving & unloading of goods			++							+					
Forwardin	Control of transport orders/bookings															
	Handling/transfer of B/L data															
	Advising	++		+	-	-					+				+	++
	Receiving forwarding, freight etc. bills															
	Transmitting forwarding, freight etc. bills															
	Sending the customs declaration															
	Receiving the clearance decision															
	Payment of taxes & tariffs															
	Drawing up Intrastat & VAT notifications															
Road transport	Transport supply & services															
	Freights & freight offers															
	Receiving transport orders/bookings															
	Booking & timing of pick-up transport	+			-	-					+					
	Booking & timing of long-distance transport															
	Booking & timing of delivery transport															
	Pick-up transport		+	+	-	-					+					+
	Unloading & receival at terminal															
	Handling at terminal															
	Shipment & loading at terminal															
	Long-distance															
	Delivery transport															
	Drawing up & transmitting B/Ls															
	Drawing up & transmitting freight bills															
Marine transport services (stevedoring, shipping	Transport supply & schedules															
	Freights & freight offers															
	Receiving transport orders/bookings															
	Booking & timing of marine transport															
	Timing of vessel traffic at the port															
	Timing & control of stevedoring	+			-	-										+
	Timing & control of pilotage operations															
	Timing & control of ice breaking operations															
	Receival at port															
	Port handling & loading onto ship															
	Ship departure															
	Liner service															
	Tramp vessel service															
	Ship arrival															
	Unloading & port handling				-	-										+
	Delivery of goods															
	Drawing up & transmit of documents															
	Drawing up & transmit of freight bills															
	Paying & transmitting fairway, pilotage etc. dues															
	Paying & transmitting port dues															

Figure. Project function analysis

DU PONT CALCULATIONS

In order to assess the ITS project's impacts on private economy, these impacts have been assessed according to the Du Pont model in relation to the stevedore, transport company, forwarder and wholesaler.

The Du Pont applications and their input data sheets are shown in one of the appendices in this project evaluation (cf. Appendix 3).

Private economy-related impacts of ITS project "Improving timing management within delivery chain between ports and wholesalers"

Party	Capital return rate prior to ITS project	Capital return rate after ITS project	Change in capital return rate
Stevedore	16.2 %	16.9 %	+ 5 %
Transporter	23.5 %	30.4 %	+ 29 %
Forwarder	10.4 %	14.2 %	+ 37 %
Wholesaler	2.6 %	5.4 %	+ 105 %

SOCIO-ECONOMIC IMPACTS

The project has no socio-economic impacts, nor does it cause or promote socio-economically significant changes in logistics modes of operation.

FEASIBILITY

- The project is a pilot project for implementing and testing new identification methods and principles associated with goods deliveries in one part of the delivery chain. The solutions used in the project can easily be implemented within the whole delivery chain and in other order/delivery processes.
- The project has clear market potential (e.g. deficiencies in the current delivery tracking system and the provision of information in case of deviations from arranged plans).
- The project is technically feasible.
- There are no risks involved with the implementation, budget and financing of the project.
- The ethical, legal and institutional factors associated with the project have been noted.

The project has a positive impact on the competitive capacity of all the participating enterprises. The project does not cause inequality between sectors or small and medium-sized commercial and industrial enterprises

Appendices associated with project evaluation:

Appendix 1. Du Pont calculations and their input data sheets

Reports, plans and documents drawn up on the project:

– Telematiikkaratkaisun yleiskuvaus (General description of ITS solution)
(SysOpen Oyj, 2001)

– Project evaluation (enterprises, 2001)

ABSTRACT

A public transport ITS system was implemented in Helsinki in 1999 by Helsinki City Transport and the Helsinki City Planning Department. The trial lines chosen were tram line 4 and bus line 23. Both lines are heavily trafficked. 39,000 passengers use tram line 4 daily, while 6,700 passengers use bus line 23 every day. Both lines are over 8 km long, with a total of 24 stops.

The ITS system provides many public transport telematics services, such as real-time information services, priorities at signal-controlled junctions and timetable monitoring. The objective of the system is to decrease public transport delays, increase the regularity and punctuality of public transport services and improve information services. Bus/tram stop displays have been installed at 15 stops, and public transport signal priorities are in place at 50 junctions. The system's investment costs are around €0.9 M.

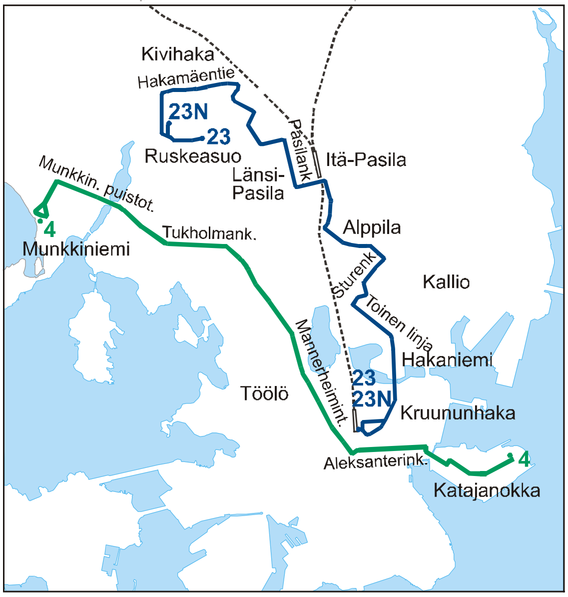
The ITS system's benefit/cost ratio was calculated at 3.3. The benefits are mostly passenger time savings caused by the decrease in delays at traffic lights.

The system has not been found to have any significant detriments. Rather, it was seen to promote Finland's general transport policy objectives.

The capital return rate for public transport operators was decreased by 1% on the tram line and increased by 6% on the bus line.

The bus line operations became so much faster that the fleet could be cut from seven to six buses, thus producing savings for the public transport operator.

The study findings clearly show that similar systems should be implemented in other large and medium-sized cities in Finland.



ADDITIONAL INFORMATION

Jari Seppänen, Helsinki City Transport
Tel. (09) 472 3547
Fax (09) 472 3742
E-mail jari.seppanen@hkl.hel.fi

Project's main impacts and their allocation to the transport policy objectives	Transport system level of service and costs	Safety and health	Social sustainability	Regional and community development	Detriments to environment
Increase in passengers of 1% on the tram line and 11% on the bus line.	☺	☺	☺	☺	☺
Decrease of over 40% in delays at traffic lights on both public transport lines. Decrease in travel times of 1% on the tram line and 11% on the bus line.	☺			☺	
Service regularity increased by 18% on the tram line and 20% on the bus line. Service punctuality improved by 22% on the tram line and 58% on the bus line.	😐	😐			
Passengers felt displays were necessary and had a positive impact on travelling comfort.			😐	😐	
Fuel consumption and emissions decreased by 1… 5% on the bus line.	☺				☺

PROJECT DESCRIPTION

PROJECT BACKGROUND AND OBJECTIVES

A public transport ITS system was implemented in Helsinki in 1999. The lines chosen for the trial were tram line 4, because it had a large volume of passengers, and bus line 23, because it had been a low-floor bus trial line. The system was implemented by Helsinki City Transport and the Helsinki City Planning Department. The objective of the ITS system is to decrease public transport delays, increase service regularity and punctuality and improve information services. The system's main services are the provision of real-time transport information via stop and in-vehicle displays, giving priorities to delayed vehicles at signal-controlled junctions, a real-time timetable monitoring system for drivers and the possibility of vehicle tracking. Displays have been installed on 15 stops and inside public transport vehicles on the lines in question. Equipment has been installed at 50 signal-controlled junctions to provide public transport signal priorities. The timetable monitoring system is in use in all vehicles and can be accessed via the driver's display. The system is based on modern radio communications and satellite navigation.

IMPACT STUDY

The impact study aims at finding out the impacts and economic feasibility of the ITS system. The evaluation guidelines of ITS projects state that information services for public transport passengers mainly affect the choice of transport mode and route, i.e. the public transport line. Public transport information services can also somewhat affect the timing of trips. The impacts are connected with travel time, regularity and punctuality, accessibility, and valuations and comfort. Public transport signal priorities affect the choice of transport mode as well as somewhat affecting transport system management by increasing management opportunities. These impacts can be seen in the fleet and operating costs as well as the travel time and its regularity and punctuality. Signal priorities also somewhat affect emissions and energy consumption as well as valuations and comfort. As far as the transport policy objectives are concerned, the pilot system affects both private and social economy from the point of view of the transport operator.
Based on the aforementioned impact mechanisms, the pilot system impact assessment attempted to find out the following impacts: 1) fleet and operating costs, 2) accessibility, 3) travel time and its regularity and punctuality, 4) emissions and energy consumption, and 5) valuations and comfort. The economic feasibility of the project was assessed using analyses of social and private economy. The methods used included before-and-after field studies, interview and survey studies, simulation and economic analyses.

The field studies examined the accessibility of the service as well as the travel time and its regularity and punctuality. The field studies included cross sectional counts and counts made while travelling in vehicles. The field studies were carried out on the tram and bus lines in April and May 1998, October and November 1999 and May 2000. Material from the spring of 1998 was used for the before-stage. The after-stage used material from the spring of 2000, since the system was not in full use until then and since the time of the year matched that of the before-stage.
The interview and survey studies examined the accessibility of the service; travel time, its regularity and punctuality, and valuations and comfort. The minute-long interviews were conducted on tram and bus stops. Questionnaires for the survey were handed out in vehicles to passengers, who returned them by mail. The interview and survey studies were carried out in May 2000 on five weekdays between 7 a.m. and 6 p.m. A total of 727 tram passengers and 753 bus passengers were interviewed.
The simulation examined the service's impacts on emissions and energy consumption. The aim was to examine the effects of signal priorities for buses on fuel consumption and nitrogen oxide (NOX), carbon monoxide (CO), hydrocarbon (HC) and particle (PM) emissions. The simulation was carried out using the VEMOSIM vehicle simulator, which can simulate the movement of a vehicle under normal road and traffic conditions. The simulation helped assess the average fuel consumption and emissions in both directions on the bus line. Separate parameters were defined for buses in traffic and idling buses.
The aim of the company interview was to find out the fleet and operating costs of the ITS system. The company interview was carried out by interviewing representatives of Helsinki City Transport.
The aim of the socio-economic analysis was to find out the ITS system's benefit/cost ratio, and evaluate the system's impacts and implementation. The findings of the field studies and simulation were used as the basis for the analysis.
The aim of the private economy-related analysis was to outline the economic impacts of the ITS project on the public transport operator. The basis for the analysis was defined using order/delivery process and function analyses. The actual impacts were assessed using the Du Pont model.

LINKS WITH GREATER PROGRAMMES AND OBJECTIVES

The work was carried out as part of the Ministry of Transport and Communications' TETRA Programme. The objective was to determine the impacts and socio-economic feasibility of Project 423 so that the findings could be utilised in the implementation of similar systems around Helsinki and the rest of Finland.

IMPACTS

FIELD STUDIES

The cumulative number of passengers assessed in the cross sectional counts increased by 4% on the tram line and 10% on the bus line. The counts made while travelling in vehicles showed the average increase in passengers per departure to be 2% on the tram line and 12% on the bus line. As the total increase in passengers between 1995 and 1999 was about 6% for trams and 0.4% for Helsinki's internal bus traffic, the increase in passengers caused by the ITS system could be evaluated to be 1% (390 passengers/day) on the tram line and 11% (737 passengers/day) on the bus line. The great impact on the amount of bus passengers may be explained by the twice as long headways. The tram line also already had a different kind of signal priority in use during the before-stage, so the ITS system did not have a significant impact on travel times on the tram line.

According to the findings, signal priorities decreased delays at signal-controlled junctions on both public transport lines. The decrease in delays was lower on the tram line, since it already had a different kind of signal priority system in use during the before-stage of the study. Apparently, at least part of the increase in delays at stops on the tram line was caused by the aforementioned increase in passengers.

The decrease in travel times was approximately 1% on the tram line and 11% on the bus line. Studies showed that delays at traffic lights were decreased quite significantly on the tram line, but since the delays at stops increased by almost the same amount, the overall decrease in travel times was quite small. The results of the field studies show that the decrease in travel times on the bus line was almost entirely caused by a decrease in delays at traffic lights, as there were no significant changes in other delays. Signal priorities appear to have decreased the travel times somewhat on the tram line and quite significantly on the bus line.

Service regularity was increased by approximately 18% on the tram line and 20% on the bus line, while service punctuality was increased by 22% on the tram line and 58% on the bus line. The studies showed that signal priorities decreased delays at signal-controlled junctions on both public transport lines. The increase in regularity was apparently due to the decrease in delays at traffic lights. The increase in punctuality can also be traced to the same cause on both lines. The increase in regularity was probably also due to the timetable monitoring system, which provides the driver with real-time information on the vehicle's possible deviations from the set timetable. Owing to the greater headway, the bus drivers benefited from the timetable monitoring system more than the tram drivers did.

INTERVIEW AND SURVEY STUDIES

Most passengers had noticed the displays and understood the information on them. Passengers considered the displays to be necessary and reliable, and beneficial to travelling comfort. Three out of four passengers supported extending the use of displays to other stops and lines. However, more than half of all passengers said that good bus/tram stop shelters and free timetable books were more necessary services than the displays. About one in four passengers surveyed thought that stop displays had affected their travelling behaviour, either by increasing their use of public transport in general or by increasing their use of the line in question. In reality, the percentage is probably less than half of this. One third of the passengers thought travelling had become easier and more punctual since the ITS system was introduced. This increased ease and punctuality is probably due to the decrease in delays at traffic lights and the implementation of the timetable monitoring system.

The interviews and surveys showed that passengers thought that displays – especially those on stops – were necessary and particularly beneficial to travelling comfort. Three out of four passengers supported extending the use of displays to other stops and lines. Stop displays were generally considered more useful on the bus line, with its longer headways, than the tram line. The stop displays were used more than the in-vehicle displays. Stop displays were also considered to be more useful and more beneficial to travelling comfort than in-vehicle displays.

According to the results of the interview and survey studies, in addition to increasing travelling comfort and making transferring from one line to another easier, the ITS system could also affect the number of trips made using public transport and even the transport mode passenger distribution. More detailed study is, however, required before these findings can be verified.

SIMULATION

The simulation shows that signal priorities seem to have decreased fuel consumption on the bus line by about 4%, while decreasing emissions by 1–5%, depending on the type of emission. However, the simulation method only took into consideration decreases in delays on the route and the consequent decrease in idling times. In reality, signal priorities decrease not just delays but also the number of stops a bus has to make. The braking and accelerating involved in making stops have a significant impact on fuel consumption and emissions. The simulation did not take the decrease in the number of stops into consideration, which means that the actual impact of signal priorities on emissions and energy consumption are probably greater than this study shows.

PROFITABILITY ANALYSIS

The system has the following quantifiable impacts that can also be assessed in monetary terms:

- passenger time savings due to the decrease in travel time
- savings in operating costs due to the increased fluency of public transport
- savings due to the decrease in emissions

The findings on public transport travel times and their predictability are based on the before-and-after field studies. The impacts on fleet costs and emissions are based on the simulation. The impacts on other traffic were not assessed.

The quantifiable benefits are caused by the speeding up of the bus line. The benefits of the system for the first ten years and the costs of system implementation discounted to the year of implementation are as follows:

BENEFITS (10 years, 5 %)	
Time savings for passengers	3.4 M€
Savings in public transport operating costs	0.3 M€
Savings in emission costs	0.0 M€
System operation & management costs	-0.6 M€
Remainder value of investments	0.0 M€
Total benefits	**3.11 M€**
Investment costs:	
Line 4	0.45 M€
Line 23	0.47 M€
Interest at time of construction	0.02 M€
Total investments and interest	**0.94 M€**
Benefit/cost ratio	**3.3**
Current value of project	**2.17 M€**

The profitability of the ITS system depends mostly on its impacts on other traffic, which are not included in this calculation. If these impacts are negative, the costs may outweigh the benefits for public transport passengers.
The system's benefits are almost entirely directed at public transport users and operators.

IMPACT ANALYSIS

Service level and costs

The ITS system improves the level of service for transport by decreasing travel times and increasing the regularity and punctuality of the service. The system improves the quality of transport by providing up-to-date, easy-to-use information services. The impacts on the level of service are significant, considering the size of the system. The system is very cost effective.

Private economy

According to the assessment of the impacts on private economy, the development of the bus line can be considered profitable. The capital return rate increased from 4.51% to 4.79% (+ 6%) on the bus line. On the tram line, the investments required by the ITS system decreased the capital return rate (–1%), thus making the system unprofitable.

Safety and health

The ITS system has not been shown to have any impact on traffic safety. The system decreases traffic emissions somewhat, but this is only a small impact.

Social sustainability

The ITS system improves the quality of travel for citizens without cars, but does not provide more opportunities to travel. The benefits are directed almost entirely at citizens who use public transport.

Regional and community development

The ITS system improves the region's internal traffic flow and helps improve the community infrastructure.

The ITS system has no impact on land use development opportunities, nor does it decentralise the community structure.

Detriments to environment

The ITS system improves the quality and service level of public transport, so it has a positive impact on the development of environmentally friendly transport. The system also has a positive, but limited impact on emissions.

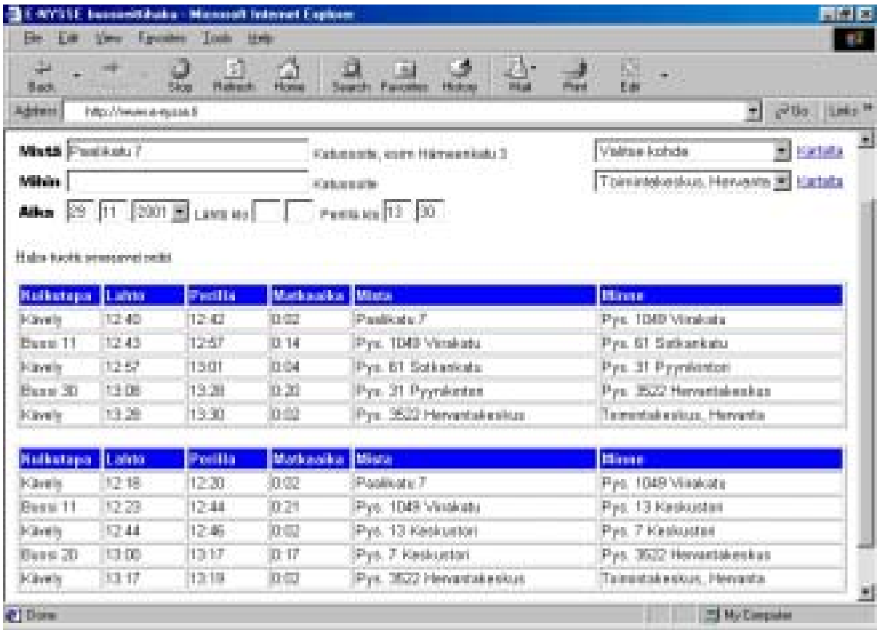
FEASIBILITY

The implementation of the ITS system has gone relatively well, technically speaking. Most of the interviewed passengers have thought that the information services provided by the system are useful.

The system is part of a greater system aimed at improving public transport fluency and information systems. The examined system is a pilot, aimed at providing information on the applicability and impacts of the technology as well as the valuations of its users.

REPORTS ON THE PROJECT

Liikennevaloetuudet ja ajantasainen tiedotus. Vaikutukset raitiolinjalla 4 ja bussilinjalla 23 Helsingissä (LVM B41/ 2001) (The Benefits of A Pilot Implementation of Public Transport Signal Priorities and Real-Time Passenger Information, Ministry of Transport and Communications B41/2001)



Example of service results for trip between Paalikatu 7 and Hervanta Activities Centre

SUMMARY

E-NYSSE is an on-line multimodal routing service for the Tampere region. In the service, the user inputs his departure point and destination, and is provided with a table outlining the trip using the desired mode of transport.

The objective of the project is to promote transport modes competing with private cars in the Tampere region. The service is being implemented in conjunction with the City of Tampere.

The project is part of the development of public transport and pedestrian and bicycle traffic in the Tampere region, decreasing private car traffic by an estimated 1%. The on-line service is expected to have 50–100 users daily (*Kirsi Koski/Tampere City Transport, phone conversation in January 2002*).

The project has some positive impacts (see table below). The project can be seen as being socio-economically profitable. The project's implementation costs are Euro 20,000, while maintenance costs are about 14,000 Euros/year. The project has no significant technical, financial, legal or institutional problems.

Small-scale user trials showed that the user interface needed much developing. The service would especially be improved by providing route data in map form instead of or in addition to the tables currently given.

Additional information:

VTT Building and Transport, Mikko Lehtonen
tel. (09) 456 4694, mikko.j.lehtonen@vtt.fi.

Project's main impacts and their allocation to the transport and information society policy objectives	Information society	Transport system level of service and costs	Safety and health	Social sustainability	Regional & community development	Detriments to environment
A decrease in private car traffic and an increase in public transport, decreasing environmental and safety hazards caused by traffic		:)	:)	:)	:)	:)
Less need for transport infrastructure investments		:)			:)	
Creation of private value-added services around the service	:)					
Increased pedestrian and bicycle traffic		:)	:|	:)	:)	:)
Use of the service provides information on information systems' development needs	:)	:)				
Use of service via mobile communication devices increases driver workloads			:(			

An example of the functions of the logistics process

FUNCTIONS BY TARGET		Economic impacts							Qualitative impacts							
		Net sales	Variable costs	Fixed costs	Depreciation	Fixed assets	Current assets	Financial assets	Availability	Lead time	Delivery accuracy	Delivery time flexibility	Delivery mode flexibility	Delivery reliability (amount)	Delivery reliability (quality))	Delivery control
Buyer & serller	Man. of sales order														
	Man. of purchase order														
	Payment transactions														
	Planning & control of production														
	Inventory man.														
	Def. of transport demand														
	Analysis of transport supply														
	Transportation schedules														
	Cargo clearance														
	Shipment & loading of goods														
	Receipt & unloading of goods														
Storage, handling	Service supply & charges														
	Delivery data transfer														
	Timing & man. of operations														
	Receipt & unloading of goods														
	Shipment & loading of goods														
	Balance of inventory														
	Payment transactions														
Forwarding	Control of transport orders/bookings														
	Handling/transfer of B/L data														
	Advising														
	Receiving forwarding, freight etc. bills														
	Transmitting forwarding, freight etc. bills														
	Sending customs declaration														
	Receiving the clearance decision														
	Payment of taxes & tariffs														
	Drawing up Intrastat & VAT notifications														
Customs	Receiving customs & statistical data														
	Transmitting clearance decisions														
	Collection of taxes & tariffs														
	Customs control														
	Statistics														
Road transport services	Transport supply & schedules														
	Freights & freight offers														
	Receiving transport orders/bookings														
	Booking & timing of pick-up transport														
	Booking & timing of long-distance transport														
	Booking & timing of delivery transport														
	Pick-up transport														
	Unloading & receipt at terminal														
	Handling at terminal														
	Shipment & loading at terminal														
	Long-distance transport														
	Delivery transport														
	Drawing up & transmit of B/Ls														
	Drawing up & transmit of freight bills														

An example of the functions of the logistics process, continued

FUNCTIONS BY TARGET		Economic impacts							Qualitative impacts							
		Net sales	Variable costs	Fixed costs	Depreciation	Fixed assets	Current assets	Financial assets	Availability	Lead time	Delivery accuracy	Flexibility of delivery time	Flexibility of delivery mode	Reliability of delivery (amount)	Reliability of delivery (quality))	Delivery control
Rail transport services	Transport supply & schedules															
	Freights & freight offers															
	Receiving transport orders/bookings															
	Booking & timing of cars															
	Booking & timing of long-distance transport															
	Delivery of cars & pick-up of goods from sender															
	Unloading & receipt at terminal															
	Handling at terminal															
	Shipment & loading at terminal															
	Train formation															
	Long-distance transport															
	Delivery of cars & goods for receiver															
	Drawing up & transmit of B/Ls															
	Drawing up & transmit of freight bills															
Maritime transport services (stevedoring, shipping company, FMA)	Transport supply & schedules															
	Freights & freight bills															
	Receiving transport orders/bookings															
	Booking & timing of marine transport															
	Timing of vessel traffic at the port															
	Timing & control of stevedoring															
	Timing & control of piloting operations															
	Timing & control of ice breaking operations															
	Receipt at port															
	Port handling & loading onto ship															
	Ship departure															
	Liner service															
	Tramp vessel service															
	Ship arrival															
	Unloading & port handling															
	Delivery of goods															
	Drawing up & transmit of documents															
	Drawing up & transmit of freight bills															
	Paying & transmitting fairway, piloting… bills															
	Paying & transmitting port dues															
Air transport services	Transport supply & schedules															
	Freights & freight offers															
	Receiving transport orders/bookings															
	Booking & timing of air transport															
	Air-traffic control & timing of land operations															
	Receipt at terminal															
	Handling at terminal															
	Loading from terminal to plane															
	Air transport															
	Unloading from plane to terminal															
	Handling at terminal															
	Goods delivery															
	Drawing up & transmit of B/Ls															
	Drawing up & transmit of freight bills															
	Paying other aviation charges															

FITS Publications
Earlier reports in the series

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3/2002 Liikennetelematiikkahankkeiden arviointiohjeet. 92 p. ISBN 951-723-762-6

4/2002 Guidelines for the evaluation of ITS projects. 87 p + appendices. ISBN 951-723-763-4

Additional information

Programme web site
www.vtt.fi/rte/projects/fits

Ministry web site
www.mintc.fi

Chairman of Programme Steering Committee
Director ***Matti Roine***
the Ministry of Transport and Communications
P.O.Box 235, 00131 HELSINKI
telephone +358 9 1602 8577
fax +358 9 1602 8592
e-mail matti.roine@mintc.fi

Programme Co-ordinator
Research professor ***Risto Kulmala***
VTT Building and Transport
P.O.Box 1800, 02044 VTT
telephone +358 9 456 4990
fax +358 9 464 850
e-mail risto.kulmala@vtt.fi or fits@vtt.fi

Mainostoimisto Sinervo&Co.