TRANSPORT AND TELECOMMUNICATION INSTITUTE

Vaira Gromule

THE SYSTEM OF MONITORING THE QUALITY OF THE COACH TERMINAL SERVICES FOR THE REALISATION OF A CONCEPTION OF A PASSENGER LOGISTICS CENTRE IN A MULTIMODAL TRANSPORT SYSTEM

Summary of the promotion work

to obtain the scientific degree Doctor of Science in Engineering (Dr.sc.ing.)

Scientific area "Transport and Logistics"

Scientific supervisor
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THE PROMOTION WORK PRESENTED TO THE TRANSPORT AND TELECOMMUNICATION INSTITUTE TO OBTAIN THE SCIENTIFIC DEGREE – DOCTOR OF SCIENCE IN ENGINEERING (Dr.sc.ing.)

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The defence of the thesis will be delivered in 15.12.2010 at 16:00 o'clock at the special Promotion Council of Transport and Telecommunication Institute on award of a doctor's degree to the address: 1, Lomonosova Street, conf. hall 4-130, Riga, Latvia, tel. +371 67100594, fax: +371 67100535.

CONFIRMATION

I confirm that I developed the promotion work that is presented to the promotion council of Transport and Telecommunication Institute to obtain the scientific degree of Doctor of Science in Engineering. The promotion work has not ever been presented to any other promotional council to obtain the scientific degree.

.... Vaira Gromule

The promotion work is written in Latvian, contains an introduction, 6 chapters, conclusions, 65 figures, 42 formulas, 34 tables, 158 pages, 13 appendixes. Bibliography contains 118 sources.

ANNOTATION

Vaira Gromule's promotional work: Monitoring System of the Quality of Passenger Terminal Services and the Realization of the Passenger Logistics Centre within a Multi-modal Transport System.

Academic supervisor: Professor Dr.sc.ing. Irina Yatskiv.

This promotional work presents the results of research regarding the improved adaptability and management of a passenger terminal, based on the example of the Riga International Coach Terminal, in ensuring the improved quality of the offered services and introducing new instruments to support decision making on the terminal information system (IS) base.

A systemization of the factors which allow the introduction of the logistics centre concept to the passenger terminals is undertaken in this work. The broadened functionality of the terminal's IS is particularly accented with the goal to further develop the passenger logistic centre, so as to integrate it into the multi-modal passenger transport network and to create a virtual logistics centre („virtual coach terminal") and expanding the logistics service systems.

This work reviews different ways to evaluate the quality of passenger services and offers a quality monitoring system for the services offered by the terminal, which is based on objective as well as subjective data. This work also offers a methodology for a reliability analysis which is based upon the calculation and analysis of the punctuality index for the coach service.

A methodology for a survey and questionnaire has been developed, in order to obtain subjective data about the evaluation of the services' quality. This work has developed a Discrete Choice Model for determination the factors which influence the choice of transportation mode by the client within a multi-modal transport system, if an alternative exists. An algorithm for constructing the integral quality indicator (IQI) for the services offered by the passenger terminal has been developed. The option of how to use the developed approach for determining the factors which crucially influence the quality of services has been demonstrated.

The developed models and methodology have been tested on the real terminal data at the Riga International Coach Terminal. Upon the basis of the undertaken analysis, the critical factors for the quality of services in the passenger terminal have been determined and a methodology for the analysis and planning of the passenger terminal's development, using a simulation modelling which is in the project stage, has been developed.

CONTENTS

1. ACTUALITY OF THE PROBLEM

The basic principles of "sustainable transport development" are the solution of the tasks of satisfying transport needs, which do not contradict the priorities of the environment and the citizens' health security and do not interfere with the interests of the future generations. Integration of Latvia in the Common European Market and its joining the EU has presented new demands to passengers' transportations – high mobility, inter-modality, comfort observing of passengers' rights as well as new requirements to the interaction of transport and environment. It is impossible to exercise complete account of all these requirements without a systematic approach and applying the logistics instruments to the formation and management of the passengers' services market on the basis of synthesising the systems of public transport at the level of the country, region and big cities.

Competition between different modes of transport, unprofitability of passenger transport and at the same time lack of satisfying the increasing demands of the population in modern transport services – all this is the reality of the passenger transport development in Latvia. It is especially evident under the condition of agglomeration of cities where railway transportations and bus traffic, working in the same price range, compete with each other. And there is one more successful competitor, route taxi, which offers either at the same or at a higher price a higher quality (speed first of all) of transportations. A traditional approach to the organisation of the passenger transport system in Latvia does not meet the given situation and the perspective requirements to the development of passenger transportations. One of the key directions of settling the situation is the development of intermodal transport systems (ITS) which can give new abilities to the development of passenger transportations.

Necessity of researching the problems of functioning of the public transport system in the region, role and place of the coach terminal in this system, formation on its basis of the logistics passenger centre (hub), actuality and importance of the theoretical and practical questions of the transport service quality for the population as a required condition for the integration into the multimodal system determined the choice of the promotion research theme and the formulation of its aims and tasks.

Raising the efficiency of the terminal control in conformity to the system approach requirements is greatly liaised with the formation of the coordinated management system including strategic, tactic and operative decisions as well as with the provision of the information-analytical base of managerial decision making of the above types and working out the corresponding instrumentation based on the monitoring and estimation of the indicators of the inner-organisation development. Systems of the organisation strategic, tactic and operative management are often built on different information bases and with different instrumentation that leads to non-coordination of management decisions of different levels negatively impacting the efficiency of the above decisions realisation. In this connection it seems reasonable to consider the instrumentation for building a coordinated system of the organisation managerial decision making, their realisation and evaluation of the efficiency.

The suggested solution in the inter-modal system of passenger transportations envisages strengthening of the terminal role that results in improvement of the general service and of the accessibility to the public passenger transportations. It also brings about elimination or minimization of the following serious lacks and limitations which are present today in the system of passenger transportations in Latvia, especially in the passenger terminals' performance:

1. Insufficient integration of the public passenger transportations by different modes of transport in the sphere of routes, traffic and information support.
2. Unsatisfying technical condition of the terminals and their functional layout interfere with the development of proper passengers' exchange and with setting of transfer inter-modal points.
3. Difficult access and movement of the public transport to/from the bus terminal as well as insufficient space for buses parking between trips.
4. Under the condition of the economic crisis in the sphere of passenger transportations, the main criterion of the development planning is a short term economy of financial resources. There is not enough research of the reaction of the transportations market to the suitability of the transport mode choice from the point of view of passenger and changes of the service quality in the long term period.
5. Lack of systematic in the analysis of development of passenger transportations in the state complicates both the strategic planning of the development and planning of the passenger terminals' operative activities.
6. Limitations of resources which underline the necessity of employing rational and effective methods of providing the passenger terminals' performance and development planning.

The main components of the ITS are the infrastructure, the transfer hubs and terminals, the transport means, the system of the transportation process management, the ambient service. Under this conception, the terminal becomes a vital core of a multimodal transport system or a part of a passenger logistics chain and its safety, reliability and other properties influence the properties of the whole chain.

2. GOAL AND TASKS OF THE RESEARCH

The main goal of the promotional research is increasing of the manageability and adaptability of a passenger terminal for its integration as a passenger logistic centre into a multimodal system on the basis of developing analytical instruments of an information system.

For the realisation of the above goal, the author has set and solved the following main tasks:

- there have been researched and determined the up-to-date tendencies of development and functioning of the regional system of passenger transport in Latvia and formulated the principles of its sustainable development;

- there has been preformed systematisation of the factors which allow to introduce a conception of a logistics centre in reference to a passenger terminal;

- there have been described the information flows at a passenger terminal and worked out the principles of development an information system (IS) of a terminal at the morphological, functional and information levels with the example of *Riga International Coach Terminal (RICT)*;

- there has been suggested the functionality of the terminal IS for realizing on its basis of a passenger logistics centre and its integration into the European multimodal network of passenger transportations by means of building a virtual logistics hub;

- there have been considered the approaches to estimating the quality of passenger services and defined the components of the services provided by the terminal;

- there have been suggested and worked out the analytical instruments for monitoring the quality of the terminal services and the instruments of supporting decision making in adaptation of the terminal to the changing conditions of functioning of a multimodal transport system:

  - there has been developed the method of calculating and analyzing the punctuality index of bus connection with the purpose of examining the reliability of the service in the hub of a multimodal transport system (passenger terminal);
  - there has been worked out a model for determining the criteria of the clients' preference influencing their choice of the mode of transport under the condition of different alternatives;
  - there has been developed an algorithm of building an integral quality indicator (IQI) of the service provided by the terminal on the basis of the developed algorithm of constructing an IQI;

- there has been developed the methodology of questioning and survey which will allow to perform the monitoring of the quality of services provided by a passenger terminal on the basis of the suggested analytical instruments;

- all the suggested and developed instruments and methods have been approbated on the data of the Riga International Coach Terminal (RICT). On the basis of the developed methods there have been defined the factors which influence sufficiently the IQI of the RICT and suggested the measures of their improvement;

- there has been demonstrated the possibility of using simulation modelling for improving the processes of managing the development of the terminal at a strategic level.

3. DEGREE OF THE THEME RESEARCH

Many investigations are devoted to the public transport system research. Though there are not so many of them which are devoted to considering of the subsystem – bus transport of regional and inter-state destination. Generally, the main part of scientific works reflects tendencies of improving the transportations planning (Gannopoulus G., Meyer M., Tanaboriboon Y. and others). Moreover, bus transport functioning is generally considered in the frame of an urban transport system. Actually, there is small part of research works devoted to the problem of bus transportations in the regional, national or international aspects.

The author of the present research used mainly the ideas and methods devoted to the service quality in general and those suggested by Parasuraman A., Zeithaml V., Berry L., Cronin J., Taylor S., Morgan C., Murgatroyd S., Peña D. It is generally accepted that the service quality is the function reflecting comparison between the perceived quality and the clients' expectations. Some authors consider models based on the difference between these two quantitative measures (Parasuraman A., Zeithaml V., Cronin J., Taylor S., Teas R.). The perceived quality is usually (Peña D. and others) a function of several particular attributes-variables and the key step is to measure the weight of each attribute. There are a great number of approaches to estimate weighing: based on the Conjoint Analysis (Luce D., Tukey J.) and on the regression analysis (Peña D., Carroll J., Green P., etc.). But every application task being solved in this direction has its own peculiarities both in setting and in approaches to the resolution since it is necessary to account a number of different quality attributes, scale of measurement, means and quality of measurement, etc.

Among the scientists whose papers are devoted to the public passenger transport service and which papers have become the starting point of the given research we could point out the works of Seco A., Goncalves J. on the issues of performance for evaluating the quality of the public transport, Vanhanen K, Kurri J. devoted to the quality indicators, the works of Friman M., which emphasize and develop the idea of complexity of estimating the public transport service quality and point out the necessity of including therein the estimation of the service punctuality which has big influence on the passengers' satisfaction and on their perception of the public transport quality. Rodrigue J.P. and others, using the terms of the graphs theory, considers the public transport service as a complex service both on lines – provided by transport companies mainly on the route (transport network edge) and in the transport network nodes – terminals.

Service in the terminal is connected, first of all, to the quality of the terminal infrastructure; therefore planning of the infrastructure development becomes a key question of the terminal strategic development. Today, both in scientific and practical research, a lot of attention are paid to the use of analytical instruments in decision making on development, improvement and reconstruction of a TS or its fragment. Simulation modelling of transport flows today is used for making decisions about the transport infrastructure change at the micro- and macro-levels. There are some papers considering its application for making decisions on re-planning of transport nodes. The author has also relied on the works of such scientists as Ginzberg M., Stohr E., Barselo J., Merkuryev Y., Toluyev Y., Laniado E., Teodorivic D., Collura J., Żak J. and others.

Having analysed a number of scientific issues the author made the following conclusions and put forward the following hypotheses which encouraged further promotion research:

- an integral quality of the public transport is the result of the combined effect of objective (time of trip, punctuality, cost, accidents, etc.) and subjective factors (opinion of clients) connected with the stored impressions of the previous experience of travelling;

- in considering and analysing complex public transport service we usually examine the first part of the service (on lines) and do not actually examine the second part, namely: the quality of the service provided at the terminal though it is this type of service which influences, first of all, the possibility of creating a multimodal transport system;

- measures aimed at improving the quality of service on lines inevitably contradict with a lot of restrictions: restrictions of increasing the service rate on lines, natural restrictions of using of some particular modes of transport, requirements of the environment, etc. In its turn, improvement of the service quality in the transport network hubs (terminals) fully depends on their clever design and activity planning, strategic and operative management;

- transport planning influences many elements of the society: economic wealth, environment conditions, social integration. Planning is a continuous process, plans must be constantly re-considered according to the changes of the society needs, the changes in economic conditions and the development of technical capabilities. Such capability can be provided by using the decision support systems built on the models of different types on which all possible decisions could be checked and their consequences could be analysed.

4. METHODOLOGY AND METHODS OF RESEARCH

The promotion research is based on the analysis of scientific-technical literature, periodic, technical documentation and other special literature devoted to the considered in the given promotion work issues, laws and normative acts of the Latvian Republic and the EU in the sphere of public transport, statistic data on the development of public transport in Latvia and Europe and statistic reports on the performance of the enterprise presented by the Join-Stock Company (JSC) Riga International Coach Terminal (RICT).

The theoretical basis of the given research is grounded by works in the sphere of mathematic and applied statistics, transport and logistics, information technologies and modelling.

The methods of research used are mathematic methods of system analysis and econometric analysis, namely the analysis of variance, correlation and regression analysis of statistic dependences. Besides, the methodology of the simulation modelling at the micro-level is used. All the suggested methods ad methodologies have been approbated on the real data presented by the JSC Riga International Coach Terminal. The calculations have been made with the use of the software *Statistica/Win*, *SPSS*, *EXCEL*, *MathCad*, simulation modelling was exercised in the package *VISSIM PTV Vision*.

Practical trustworthiness of the formulated problems and tasks is grounded by more than ten years experience of the author’s work for the enterprise Riga

International Coach Terminal as a managing director as well as by the author's experience acquired while working in some international projects as an expert in public transport and discussing the results of research at practical seminars and international conferences. The author has frequently made reports on the results of her scientific research at the meetings the Association of Pan European Coach Terminals (2007–2010).

5. SCIENTIFIC NOVELTY OF THE WORK

The given work suggests a new approach to development a system of managing the passenger terminal quality for increasing its adaptation in a multimodal transport system with the use of modern automated instruments of decision making support.

Scientific novelty of the research lies in the following:

- formulating a notion of a logistics centre in relation to a passenger terminal and systemizing the factors influencing its functioning;
- development of the analytical instruments for monitoring the quality of the terminal services, namely:
  - an algorithm of IQI constructing with the further determination of those particular quality attributes, which viably influence the overall quality evaluation;
  - a model for analyzing the reasons of choosing the alternative modes of transport;
  - a method of constructing and analyzing the punctuality index for the coach service in the terminal;
- development of methodology of questioning and surveying that would allow monitoring the quality of services provided by the passenger terminal on the basis of the suggested analytical instruments;
- working out a methodology of decision making in analyzing the scenarios of the terminal development at the planning stage with the use of methods of simulation modelling.

6. PRACTICAL VALUE AND REALISATION OF THE WORK

The conducted research has contributed to the improvement of the information systems employed at Riga International Coach Terminal, especially of the ticket booking and trips accounting system Baltic Lines.

The models and methods developed by the author in the promotion research have been used in planning the Riga Coach Terminal strategic development and analyzing it activity:

1. The suggestions made by the results of the research are used in developing the conception of RICT development:
   - in working out a strategy of developing a new Riga Coach Terminal;
   - in working out a strategy of developing the Riga Coach Terminal up to 2015;

- in working out a conception of the international passenger transportations integration by means of developing the suggestion about a virtual passenger information centre on the basis of the Coach Terminal information system.

2. The system of the quality management of the RICT has been improved by means of including additional elements of the quality monitoring. The results of the research have been used by the author in developing the documents of Association of the Pan Europe Coach Terminals and in the activities of its working groups.
3. The results of the research are used in the education process of Riga Transport and Telecommunication Institute and are included in some parts of the course “Collecting and processing of transport survey data” in the professional program “Transport Management”.

7. APPROBATION OF THE WORK

The main results of the author’s research are reflected in scientific publications in journals and articles of international conferences in Latvia, Lithuania, Italy, Israel, Belorussia, Azerbaijan and Russia, there included:

1. International scientific conference „*Qualitative Growth of Institutions of Higher Education and its Impact on the Development of Science and Economy*”, Banking Institution of Higher Education of Latvia, Riga, Latvia, 2002, 12–13 September.
2. International scientific conference „*Conditions of Sustainable Development: new Challenges and Prospects*”, Banking Institution of Higher Education of Latvia, Riga, Latvia, 2003, 11–12 September.
3. 5th International conference „Investment in the Baltic Metropolitan Regions”, Riga, Latvia, 2006, 24–25 August.
4. 6th International conference „Reliability and Statistics in Transportation and Communication (RealStat’06)”, Riga, Latvia, 2006.
5. 7th International conference „Reliability and Statistics in Transportation and Communication (RelStat’07)”, Riga, Latvia, 2007.
6. International conference „TRANSBALTICA 2007”, Vilnius, Lithuania, 2007.
7. 6th WSEAS International conference ”System Science and Simulation in Engineering (ICOSSE’07)”, Venice, Italy, 2007.
8. International conference Economical development of Society*: innovation, informatization, system approach.* Minsk, Belorussia, 2008.
9. International conference „Modelling of Business, Industrial and Transport Systems”, Riga, Latvia, 2008.
10. VIII International conference „Reliability and Statistics in Transportation and Communication” (RelStat`08), Riga, Latvia, 2008.

11. IX International conference „Reliability and Statistics in Transportation and Communication" (RelStat`09), Riga, Latvia, 2009.
12. International symposium „International Symposium on Stochastic Models in Reliability Engineering, Life Science and Operations Management", Ber-Sheeva, Israel, 2010.
13. The Third International Conference "Problems of Cybernetics and Informatics", Baku, Azerbaijan, 2010.

8. PUBLICATIONS

By the results of the research there have been published 16 scientific works, including 13 papers and 3 abstracts. They consider the issues of searching optimal management decisions for the successful activities of passenger terminals, building information systems and decision support systems. Special attention is given to methods of complex estimation of the service quality provided by the passenger terminal.

9. PROMOTIONAL WORK STRUCTURE

The promotion thesis consists of 6 chapters, bibliography and 13 appendixes. The structure of the promotional work and the chapters' logical inter-dependence is shown in Fig.1. The main text of the promotion work is presented in 158 pages. The results of the research are illustrated by 65 figures, explained by 42 formulae and presented in 34 tables. The list of literature includes 118 information sources.

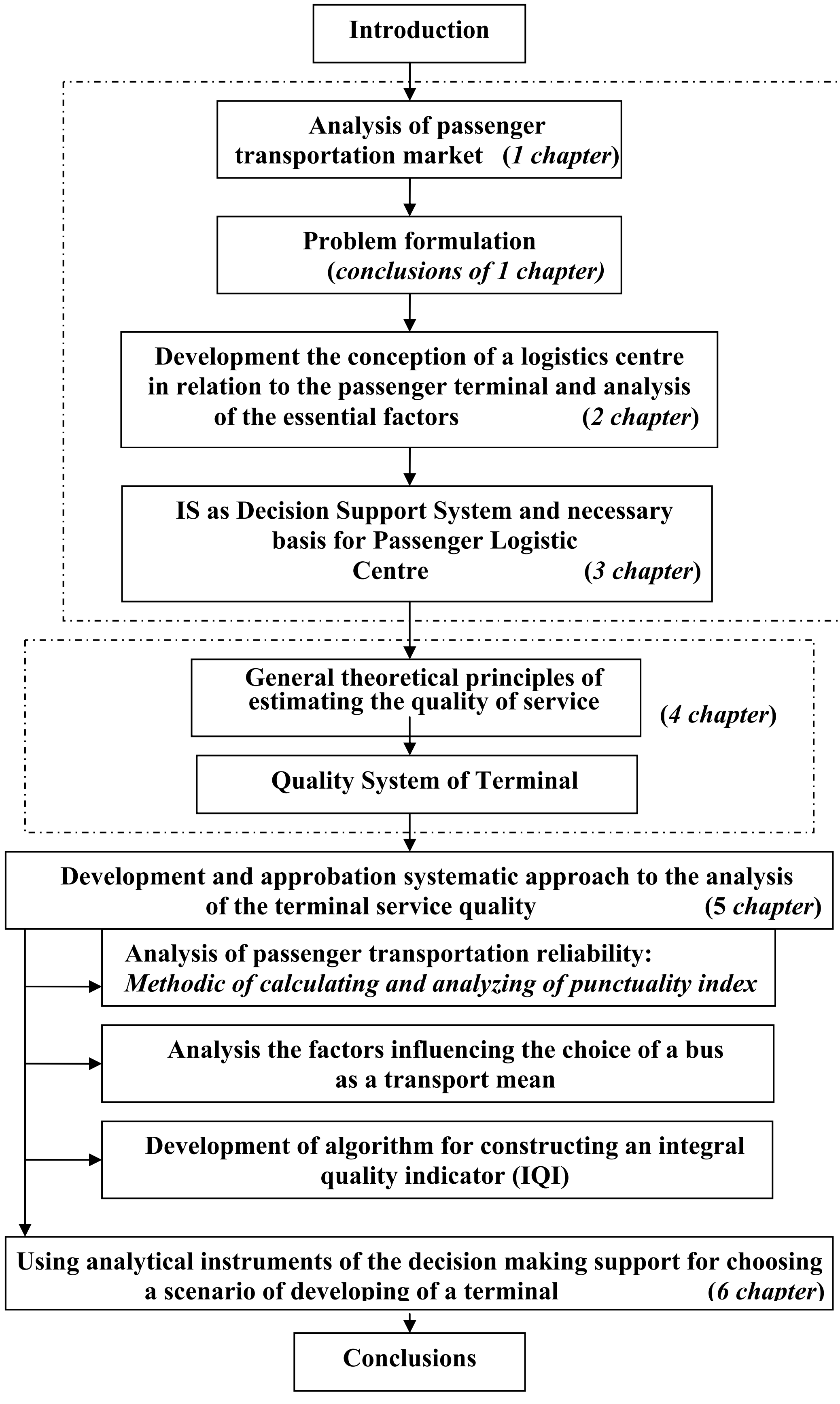


Fig. 1. *Logical structure of promotion work*

The first chapter of the work gives consideration of the system of public transport in Latvia in general, place and role of the bus transport in the regional system of the Latvian public transport. There are formulated the main problems of the coach terminal development, which are aggravated against the background of today's economic crisis. There is given ground to the actuality of researching the issues of increasing the manageability and adaptability of the passenger terminal for the account of analytical instruments which help to take duly management decisions. The author makes SWOT-analysis of the Riga International Coach Terminal functioning by the example of which there will be conducted approbation of all the suggested approaches, methods and methodologies.

The second chapter gives suggestion to realize the conception of a logistics centre in relation to the passenger terminal. The conception of a passenger logistics centre (PLC) is developed on the basis of the notions of a cargo logistics centre and an aviation hub used in the organisation of aviation passenger transportations. The analysis of the factors essential for the PLC factors is conducted at the example of RICT.

The third chapter gives analysis of the passenger terminal IS and the possibilities of its use as the decision support system (DSS) and as the basis for realizing of the PLC conception. There is examined the terminal IS: structure, functionality, architecture, organisation of information flows and there is defined the place of the IS in the quality system. The example given in the chapter is the IS *Baltic Lines* worked out at the beginning for RICT specially and used now all around Latvia and issued for many Bus and Coach Terminals of the European Union. In the chapter there are formulated suggestions on the development of the given system and formation on its basis of a virtual logistics hub as the basis and essential part of realizing the PLC conception.

The fourth chapter gives consideration of the general theoretical aspects of estimating the quality of passengers' servicing and of the passenger terminal service. There are analysed the components of the service quality. There is also examined the quality system existing at the terminal and described the main processes and approaches.

The fifth chapter of the given work suggests a systematic approach to the analysis of the service quality based on both the objective data stored in the terminal information system and on the subjective data.

It also suggests the methods of estimating and analyzing the index of punctuality as a reliability measure. By means of the statistic analysis there is conducted the research of some selected data of trips' delays at RICT in the period of 2005–2007.

For analyzing the factors influencing the choice of a bus as a transport mean there is employed the econometric modelling on the basis of the discrete choice models' theory. In building the models there are considered both the social-economic characteristics of passengers and the characteristics of the given service: time-table, network, etc. The detected key characteristics of the service are analysed from the point of view of their influence on the overall estimation of the quality.

The main accent in the complex approach is made on the formation of an integral quality indicator (IQI) and the detection, on this basis, of those particular attributes of quality which considerably impact the overall estimation of quality. Resulting from the application of the algorithm being developed in the work, there is built the function of dependence of the overall quality indicator on particular indicators, which will allow control and management of the service quality, coordination of special practical steps aimed at the correction of particular attributes of quality with the account of their possible influence on the overall estimation of the service quality – on IQI.

In the sixth chapter there is described the procedure of working out the scenario of the terminal development on the basis of applying the analytical instruments of the decision making support. There are described the stages of the decision making process in working out the scenario of the terminal development. There is realized a practical example of the modelling application at the stage of designing an object of the public transport infrastructure.

10. DESCRIPTION OF THE MAIN RESULTS OF THE RESEARCH

10.1. Main theses

Increase of the population mobility, as a result of globalization, requires new complex decisions in operative approaches of an organisation engaged in public passenger transportations. Observation of the principles of multimodality helps to establish a comprehensive and rational network of the public transport routes in the state and the regions as well as to develop the public transport terminals. The resulting developments of the research are the following:

- Conception of a passenger logistics centre for realizing in a multimodal system as shown by the example of the RICT;
- Complex approach to estimating the quality of the coach terminal services based on the integral analysis of the provided services' quality;
- Simulation model as instrument of DSS for analyzing the scenario of the terminal development.

10.2. Realisation of the conception of a passenger logistics centre in a multimodal transport system with its possible integration into the European network of passenger transportations

The Council of Logistics Management (CLM) of the USA gives the following definition of logistics: "Logistics is a process of planning, managing and controlling the flows of raw materials, stores, finished and non-finished products, services and information from the point of origin to the point of consumption (including import, export, inward and outward movement), which is effective from the point of view of costs and fully meets the consumers' demands" (*CLM*, 1985).

Let's point out three major points of the above definition:

- The integrated character of logistics which covers the process from the moment of appearing of the material resources and finished products flows to the places of their consumption;
- Accent on the importance of the information management;
- Appearance for the first time in logistics of the notion "service" (non-material elements). It is vital from the point of view of developing the logistics approach in the sphere of passenger transportations.

Today in passenger transportations airports or aviation hubs function according to the principle of a passenger logistics centre which serves as the point of both arrival and departure, of main lines, the point of meeting of both regional and international passenger flows. From the point of view of logistics, an aviation hub acts as a kind of a centre for distributing clients, into which a passenger flow comes with the parameters of one type and then these parameters change cardinally. If we consider a passenger terminal – a coach terminal from the same point of view, we can divide the flow of passengers and bus transportations according to different criteria: character of trip, place of transfer, etc. (presented at Fig.2.)

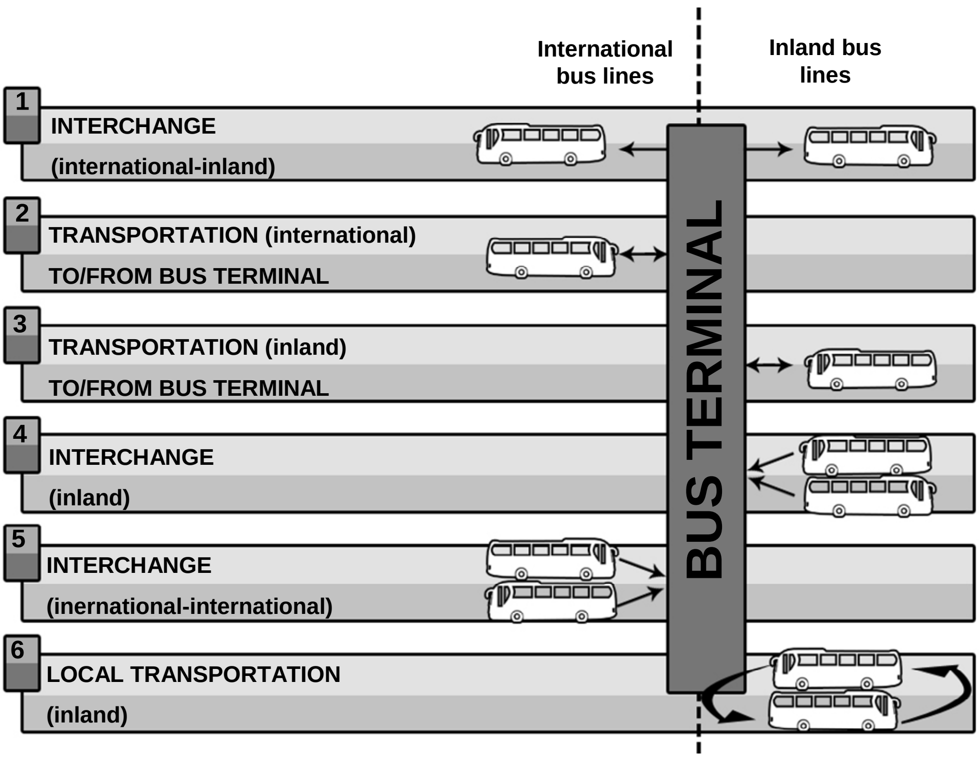


Fig. 2. *Possibilities of intermodal passengers transfers at a coach (bus) terminal*

To apply a traditional notion of a logistics centre to passenger transportations, it necessary to define the functions of a logistics centre. From the point of view of functionality a logistics centre may be defined as the place of concentration of operations and logistics flows or as the territory at which there are concentrated the types of activities connected with transport, logistics and distribution, which are realized by some operators and enterprises with commercial aims.

Table 1 presents the results of comparison of the main requirements set to a logistics centre in a traditional sense (to cargo transportations) and to a passenger logistics centre.

Considering the conditions necessary for successful functioning, the main crucial factors of the logistics centre development are determined (Fig. 3).

A coach (bus) terminal is a linear building consisting of special edifices, platforms and territory envisaged for servicing passengers and motor transport along the routes.

Table 1

Comparison of logistics centres of cargo and passenger transportations

	Requirements	**Cargo transportations**	**Passenger transportations**
1.	**Multimodality**	Possibility of using different modes of transport for cargo transportations	Possibility of transfer from one route to another as well as to other modes of transport
2.	**Openness**	Accessibility of private and social enterprise to services	Accessible to passengers and companies (private, state, municipal)
3.	**Multi-functionality**	Servicing at all stages of the transportation process with the help of transportation companies, agents, brokers, customs, etc.	Providing of all the functions of the passenger transportation: information, tickets reservation and realisation, luggage checking and delivering, dispatch service, bus servicing, etc.
4.	**Management of flows**	Organisation of the flows management inside: distribution, containers and other terminals, warehouses	Organisation of the passenger flow management and bus servicing: platforms of departure and arrival, bus parking, waiting room for passengers, etc.
5.	**Accessibility to information systems**	Access to telematic systems engaged in transportation, administration and deliveries	Accessibility of information systems for passengers and transportation companies; Dispatch accounting; Integrated system of selling and reserving tickets; Information system of service management, etc.
6.	**Interaction**	Closely connected and integrated cooperation with the business-sector which is being provided with the services of transport and logistics	Close cooperation with transportation companies providing international and internal transportations, with travelling agencies and service agencies

Continuation of Tabl.1

	Requirements	Cargo transportations	Passenger transportations
7.	**Distribution of expenses**	Distribution of expenses on information technologies, warehousing services, etc.	Distribution of expenses on using of information technologies, passenger servicing, etc.
8.	**Services**	Packaging, clearance of goods, fuelling stations, etc.	Services complementing passenger transportations: waiting room, luggage checking and delivering, sanitary services (shower, toilet), baby-sitting service, food catering, commerce, etc.

Passenger Logistics Centre

Strategic location	Support by government	Logistics infrastructure services	Partnership. Opportunities of logistics development	Quality of labour force	Development of information technologies
- Market share; - Loca-tion	- Regulation of entrepreneurship; - Tax legislation; - State aid (grants, recovery of losses)	- Technical characteristics of a coach terminal; - Possibilities of inter-modal transportations; - Level of services	- Co-operation with haulers; - Co-operation with public authorities regulating haulers; - Co-operation with other stakeholders, (Travel agencies, service providers, etc.)	- Training of personnel; - Manage-ment of human resources; - Ensuring high quality services	- IT and telecommunication infrastructure; - WEB based easy interface; - E-commerce platform

***Fig. 3**. Crucial factors of the passenger logistics centre functioning*

A coach terminal is the part in the logistic system of the public transport which is characterized by the following peculiarities:

- Economic independence and diversity of the forms of ownership;
- Difference, from other parts, in the aims and character of functioning, power, degree of concentration and consumption of resources;
- Influence on the results of its functioning of both external factors and other parts of the chain;

– Differences of the logistic interaction mobility.

In connection with the necessity of providing the accessibility of public transport, a coach terminal can be considered as a part of the logistic system (Fig.4), which transforms the incoming material, financial and information flows into a product – a set of the required services offered to passengers.

Fig. 4 presents the external factors (N_d, N_z), to which, first of all, is referred the market influence, i.e. the impact of other modes of passenger transportations on the performance of the coach terminal as well the impact of the state regulating instruments. Building of a structure – a passenger logistics centre in the form of a coach terminal which must be manageable and flexible in reacting to the external factors – is the subject of the given work research.

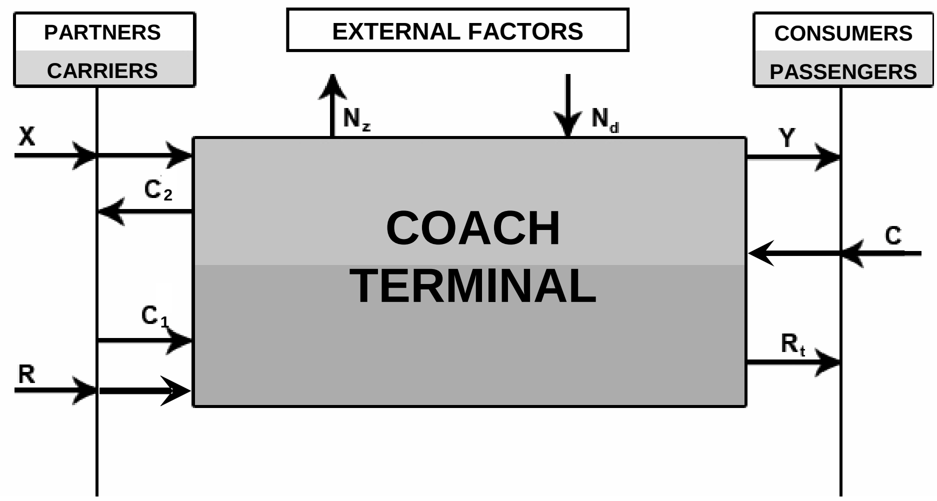


Fig. 4. *A coach terminal as a chain of a logistics system of passenger transportations*

The incoming flows:

X – materials (terminal services);

R – information;

C – finance (revenue from passengers);

C_1 – finance (revenue from transportation companies);

N_d – revenue connected with the external factors (investments, factor of time, etc.)

The outgoing flows:

Y – services;

R_t – information;

N_z – external factors resulting in expenses (taxes, currencies rate, factor of time, etc.);

C_2 – finance (revenue of transportation companies from the tickets sold at the Terminal)

10.3. Information technologies – basis for building a passenger logistics centre

The main conditions for realizing the conception of a logistics centre lie in the development of a system of the logistics centre management and its integration into a global network that is possible only on the basis of the all-round application of information technologies.

Bringing of the information system *Baltic Lines* of the terminal into operative allowed to create an integrated system of selling/reserving tickets (Fig.5) which provides servicing passengers and transportation companies at a new quality level.

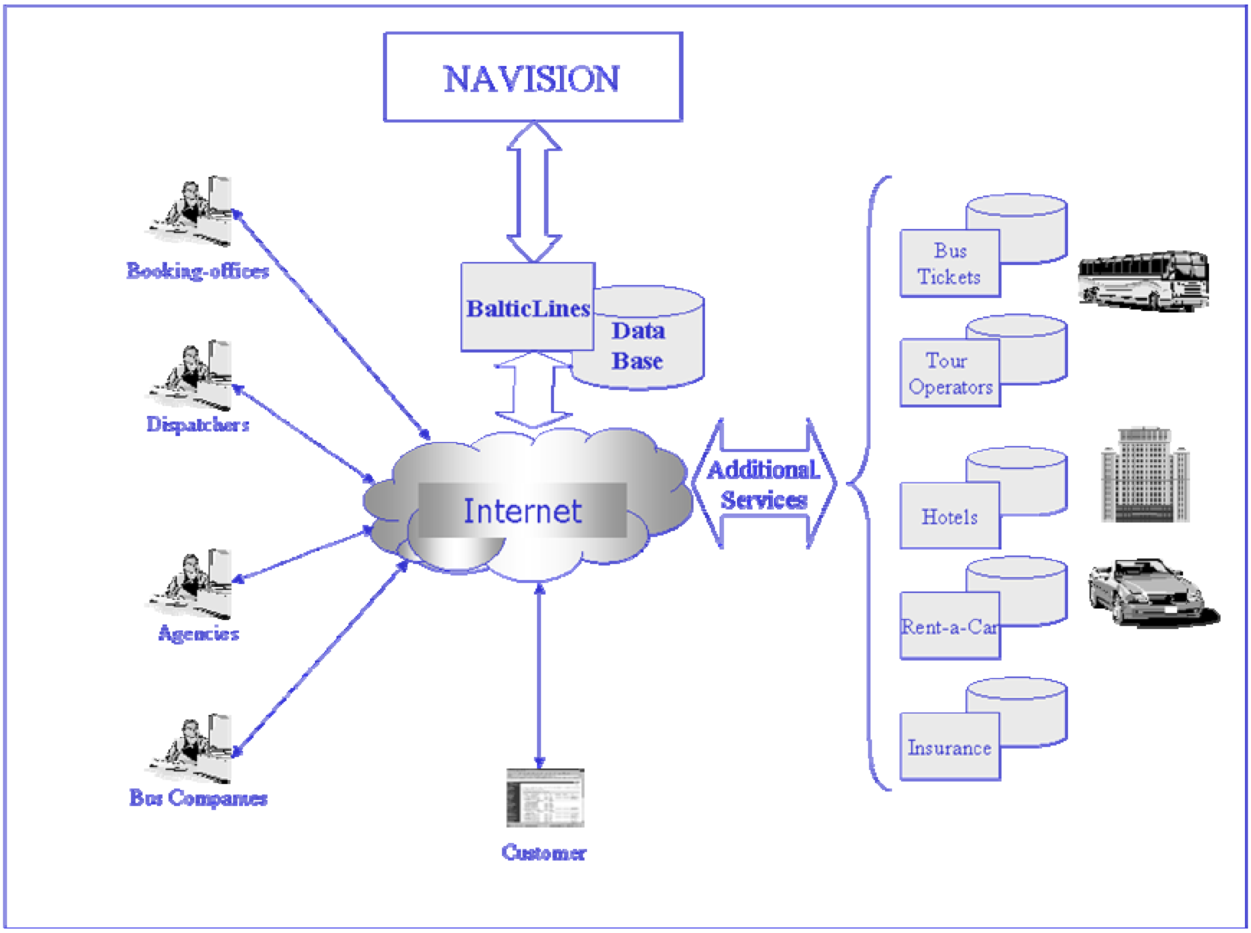


Fig. 5. *Scheme of functioning of IS Baltic Lines*

The structure of the IS *Baltic Lines* is formed by ten modules with the continuous inter-exchange of information flows as it is shown at Fig.6. Organisation of the outward and inward information flows of the IS Baltic Lines provides necessary connection between the users of the system and other IS, such as book-keeping accounting in the IS *Navision Attain*, selling tickets at www.bezrindas.lv and others.

The functional structure of the system envisages different users of the system:

At the terminal: system administrator; logistics specialists; administration; dispatchers, cashiers; information service;

Other users of the system: travelling agencies selling tickets, transportation companies; employees of the State Ltd “Direction of Auto-transport”; clients.

The users’ rights are spelt out in conformity with the users’ functions, performed operations and levels of responsibility.

The IS of *Baltic Lines* provides:

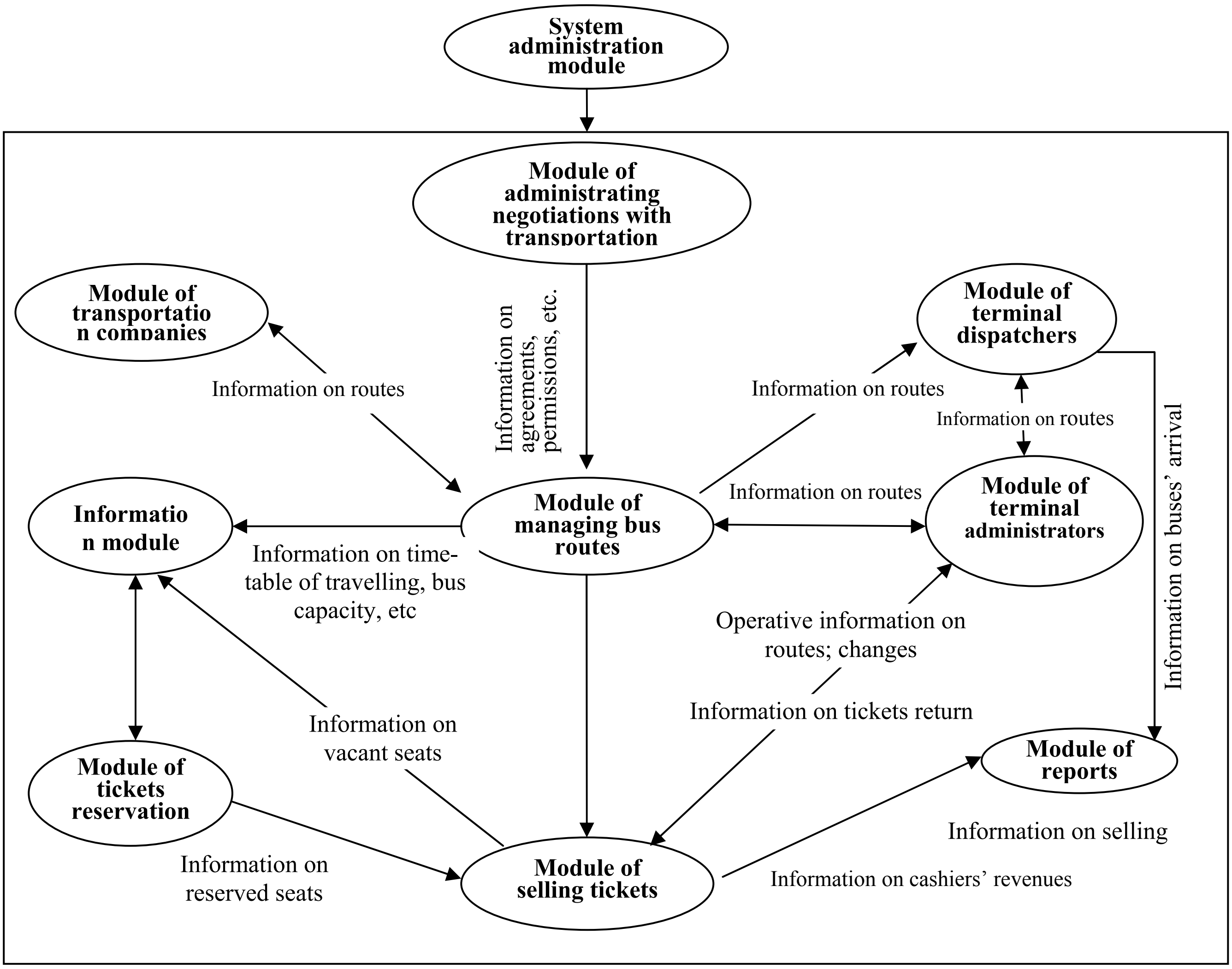


Fig. 6. Interaction of information flows in the IS Baltic Lines

- **For passengers**:
  - A new level of service – possibility of reserving or selling public transport tickets for all internal trips in Latvia (no matter what the location of the passenger is);
  - Possibility of buying tickets through the Internet (print, send by *e-mail* or mobile phone);
- **For transportation companies and terminals**:
  - New possibilities of attracting passengers and raising the number of clients;
  - Reduction of the tickets selling costs;
  - Improving the efficiency of the work by means of an accelerated and unified process of tickets selling;
  - Increasing the quality of financial accounts;
  - Possibility of the operative statistics analysis;
- **For the State Ltd "Direction of Auto-transport"**:
  - Accessibility to operative statistics;
  - Possibility of controlling quality and transportations' volume;
  - Getting finance information.

The IS *Baltic Lines* constantly storing and processing in real time big volumes of updating information is used for making decisions at both the level of strategic planning, management control and tactic planning and the level of operative planning. To support decision making in the system of public transport and at all stages of providing services, a certain volume of information is used at every level of decision making. While defining the volume of this information, it is necessary to take into account what actions and processes are controlled and what level of influence on the whole system is.

To support the decisions of strategic planning, the information of the IS *Baltic Lines* is complemented with the information of administrative character from the newly established *VBTS* state information and ticket booking system with the aim of improving and controlling of the state orders execution and approval of the corresponding state financing.

Possibilities of tactical planning and control are very helpful for the high and medium level management and transportation companies and employees of the State Ltd "Direction of Auto-transport" because they provide a continuous process of controlling the terminal services and passenger transportations according to the changing demand. Operative planning supports everyday processes, prompt reaction to changes and extraordinary situations providing, at the same time, servicing of passengers and buses in the required volume and at a high quality level.

To make passenger transportations by buses more attractive for passengers and to increase the number of passengers, it is necessary to enlarge the network of transportations by increasing the accessibility of services. In this situation the role of terminal is vital. The volume of transportations and routes is determined by the policy of municipal-governments and the state. Following the best examples of passenger transportations by air, it would be useful for the terminals to unite, in cooperation with transportation companies, a split network of transportations and to build a common network of realizing tickets and informing passengers for several European states. At the end it will bring to the so-called "virtual" terminal on the basis of using the up-to-date information technologies and a general technical standard, thus making a unified IS for passengers and a basis for the passenger logistics centre.

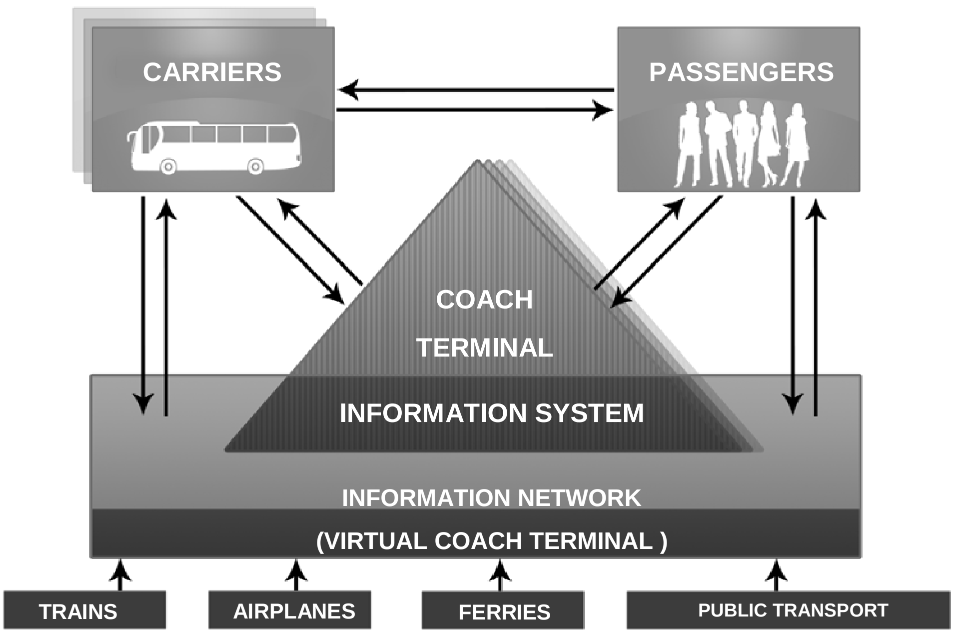


***Fig.** 7. General scheme of a "virtual" terminal*

In this connection the role of the terminal as an infra-structure of passenger transportations increases: with “virtual” terminals, which could service a wider number of users than a linear building terminal, there will increase the functions of providing and exchanging information for transportation companies, passengers and other users. As a result of developing such passenger terminals, a wide number of passenger transportations’ users would get benefit as shown in table 2.

Table 2

Benefits of the matching of IS (“virtual” terminal)

Subjects of benefits	**Benefits**
EU	- Growth of mobile population - Propagation of the knowledge „*know-how*” - Cultures exchange - Reduction of economic differences - Quicker integration of states in the EU - Support of small and medium enterprises – transportation companies and terminals
Passenger transport enterprises (transportation companies)	- Tickets supply and possibility of marketing - Market expansion - Prospects of business development - More effective usage of resources - Growth of profit - Better meeting of clients’ needs
Passengers	- Improving the accessibility of services - Accessibility of the information about possible bus trips – routes, timetable, time, possibility of transfer, etc. - Simpler travelling - Reserving and buying tickets with the help of information technologies - Standardised services procedures - Security - Saving time at borders’ crossing
Terminal	- Increment of the passengers’ turnover - Development of an terminal as a centre of logistic transportations - Development of the inter-modality - Introduction of planning actions - Harmonisation of the terminal services; - Improvement of the cooperation between transportation companies and the terminal
Cities included into the network of passenger transportations	- Increase of the number of tourists and travellers - Possibility of including the local systems of passenger transportations and the services of travelling into the general IS

In the research there is given comparison of a logistics centre of cargo transportations and a passenger terminal, the required functions and characteristics and there is made the conclusion that a passenger terminal corresponds to the *third-party logistics provider – 3PL*, which offers logistic and management services to clients – transportation companies, passengers, travelling agencies, etc with the help of specialized IS. Thus, the provider of such logistic services performs optimization of servicing operations, reduction of costs, increase of competitiveness, offering at the same time services of due quality. Table 3 describes the system of logistic services and their indications in organizing cargo and passenger transportations.

Table 3

Description of the logistic services' systems

System of logistic services	Cargo transportations	Passenger transportations	Examples
3PL	▪ Cargoes servicing; ▪ Handling; ▪ Re-loading; ▪ Additional services, information systems included	▪ Passengers servicing; ▪ Services of the transfer point; ▪ Luggage handling; ▪ Information systems services to transportation companies and passengers	Ltd "Riga International Coach Terminal" using the IS *Baltic Lines*
4PL	+ Planning, managing and controlling of all logistic procedures (there included information, materials and capital), long term servicing of one supplier	+ Services of IS for state institutions and municipalities which regulate and order the volume of passenger transportations	Ltd "Riga International Coach Terminal" partially using the IS *Baltic Lines* in integration with the IS *VBTS*
5PL	+ Internet-logistics, management of all logistic components with the use of information systems in the organisation dealing with cargo transportations	+ Internet-logistics, management of all logistic components with the use of information systems in the organisation dealing with passenger transportations and touristic companies	"Virtual Terminal" – integrated passenger information centre providing a wide range of clients with the data of the IS of transportation companies and terminals and based on the "single-window" principle

The *four-party logistics* (*4PL*) offers integration of the functions of the service provider (terminal, transportation company) including planning, managing and controlling of the whole complex of transportations so as to achieve long term strategic aims and to promote business development. This aim can be achieved by means of introducing into practice of the direct interaction between the information systems used by the passenger terminal and the information systems used by transportation companies, institutions regulating the industry and institutions providing state orders. The author of the promotion work gives an example of integrating the IS *Baltic Lines* into a unified IS of selling tickets *VBTS*. Developing geographically and administratively distant terminals and a single passenger information centre of transportation companies on the basis of the passenger terminal IS ("virtual terminal") with the use of the logistic system of services based on the Internet resources corresponds to the *five-party logistics* (*5PL*).

10.4. Development of a complex approach to estimating the quality of terminal services

A coach terminal is a node of a multimodal transport system or a part of a passenger logistic chain and its reliability, safety and other properties influence the properties of the whole chain. A complex approach to the questions of the servicing quality and monitoring on a constant basis are a necessary condition of the sustainable development of public transport, especially in the period of restrictions on resources state support of transport in the form of investments.

At the present time, the IS of a passenger terminal is mainly used for collecting statistic data. Their real purpose is to develop most effective management decisions. Considering the IS *Baltic Lines* as an example, we can define two stages of its development:

(1) realisation of collecting primary statistic data on technological processes,
(2) providing necessary instrumentation to support management decision making, that is realisation of the analytical part, there included analysis of the statistic data and prognosis of the indicators of the quality and efficiency.

The promotional work is supplied with the instruments, methods and algorithms which allow development of the analytical part of the terminal IS. Fig. 8 presents the system of complex analysis of the terminal services' quality which includes a number of tasks of the quality analysis on the basis of information from the objective and subjective factors. These are the following tasks:

- *Calculation of the quantitative criteria of the service quality.* In addition to the existing criteria under calculation today which characterize the work of dispatchers, the number of the tickets sold, the number of the errors made, the author suggests calculation of some additional criteria on the basis of the objective information of the terminal IS which characterize the following:
  - reliability (index of punctuality);
  - coefficient of network covering;
  - congestion of buses, etc.

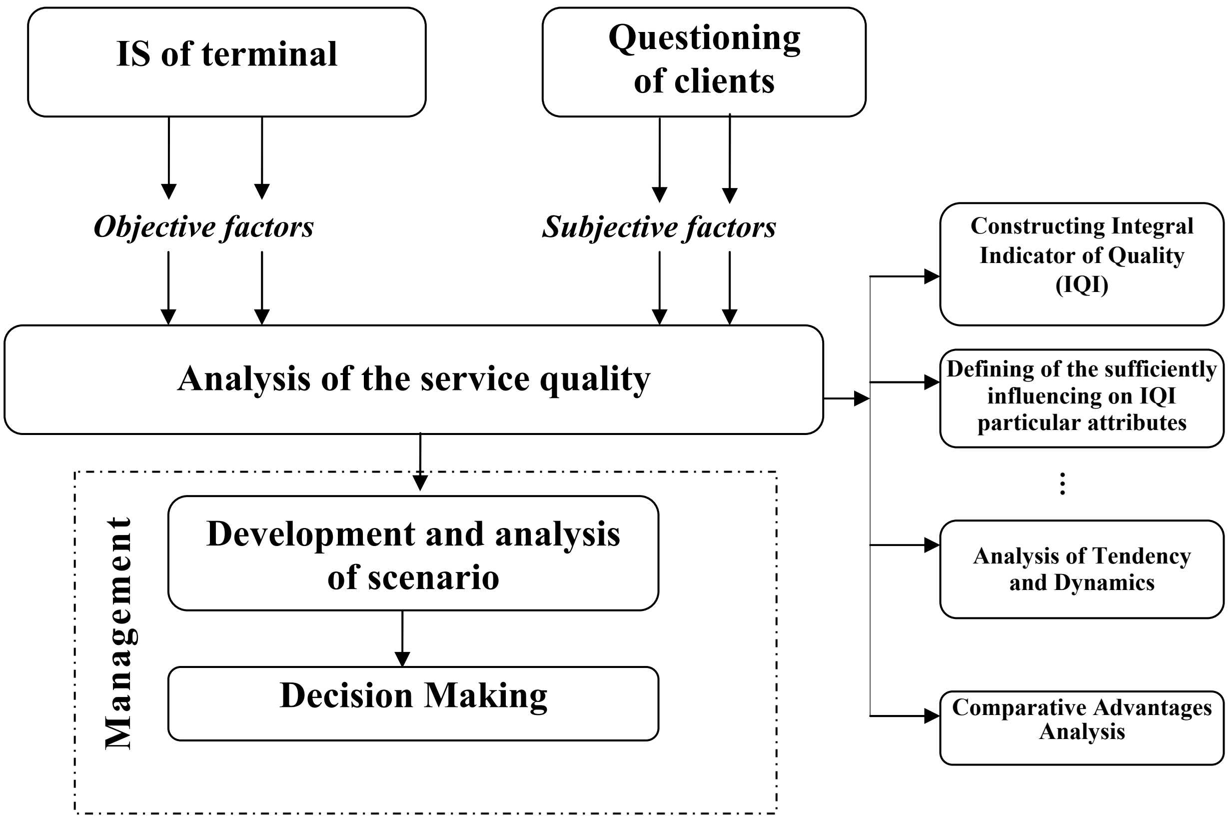


Fig. 8. *System of complex analysis of the terminal services' quality*

These criteria characterize the quality of the service provided, first of all, by a transportation company and the terminal hardly influences these services. But it's not evident for the client and client estimates the quality in general; therefore constant monitoring of these indicators is important for managing the terminal either. For calculating the above criteria we need information which is not always available in today's terminal IS. As an example of improving the possibilities evaluating quality, there has been developed an algorithm of calculating and analyzing the punctuality index and the procedure has been approbated on the data existing in the IS *Baltic Lines.*

- An integral part of the quality system is questioning. There has been developed a system of questioning which is designed for solving the following tasks:
  - comparative advantages analysis (clients' choice of the transport mode);
  - analysis of mobility;
  - analysis of the constituents of the service quality general estimation and defining of the sufficiently influencing particular attributes.

In the given work there are considered those types of questioning, which have been approbated at the RICT in the last three years, and there are suggested those methods and algorithms which may be used for solving the tasks of complex analysis of the passenger terminal service quality.

10.5. Analysis of the transportations reliability by means of calculating and analyzing the punctuality index

Punctuality reflects reliability of the transport enterprise activity and is accounted by passengers in choosing a transportation company and a mode of transport. If we consider railways and bus transportations we'll see that railways are a more reliable means of transportation since its reliability is not dependent on jams and weather conditions. On the other hand, this mode of transport is less available as compared to buses because not all regions have access to the railway network. In such competitive market, combination of comfort and service may play a deciding role in choosing a transport mode. And if the time of transfer does not differ greatly, observing the timetable may become a problem for the bus transport, especially if we consider realisation of inter-modality of transportations.

The work suggests the methods of calculating and analyzing the index of punctuality as a measure of reliability of bus transportations. The index for the *i-th* trip with the *κ* points of arrival is calculated as the value of the time interval between the actual time of arrival of the transport means at the j point for the *i-th* trip t_{ij}^{f} and the planned time of arrival t_{ij}^{r}:

$$h_i = \sum_{j=1}^{k} \left(t_{ij}^{f} - t_{ij}^{r} \right) * w_j , \tag{1}$$

where w_j – a weighting coefficient for the j point equals

$$w_j = \begin{cases} 0, \text{ if } & t_{ij}^{f} < t_{ij}^{r} \\ 1, \text{ if } & t_{ij}^{f} > t_{ij}^{r} \end{cases} .$$

The methodics include:

- calculation of the punctuality index for the examined period of time for a sample of the analysed trips on the basis of the data of the terminal IS;
- calculation of the descriptive characteristics of a random value – punctuality index;
- investigation, on the basis of the analysis of variance, of the degree of influence on the punctuality index of the following factors: (1) weather conditions; (2) day of the week; (3) time of the day; (4) direction of entering the city, etc.

Approbation of the methods on the data of RICT has been performed by the author only in reference to the final stop since information about the time of arrival and departure of the buses in the intermediate points of the route is lacking in the current version of IS. The results of the approach application are published in the author's papers [8, 9, 10].

On the basis of the punctuality index analysis for the data of RICT in the period 2005–2007 and defining the factors substantially influencing this index, there have made, for example, the following conclusions:

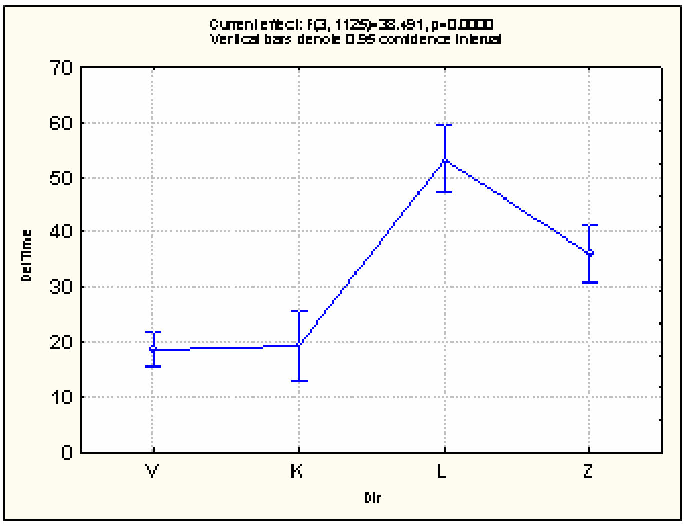
1) Significant influence on the value of delay (the punctuality index) is made by the day of the week – the hardest delays occur on the weekends (see table 4). For the data of 2007, the value of the *F* criterion is most significant and equals 19.847 (p-value=4.00E-22). The audit performed according to the results of the analysis has revealed the reason – absence of the administration in regional terminals on the weekends.

Table 4

Results of calculating the F criterion for testing the hypothesis about influencing of the day of the week on the punctuality index (July 2005, 2006 and 2007)

Year	SSB, between group sum of squares	df_1, degree of freedom	SSW, within-group sum of squares	df_2, degree of freedom	F-criteria	p-value
2005	88095.83	6	3332266	1071	4.719	0.000094
2006	20426.35	6	1358477	1432	3.589	0.001553
2007	187406.2	6	1765744	1122	19.847	4.00E-22

2) Degrees of influence of the direction of entering the city – the hardest delays have been checked with the trips entering the city in the Latgale direction (see Fig.9). For the data of 2007 the value of the *F* criterion equals 38.45 at the critical level *F*(3,1125)=2.61. As a result, there have been suggested some alternative routes of entering the city in case of jams in the regular directions.



Latgale (L)
Zemgale (Z)
Kurzeme (K)
Vidzeme (V)

Fig. 9. *95% significant intervals for the value of delay depending on 4 directions (July, 2007)*

Application of the methods to the data of the terminal IS gives possibility of solving the task of influencing on the reliability of both controlled and non-controlled factors, such as:

- Strategies of managing the process (on the part of the personnel), which can be and are used for reacting to the problems of reliability with the purpose of their minimization;
- State of transport means (TM) and quality of their maintenance;
- Sufficiency of transport means and personnel (drivers, dispatchers, etc) available and required for the trips according the timetable in the given day;
- Introduction of priority for bus transportations, for example a special traffic line for bus transportations, special traffic lights;
- Making the timetable in such a way that in case of a later departure of the bus or its delay in the route it would be possible to compensate the delay during the way and arrive at the point of destination in time;
- Difference in driving skills, knowledge of the route, keeping to the timetable;
- Length of the route and number of stops which increase the probability of the bus delay in the route;
- Transport conditions (in the streets), including traffic congestions, delays of traffic lights, manoeuvres at parking, different accidents, highways' building or current repair, etc.

10.6 Models of examining the reasons of the transport mode choice by passengers

In the analysis of a multimodal TS functioning and introducing new routes, one of the important tasks is to determine demand of each alternative mode of transport and find out the factors which influence the above. For this, we can use the theory of discrete choice which is being developed by scientists Ben-Akiva, Lerman and others. In the disaggregated models of a discrete choice there are accounted the factors which influence generation of trips: social status, way of life and other characteristics of an individual. Besides, the behaviour of an individual is influenced by the characteristics of a transport mode, such as: cost and time of transfer, punctuality, comfort, suitability and quality of the transport infrastructure. To develop models which allow taking into account influence of numerous factors on the volume of the passenger turnover and transport needs of every individual traveller, it is necessary to have a well developed system of transport research and surveillance.

To build a model of choosing a transport mode on the route Riga – Daugavpils, the author of the given work performed questioning of passengers at the RICT in the period from 01.07.2008 to 10.07.2008. The total number of the filled questionnaires, in interviewing face to face, was 180 but not all of them were filled correctly: spaces, answers not coordinated with the questions, etc. For questioning, only one selection of passengers interrogated at the RICT was used; therefore, as a dependent variable there was used the answer to the question "If the given trip to Daugavpils/to Riga is not a single one, what transport mode do you usually use? (Car, bus, train)"; that is discrete choice may be formulated as "usual choice of transport for the bus passengers".

There were built two models of the discrete choice of the transport mode for trips to Riga/Daugavpils. As alternatives of modes of transport there were use a car, a train, a bus. There was considered a consistent model of the discreet choice (Fig.10). The first stage choice ("use a car" vs. "don't use a car") represented by an usual discrete choice model (the Model I) estimated on the base of the full sample, and the second stage ("use a train" vs. "use a bus") represented by a conditional discrete choice model (the Model II) estimated on the base of the restricted sample. There was examined the influence of a wide range of factors on the passenger choice, evaluated their particular effects. All meaningful coefficients in the models had the explained signs (and therefore, correct directions of influence). Both models had a high percentage of correctly classified cases (92.06% and 86.27% correspondingly).

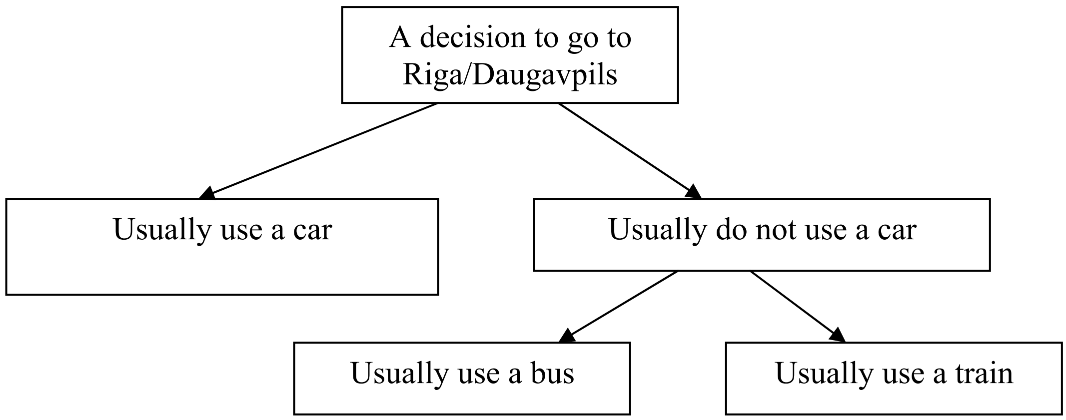


Fig. 10. *Two-level scheme of decision (*Passenger's decisions hierarchy)

The alternative "a car is usually used" regarded as an event incompatible with the choice between a public transport and a car in the first model (fig. 10). The final formula, which includes the significant variables and estimates the probability of choice of car as transport mode the following:

$$P(vid\_auto) = Logistic(x) = \frac{e^x}{e^x + 1}$$

with

$$x = 1.872 - 1.654\,why\_comfort + 2.400\,income500 + 2.025\,age40\_60 -$$
$$- 1.630\,time\_6\_12 - 0.468\,time1530 - 1.537\,destn\_final - 3.399\,lang\_lat + \varepsilon\,,$$

where *why_comfort* – a variable «a person states a comfort as a reason for choice»;
income500 – a variable «income per person - from 500Ls till 1000Ls»;
age40_60 – a variable «person age – from 40 till 60»;
time_6_12 – a variable «departure time is from 06:00 till 12:00»;
time1530 – a variable «person arrives at the Terminal 15–30 minutes before the departure»;
destn_final – a variable «Daugavpils is the final point of destination»;
lang_lat – a variable «questionnaire language – latvian».

The second model was developed for choice "use a train" vs. "use a bus" (fig. 10). There are the results of the Model II construction in the table 5 (significant variables, the coefficients estimation, values of quality criteria).

Table 5

The Model II estimation results

Sample		The sample with “use a train” and “use a bus” answers for the goal question only		
Sample size		102		
Dependent variable		“use a train”		
Dependent variable values		1, a person usually uses a train (18 cases, 17.65%) 0, a person usually uses a bus (84 cases, 82.35%)		
Log likelihood function value		– 31.69122		
LR test for goodness of fit, χ^2_{obs}		31.68		
LR test for goodness of fit, p-value		0.0002		
LRI value		0.3333		
Explanatory variable	*Description*	*Coefficient*	*p-value*	*Marginal effects*
time_12_18	Departure time is from 12:00 till 18:00	-1.785	0.116	-0.084
Riga	A person travels from Riga	1.976	0.051	0.106
why_habit	A person states a habit as a reason for bus selection	-2.079	0.088	-0.892
why_price	A person states a price as a reason for bus selection	2.657	0.005	0.399
age4060	A person is from 40 to 60 years old	-1.988	0.029	-0.115
direct	A trip is a direct one (vs. a return one)	-1.867	0.023	-0.193
freq_year	A person travels this way once a year or more rare	1.014	0.183	0.084
destination_final	Person’s destination is the terminal point	1.178	0.131	0.069
alt_cheaper	A person thinks that a train is cheaper than a bus	1.167	0.150	0.100
Constant		-2.919	0.049	

On the basis of the build models there were made the following conclusions:

- passenger age is an important factor in the model, and with the account of a negative sign of the coefficient for a variable, there was made the conclusion that passengers in the age of 40-60 use a car for these long trips less frequently;
- since the income influence was considered in the model separately, it may be supposed that middle-age passengers prefer quiet trips by bus to the intensive car driving;
- those passengers who start their travel in the morning (from 6 to 12) do not usually use a car. This fact may be used by transportation companies, namely: it is necessary to pay attention at early trips; besides, competition between buses and trains is stronger in these hours;
- by the meaning of a particular effect for the arrival variable, it was found out that the majority of passengers, preferring city transport, arrive at the Terminal 15–30

minutes before the departure. This time interval may be used to analyse the coach terminal possibilities of offering additional services.

On the basis of the performed econometric modelling with the help of the discrete choice theory, we can make the conclusions:

- considering further possibility of using this kind of analysis on a constant basis in the system of quality of a passenger terminal, we may divide the explaining variables into two parts – observed and non-observed ones. The values of the observed variables (for example, point of destination) can be received without direct contact with person, and the values of the non-observed variables (for example, opinion about service) can be received only by questioning. Therefore, practical application of such models for making decisions requires thoroughly planned and wide transport surveillance;
- the detected key factors and their directions of influence are vitally useful for quality monitoring and may be used for improving the quality of services of bus and railway transportation companies and terminals.

10.7 An integral indicator of the terminal services quality and approbation on the data of the RICT

10.7.1 Model of an integral indicator of quality

Quality has a complex character and depends on many categories and dependence is not constant, therefore, we need a mechanism which tracks the influence of particular categories of quality on the integral indicator of quality. The given work suggests an algorithm of building a function for an integral (composite, compound) indicator of quality which allows comparing the quality of different terminals' services and revealing important quality categories influencing the total quality indicator.

Let us assume that we have an population of users and the i user from the population estimated the quality of the considered service as Q_i. Let the total estimate of the service quality be the function of several attributes $X_1, \ldots, X_K$. Let define by $X_{i1}, \ldots, X_{ik}$ the estimates of attributes made by the i-th user. Then, the total estimate of quality made by this user equals

$$Q_i = f(X_{i1}, \ldots, X_{ik}). \tag{2}$$

The linear indicator of quality assumes that function (2) may be presented in the form

$$Q_i = \sum_{j=1}^{k} \beta_{ij} X_{ij}, \tag{3}$$

where weight β_{ij} measures a relative importance of the attribute X_j in relation to the quality of service for the i-th client.

Let us assume that all the estimates of clients X_{ij} and Q_i are made at one and the same scale (0…5), and in relation to weight β_{ij} there are performed the following conditions:

$$\beta_{ij} \geq 0 \text{ and } \sum_{j=1}^{k} \beta_{ij} = 1. \tag{4}$$

We also assume that weight β_{ij}, used by the i-th client for the attribute j, does not depend on the estimate made by him for the given attribute X_{ij}.

The service quality may be received by using the property of independence of the variables β_{ij} and X_{ij}. The quality of the given service will be

$$Q = E[Q_i] = \sum_{j=1}^{k} E[\beta_{ij}]E[X_{ij}] = \sum_{j=1}^{k} \beta_j m_j, \tag{5}$$

where m_j is a mean estimate of the attribute j in this aggregation, and β_j is a mean weight of this attribute in this aggregation.

Selection of a model of type (5) presupposes estimation of the mean weight of each attribute in the aggregation. The given work suggests an algorithm of calculating weights based on a regression analysis.

Suppose that random sample with size denoted n from population of users involves estimates of overall quality of service – Y_i, ($i = 1,\ldots, n$) and estimates of attributes (particular quality indexes), which define quality of service – X_{ij}, for k –th concrete attributes ($i=1, \ldots, n; j=1, \ldots, k$). Assume that these estimates are made on the basis (0-5) scale. Let the quality of service is unknown variable, which is measured by user's estimation Y_i and determined as follow

$$Y_i = \boldsymbol{\beta}^T \mathbf{x}_i + Z_i, \tag{6}$$

where $\mathbf{x}_i = (X_{i1}, \ldots, X_{ik})$ – estimations of attributes, made by i-th user,

$\boldsymbol{\beta} = (\beta_1, \ldots, \beta_k)^{\mathrm{T}}$ – vector of unknown weights,

Z_i – error of measuring (residual), which assume is normally distributed $Z_i \sim \mathrm{N}(0, \sigma_z^2)$.

Models assumptions are assumptions of the classical regression analysis, except the assumption about model coefficients. It is logical to assume that the increase in an estimation of partial attribute should lead to increase in an estimation of the general attribute of quality. In this case dependence between the general estimation of quality and partial attributes should be with a positive sign. The second restriction – usual for weight – on value. Taking these conditions into account let's enter the restrictions on parameters (weights for partial attributes of quality) into model and restriction of the weights vector is the following:

$$\beta_j \geq 0 \text{ for } j=1,\ldots, \mathrm{k} \text{ and } \sum_{j=1}^{k} \beta_j = 1. \tag{7}$$

Therefore, we have a task of estimating the unknown parameters of the function (6) with restrictions (7).

10.7.2 Procedure of estimating weights

In the given research there have been tested several variants of finding weights.

A. Method of the least squares for a classical regression model

Matrix form of a classic regression model:

$$\mathbf{Y} = \mathbf{X\beta} + \mathbf{Z}, \tag{8}$$

where $\mathbf{X}$ is a matrix of independent variables of the dimension $(n\times k)$,
n – number of observations,
$\mathbf{Y}$ – vector of the independent variable of the dimension $(n\times 1)$,
$\mathbf{Z}$ – vector of the dimension $(n\times 1)$, which components $Z_1, Z_2, \ldots, Z_n$ are independent, similarly distributed random values with the mean zero meaning and variance σ^2 and covariation matrix $Cov(\mathbf{Z}) = \sigma^2\mathbf{I}_n$,
$\boldsymbol{\beta}$ – vector of the regression model parameters of the dimension $(k\times 1)$, which need estimation.

Estimate (LSE) received by the methods of the least squares $\boldsymbol{\beta}$, is calculated by the formula**:**

$$\widehat{\boldsymbol{\beta}} = \left(\mathbf{X}^T\mathbf{X}\right)^{-1}\mathbf{X}^T\mathbf{Y} \tag{9}$$

and gives the smallest value of the function

$$f(\boldsymbol{\beta}) = \sum_{i=1}^{n}\left(Y_i - \sum_{i=1}^{k}\widehat{\beta}_i X_{ij}\right)^2 = \sum_{i=1}^{n}\left(Y_i - \widehat{\boldsymbol{\beta}}^T\mathbf{x}_i\right)^2, \tag{10}$$

where $\mathbf{x}_i = (X_{i1}, \ldots, X_{ik})$ – vector-column of the dimension $k\times 1$.

Since independent variables (particular attributes of quality) may correlate between each other, there will be applied a stepwise procedure of the building of a regression model (*Forward Stepwise* or *Backward Stepwise*).

B. Regression model with restrictions on the coefficients' sign (a Restricted Least Squares Problem)

Let consider the first restriction on the parameters (weights for particular attributes) of model (6):

$$\beta_{ij} \geq 0.$$

For estimating the model parameters we'll make use of the approach first applied by M.S.Waterman. The basis is the same method of least squares, but with restrictions, which is realized by the following iteration algorithm:

Step 1. By using the method of least squares, we estimate the vector-column with the unknown parameters $\widehat{\boldsymbol{\beta}} = \left(\mathbf{X}^T\mathbf{X}\right)^{-1}\mathbf{X}^T\mathbf{Y}$. If the received vector has negative elements we pass on to step 2, if not – to step 3.

Step 2. In case of presence s of negative elements in the parameters vector $\boldsymbol{\beta}$ ($\beta_i < 0$), we perform the next modification of the initial matrix $\mathbf{X}$: the lines referring to negative values are excluded from consideration. The transformed matrix $\mathbf{X}$ of the dimension $(k\text{-}s)\times n$ is used for the repeated estimation of the parameters, that is transition to step 1.

Step 3. In case of the positive component of the parameters vector $\boldsymbol{\beta}$, there is performed calculation of the standard objective function *f(*$\boldsymbol{\beta}$*)* of the method of least squares according to formula (10).

Step 4. (search of optimum value of the purpose function). Let us assume that in the aggregation the number of the remained positive parameters equals *l*. By bringing to zero, in turn, (all possible combinations of one, two, three, etc from the *l* remained positive parameters) and sorting out all the received, in these combinations, parameters of the objective function values, we determine such set at which the objective function *f(*$\boldsymbol{\beta}$*)* is a minimal one. It is vector $\boldsymbol{\beta}$, corresponding to the minimal value of the objective and without negative elements that is the solution of the task.

Thus the result of the algorithm work is vector-column $\boldsymbol{\beta}$ (of dimension $l\times 1$), containing evaluations of the unknown parameters of a regression model only with positive signs.

C. Regression model with restrictions of the coefficients' value

The work gives consideration of an algorithm of finding weights for particular attributes of quality with the restriction of value

$$\sum_{i=1}^{k}\beta_i = 1 .$$

Thus to find coefficients $\boldsymbol{\beta} = (\beta_1, ..., \beta_k)^T$, minimizing function (10) under the condition

$$g(\boldsymbol{\beta}) = \sum_{i=1}^{k}\beta_i - 1 = \boldsymbol{\beta}^T\mathbf{e} - 1 = 0 , \qquad (11)$$

where $\mathbf{e}$ – is vector-column corresponding to the dimension from ones.

Lagrange function for the task has the form

$$L(\boldsymbol{\beta},\lambda) = f(\boldsymbol{\beta}) + \lambda g(\boldsymbol{\beta}) , \qquad (12)$$

where $\lambda \geq 0$ – is Lagrange Multiplier.

This function must be minimized at variables $\boldsymbol{\beta}$ и λ. it brings to the system of equations:

$$\begin{aligned} &\frac{\partial}{\partial\boldsymbol{\beta}}L(\boldsymbol{\beta},\lambda) = \frac{\partial}{\partial\boldsymbol{\beta}}f(\boldsymbol{\beta}) + \lambda\frac{\partial}{\partial\boldsymbol{\beta}}g(\boldsymbol{\beta}) = 0, \\ &\frac{\partial}{\partial\boldsymbol{\beta}}L(\boldsymbol{\beta},\lambda) = g(\boldsymbol{\beta}) = 0 . \end{aligned} \qquad (13)$$

The first of these equations has the form:

$$\frac{\partial}{\partial\boldsymbol{\beta}}L(\boldsymbol{\beta},\lambda) = -2\sum_{i=1}^{n}\left(Y_i - \boldsymbol{\beta}^T\mathbf{x}_i\right)\mathbf{x}_i + \lambda\mathbf{e} = 0 .$$

We write the equation in a matrix form:

$$-2\mathbf{X}^T\mathbf{Y} + 2\mathbf{X}^T\mathbf{X}\boldsymbol{\beta} + \lambda\mathbf{e} = 0 .$$

From this we write the expression for **β***:*

$$\boldsymbol{\beta} = (\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{Y} - \tfrac{1}{2}\lambda(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{e}. \quad (14)$$

Lagrange multiplier is from the second equation of system (13):

$$1 = \mathbf{e}^T\boldsymbol{\beta} = \mathbf{e}^T(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{Y} - \tfrac{1}{2}\lambda\mathbf{e}^T(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{e}.$$

From this we find

$$\lambda = 2(\mathbf{e}^T(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{Y} - 1)(\mathbf{e}^T(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{e})^{-1}. \quad (15)$$

D. Regression model with restrictions on coefficients' value and sign

The research suggests an algorithm which is a combination of algorithms described in **B** and **C**. The key change is that at step 1 the solution is searched not by the classic method of least squares but with the use of formulae (14) and (15). Then there are applied the procedures of excluding of that component of vector **β**, which has a negative sign. In this case there remains restriction on value and sign.

Step 1. By formulae (14) and (15) we find the evaluation of the vector-column with the unknown parameters **β**, at which the value of function (10) is minimal and condition (11) is observed. If the received vector has negative elements we pass on to step 2, if not – to step 3.

Step 2. In case of presence *s* of negative elements in the vector of parameters **β** ($\beta_i < 0$), we perform modification of the source matrix **X**: the lines referring to negative signs are excluded from consideration. The transformed matrix **X** of the dimension $(k\text{-}s)\times n$ is subjected to the repeated evaluation of parameters, that is transition to step 1.

Step 3. In case of the positive component of the parameters vector **β**, we perform calculation of the objective function *f(*β*)* by formula (10).

Step 4. (Search of the optimal value of the objective function). Let us assume that in the aggregation the number of the remained positive parameters equals *l*. By bringing to zero, in turn, (all possible combinations of one, two, three, etc from the *l* remained positive parameters) and sorting out all the received, in these combinations, parameters of the objective function values, we determine such set at which the function of chain *f(*β*)* is a minimal one. It is vector **β**, corresponding to the minimal value of the chain and without negative elements that is the solution of the task.

The result of the algorithm work is vector-column **β** (of dimension $l\times 1$), containing estimations of the unknown parameters of a regression model only with a positive sign and the total value of these parameters (weights) equals 1.

10.7.3. Numerical results

Approbation of the suggested approach to building an integral indicator of quality was made on the basis of the results of questioning of 44 experts in transport; this questioning was performed in spring 2009. The questionnaire included 7 groups of categories, consisting of 22 questions which are presented in Table 6. Overall quality of service was also evaluated. The scale of evaluation of all attributes – (0-5).

Table 6

Particular Attributes of Quality

Title of chapter in questionnaire	Coding	Description of variable	Coding
1. Accessibility	**W_1**	Accessibility for external participants of traffic	X_1
		Accessibility for terminal passengers	X_2
		Ticket booking	X_3
2. Information	**W_2**	General information in terminal	X_4
		Information about trips in positive aspect	X_5
		Information about trips in negative aspect	X_6
3. Time	**W_3**	Duration of trip	X_7
		Punctuality	X_8
		Reliability/trust	X_9
		Bus time schedule	X_{10}
4. Customer service	**W_4**	Customer trust to terminal employees	X_{11}
		Communication with customer	X_{12}
		Requirements to employees	X_{13}
		Physical services providing	X_{14}
		Process of ticket booking	X_{15}
		Services provided by bus crews during boarding/debarkation	X_{16}
5. Comfort	**W_5**	Cleanness and comfort in terminal premises and on terminal square	X_{17}
		Additional opportunities/services providing in coach terminal	X_{18}
6. Security /safety	**W_6**	Protection from crimes	X_{19}
		Protection from accidents	X_{20}
7. Environment	**W_7**	Dirtying, its prevention	X_{21}
		Infrastructure	X_{22}
		Overall estimation	X_{23}

The results of questioning (estimation of particular attributes of quality) have shown high indicators of internal coordination. The value of the coefficient *Cronbach alpha* equals 0.933 and the standardized value – 0.93, which allows making a suggestion about the reliability of the results.

In the analysis of the descriptive characteristics of the estimates of particular quality attributes, the lowest estimates were received by the attributes connected with the infrastructure and the environment: mean value of X_{22} equals 3.035 и X_{21} – 3.182. It corresponds to the real situation: today RICT is experiencing difficulties and looking for new territories for transfer and further repair of the existing territory. Other attributes with low estimates are the attributes “cleanness and comfort” in the rooms of the RICT and the adjacent square (mean value – 3.419), “protection from crime” (3.500) and “providing physical services” (3.550). These attributes also directly depend on the state of the terminal infrastructure. The highest estimates were given to the particular quality attributes “buses’ timetable” (mean – 4.409) and “accessibility/realisation of tickets (mean – 4.527) which is also understandable. The questions of accessibility (possibilities of getting tickets both at the terminal and through the Internet and mobile phone) are regarded by the administration of the RICT as first priority; therefore the success of these quality sub-indicators is evident.

In the further research there is considered another way of forming the independent variables, namely: grouped variables corresponding to 7 categories of attributes (questions) (Table 6, left column). The values for each new grouped variable have been received by calculating the arithmetic mean of the variables of the given category. The reason of introducing the so called "grouped" variables as independent, is, first of all, a big number of variables and a small number of observations and then, in the change of the categorical variable X_i (i=1, ..., 22) for the interval variable w_l (l=1, ..., 7).

Table 7 presents the results of estimating of all the considered models. For models *A1, B1, C1, D1* there are used 22 initial attributes and the algorithms of evaluating described in 10.7.2 with the corresponding letters, and *A2, B2, C2, D2* use 7 "grouped" attributes as the independent variable.

Table 7

Results of weights estimating

Attribute	**Model A1**	**Model B1**	**Model C1**	**Model D1**	**Grouped attribute**	**Model A2**	**Model B2**	**Model C2**	**Model D2**
X_1	-	0.126	0.069	0.144	1. Accessibility	-	0.175	0.167	0.17
X_2	-	-	0.134	-					
X_3	0.218	0.035	0.166	-					
X_4	-	0.102	0.174	0.082	2. Information	-	0.084	0.082	0.075
X_5	-	-	-0.162	-					
X_6	-	-	0.056	-					
X_7	-	0.147	0.175	0.171	3. Time	0.337	0.255	0.232	0.235
X_8	0.189	0.068	0.334	0.05					
X_9	-	-	-0.217	-					
X_{10}	-	-	-0.181	-					
X_{11}	0.260	0.131	0.088	0.133	4. Customer service	0.620	0.406	0.346	0.338
X_{12}	-	0.148	0.195	0.141					
X_{13}	0.180	0.067	0.149	0.058					
X_{14}	-	-	-0.011	-					
X_{15}	-	-	-0.046	-					
X_{16}	-	-	-0.147	-					
X_{17}	-	-	-0.142	-	5. Comfort	-	0.031	0.074	0.056
X_{18}	-	-	-0.011	-					
X_{19}	-	0.107	0.317	0.128	6. Security /safety	–	–	-0.031	–
X_{20}	-	-	-0.194	-					
X_{21}	-	-	0.029	-	7. Environment	–	–	0.13	0.125
X_{22}	0.103	0.137	0.225	0.093					
$f(\boldsymbol{\beta})$	5.221	4.133	2.274	4.355	$f(\boldsymbol{\beta})$	6.509	5.992	6.609	6.618
SEE	0.366	0.349	0.322	0.353	SEE	0.394	0.392	0.423	0.417
F	1024.400	564.953	304.867	625.669	F	2208	891.416	567.579	678.624

As the final formula of the model for the non-grouped initial data, with keeping all the restrictions of the weight, there is chosen model *D1:*

$$y_i^* = 0.144\,x_{1i} + 0.082\,x_{4i} + 0.171\,x_{7i} + 0.050\,x_{8i} + 0.133\,x_{11i} + 0.141\,x_{12i} + \\ + 0.058\,x_{13i} + 0.128\,x_{19i} + 0.093\,x_{22i}$$

and for the grouped data – model *D2:*

$$y_i^* = 0.170 w_{1i} + 0.075 w_{2i} + 0.235 w_{3i} + 0.338 w_{4i} + 0.056 w_{5i} + 0.125 w_{7i}\,.$$

For *D1 Standard Error of Estimate (SEE)* makes about 9% in relation to the mean value of the overall estimate, for *D2* – less than11%. Both regressions are significant according to the Fisher criterion.

Knowledge of the weights allows regulating of the attributes according to their relative importance for the user and shows the key attributes from the point of view of improving quality. For example, revealing the fact of the greatest importance of the w_4, corresponding to the quality attributes "Customer service", underlines once again the importance of measures of managing the coach terminal personnel. And, the second place according to significance X_1 – "Accessibility for external participants of traffic" – in model *D1* confirms a correctness of a strategic goal of the terminal's management – to make it as a modern logistic passenger centre with the high level of intermodality. Also it is confirmed from models the important role of planned reconstruction of infrastructure for improving the overall quality of service.

The practical result of building the given models is revealing the importance of particular attributes of quality in their influence on the evaluation of the quality provided by a passenger terminal – coach terminal. It will allow the administration to take more grounded measures of improving the quality of service. Figure 11 shows the scheme of possible usage of the quality indicator for making decision.

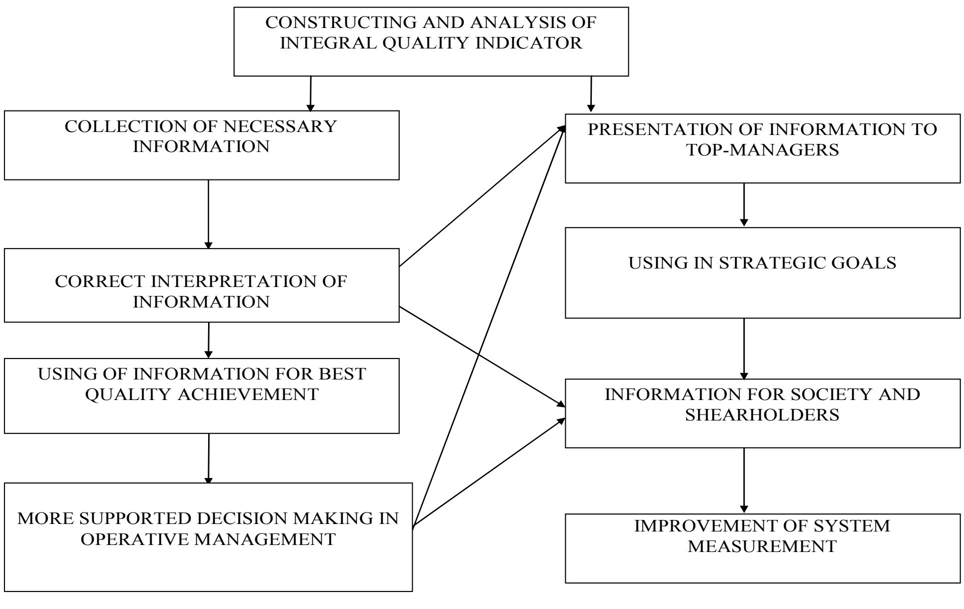


Fig. 11. *Scheme of using an integral quality indicator*

10.8. Using analytical instruments of the decision making support for choosing a scenario of developing of a terminal

The above developed analytical instruments make up a system of monitoring of the quality of the terminal services, which aim is improving the manageability is the terminal. Solving the tasks of management in complex systems today lies in the sphere of designing of corporate information systems, the integral part of which is the decision support system (DSS). And main decision is paid to the process, not to the result of the decision or the essence of the problem.

Decision making is a conscious choice between the existing variants or alternatives of the direction of actions which reduce the break between the present and the future desired state of the object of management. Thus, the given process includes a great number different elements but it always has such elements as; problem, goals, alternatives and decisions – the choice of an alternative. The work gives detailed description of the constituents of this process and demonstrates the realisation of the process of the decision making support for a particular coach terminal with the data of a real terminal.

Figure 12 presents the stages of the process of the decision making support for a particular passenger terminal.

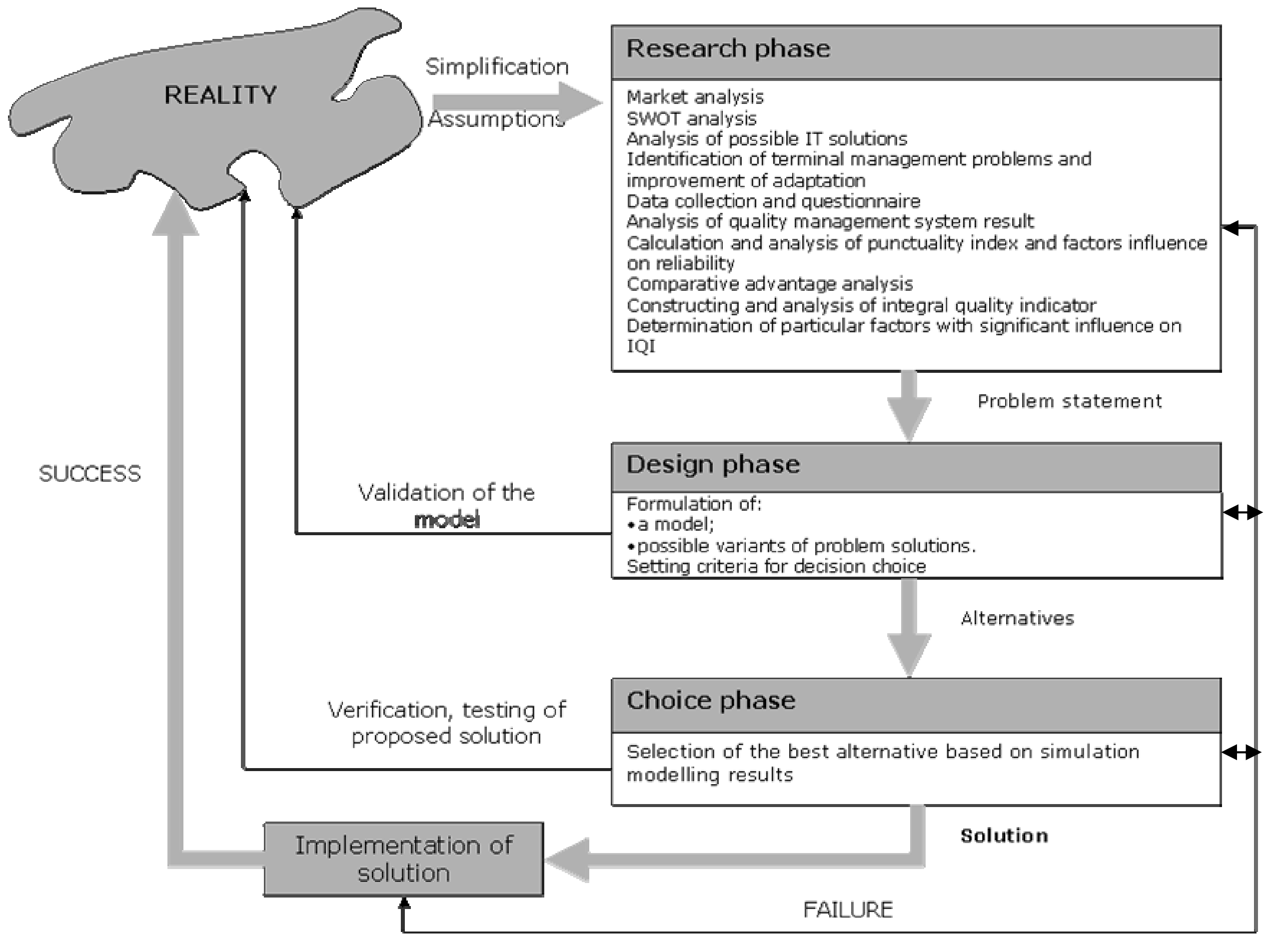


Fig. 12. Stages of decision making process

At the research phase there was made the analysis of the market of public transport in Latvia and SWOT analysis of the existing terminal functioning. There have been determined the significant factors for the development of a terminal as a passenger logistics centre for building on its basis of a virtual coach terminal. There have been considered the possibility of the existing IS and suggested additional instruments for realizing a new systematic approach to monitoring of the service quality (see fig.8). The offered instruments allow due identification of a problem in the manageability of an coach terminal and setting a task for making decisions on the adaptation of the terminal to the changing conditions.

With the application of the analytical instruments developed in the 5th chapter of the given work to the Riga International Coach Terminal data, there have been revealed the crucial factors from the point of view of the provided service quality. The quality and correspondence of the infrastructure to the requirements of the market are the most significant now. The decision of the reconstruction (planning) of the transport infrastructure is one of the most important decisions which need thorough prior consideration. Often, in making project decisions there is lack of sufficiency and clearance of the technical-economic information. Therefore, the decision maker will have to deal with uncertainty and risk. In this connection, the problem of the decision making support in choosing a project decision on building new and reconstructing the existing transport infrastructure objects acquires special actuality and requires improvement of the methodology of its decision.

The work gives an example of applying simulation modelling as an analytical means of the DSS at the stage of planning a passenger terminal – RICT. In designing and planning a terminal, namely an Coach Terminal, it is important to take into account the space of the projected terminal from the point of view of the number of the trips under service and the passenger turnover, both general and market segmented – international, inter-city and regional trips. Provision of the possibility of the passengers' transfer in a multimodal system of passenger transportations is also important. Therefore, the criterion of choosing a particular decision on a new terminal is the complete meeting of transportation demands in peak hours.

For building the model there have been used the data of the IS *Baltic Lines*:

- buses' timetable during the day;
- characteristics of employed buses;
- statistics of the buses' congestion, etc.;
- the data which present one of the alternatives of solving the problem – the design of a new terminal with platforms, schemes of buses' entrance and departure from/to the territory.

The model is built on the basis of the simulation software *VISSIM 4.0.* of the German company *PTV* and allows modelling transport flows at the micro level. Fig. 13 shows the detailed stages of model creation for coach terminal.

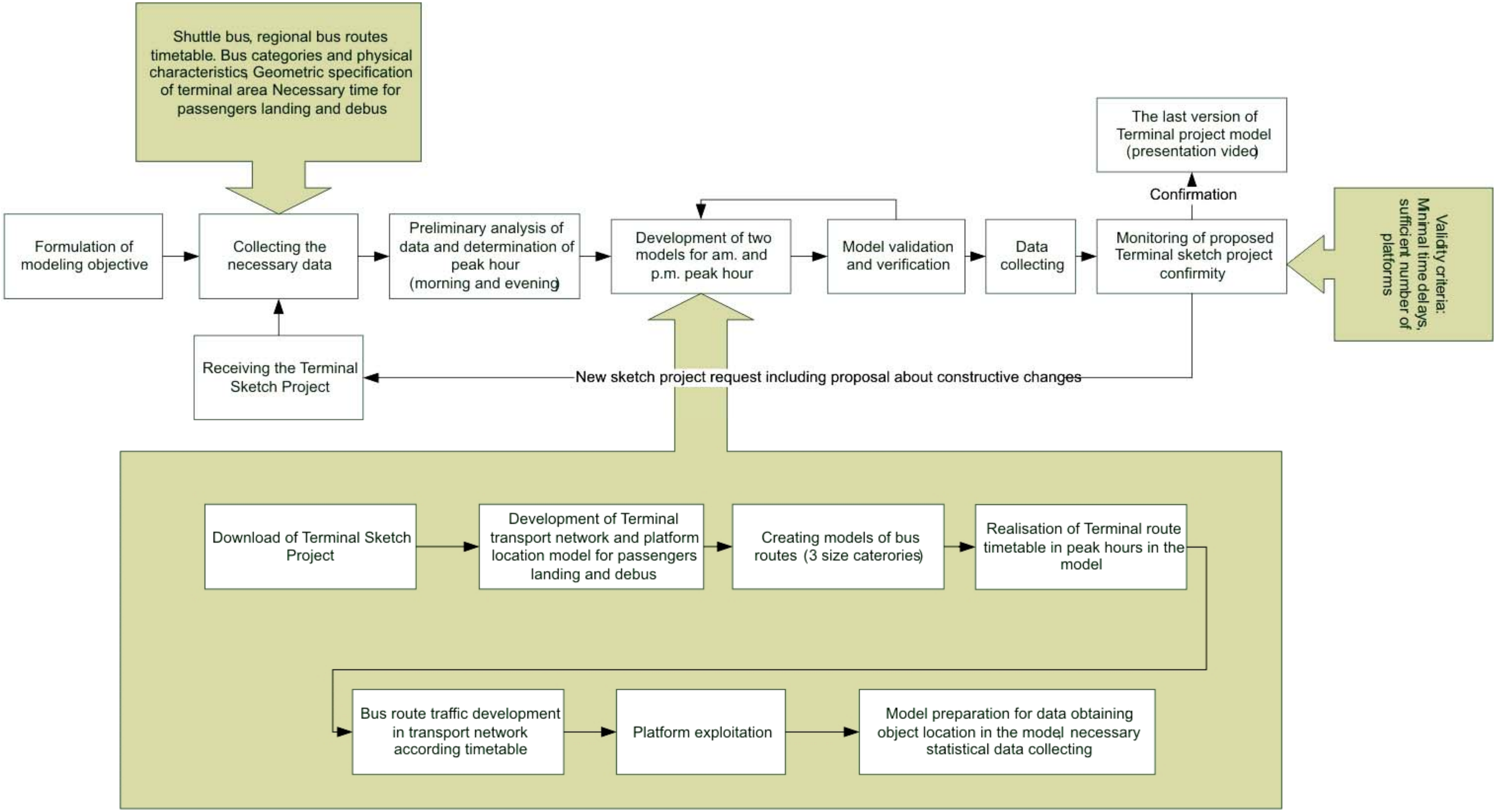


Fig. 13. The detailed stages of model creation for coach terminal

In the process of modelling there have been revealed "the narrow places" of the supposed design; their analysis and elimination were performed at the stage of designing and preparing of the final decision on the design of the new terminal. Thus, for example, the suggested design of the new coach terminal did not have enough resources for supporting of the existing timetable and in the period of the analysis of the terminal performance did not provide the required number of platforms and access roads in the peak hours (17.00 – 19.00). Figure 14 clearly shows "a narrow place" of the design – only one departure road which crosses the buses' roads of approaching the platforms that leads to the buses' queue. The diagram of fig. 15 shows the quantitative characteristics of the queue length; their values spell out the clients' dissatisfaction and the insufficient level of safety in organizing traffic with such planning of the terminal.

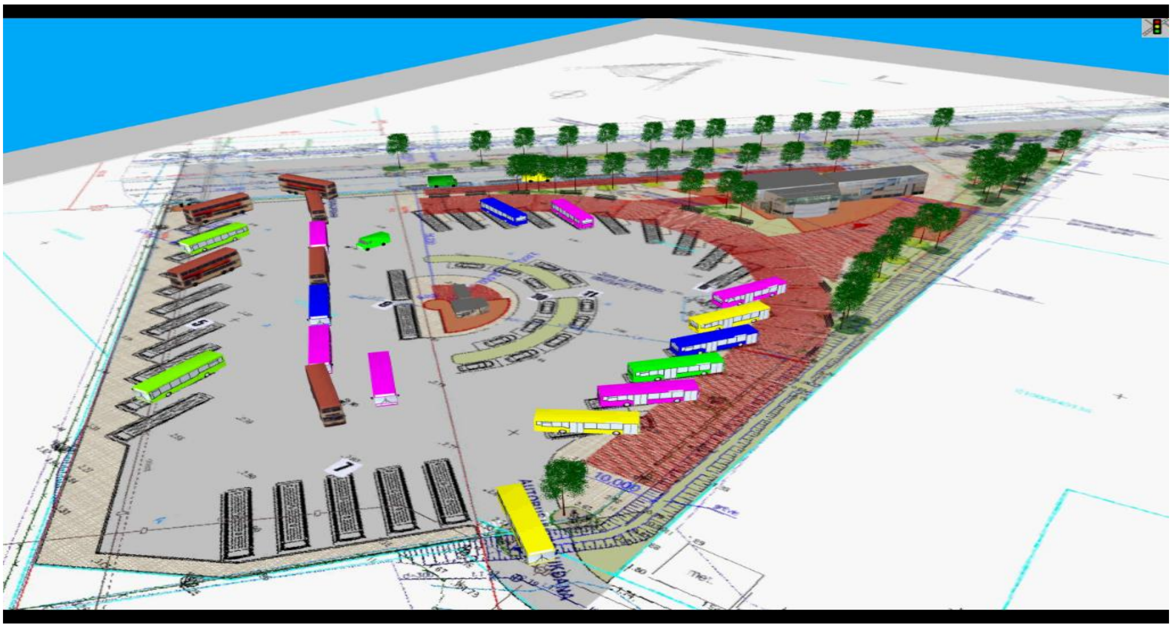


Fig. 14. An example of the terminal functioning model during the evening peak hours when coaches are forming maximal queues to boarding platforms

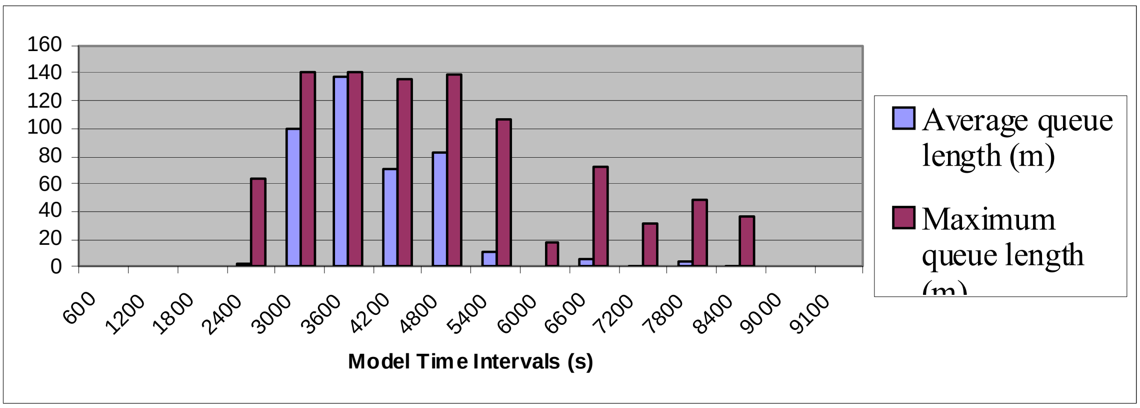


Fig. 15. The quantitative characteristics of the queue length during the evening peak hours

In the process of the research there have been analysed three alternatives of the new project and chosen the most reasonable one from the point of view of maximal satisfaction of the transportations needs.

The research shows how the simulation model at the stage of processing the alternative for the planned decision allows:

- revealing advantages and disadvantages of the planned decision;
- analyzing the suggested variants of the buses' traffic and of the passengers' flow in the terminal;
- analyzing the sufficiency of resources (platforms, for example) for performing the timetable of the bus traffic and the convenience of their allocation, etc.

The research demonstrates the possibility of better identification, with the help of the data of the terminal IS and the developed analytical instruments, of the problems, of setting tasks, possible alternatives and of making decisions for providing functioning and development of the terminal in the period of its design, reconstruction and performance, operatively reacting to the necessary changes.

11. CONCLUSION

The analysis of the activity of a passenger transport terminal shows that in the chain of passenger transport, the terminal is an important logistic part which provides wide possibilities of transfer and instillation of the principle of multimodality into the network of passenger transportations.

Taking the conception of a cargo logistics centre and of an aviation hub as the basis, the author suggests a new conception for passenger terminals – that of a passenger logistics centre. The research gives systematization of the crucial factors which are necessary for applying of the conception of a logistics centre for passenger terminals of public transport with the example of the functioning of a coach terminal servicing both regional and international trips in a multimodal transport system.

There has been analysed the correspondence of the services provided by the passenger terminal to the principles of 3PL of the operator offering the logistic and management services to the clients – to the transportation companies, travel agencies, etc., with the help of specialized information systems. The provider of such kind of logistic services provides optimization of servicing operations, reduction of costs, raising competitiveness along with the services of high quality. The author has developed suggestions on further development of the passenger terminal information systems for providing logistic services to the clients at a higher level and in a wider range, as of both 4PL and 5PL-operator.

Taking into account the fact that the services of a passenger terminal are integrated into the whole chain of passenger transportations and are accepted by the user as a single service of the chain, development of a complex approach to the analysis of the passenger terminal service quality is quite actual. For passengers, there are several important aspects of travel – route, timetable (frequency of trips), time of travel, service reliability, security, etc. Some of these characteristics are objectively estimated and stored in the terminal IS; some of them are subjective and need constant questioning of the clients. The research suggests the system of questionnaires and surveys for monitoring the quality of the passenger terminal services. With the example of the RICT there is shown how these data may become a base for building a system of managing quality with its usage for making decisions on the terminal management at different levels.

The author has developed the analytical instruments of decision making which may become the basis of the DSS for any passenger terminal:

- the methods of the reliability analysis with calculating the punctuality index of the bus traffic and revealing the factors which influence reliability,
- the discrete-choice model for revealing the factors which influence of bus transportations from other modes of transport,
- the algorithm for constructing an integral quality indicator on the basis of particular indicators of quality which helps to estimate influence of every particular indicator on the overall estimate of quality.

Using of these instruments on a constant basis will allow, by improving the adaptability of the terminal, to increase the competitiveness not only of the terminal but of the passenger transportations under service.

The promotional work gives an example of these instruments using for the Riga International Coach Terminal and scenario of the terminal development based on simulation modelling.

The results received in the course of the given research are universal and may be used for any passenger terminals which act in a multimodal transport system and offer logistic services on the basis of advanced information technologies.

The management instruments regarding public transport terminals which are proposed in this research work will increase the possibilities for the sustainable development of the terminal and its inclusion into the regional multimodal transport system.

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