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MODEL APPROACH TO QUALITY PROVISION OF PUBLIC PASSENGER TRANSPORT

ABSTRACT

Modern approach to transportation system research is based on the system theory. System analysis is relevant. Constant transportation technique and technology development caused by the need of conformation to the new market conditions is the basis for such an approach. The model approach for resolving the problems of public passenger transport is provided in a scientific report. The model of quality of passenger transport comprises the submodels which define relevant measures for the provi-sion of passenger transport quality. The synthesis of sub-model for adoption of quality standards, submodel of pas-senger demands, submodel of operation safety and securi-ty and economic submodel construct the model of quality of public passenger transport (PPT). Its evaluation has been carried out using SWOT analysis.

KEY WORDS

public passenger transport, traffic, lines, network, quality, mobility

1. INTRODUCTION

1.1 Research topic

The mobility of people is implemented using various means and types of transport. Public scheduled passenger transport is a subsystem of passenger transport which regularly (daily) transports people or passengers who wish to travel quickly, easily and cheaply. As passenger transport is being carried out in the form of public or personal transport and as own-account transport, one urgently needs to study the appropriate system solutions of passenger flow management or system consistency of transport supply and demand. The subject of this study features interaction between the key elements of public passenger transport system.

A few years ago, the public passenger transport system in the Republic of Slovenia was broadly used for daily migrations of citizens, as an advantageous financial policy of the public transport which had been provided by the Slovene government. In the market system, the public passenger transport system strived for its own business operations, with the exception of a few transport carriers that are co-funded by the state.

The human being as a transported object with their personality, virtues and characteristics represents the centre of the public passenger transport. In transportation, passengers are most sensitive and fragile. They are demanding, sensitive to comfort, safety, cleanliness, speed and appropriate price for the service offered. For the provider of public passenger service to meet the passengers' high demands, an adequate service level must be constantly provided and the offer continuously updated. The latter is important due to the fact that passengers are more and more aware of the possibility of choosing among different providers. In order for the transport operators to meet the desired goals, they must provide adequate human resource capacity, modernise the suprastructure, introduce contemporary work organisation, modern information system etc.

1.2 Research problem

The research problem is defined within the context of the presented research topic. Due to its general characteristics, the public passenger transport in the Republic of Slovenia is now becoming less and less attractive and efficient. The reasons for this may be found in inefficient measures of the transport policy which is further reflected in the entire implementation of the public passenger transportation. The consequences of such a situation are negative economic aspects for transport operators, negative impact of transport on the environment, unbalanced develop-

ment of transport subsystems and inadequate passenger mobility.

1.3 Scientific hypothesis

The problem and topic of this research have indirectly defined the scientific hypothesis: consistent knowledge of transport policy and the process of public passenger transportation – especially from the viewpoint of transport process standards, passenger decisions regarding the choice of transport, traffic safety, and from the economic viewpoint, a modified model of public passenger transport – may be presented that result from a balanced transport supply and demand, taking into account the quality elements of the public passenger transport. The modified model enables system implementation of transport system key elements. The consequences of the implemented modified system may be expected in the establishment phase of the successful, efficient and attractive public transport system that will be able to work effectively under the conditions of free transport market.

2. PUBLIC PASSENGER TRANSPORT SITUATION IN THE REPUBLIC OF SLOVENIA

In 2006 the government of the Republic of Slovenia adopted a Motion for a Resolution on the Transport Policy [1] that determined the fundamental directions of the future transport policy in a contemporary and simple manner with the vision, objectives and measures. The main indicators of the transport policy arise from the mobility, accessibility, environment and safety, economy development, optimal use of resources, intermodality/interoperability and balance of various transport systems. The transport policy of the Republic of Slovenia takes into account the principles of sustainable development and at the same time implements the transport policy of the EU. Upon adoption of the White Paper in 2001, six years later a working document called the Green Paper "Towards a new culture for urban mobility" [2] was adopted. In the European Union, over 60% of popula-tion live in urban areas. These areas produce nearly 85% of the EU gross domestic product. Cities drive the European economy and hence, attract new in-vestments and create new jobs. Therefore, cities (urban areas) are an indispensable factor for unob-structed performance of the national economy. Today, city areas are residential areas to the majority of the population. That is why the highest possible quality of life must be provided. It is thus highly important to provide adequate mobility of the population in urban environments, in which congestion occurs on a daily basis and causes numerous harmful effects, such as time loss and environmental pollution.

Figure 1 shows the state of the public passenger transportation in the Republic of Slovenia. The -realisation of the transport (pkm) for the period be-tween 1990 and 2006 shows that the carriage of passengers by bus or coach [3] decreased by 86.8% (from 6,444 mio. to 850 mio. pkm), rail transportation fell by 42.1% (the past few years indicate an upward trend) and air transportation decreased by 32.8% and saw a slight increase after the drastic fall.

The biggest decline in the scope of transportation can be seen in the carriage of passengers by coach and bus. After a drastic decline in 1991 and small variations during the years 2000 and 2002 a slight increase can be detected in air and rail transportation. Increased usage of air transportation services may be understood as a regulation of social – national condi-

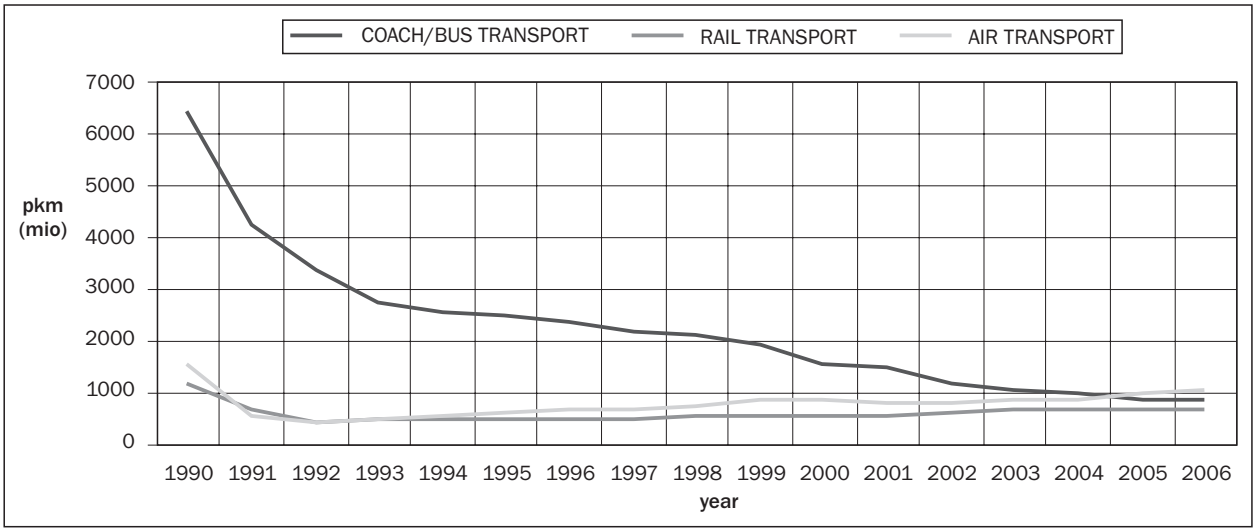

Figure 1 - Transport services in public passenger transport of the Republic of Slovenia for the period 1990 –2006

Source: SURS, 2008 [3]

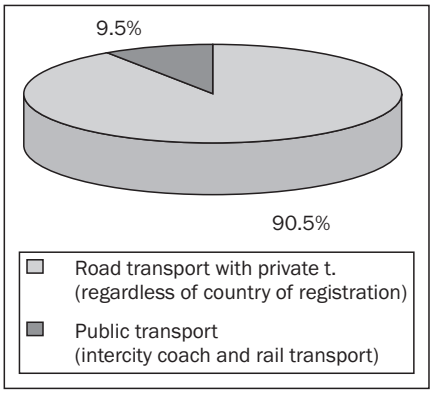

Figure 2 - Proportion of public passenger transport (road and rail) and personal passenger transport in the Republic of Slovenia in 2001

Source: SURS, 2008 [3]

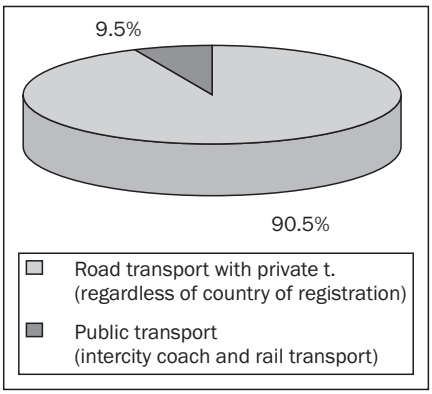

Figure 3 - Proportion of public passenger transport (road and rail) and personal passenger transport in the Republic of Slovenia in 2006

Source: SURS, 2008 [3]

tions in the Republic of Slovenia after 1991 and recently due to the increased labour migration, business trips and tourism. Increased usage of railway services is a consequence of the modernised railway fleet (InterCity Slovenia) and the price policy, in comparison to coach services.

When comparing private and public inland transportation in the Republic of Slovenia (intercity coach and railway transport) an obvious difference between both modes of transport can be seen. During the period of 2001 and 2006 road transport (private vehicles) increased from 20,801.1 mio. pkm to 23,018 mio. pkm. However, public passenger trans-port (road and rail) fell from 2,184.9 mio. pkm to 1,643.5 mio. pkm. In rates this means that compared to the year 2001, in 2006 the proportion of road transport demand for private vehicles increased from 90.5% to 93.3%, whereas the proportion of public transport demand in the same period fell from 9.5% to 6.7% (*Figures 2* and *3*).

It can thus be confirmed that recently, public passenger transport has been in decline and as a consequence private transportation is on the rise.

3. QUALITY MODEL OF SCHEDULED PUBLIC PASSENGER TRANSPORT

Passengers can be transported using logistic processes which are defined as part of individual transport subsystems. Work technology in transport is a basic process for the production of transport services. It makes sense to analyse the characteristics and define elements, degrees and principles of the transport process. When talking about passenger transport – logistic passenger transport flows, the passenger must be dealt with as an object of transport. When searching for new strategies for the implementation of passenger mobility it is common to search and use a model approach to implement strategic goals to reach quality of passenger transport. One should bear in mind that certain measures are needed for passenger flow regulation if the relationship between public and personal transport is to be regulated. Possible measures may be: planning of urban space usage, optimisation of transport network capacities, optimisation of infrastructure network usage, implementation/improvement of multimodal systems when implementing new connections/services/modes of public transport. Each organisation of a transport process, like all other operators of commercial activities is based on individual quality service principles. This means that the quality of transport is made of a set of components and aforementioned measures that are interwoven and complement each other. When choosing the most appropriate means of transport, and hence the subsystem, one needs to compare the aforementioned with each other and then choose the optimal transport process. Based on the set quality criteria the basic position for the structuring of the model of quality is determined, based on the defined incoming assumptions, which are described as submodels. The quality of transport process is expressed using process standards, passengers' decisions regarding the choice of transport, safety in transport and the economic aspect. By studying the quality aspects of the public passenger transport, the submodels are determined (*Diagram 1*). The latter presents a set (synthesis) of quality of public passenger transport. Should one of the subsystems

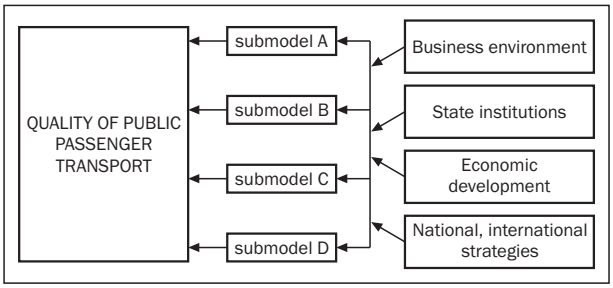

Diagram 1 - Model structure of public passenger transport quality

fail or perform inadequately, deficiencies in public passenger transport performance may arise. Consequences of this are bad business results of transport operators that can be seen in their performance on the transport service market. The structure of the model of quality features an incoming application for model design. The quality field (*Diagram 1*) features all submodels that determine the necessary measures for model design.

The notion of quality in the public passenger transport system must actually represent a dominant business function. A fact is that successful business performance and future development of an organisa-tion, the degree of user satisfaction, owners and workers and long-term cooperation with a partner depend on the achieved level of the business processes quality.

3.1 Submodel A – standards in the public passenger transport system

The following standards are of key importance to public passenger transport operators for the implementation of quality strategy:

- ISO 14001 business performance or environmental management system features a holistic management of environmental aspects of production or service provision;
- SIST EN 45004 for the implementation of control of tachographs in line with the Rules on metrological requirements for the equipment recording the driver's work and the movement of vehicles in road transport [4], that is supplemented with SIST EN ISO/IEC 17020:2004 type C;
- ISO 9001:2000 takes quality management principles into account that are used today as part of successful organisation, in production and in the service sector;
- OHSAS 18001 a system providing a safe and healthy working environment;
- SIST EN 15140:2006 Public passenger transport – basic requirements and recommendations for the system of quality evaluation of performed services;
- SIST EN 13816:2003 Transport – logistics and services – public passenger transport – determination of quality, objectives and measuring quality service.

The model for integrating standards into transport services (*Diagram 2*) stems from the set standards that are relevant to the operation of the public passenger transport. It encompasses the basic and most frequently represented or implemented standards. When a company gains or accepts certain standards and includes them in the business principle, one of the conditions for quality business processes is fulfilled.

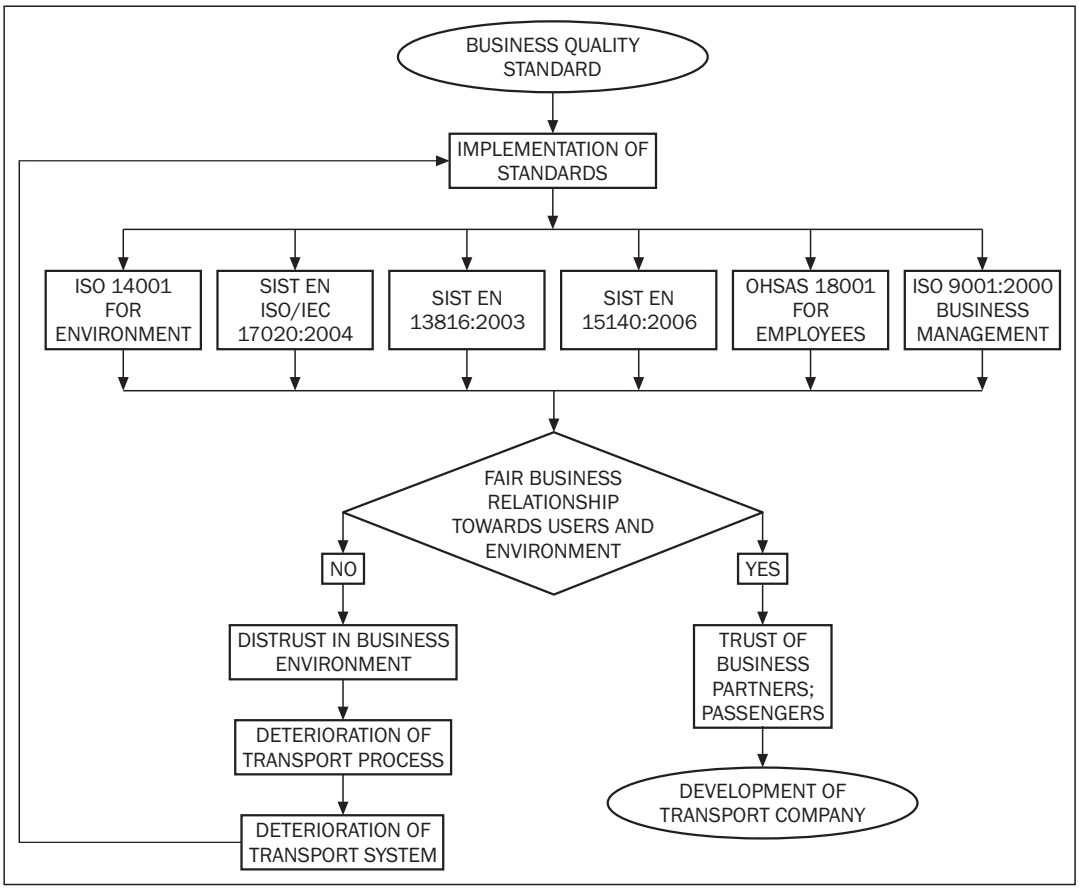

Diagram 2 - Model of standard integration into transport activities

With an adequate level of quality, a transport operator can top the set objectives on the transport service market. This results from the goals of various sectors in a company and goals of operative transport process along with an obvious result of quality development operation of a transport company. The prerequisite for the determination and usage of this model for the integration of standards into the business process is a study of specific elements that influence the expected result. Apart from defining the goals of the model, restrictions and the role of the elements of the model, the model structure needs to be defined – from the set of standards to the planned end of the procedure. It is understood that the acquired standards influence the quality of the transport process.

3.2 Submodel B – passengers' decision regarding mode of transport

The scope and structure of passenger transport is an important indicator for transport system operations, as it shows how much and how citizens of a particular country, region and/or town travel. The choice of a particular transport operator and thus type of transport (transport subsystem) is important due to differences in environmental, economic and social efficiency of specific transport modes and different effects of their usage. Due to the growth of gross domestic product, decreased demand in public passenger transportation, and hence increased use of private vehicles, growing motorisation, and energy use in transport and road infrastructure load it can be as-

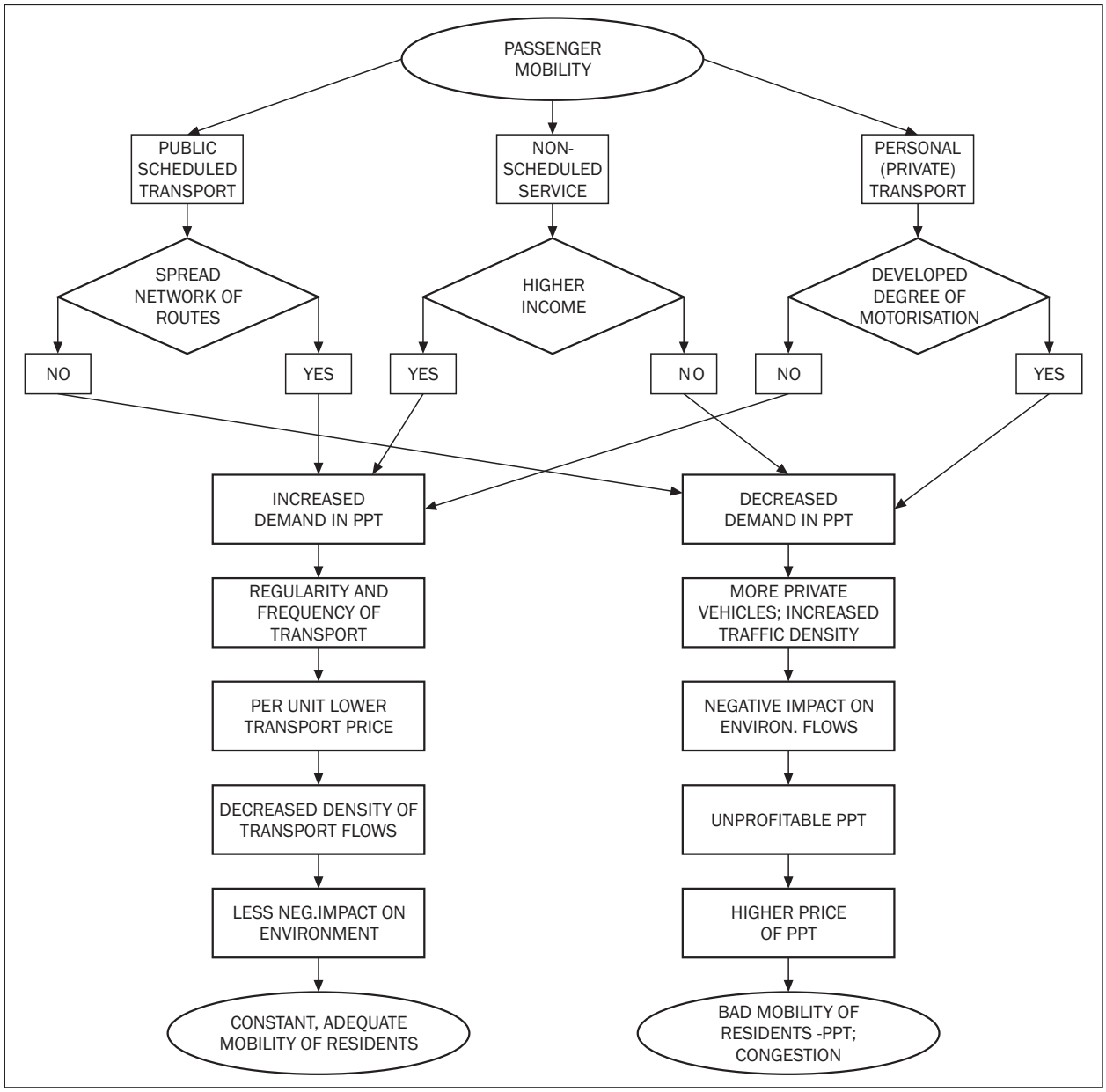

Diagram 3 - Model regarding passengers' decisions on the use of transport modes

sumed that the entire scope of passenger transport is expanding. Numerous factors (motorisation development, investments in infrastructure etc.) indicate a continuously prominent automobilization of passenger transport in Slovenia [4]. That is why the first move towards a sustainable development of transport may be expected at urban level. Some of the measures for traffic flow regulation, especially regarding private vehicles, include various methods for the reduction of traffic flow volume. A Decree on Spatial Order of Slovenia [5] states that public passenger transport, which comprises interlinked networks of road, rail, water and other transport modes needs to be planned in residential areas so that it enables accessibility of "five-minute walk" from built-up areas, mixed areas, special areas and areas of social infrastructure to the stations of public passenger transport. If this is transformed into the proposed model regarding passenger's decision on the use of a transport mode (*Diagram 3*), available modes of transport must be taken into account.

3.3 Submodel C – passenger transport safety

Transport safety is one of the contemporary issues. Safety provision in a transport system is based on the interdisciplinarity of the subject area, which also includes areas of scientific achievements in implementation of techniques and technology, psy-chology, medicine, sociology, law and culture. In traffic, road users are provided with basic knowledge and importance of responsibility. When designing a sub-model the users' viewpoints (as drivers or passengers) are taken into consideration. To this end, the notion of safety in transport plays an important role in the choice of transport system or travel. The greater the density of private vehicles, the higher the possibility of traffic accidents. Similarly, in a dense network of public transport there is a possibility of a technical or human error (for example density of air corridors). However, the fact remains that the smaller the number of individual transport services – individual participants – the smaller the number of conflict situations. A counter-aspect is present when more people can be injured in mass transportation than in single trans-portation system. There will never be absolute safety in traffic. We can, nevertheless, minimise the number of occurrences by regulating transport flows. There are other factors that influence transport safety, such as technology of flow management, the state of su-prastructure, training and education, development of transport culture, etc. These are the starting points for the formalisation of safety in passenger transport model (*Diagram 4*). The expected result of co-depen-dence of participating and influential factors is the reduced number of traffic accidents or an adequate level of safety for the benefit of the public passenger transport.

The model can be used to design a diagram of events that emerge as incoming or side factors in the public transport diagram. The influence public and private transport has on the safety level is outlined. Firstly, two types of transports were designed: public and private. In case of technique and technology development in public passenger transport system and qual-

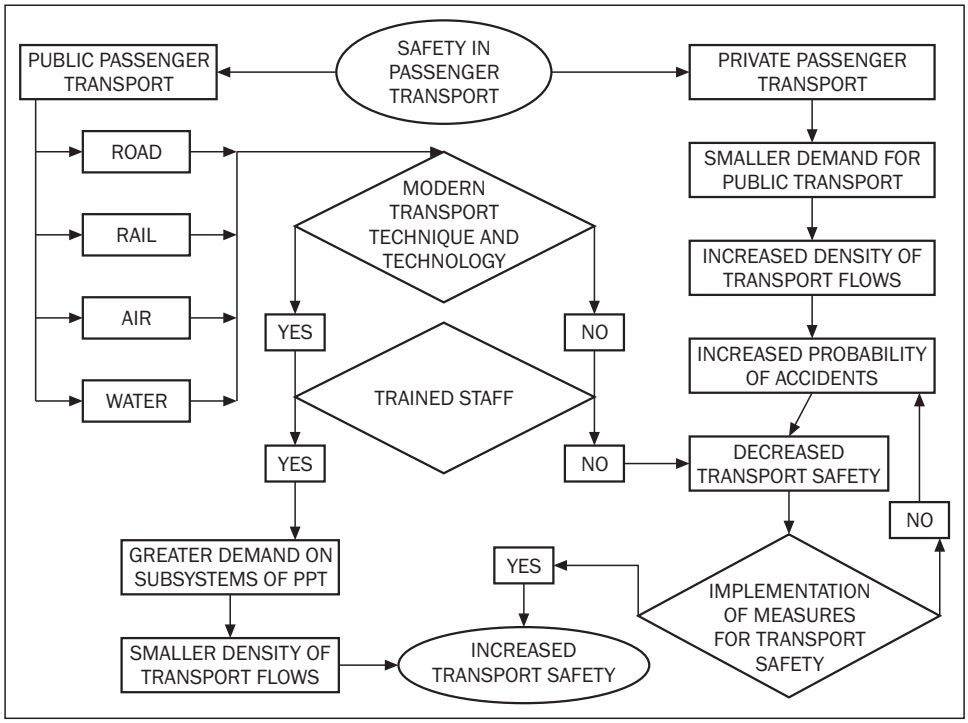

Diagram 4 - Model of passenger transport safety

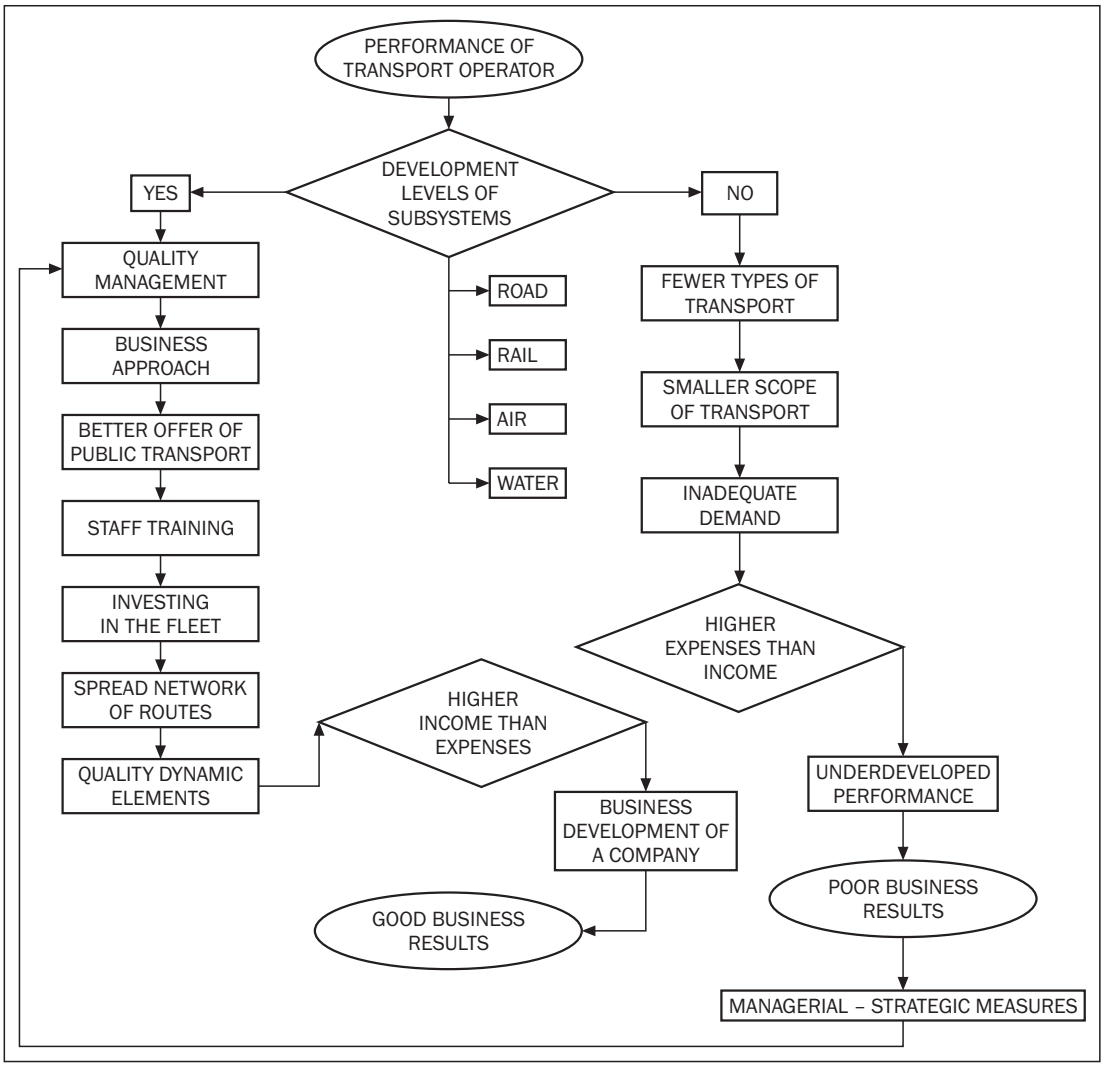

Diagram 5 - Model of economic impact on public passenger transport

ity performance of staff, an adequate level of transport safety is expected. This way, passengers trust the staff, and hence the performed transport services of subsystems. This can be compared to passengers' definitions of safe travel by train or plane, etc. If the model is dimensionalized by private transport, each passenger (driver) is a potential person or road user, responsible for an accident. If this is further transmitted to the broad number of road users, private transport is far more exposed to potential dangers. Finally, the model can influence the measures for road safety improvement. These measures are designed in accordance with the development of safety in the society (for example ReNPVCP) [6].

3.4 Submodel D – economic aspect

Economic aspect refers to interdisciplinary regularities, know-how, capabilities and activities related to economy production, usage and maintenance of transport infrastructure and suprastructure, economy production of transport services, economy organisation and economy of human potential. Based on the proposed model (*Diagram 5*) the economic impact on increased quality of transport process may be defined.

Economic aspects are present in all transport activities in the broadest sense of the word, for example: working out calculations and tariffs, costs, quantitative assessment of supply and demand, calculation of success parameters and stability of transport business operations. These are the reasons as to why everyone who in any possible way participates in the exploitation of transport process should be familiar with the scientific and empiric study, performance and development of all economic phenomena [7].

4. MODEL SYNTHESIS IN SCOPE OF QUALITY OF PPT

Based on the set secondary models (submodels) a synthesis model or a quality model of passenger transport (*Diagram 6*) is outlined. It is difficult and at

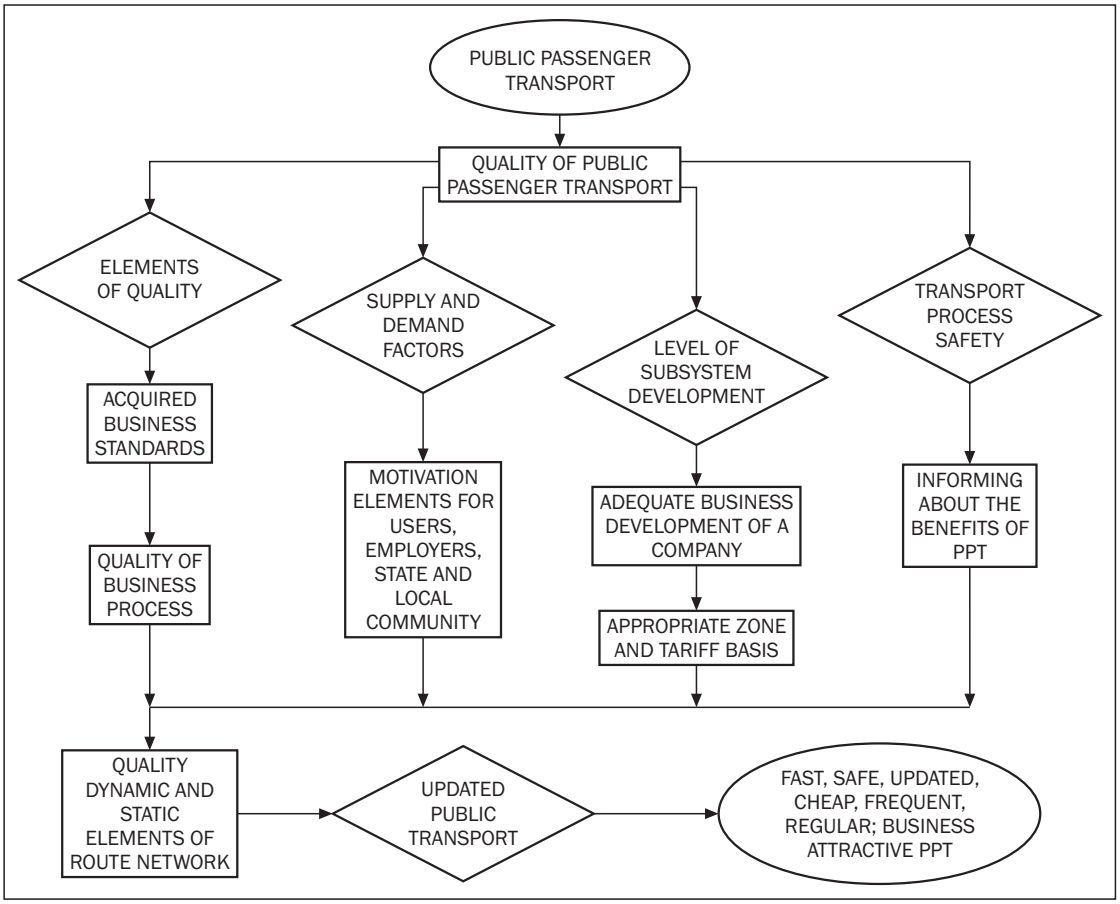

Diagram 6 - Model of quality of public passenger transport

the same time impossible to exclude or study particular segments of the public passenger transport. From logistics viewpoint, it is therefore appropriate to study public passenger transport holistically. A set of the aforementioned submodels directs the aspect of possible and necessary measures for solving the problems of quality public passenger transport.

The quality model has found new possible participants, who contribute to the business results with their activities. This means that for a quality performance on the transport market appropriate and adequate resources must be included and necessary measures for goal achievement defined. Based on the appropriate offer of transport services, achieved standards for quality business processes, provision of acceptable safety level and low-costs, the result of the quality model of transport processes may be fast, safe, updated, cheap, frequent and business attractive public passenger transport. The quality of public passenger transport is measured using dynamic and static elements. The implementation of the quality model in a real environment is made dependent upon the optimisation of time intervals between vehicles, adequate frequency of vehicles, adequate time of vehicle circulation and adequate areas for stations or stops.

The evaluation of the suggested model in the actual environment was conducted using the SWOT analysis (*Table 1*), whereby weaknesses and strengths as well as opportunities and threats were studied that should be taken into account when applied.

5. CONCLUSION

There are various factors that influence the choice of transport subsystem, mode of transport and transport operator. They can be consolidated into dynamic and static elements. The following scientific discussion referred to only some of the key elements of the quality system of the public passenger transport. Its aim was to use the systemic approach for searching for the most suitable business decisions for the growth of the public passenger transport. Furthermore, the fundamental guidelines (transport policy) for public transport performance have been adopted. However, from the viewpoint of the aforementioned elements of the transport system much more is to be done. One of the needed measures for improving the situation is quality provision of the public passenger transport. This presents the key element for sufficient popularisation of the public transport. The presented quality model encompasses the designed submodels that serve as ba-

Table 1 - SWOT analysis of the quality model of public passenger transport

	Description
Strengths	– better local air quality, less noise, less congestion, – harmonisation of the local transport policy and sustainable development of a city, – changing residents' habits and behaviour, – working tradition of operators, – route network coverage, – optimisation of city space, – transport provision to all users, – minimisation of unbalanced transport.
Weaknesses	– increased mobility – increased number of trips, – instable financial frames for investments, – low level of availability of private finances and underdeveloped alternative models for financing, – insufficient infrastructure, – high vulnerability of urban areas, – dispersed human settlements and thus expensive implementation of transport process, which can meet the demands, – less competitive (city) railway network and (compared to the road) poor organisation of rail transport.
Opportunities	– preservation of natural resources, – preservation of quality of living environments, – positive effects on economic and tourist development and development of new technologies, – citizen awareness, – positive effects on public health, – raising awareness about environmental issues, – development of new transport technologies, – reduced costs for the society, – improved accessibility to work and school.
Threats	– migration of citizens (within the Republic of Slovenia), – low level of awareness of users regarding economic and other benefits, – insecurity, – increased congestion due to inadequate transport infrastructure, – alteration of the city atmosphere, – increased dispersion of settlement of inhabitants, – continuous lack of connectivity of public passenger transport operators, – socially unacceptable degradation of the (living) environment.

sis for the new approach, which aims to create an overall picture of the quality public passenger transport. The elements of safety, economy, frequency, regularity etc. were outlined using the quality model.

The application of the proposed model could contribute to a systematic approach for solving mobility issues in urban environments. The SWOT analysis, which has been carried out, defined the role and stressed the importance of the public passenger transport in urban areas in greater detail.

Based on this, the conclusion can be drawn that with consistent knowledge of the transport policy and the process of public passenger transport, and taking into account various aspects such as transport process standards, passengers' decisions on the choice of transport, transport safety and the economic aspect, a public passenger transport model can be presented that results from a balanced transport supply and demand and at the same time takes into account the quality of public passenger transport. To this end, the scientific hypothesis, which was introduced at the beginning of this paper, has been confirmed.

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POVZETEK

MODELSKI PRISTOP K ZAGOTAVLJANJU KAKOVOSTI JAVNEGA POTNIŠKEGA PROMETA

Sodobni pristopi k raziskovanju prometnega sistema javnega potniškega prometa temeljijo na upoštevanju teorije sistemov posledica česar je sistemski pristop k obravnavanju problematike. V slednje nas usmerja predv-sem nenehen razvoj tehnike in tehnologije proizvodnje prometnih storitev, ki se mora prilagajati novim tržnim pogojem poslovanja. V znanstvenem prispevku je prikazan modelski pristop k reševanju javnega potniškega prometa. Model kakovosti javnega prevoza temelji na podmodelih, ki določajo potrebne ukrepe za zagotavljanje kakovosti javne-ga pre-

voza. Sinteza podmodela osvajanja standardov, podmodela povpraševanja po javnem prevozu, podmodela varnosti obratovanja in ekonomskega podmodela vzpos-tavlja model kakovosti javnega potniškega prometa, kate-rega vrednotenje je narejeno s pomočjo SWOT analize.

KLJUČNE BESEDE

javni potniški transport, promet, linija, mreža, kvaliteta, mobilnost

LITERATURE

[1] RePPRS- Resolucija o prometni politiki RS, Ul. RS št. 58/2006.
[2] Zelena knjiga EU (EU Green Paper), Komisija evropskih skupnosti, 2007.
[3] Statistični urad RS, 2008.
[4] www.dc.gov.si/fileadmin/dc.gov.si/pageuploads/pdf_datoteke/prometno_delo (2008).
[5] Uredba o prostorskem redu Slovenije, Ul. RS. 122/2004.
[6] ReNPVCP – Resolucija o nacionalnem programu varnosti v cestnem prometu, Ul. RS. št. 2/2007.
[7] **Zelenika. R., Kamnik Zebec, S.**: *Multimodalni prometni sistemi*. Fakulteta za gradbeništvo Maribor, Maribor 2007.