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SMART MOBILITY – BASE FOR SUSTAINABLE TRAFFIC-TRANSPORTATION SYSTEMS DEVELOPMENT

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Key words: *information and communication technologies in transport, smart mobility, smart traffic – transportation infrastructure, smart cities.*

Abstract: *Smart mobility is a complex, long term concept for sustainable development of traffic – transportation systems. It is the result of harmonization between transport supply and demand, due to globalization, urbanization, current requests for environmental protection, safety and security. Namely, the role of smart devices in trips planning, shared usage of means of transport, as well as usage of so called green vehicles; smart city development based on applying of communications technologies with respect of the social dimension, as well as the modern traffic – transportation infrastructure that allows greater availability and safety, by high level of innovations usage, are defining the mentioned concept of future traffic – transportation systems. Therefore, series of measures and activities within of this proactive approach is primarily based on the information and communication technologies usage. The last are fundamental factors for creation of smart mobility, especially when it comes to later phases of its implementation.*

The application of mentioned factors is directed towards collecting, analysis and real time information sharing, different web technologies usage, visualization and animation, monitoring by satellite, geographic information systems, advanced modelling, in creation of efficient, economical, ecological traffic – transportation systems which correspond to transport demand characteristics.

INTRODUCTION

In accordance with the reference literature, personalization of mobility, sustainable means of transport, further process of urbanization, as well as growing use of innovations, are four key factors of influence on transport supply and demand in future.

Smart mobility is the base of so called smart city development. It implies applying of new technologies in practical realization of travel needs bearing in mind the requirements for higher level of efficiency, economy and environmental protection.

The subject of analysis in this paper is the basic characteristics of the proactive approach in traffic – transportation systems development, which is presented through smart mobility. The goal is to acquaint the professionals with modern, global directions for creation of smart, integrated and green city.

Additionally, initiatives for smart development of Bitola, the second biggest city in North Macedonia, are presented. Therefore, in order to manage the complex challenges of modern urban systems, new practices and trends within the smart city approach is recommended.

SMART MOBILITY

Processes of globalization and urbanization, climate changes, rapid technological and economic development, have imposed the need for taking initiatives and defining of strategies that will enable easier and more efficient functioning of traffic and transportation systems. The basic attributes of smart mobility are simplicity and efficiency, bearing in mind the goals relating, from the one side, on reducing of traffic flows, travel time, travel costs, environmental pollution and noise, and on the other side, increasing of safety and security.

Smart mobility is an element of smart, (sustainable), transport future, (there are also smart transport infrastructure, various types of intelligent management of traffic flows, green mobility) [1], to which, according to global documents, there is a need for moving of future traffic – transportation systems. Bearing in mind the high level of relationship between the mentioned elements, smart mobility can be defined as a concept for development, which is presented through forms, solutions and activities, which are, according to the purpose, goals, and contents, implemented through different factors.

Purposes of this concept, (which are closely connected with each other), are directed towards establishing of well-connected and intelligent traffic – transportation infrastructure, creation of smart cities, promotion and development of so called green vehicles.

Identification, creation and practical implementation of systematic, modern and applicable solutions, appropriate to social and economic demands, as well as to the demands of environment protection, are the basic goal of the concept.

The contents of the activities, (innovative forms for traffic flows management, usage of modern technologies for construction and maintenance of infrastructure, new and efficient transport services), as well as the key factors for their practical realization, (state administration and local government, scientific research institutions, public and private companies, various bodies and organizations), are the direct consequence of the purpose and goals.

In accordance with the mentioned characteristics and modern trend of global social and economic development, it can be concluded that the functioning of this concept means existence of a system in two levels. The first level allows, from one side, detecting, collecting and analyzing of informations regarding transport states in real time, and from the other side, enables their exchange between providers and users of transport services, as well as the coordination between different transport modes. In addition, the system can provide higher level of service which is presented through forecasting, solving and preventing of certain states, (conditions).

SMART MOBILITY INDICATORS

Indicators of smart mobility are a part of the smart city concept, based on optimizing traffic sector in urban areas. Optimizing the mobility could be done by introducing new information and communication technologies. To achieve this optimization, the goals of smart mobility need to be determined first. The goal of smart mobility is to reduce the economic, environmental and time costs (in every mode), and therefore, to achieve these goals, setting the indicators becomes crucial. There are many indicators that can be suitable for smart mobility, but only few of them can be chosen if the data wants to be collected efficiently. The indicators must be chosen for each city separately. The reason for choosing the indicators for each city individually lies in the fact that particular city has specific urban area features,

population, socio-economic characteristics, specific city administration, traffic and transport problems and financial framework.

The sustainable urban mobility documents as for example [2], describes that cities need to choose a set of mobility indicators. More important is that the indicators need to be a result of citizen's real needs and to be determined on SMART measures principle (Specific, Measurable, Achievable, Relevant and Time bound) that will help in determination of optimal set of indicators for assessing the level of quality in traffic and transport sector.

As sustainable urban mobility means alternative planning versus traditional one, the indicators for smart mobility will be evaluated as factors for Smart City (SC) versus Conventional City (C). Since the concept of smart mobility (a holistic concept) widely used is focused on citizen needs, quality of life and health in the city, measures, should be measurable by indicators. The indicators are based on measuring the rate of implementing information and communication technologies.

At planning the sustainable urban mobility process, smart mobility indicators must be set. Further description (Table 1) is an example of "n" evaluated factors as representatives to measure the extent of smart mobility.

Table 1

(SMART Measure "1") Sustainable Mobility Urban Plans (SUMPs) SC > 1 with SUMP or C = 1 without SUMP
(SMART Measure "2") Integrated payment method in multimodal transport systems SC > 1 with smart card payment/smart phone payment or C = 1 with Common tickets
(SMART Measure "n") ICT in traffic control SC > 1 with ICT integrated or C = 1 with Basic control

Various cities in EU countries implement various smart mobility measures. The leading countries in the European Union in this segment are the Netherlands, Sweden, Denmark and Germany. In transport and mobility sector, the opinion on what kind of infrastructure is adequate for mobility of people has changed in the past 20 years. The old way of thinking – building roads or other infrastructure and increasing their capacity will solve mobility needs is replaced with the new one – how to use various solutions especially information and communication technologies to optimize the performance of the existing infrastructure and transport systems.

Implementing smart technologies into real transport sector brings significant improvements in road safety and impact on the environment in general. The implementation of the technologies is expected to increase in future years, depending on budgets and funding because of higher awareness to use new and modern technologies in optimizing system performance. Public transport and parking management are the fields of urban mobility that have many possibilities to implement information and communication technologies. Developing technologies such as Internet of things, smart cards and chips, cloud computing, mobile devices, various software, data collection software and management have various potential to increase possibilities, performance and attractiveness of public transport and parking management. Smart cards have simplified and accelerated fare charging process, and thus expanded possibilities for its users (more charging schemes, one card for multiple services, etc.). Smartphone apps can be used as means of payment, but also as a source of information about real-time traffic, public transport, or parking facility status. The existing technologies implemented in public transport are: smart card, e-vehicles, autonomous vehicles, software for planning and organizing public transport network, data collecting devices, software for data processing, various real time information systems, smart public transport stops, etc. The existing technologies implemented in parking facilities and parking

management are: applications for optimizing available car parks, devices and sensors for counting available on-road parking spaces, smart cards for charging parking fees, software for parking management, etc.

SMART CITIES – KEY CHALLENGE FOR SUSTAINABLE DEVELOPMENT OF TRAFFIC – TRANSPORTATION SYSTEMS

Bearing in mind the latest researches results, (75% of world population will live in cities by 2050; the number of vehicles along highways is expected to be 2.5 billion in the same year, which in comparison with 2011 implies increase of 154% [3]; the average number of deaths as a consequence of air pollution in cities worldwide is 400 000[4]), it is obvious that the future global development should be directed towards creation of so called smart cities. It is about future places, in which, by using of telecommunication technologies, city administration, responsible and dedicated will take care of meeting modern needs of various cities category in all parts of their lives.

The analysis of the definitions regarding smart cities presented in articles of various authors, lead to the conclusion that the attribute "smart" should include all of the components that make up a city: smart people, smart living, smart mobility, smart energy and environment, smart governance, smart economy. In short, connecting of classical and modern transport infrastructure, organized and well thought out management with natural resources, planned and on the detailed analysis based investments in social capital and human resources, and in that way formed life conditions and prosperity, are the basic directions for smart cities development. Therefore, smart city approach strengths and weaknesses as well as the mitigation of its limitations should be identified and organized through the Sustainable Urban Development process.

The basic strategy of intelligent systems promoting "smart cities" is to use all available data sources about the city, including synergies between individual and so far separate sectors (transport, SIA, IT, energy, etc.), financial possibilities of the city, possibilities of its limited infrastructure and resources, all information support to enable the local government to make decisions in order to fulfill the given multi-criteria function.

IMPLEMENTING SMART CITY CONCEPT – CASE STUDY OF BITOLA

Municipality of Bitola is one of the leading cities in our country that works on the inclusion of safety as an essential component in sustainable urban mobility. On the proposal of the Municipal Council for Road Traffic Safety, on the 19 June the Municipal Council makes a decision to start with the Sustainable Urban Mobility Plan (SUMP) development process. Namely, safe road design for walking and cycling is the primary strategic, SUMP goal, that will likely to enhance these modes and to reduce their risk.

City of Bitola, the second largest city in North Macedonia, (77 044 inhabitants, Census 2002), is located in its southwest part, on the edge of the Pelagonija valley. As it is shown on the map 1[2], the city is at the foothills of the Baba Mountain with the peak Pelister, (2601m), 13km away from the border with Greece.

Bitola stretches from both sides of the river Dragor. It is surrounded by the Bairo hills on the north as part of the cloud-snow mass with the peak Kale, (890m), to the south it is surrounded by the hill Tumbe cafe, (744m), as a branch of Neolica, i.e. Baba mountain. To the east, Bitola is widely open to the Pelagonia valley, and towards the west, it is open to the floodplains of the river Dragor, the Gavatian overbearing valley and the peak Pelister. The city extends on terrain that is sloped from west to east, from 720m to 585m, with an average attitude of 652m. Regarding the traffic situation, it can be said that the parts of the city are relatively poorly connected. This unfavorable traffic connections are from the previous century, when with the reshaping of the borders, a large number of traffic routes lost their

meaning or completely disappeared. Thus, Bitola gravitational area was reduced and deformed. [5].

The street network of the city (inherited from the past) regarding its width and direction, is a network of the same-looking streets, narrow and crooked, which cannot take in the rapid increase in traffic and its capacity. The street network consists of 13 main roads, 62 collector roads and 270 local roads. Over 90% of the roads can be determined as modernized, being paved with asphalt or stone cube. The number of streets with clearly differentiated pedestrian traffic from the motor traffic is very small. The peripheral streets define the subsequent closure of the urban blocks, forming a monocentric city core. [6]

Map 1. Geomorphological characteristics and transport position of Bitola

The general objective of Municipality of Bitola smart city approach (announced during the visit of the Minister of Internal Affairs), is to make the urban mobility more environmentally sustainable, by means of the wide deployment of video control. With this regard, Municipality of Bitola smart city approach aims at the maximization of a complete ICT based integrated system, able to interact between driver, vehicle, transportation and energy infrastructure as well, taking advantage of the informations provided from these sources, in order to increase citizens' quality of life.

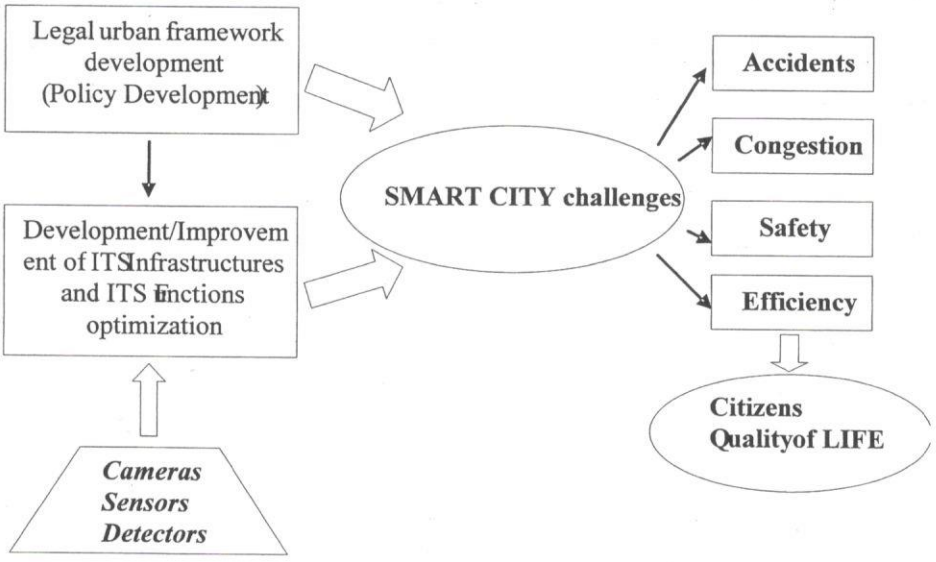

Fig.1 The basic concept of "smart city approach challenges" for the Municipality of Bitola

CONCLUSION

Creation of the traffic – transportation systems in which realization of the smart mobility concept has the key role, is the adequate response to contemporary and future challenges in society development.

Applying of the information and communication technologies, as an essential characteristic of the mentioned concept, enables sustainable, (efficient, economical, environmentally acceptable and safe) traffic – transportation supply, in the era of globalization, urbanization, high level of environmental pollution.

The possibility of real – time data and informations collection, analysis and dissemination, various web technologies, (internet, intranets, extranets), mobile communications, global positioning system, geographic information systems, advanced modelling, form the base for creation and functioning of the elements of sustainable transportation future, (smart traffic – transportation infrastructure, smart cities, green mobility, various forms of intelligent management and control of traffic – transportation flows), through which the smart mobility concept is realized.

In order to improve the overall living conditions of citizens by taking of series of measures for raising the sustainability level in city of Bitola, the smart city approach is recommended. It implies taking into account, besides the global smart city framework, the local surrounding environment in many areas.

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„УМНА МОБИЛНОСТ“ – ОСНОВА ЗА УСТОЙЧИВО РАЗВИТИЕ НА ТРАНСПОРТНАТА СИСТЕМА

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Ключови думи: *информационни и комуникационни технологии в транспорта, умна мобилност, умна транспортна инфраструктура, умни градове.*

Резюме: *“Умната“ мобилност е сложна, дългосрочна концепция за устойчиво развитие на транспортната система. Тя е резултат от хармонизирането между търсенето и предлагането, глобализацията, урбанизацията, необходимостта от опазване на околната среда, безопасност и сигурност. Основно, ролята на умните устройства за планиране на трафика, както и споделеното пътуване, използването на зелени превозни средства, създаването на умни градове, основани на приложението на комуникационни технологии, както и изграждането на модерна транспортна инфраструктура, определят бъдещото развитие на концепцията за устойчиво развитие на транспортната система. Следователно, преобладаващата част от действията за устойчиво развитие ще са свързани с приложението на информационни и комуникационни приложения. Последните, са фундаментален фактор за създаването на „умна“ мобилност, особено когато става дума за нейното внедряване на по-късен етап.*

Приложението на споменатите фактори е насочено към събиране, анализ, и споделяне в реално време на информация, използване на различни видове уеб-приложения, визуализация и анимиране, сателитно наблюдение, географски информационни системи, моделиране, с цел създаване на икономически ефективна, екологична транспортна система, която отговаря на потребностите на ползвателите.