SOME ASPECTS OF SUSTAINABLE URBAN TRANSPORT IN THE CITIES

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Abstract: *A sustainable urban transport system requires strengthening various features of the system including mobility, accessibility, affordability, social equity, efficiency, safety, security, convenience, low carbon, comfort, and people- and environment-friendliness. In order to achieve all these elements, various challenges need to be addressed in an integrated manner. There are various ways to describe an implementation method for sustainable urban transport in a city. Energy efficient, safe transport and sustainable mobility is a cornerstone of a sustainable city. The paper describes the main features of the above elements. A holistic response to urban mobility optimises both supply and demand solutions to facilitate more sustainable outcomes.*

Keywords: *eco-efficiency, safety, urban mobility, sustainable transport.*

INTRODUCTION

Transport plays an important role in the economic development of each country, the development of cities, the mobility of the population, the organization and use of space and the quality of the environment. Traffic and economic development are essentially interconnected, as traffic facilitates, facilitates, and catalyses economic development. [1] The connection between traffic and the environment is paradoxical. On the one hand, traffic activities support the increasing demands of mobility for travelers and goods, especially in urban areas. On the other hand, these activities resulted in increased motorization and traffic congestion. With technologies that are almost entirely based on the use of oil and its derivatives, or with internal combustion engines, the impact of traffic on environmental systems has increased. In recent years, this has reached a point where spatial traffic accumulation is the dominant factor behind the emission of most pollutants and its environmental impacts. [2] The complexity of traffic systems in cities is high. Many cities, in developing countries, are experiencing rapid growth in motorized modes of transport. [3] Today, each city, in accordance with its requirements and possibilities, organizes city traffic, and it is difficult to determine the identity or unification of the world's urban traffic, which greatly complicates more rational planning traffic on a global scale. Urban traffic in modern conditions has everything more complicated transport requirements, and the conditions for its normal development are complicated. The rapid pace of urban development and the complexity of this development lead to many conflicting situations in the city life. For the normal functioning of the city organism, there are growing demands right before traffic. [4] A smart city is an efficient city, a city suitable for a quality life, also an economically, socially and ecologically sustainable city. This vision can be realized today, using innovative operational and information technology, and aligning meaningful and reliable data in

real time, supported by appropriate urban infrastructure. [5]

Energy efficiency, traffic safety and sustainable mobility are the cornerstone of a sustainable city. Urbanization accelerates the pace of life and creates new, more intense pressures on city resources and infrastructure. Energy-efficient, safe and mobile urban traffic are one of the greatest future challenges for cities around the world. In many cities, existing mobility systems are inadequate, and urbanization and population increase will further increase traffic demand in the future. Cities have traditionally sought to address such challenges by adding new capacities to respond to rising traffic demand. However, only the construction of new transport capacities is neither efficient nor sustainable. At the peak of rising traffic demand, mobility needs are changing and evolving, and user expectations are getting bigger. Many new emerging solutions improve service delivery technology and demand management. A holistic response to urban mobility optimizes solutions both for supply and for traffic demand, in order to achieve more sustainable results.

1. TRAFFIC ENERGY EFFICIENCY

The traffic sector is a major energy consumer.[17] It is also imminent that there will be an increase in negative implications, due to increased emissions from the transport sector, and the reduction in the use of fossil fuels in this sector is one of the highest priorities. Without significant changes in development policies, it is foreseen that it will remain (IEA, 2009a). Changes in the number and structure of transport means as well as in fuel quality standards are important factors for the impact of traffic on environmental pollution. The energy efficiency of road transport is determined by three main parameters:

Road traffic energy / consumption = (fuel consumption) x (vehicle movement, km) x (population using vehicles)
where energy efficiency of a vehicle or fuel consumption is determined by technical energy efficiency; movement of the vehicle means the type of journey / drive and the number of kilometers traveled; and the population is determined by the number of vehicles on the road.

It is clear that individual measures do not provide a solution, and that necessary activities are also necessary, which also include: (1) Improvement of vehicle technologies (increasing the energy efficiency of vehicles); (2) Changing the behavior of the driver (to use less fuel on the way); (3) Reduction of traveling distance per vehicle; and (4) More sustainable modes of transport.

The implementation of various measures, in order to achieve energy efficiency, remains a priority goal for all countries. [7] Energy saving is without a doubt the fastest, most efficient and cheapest way to reduce greenhouse gas emissions, as well as to improve air quality in densely populated urban areas (Figure 1). Measures that could be implemented to increase energy efficiency can be classified into three main categories: technical measures, infrastructure measures and organizational and customization measures.
To technical measures fall; encouraging the development of a market for more efficient and environmentally friendly vehicles (hybrids, plug-in hybrids, electric vehicles (EV)), developing a market for more efficient alternative fuels (natural gas, electricity, hydrogen), increasing urban transport efficiency, water and air traffic.

[17] 19% of global final energy consumption in 2007, and it is estimated that in the world there will be an increase in primary oil consumption by 97% between 2007 and 2030.

Infrastructure measures are included; expansion of railway infrastructure and increase of number
buses in public urban transport.
In organizational and customary changes, we include; moving towards more efficient traffic forms and optimizing their participation in total traffic and increasing the factor of occupancy.

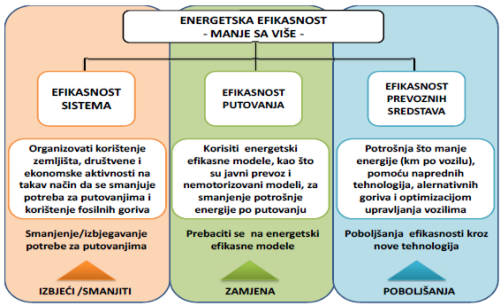

Figure 1. Energy efficiency in traffic

Avoidance-Replacement-Improvement, the most widely accepted approach, to manage traffic demand in modern cities:
1) "**Avoiding / Reducing**". This approach seeks to reduce the need for travel, for example, through online shopping and telecommuting. Good land use planning, focused on the development of compact cities and mixed-use land, contributes to reducing the need for motorized travel and reducing the length of travel required.
2) "**Replacement**". This approach seeks to convince people to distance themselves from their motorized ones means of transport, using public transport and non-motorized forms traffic, which are more efficient, in terms of urban space they occupy, the amount of fuel consumed and the amount of polluting substances they emit. For this purpose, it is necessary to discourage the use of private cars and ownership of them. Some of these measures include: increasing fuel taxes and parking fees, limiting the number of parking spaces available in the city, increasing vehicle registration fees, and even limiting the ability to purchase personal cars.
3) "**Improvement**". This approach seeks to reduce the negative effects that inevitably occur when using motor vehicles. Improving traffic flow, energy efficiency of motor fuel, and the quality of fuel used, help reduce the negative impacts of motorization (Figure 2).

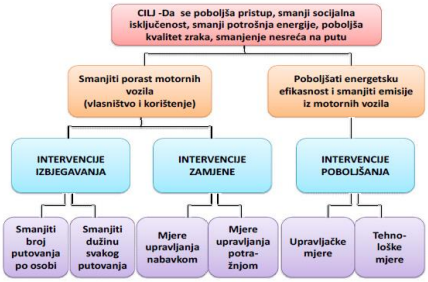

Figure 2. A comprehensive "Avoidance-Replace-Improvement" framework

Considering that traffic systems around the world are very different, it's important to get worse mentioned strategies apply in ways that fully take into account the specificities and major problems in the given regions. Many developing countries rely largely on non-motorized modes of transport, and therefore they have a greater potential for creating a sustainable transport system, unlike developed countries. [8] By adopting "avoid, replace, and improve" strategies, adequate investment in research, development, production and management is required in: (1) Infrastructure, such as bus and railways, bicycle paths and park-and-ride facilities; (2) Ecological vehicles and environmental transport models (including bicycles, public transport vehicles and low emission vehicles); (3) Fuel cleaning; (4) Telecommunications technologies; (5) Green Transport Support Technologies (GPS systems, Intelligent Transport Systems, Green Logistics, etc.).

3. SECURITY OF TRAFFIC

"Traffic systems should be such that they keep us moving, but they must be so designed to protect us in every step we take."

Traffic safety appears as one of the most important goals, not just the traffic policy, but also the entire society, because parallel to the growth of motorization development, there is a continuous decline in traffic safety.[18] The importance of focusing on traffic safety has contributed to the definition of the Decade 2011-2020 as a "Decade of Traffic Safety Action" by the World Health Organization. [9] Investing in road safety leads to economic savings, while protecting the current number of inhabitants of one country and its future generations. Priority road safety provision should not be equated with creating additional burdens for road users, which, for example, are linked to the implementation of new or more stringent traffic regulations, such as speed limits or the mandatory use of the belt. Securing road safety means a greater evaluation of human life and respect for others in the community we share. [10]

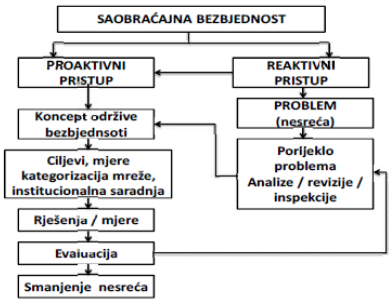

Figure 3. Proactive and reactive approach to improving road safety through road design

The traditional (reactive) response to road safety referred to: (1) identification of the danger and its ranking for treatment / treatment; (2) diagnosis of the problem and the way to resolve; and (3) "drug / activity" to address the safety problem. This was an effective strategy where it was applied, but not long-term sustainability. An integrated (holistic) approach is the engineering security of the system, based on proactive activities. It implies the removal of all road safety risks, but during their design (in the land use planning phase) and passenger transport. It is achieved through the use of empirical predictive tools that quantify the level of safety on roads for each project. This approach allows for permanent, sustainable solutions for safer roads and the community itself and ensures sustainable security (Figure 3).

2.1. Sustainable traffic safety

Sustainable safety aims to prevent all mistakes and acts as much as possible, or to mitigate their consequences for the health and safety of all traffic participants, designing traffic systems to the extent of man. For this purpose, it is important to consider the system of people / vehicles / infrastructure as a complete system. Interactions between users and physical elements are a critical point (Table 1).

Table 1. Interactions between three factors (people, vehicles and infrastructure)

FAZE		LJUDI	VOZILA I OPREEMA	INFRASTRUKTURA
Prije nesreće	Prevencija udesa	Informacije Stavovi Policijske akcije	Tehnička ispravnost Svjetla Kočnice Rukovanje i upravljanje Brzina	Dizajn i raspored cesta Ograničenja brzine vozila
U toku nesreće	Prevencija povreda za vrijeme udesa	Primjena ograničenja	Pojasevi Nasloni Ostali sigurnosni uređaji Crash-zaštitna konstrukcija	Zaštitni objekti na cestama
Nakon nesreće	Održavanje na životu	Vještina pružanja prve pomoći Pristup medicinara	Jednostavnost pristupa Opasnosti od požara	Objekti za zaštitu

The table (above) shows the interaction between three factors (people, vehicles and infrastructure) during the three stages of the collision: before, during, and after the impact.

Vehicles. Modern vehicles are much safer than older models. Today, manufacturers agree that it will take a long time to develop future technological discoveries, with the aim of improving security improvements. Technical safety standards and annual

[18] In fact, injuries in road traffic are the leading cause of mortality among people aged 15-29 (traffic accidents kill more young people than HIV / AIDS). In addition, nearly half of those killed in road accidents are pedestrians, bikers, public transport passengers and motorcyclists.

vehicle testing are mandatory in highly developed countries.

Road infrastructure. The road infrastructure observed as a whole is an important factor in traffic safety. Roads should be designed to minimize the consequences of human error. It has been proven that some not so expensive improvement of road infrastructure, can significantly reduce the occurrence of traffic accidents and reduce their weight.

Examples of improvements include the separation of different types of traffic, better road markings and road signs, safer pedestrian and two-way tracks, the construction of sidewalks and more visible pedestrian crossings, as well as the speed of traffic. On already existing roads, these improvements should primarily be in high-risk areas, especially at entry and exit from inhabited areas and in areas of high activity (such as markets and schools).

Human behavior. The behavior of traffic participants is, in fact, the main cause of traffic accidents, injuries and mortality. Among the many risk factors that increase the severity of injuries, the four most common ones are: beltlessness, wear of protective helmets, inappropriate driving speed and driving under the influence of alcohol.

The government of each country is ultimately responsible for the security of the country and should take a leading role in improving road safety. Only the Government can develop and implement policies and laws related to road safety, by providing the available resources needed for long-term improvements, ensuring that traffic laws are consistently implemented, organizing national information campaigns, introducing road safety in the school curriculum, setting standards to train drivers, but also to ensure that the road network is properly planned and maintained (Figure 4)

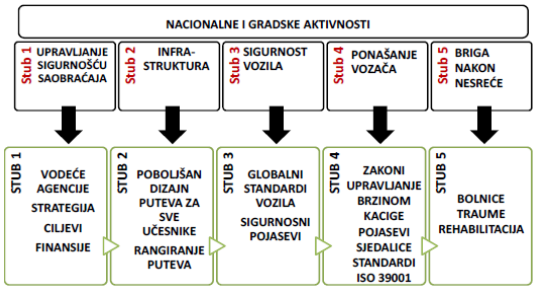

Figure 4. Strategy for sustainable urban traffic safety

The structure of local road safety can be crucial in achieving the national transport safety policy applied at the local level.

3. SUSTAINABLE MOBILITY

"If you are planning towns for cars and traffic, you will also get cars and traffic. If you are planning for people and places, you will get people and places." Fred Kent

Today's living conditions require the daily space and time distribution of the population, which creates traffic demand. Increased traffic demand, especially in peak periods, can be solved by traffic management strategies. In the city, high quality mobility is a necessity for the success of other urban sectors and for job creation and plays a key role in creating an attractive environment for residents and business. However, mobility is widely cited as one of the most difficult and universal challenges in cities around the world. [5] Sustainable mobility is the ability to satisfy the needs of society to move freely, to make society free access to content, to communicate, to trade and establish relationships without sacrificing other important human or environmental values, today or in the future. Mobility is vital to the internal market and to the quality of life of citizens, as they need to enjoy the freedom of travel. [11]

The sustainable urban mobility plan is a more efficient way of solving traffic problems in urban areas. The goal of the Sustainable Urban Mobility Plan is to create a sustainable transport system that: ensures the availability of jobs and services to everyone, improves security and protection, reduces pollution, greenhouse gas emissions and energy consumption, increases efficiency and economy in the transport of people and goods, increases attractiveness and quality urban ambience. A smart mobility system requires the integration of various structures: physical infrastructure, operational technology and communication and information technology. Without any of the components of this system, smart mobility products can not fulfill their full potential for managing operational efficiency and customer demand. The coordination of activities and integration between the different layers in the structure will enable improvement operational efficiency. A smart mobility system can be conceived as the number of "layers", each of which depends on and adds value to the layers below and above itself (Figure 5).

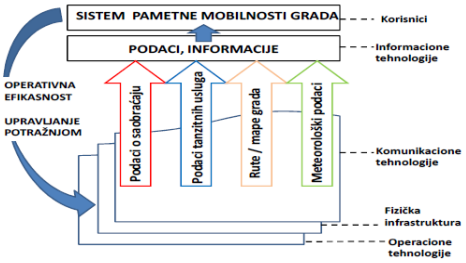

Figure 5. Structure of the "smart mobility" system

Users, passengers, operators and planners. It is primarily necessary to establish clear strategies for the management of urban transport logistics at the national and local levels. These strategies need to set clear goals and measures to be implemented. Implementation must be regularly monitored and plans must be periodically revised. In order to provide reliable support at local level, it is necessary to understand the contribution of city transport logistics to the economy to a deeper and clearer understanding. In order to improve urban logistics in the long run, it is necessary to better define, collect data, monitor and evaluate.

Urban planning is essential for the management and regulation of spatial organization of cities in order to achieve an efficient distribution of urban infrastructure and modern land use needs.
There are four key advantages that are available as the main potential of the mobility mobility mobility teams:
· Travelers. Better travel experience in urban areas and improved travel reliability, reduced time and travel costs, creating a more humane city for life.
· Transport operators. Balancing supply and demand in order to ensure improved functionality, more efficient use of transport resources, promotion of alternative ways of traveling, safe and environmentally sustainable outcome for urban transport systems.
· Urbanists. Improving the planning of future transport infrastructure and providing services based on actual data on passenger demand and behavior.
· City authorities. Generating economic growth and development of the economic sector based on technology, data and information.

Together, all these benefits contribute to the improvement of the urban sustainability agenda, on the principles of functionality, ecology, humanity, politics and economics.

Mobility, urban form and physical infrastructure. The shape and functionality of the city is crucial for the promotion of sustainable mobility. The larger the city, the greater its complexity and the potential to influence the future traffic situation. Larger cities have significantly higher average urban density

than smaller cities, and thus greater traffic density (eg, a larger number of vehicles traveling on roads per square kilometer). Physical infrastructure of urban mobility; roads, railways, bicycle paths, other trails and other physical means that enable the transport of passengers and goods. Data and information that supports smart mobility are continuously generated in dynamic patterns of human behavior, in ways that people move through the city and how they use the available infrastructure. Each city develops its unique spatial structure and traffic system in a way that enables easier access to people, goods and information. Today, urban agglomeration can be based on many possible combinations of traffic and urban forms, providing different levels of access. [12] The best world experiences show that it is better integrated to manage measures and packages that include: (1) walking, (2) cycling, (3) public transportation, (4) individual car + freight and (5) planning.

Urban mobility and IT architecture. An integrated urban environment for cities is a good opportunity to develop platforms that provide services to citizens, transport agencies and private sector actors. As cities are rapidly changing and growing, and requirements for efficient traffic flows and service information are also changing rapidly.

Globalization is accelerating this trend. Intelligent business models will, in whole or in part, automate smart transport processes (such as detecting when a car enters the collection area, collecting fees, managing customer requirements), resulting in a reduced need for operators. To achieve this, most processes need to be well defined, simplified and standardized, before it is automated. In principle, there are three limiting factors for adopting new IT applications in the urban transport system, namely: (1) high costs for users in relation to perceived benefits, with costs that increase for users, if more than one layer in the system is involved, including fixed infrastructure, (2) technological complexity, and (3) various legal issues , which have not been sufficiently resolved.

Communication technologies. Wi-Fi, 3G, 4G and Bluetooth channels are essential for real-time communication, based on accurate data at the site of the Internet of Things, and between human operators, data processors, and user information.

Operational technologists. Operational technologies generate raw materials needed for smart solutions: data. They allow; real-time data collection, data exchange between physical infrastructure and services, and rapid adjustment of management infrastructure, to create additional capacities where needed at a given moment. Such technologies have already been installed in many cities to directly coordinate and maintain traffic flows with passenger requirements, thereby contributing to increased operational efficiency on the network.

4. CONCLUSION

Cities should be designed so that they can adequately meet the daily needs of citizens and respond to peoples' demands in the peak period, not only in the transport sector, but also in the energy sector, water sector, public services, the construction sector and IT services. Each of these systems, today, faces similar challenges in balancing peak demand and constraints, or a sustainable level of supply. Densely populated urban areas require connection with world markets, and also the need for reliable transport goes far and away to rural areas. Sustainable and affordable traffic solutions provide vital access to markets, employment opportunities, education and health services. A sustainable balance between the needs of society, businesses

and the environment is best achieved through comprehensive institutional planning policies. In the world of rapid changes, traffic energy efficiency, traffic safety and urban mobility are the key to sustainable development. Sustainable traffic solutions can transform cities into places that enable a healthy life, research and innovation development, and more efficient production. The future belongs to efficient and innovative policies and technologies that can significantly and automatically change consumer behavior.

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