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8. SMART CITY INNOVATION: URBAN TRANSPORT AND STRUCTURE ELEMENTS

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8.1. The Concept of Sustainable Urban Mobilit'ies and Their Practically Applied Outcomes

8.1.1. Peculiar SUMP

A Sustainable Urban Mobility Plan (hereafter SUMP) is a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life for inhabitants living in urban and suburban areas. The purpose of SUMP is comprised of five following principles:

- Ensurance to all citizens to offer transport options to key destinations within urban and suburban areas;
- Improvement of safety and security of public and freight transportation systems;
- Reduction of air and noise pollution, greenhouse gas emissions and energy (fuel) consumption;
- Improvement of the efficiency and cost-effectiveness in transportation of persons and goods;
- Contribution to enhancing the attractiveness and quality of the urban environment for urban and suburban inhabitants;
- Ensurance of diversified modes for urban daily mobility needs based on principles of sustainability.

The SUMPs tackles transport-related problems in urban areas more efficiently. Thereon it is considered a result of a structured process, which comprises the status analysis, urban and transport planning policy and selection of the measures, active communication, monitoring and evaluation, identification of learnt lessons. The basic characteristics of the SUMPs are distinguished as following:

- Long-term vision and clear implementation plan;
- Participatory approach of local inhabitants (social groups), stakeholders, urban planners, transport companies, private companies, port authorities, research institutes etc.;
- Balanced and integrated development of all transport modes (public transport, cycling, combined, alternative etc.);
- Horizontal and vertical integration of different communication levels between institutions, social groups;
- Assessment of current and future performance of traffic flows and mobility of passengers as well as pedestrians;
- Regular monitoring, review and reporting;
- Consideration of external costs for all transport modes.

The SUMPs are based on a long-term vision for transport and mobility development for the entire urban area (town, city, agglomeration) which covers all modes and forms of transport: public and private, passenger and freight, motorized and non-motorized, moving and parking etc. The SUMPs focus on people and meeting their basic daily mobility needs. It follows a transparent and participatory approach, which brings citizens and other stakeholders on board from the outset and throughout the plan development and implementation process. Participatory planning is a prerequisite for local inhabitants and stakeholders to approach, i.e. social awareness and acceptance on implementation of SUMP and its relevant policy. In this issue, the SUMP fosters a balanced development of all relevant transport modes, while encouraging a shift towards more sustainable modes. The following topics are typically addressed to public transport, non-motorized transport (walking and cycling), intermodality and door-to-door mobility, urban road safety, flowing and stationary road transport, urban logistics, mobility management, and smart transport systems (STS). The development and implementation of SUMP follows an integrated approach with high level of cooperation and consultation between the different levels of government and relevant authorities. The SUMP also identifies specific performance objectives, which are realistic in view of the current situation in urban and suburban areas and it sets measurable targets. These targets are being measured in the framework of indicators.

Table 8.1 presents in a simplified manner some of the main differences between traditional transport planning and sustainable urban mobility planning.

TABLE 8.1. Comparison of aspects of traditional transport planning and sustainable urban mobility planning (Source: authors' systematized material, 2020)

Traditional Transport Planning	Sustainable Urban Mobility Planning
Focus on traffic	Focus on inhabitants
Primary objectives: traffic flow capacity and speed	Primary objectives: Accessibility and quality of life, as well as sustainability, economic viability, social equity, health and environmental quality
Modal-focused	Balanced development of all relevant transport modes and their shifts towards cleaner and more sustainable transport modes
Infrastructure focus	Integrated set of actions to achieve cost-effective solutions
Sectorial planning document	Sectorial planning document that is related to policy areas (such as land use and spatial planning; social services, etc.)
Short and medium-term delivery plan	Short and medium-term delivery plan embedded in a long-term vision and strategy
Related to an administrative area	Related to a functioning area based on travel-to-work patterns
Domain of traffic engineers	Interdisciplinary planning teams
Planning by experts	Planning with the involvement of stakeholders using a transparent and participatory approach
Limited impact assessment	Regular monitoring and evaluation of impacts to inform a structured learning and improvement process

Hence the need for detail sustainable and integrative planning, it deals with the complexity of urban mobility, which has been recognized since 2013. Due to the willingness of municipal authorities to adopt new modes of transport, e.g. electro bikes, shared bikes, combined modes (by private cars and by public transport alike), and thus comprising 8 basic principles of sustainable mobility to be implemented in urban and suburban areas:

- Prepared, adjusted and approved SUMP for the relevant urban area (possibly involving and suburban areas);
- Definition of a long-term vision and a clear implementation of plan;
- Ensured cooperation between different institutions;
- Development of all transport modes in an integrated manner;
- Involvement of citizens (different social groups) and stakeholders;
- Arrangement for monitoring and evaluation;
- Assessment of current and future performance;
- Quality assurance.

In fact, a good planning of the SUMP helps to select and plan the right measures, which implement the basic principles of sustainable urban mobility.

The European Commission strongly recommends that European towns and cities of all sizes should implement the concept of SUMP. These can improve the quality of life for inhabitants by addressing major challenges such as congestion, air/noise pollution, climate change, road accidents, unsightly on-street parking and the integration of new mobility services. Congestion in cities is a major source of delay for commuters and inhabitants. It also increases air pollution and affects the air quality in urban and suburban areas (Green Transportation …, 2016). The planning of freight transport movement using smart IT decisions has become essential, recently. Hence, there many different inventions and innovative solutions based on IT technologies and smart soft-ware are being implemented such as:

- Distribution of freight using e-cargobikes within the area of inner cities;
- Assurance of smart traffic management process;
- Smart mobility solutions;
- E-car-sharing pool;
- Promote shared use of electric cars and reduce number of parking spaces;
- E-cargobike pool;
- Promote shared use of e-cargobikes by residents;
- Mobility stations for multiple travel alternatives;
- Car-sharing to expand range of car;
- Bike-sharing alternatives;
- Bike-storage constructions;
- Smart taxi stand system;
- Prioritization of public transport on the lane giving sign aged priority for public transport;
- Creation of the „Green corridors" for freight and public transport by management of smart traffic lights (Fig. 8.1).

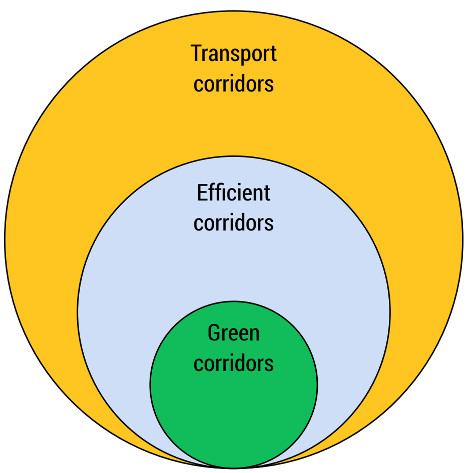

FIG. 8.1. **The structural place of Green corridor within the structure of transport corridors (Source: G. Panagakos, H. Psaraftis, 2012)**

In urban areas the Green green corridor concept was introduced in 2007 by the Freight Transport Logistics Action Plan of the European Commission (European Commssion, 2007). According to this document the following principles are distinguished:

- Green transport corridors are marked by a concentration of freight traffic between major hubs and the logistics centres, port areas, industrial areas;
- Flows of public transport and freight are being encouraged along Green corridors to rely on smart technology related to regulation of traffic lights in order to reduce the cross-urban travel time;
- Green transport corridor also can be used for trans-shipment facilities and supply of goods and materials;
- Green corridors could be used to experiment with environmentally-friendly, innovative transport units, and with advanced Smart Transport Systems (ITS) applications in urban areas in particular (Faste´n & Clemedtson, 2012).

Also, the Green corridor aims at reducing environmental and climate impact such as:

- Implementation of sustainable logistics solutions with documented reductions of CO_2 emissions;
- Implementation of logistics concepts with optimal utilization of all transport modes called intermodality;
- Creation of platform for development and demonstration of innovative logistics solutions, including IT based smart technologies.

Herein, it is possible to distinguish two definitions of Green corridor:

- A corridor which is economically efficient and environmentally sustainable;
- A corridor which takes a central position in transportation of freight and passengers by public transport.

A holistic policy approach is needed to deliver on wider sustainable development objectives. Thus, the public awareness and acceptance in behavior of daily mobility are very important social factors. Society (as local inhabitants, social groups) plays an important role in the process of the implementation of sustainable urban mobility principles. Social behavior is a key determinant in assurance of sustainable mobility processes. Addressing a broader range of policy objectives can help forming consensus among key political and societal actors.

8.1.2. Implementation of Sustainable Urban Mobility Principles: a Case of Klaipeda City

Adapting good practices in SUMP was designed to support the SUMP preparation process by collecting and presenting experiences of other European countries and other interested bodies, on purpose to promote public awareness about different mobility patterns. Adapting good practices in SUMP is a complex process, which has to be implemented in the application of an interdisciplinary approach, involving cooperative activities between different municipal and public institutions, active social groups and stakeholders as well. For Klaipeda city, the structural share of modal split of mobility foreseen until 2030 means as follows: 35 percent of population use public transport, 33 percent – walking, 25 percent use private cars, 7 percent – cycling. During the period of 2017–2020 shifts of modal split are moving towards the planned structure with some exceptions. These exceptions depend on the behavior of different social groups, weather conditions in autumn and winter, the reconstruction of infrastructure, when due to different individual obstacles the preferences, are given more to private cars and less to alternative means and public transport. This is the most important issue of public awareness and acceptance (Table 8.2).

TABLE 8.2. Summary of the main impact results of SUMP implementation in Klaipeda city (Source: authors' s research material, 2020)

Sustainable mobility principle	**Indicator**	**Results**		
		Indicator mean before, % 2017	**Indicator mean after, % 2020**	**Impact as change, %**
Shape more integrated transport infrastructure and mobility systems	Dynamics of modal split: Public transport Walking Private cars Cycling Combined Other alternatives N=258	 22,9 11,7 45,7 9,1 10,1 0,5	 20,5 11,8 51,2 2,8 11,5 2,5	 –2,4 +0,1 + 5,5 – 6,3* +1,4 +2,0
Public awareness and acceptance of SUMP implementation	Awareness level Acceptance level 1–5 (low-high) N=258	2,82 4,32	3,0 4,44	+0,18 +0,01
Improve efficiency of urban and freight transport	Increased time accuracy of public transport during the rush hours Decreased cross-urban travel time for freight	76,0 –5,0	88,0 –8,0	+12,0 (+1,5 min) –13,0 (–2,0 min)

*Due to changed habits in usage of public transport, affected by Covid-19 pandemic.

**Due to increased popularity of electro bikes as opposite to cycling.

During the period of 2017–2020 4 units of smart traffic lights installed (out of 21 planned until 2021) for creation of the Green corridor along the port‘s zone, and CO_2 emissions decreased along the port‘s zone up to –7,5 percent. Due to developed bike-sharing service by public enterprise CityBee, local inhabitants started to use the bike-sharing system as newly a developed system for daily mobility purposes and as an alternative to private cars in particular for shorter distances of daily commuting. In addition the bike-storage system started to develop by constructing units of bike-sheds related to smart technologies of their usage. The brand new bike-sheds installed in a proximity to public schools and in densely populated residential districts, where socially active local communities are active with a higher level of social responsibility towards the implementation of SUMP‘s principles. Hence the public awareness and acceptance on implementation of sustainable urban mobility principles changed positively since the SUMP started to be implemented. Social advertisement of the SUMP among different social groups gave the outputs in better social understanding of the SUMP’s importance in the processes of daily urban mobility. Supporting activities are very significant in the beginning of SUMP principles implementation in order to approach public attention, which is important in public awareness and acceptance while SUMP was under the first stages of implementation. Supporting activities were applied in the form of scientific and practical events, a public presentation of conducted urban study on daily mobility in the city for different social groups in Klaipeda.

The implementation of a traffic management system for the creation of a Green corridor in relation to the prioritisation of public transport. These two actions are considered as technical ones with IT based technologies and related to the creation of a traffic management a data system as data server and installation of smart traffic lights. The system of smart traffic lights related to traffic data created a Green corridor for the movement of freight and prioritisation of public transport in Klaipeda. After the implementation of sustainable mobility principles, the following drivers were distinguished and summoned:

Strategic: implementation of SUMP regarded by the administration of the Klaipeda municipality. The implementation process has political support due to the expectation that good practices of SUMP will be applied to the city.

Planning: the strategic planning of SUMP and its practical application match the objective to implement the principles of sustainable movement in order to reduce the use of private cars and increase the use of public transport facilities in the city. These planning objectives are highly supported by the central government of the Republic of Lithuania.

Sustainable development: the implementation of the principles of sustainability in the development of the systems of transport and communication is a priority in a national document of “White Book on Regional Development in Lithuania”. This priority was approved in October2017 on a national level.

Publicity: the inhabitants of the city and its suburban areas acquired knowledge on the significance of sustainable mobility principles in daily mobility, which affected a raised public awareness and acceptance of sustainable urban mobility principles.

Institutional: a cooperation between different institutions leads towards a better inter-institutional dialogue for discussion on the implementation of sustainable mobility principles in the city, also taking in account cooperation between the city and the port.

8.1.3. Conclusions

During the period of 2017–2020 the following key impact findings were detected on:

1. The dynamics of the modal split is moving towards the planned structure of modal split in SUMP with some exceptions. These exceptions depend on the behavior of different social groups, weather conditions in autumn and winter, the reconstruction of infrastructure, when due to different individual obstacles, the preferences are given more to private cars and less to alternative means and public transport;
2. The public awareness and acceptance on implementation of sustainable urban mobility principles changed positively since the SUMP started to be implemented;
3. Social advertisement of the SUMP among different social groups output in better social understanding of the SUMP's importance in the processes of daily urban mobility;
4. Supporting activities are very significant in the beginning of SUMP principles implementation in order to approach public attention. Supporting activities were applied in the form of scientific and practical events, such as the public presentation of a conducted urban study on daily mobility in the city;
5. Locals introduced to different scenarios on sustainable urban mobility models, focused on the meanings of improvement of pavements and roadways in the city. It helped to find out the opinion of inhabitants, stakeholders about current mobility situation in order to improve urban environment for pedestrians and cyclists;
6. Development of a Green corridor for freight movement in relation of prioritization of public transport, both are considered as technically and IT based actions for efficient regulation of freight and public transport traffic in order to decrease cross-urban time of freight movement, increased time accuracy of scheduled public transport commuting, decreased CO_2 emissions in the city, i.e. in areas of city and port interaction.
7. Cooperation platform between the city and port authorities is also considered as a focal point which plays a significant role to assure the sustainable urban mobility principles in Klaipeda.

8.2. Smart city innovation: structure elements

Klaipeda Seaport operating in Lithuania is one of the most important transport logistics centers in the country. The importance of logistics centers in the state and Klaipeda has a significant impact on the country's economy (Fig. 8.2).

FIG. 8.2. Picture BLC logictics center (Source: own elaboration, 2019)

All logistics transport centers were built using a variety of construction technologies or construction materials. Smart construction is an information modeling of buildings, it is better known as three-dimensional construction, i.e. BIM – building information model. The 3D model includes all the information about the building. The model covers the entire life cycle and the entire process during which a building is designed, built and even maintained. All data is digitized and available to different professionals (WEB-1).

8.2.1. Smart materials

The most popular building material used in the construction industry is concrete, which at first glance is relatively friendly to human and the environment. The production process of structures made of concrete and reinforced concrete elements uses chemicals which improve properties of concrete material. Many unique concrete production technologies have been developed that, at first glance, give concrete "magical powers".

Electrically conductive concrete is used for structures operated in cold climates, generally for roads and bridge pavements. Concrete is heated through electrically conductive fillers in it, preventing the formation of an ice layer on the surface and making pavements user-friendly.

Carbon concrete (Furuya, 2000) is the new composite material, which has the potential to revolutionize the entire architecture. The high-performance material is a combination of concrete and carbon fibers. It has more strength, durability and lightness than conventional concrete.

Load-bearing wood concrete. A further innovation in the field of concrete production was recently presented by researchers of the Swiss research program "Resource Wood" (NRP 66), who were using the innovative, sustainable building material "Wood Concrete". The gravel and sand content is replaced by finely ground wood, i.e. sawdust is mixed into the cement instead of fine aggregate. In some mixtures, sawdust has a proportion of more than 50 percent by volume. This makes concrete significantly lighter than conventional concrete.

Self-healing concrete (WEB-2) was created byDutch civil engineer, Dr. Schlangen at Delft University (WEB-3). In presentation, he demonstrated the effectiveness of the material by breaking it in two pieces, then putting them back together, and heating concrete in the microwave oven. Once the melted material cools down, element becomes solid. This method requires heating the concrete construction.

Construction material – Luminous cement. The construction industry is evolving and one of the main trends is to move towards more resource and energy efficiency ways of creating and manufacturing structures. Therefore, the application of the cement acting as a 'light bulb' is very broad. We can use it in swimming pools, parking lots, road safety signs and in many other situations.

8.2.2. Tilt-up method

The Tilt-Up construction technology is a method whereby building elements (walls, columns) are formed on a construction site, then lifted and placed in the design position by the crane (WEB-4) (Fig. 8.3).

The method is a cost-effective and have a shorter completion time. Tilt-up construction technology is a common method usedthroughout North America. However, it is not very popular in Europe. Concrete elements can also be formed at factories. Tilt-up differs from prefabricated or formwork cast constructions, because all elements are constructed on the job site. This eliminates the size limitation imposed by transporting elements from the factory to a construction site.

The chronological steps that need to be taken for a tilt-up project are: site evaluation, engineering, footings and floor slabs, forming tilt-up panels, reinforcement placement, embeds and inserts, concrete pouring, panel erection and finishing (WEB-4) (Fig. 8.3, Fig. 8.4).

FIG. 8.2. Tilt-up panel (Source: own elaboration, 2018)

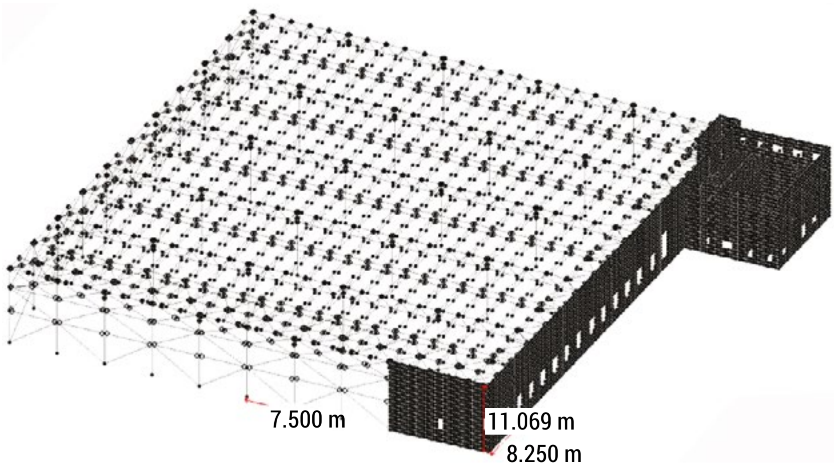

FIG. 8.3. Analytical model of wearhouse (Source: own elaboration, 2019)

This method of construction technology requires the installation of a reinforced concrete slab in the construction site for the formwork of elements. If there is no possibility or enough space, then the building floor is installed. Once the formwork has been done, all the necessary inserts (for lifting, supporting, trusses, etc.) are put together and filled with the concrete. When the concrete reaches required strength, element is placed in the design position with the crane. After that, panels are temporarily braced, until they are joined to other supporting structures (roof, floor) (WEB-5). The Tilt-Up construction technology is mostly used for the construction of low-rise storage buildings (Fig. 8.5).

FIG. 8.4. Tilted Tilt-up panels in Stariskes str 9, Laistai (Source: own elaboration, 2019)

8.2.3. Conclusions

1. The rapid emergence of logistics centers and the continuous development of the existing ones is one of the signs that a favorable environment has been created for logistics processes in the Klaipeda Region.
2. The smart technologies and materials used in the development of Klaipeda logistics centers are successfully applied and operated. According to the initial characteristics of operation, all quality requirements have been met, and in general, we can state that the objects created with materials will be of high quality and long-lasting.

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