

"Mobility game": interactive technology for urban planning education

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Abstract. Modern trends in the development of urban planning education dictate the need to implement new innovative technologies for comprehension of urban processes. The idea «from Smart Cities to Smart Territories» determines the current interest for the introduction of software systems that allow students creating and studying a smart urban environment. The article is devoted to the introduction of interactive technologies to improve the quality of the educational process in the field of urban planning. The relevance of the topic is due to modern trends in the digitalization of the urban environment. The purpose of the study is to determine the role and importance of interactive technologies in the formation of professional competencies of students in the planning and design of a smart city and its transport system. There is the analysis of possibilities of the software complex "Mobility game". This interactive game allows creating a city and developing its transport infrastructure based on specific quantitative and qualitative parameters of development of the road network, the composition of the transport system and the mobility of the population. The software package takes into account modern trends in the development of smart urban transport, such as changes in the composition of the traffic flow, increasing the number of micro-cars and passenger transport, the rapid development of information technologies for travel support, and allows students visually exploring the interaction and mutual influence of various parameters in practical classes. The application spectrum of this software is broad. In addition to communicating essential relationships between urban development issues and the necessary transport infrastructure in education contexts, local planning situations can also be modelled using defined scenarios. The implementation of interactive technologies is a proven scientific and practice-oriented tool for this purpose.

1. Introduction

Urban digitalization project «Smart City» issued by the Ministry of Construction of the Russian Federation emphasizes the need to introduce new technologies in the urban environment.

The relevant most pressing issue is securing a correct apply of the new smart city approaches to ensure sustainable urban development.

In current city planning, this topic is of vital interest, since the urban areas and urban processes are among the most actual fields for modern technologies introduction.

The idea «from Smart Cities to Smart Territories» emphasizes the need to develop scientific and methodological approaches to creation of sustainable smart territories [1, 2].



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Complex process of Smart Territories development starts at the stage of professional education required for training of future urban planning specialists able to assume professional responsibility for decision-making [3, 4,5]. The question is, how to provide future specialists with a comprehensive understanding of the reciprocal relationship between urban processes and the urban environment development, and what consequences will follow their decisions.

The effects of increased urbanization give acute and urgent priority to the issues of sustainable development of functional zones and transport infrastructure of the city.

A variety of existing forms of development, high requirements for the quality of urban environment, the need to organize such transportation system that meets the transport demand of the population — a comprehensive solution to these issue require understanding the interactions between many factors [6, 7].

Learning smart cities requires a complex, multi-methodological approach to educational process due to Interdisciplinary character of the topic and a large number of mutually affecting city formation factors and parameters.

The analysis of today's international and domestic experience allows identifying the following teaching approaches to professional education:

1. The traditional discipline-oriented approach is based on teaching within specific disciplines focused on a single subject such as, for example, transport services or district layout. As a result, students acquire universal **entry level** urban planners' competencies that include the related knowledge, skills, and job ability [8];
2. The problem-oriented approach involves the identification and detail working through a problem in order to develop an effective method to solve it, based on the available data and the prerequisites for the development of territories. As a result, students receive **entry and basic level** professional competencies [9].
3. The practice-oriented approach means active participation and interaction of the students in learning process and the engagement of the students in case studies of urban environment, which allow students to build professional **key level** competences [10].

To obtain better results of practical and problem-oriented approaches it is to provide wider use of new educational technologies which provide opportunities to collect sufficient data and tools to complex urban problems solving. The international experience shows that such new educational technologies have digital nature:

- technologies related to data acquisition, analysis and management (Big data) [11,12,13];
- Innovative virtual reality technologies that allow visualization city environment solutions [14];
- Information modelling of urban territories, infrastructures and the whole process of urban planning [15, 16].

Thus, the study puts forward a hypothesis that the use of software package having combined capabilities of the listed digital technologies in the educational process, allows reaching a qualitatively new level of professional education in the field of urban planning of smart cities.

Thus, the aim of this article is to understand the functionality of software developed at the University of Bauhaus, Weimar. The software package is an interactive “serious” game genre intended to educate and encourage students' independent thinking and skills in creating a city and local transport system, improving transport planning and managing the population mobility to providing more favorable living environment and conditions to the population [17].

2. Materials and methods

The main advantage of the Mobility game is that it can teach students the knowledge of formation of urbanized environment in a visual and simple way, creating a realistic picture of urban development (Figure 1). More than that, the program provides the ability to teach the parameters changing patterns

of urban processes, associated with the growth of territories urbanization and population mobility, in 2-D and 3-D format representation. Program structure is formed by 5 subsystems having interrelated parameters, so that changes of the value of the parameter can affect the others (Figure 2).



Figure 1. Interface of «Mobility game» (source: Glamus GmbH, Bonn)

City traffic. The program provides possibility to design a street-road network according to specified parameters, density and form of development in the territory. For a proper simulation, it is necessary to set the parameters of traffic flow, presence and frequency of passenger movement. Important is the ability to regulate population mobility on various modes of transport and passengers' distribution between individual passenger modes.

Traffic control. The program allows modeling various example scenarios to study different traffic situations and make decisions on the organisation of vehicle and pedestrian traffic. Using evaluation results, the best transport alternative corresponding to the needs of the population in a specific urban situation is selected. The success criteria for the design is based on the total mileage of the vehicle within the city territory.

Also, the program provides the ability to control access to the road network by building Park and Ride facilities.

Pricing strategy. The program allows studying pricing and understanding the problem of pricing strategy by simulation setting price costs for population traffic and use of infrastructural objects. Since the ratio of trip cost by private and public transport is one of the most effective factors to regulate transport demand on various transport services, then the experience gives a student the opportunity to explore the level of its influence.

Infrastructure. The program offers different kinds of city infrastructure: residential areas, public and business areas, recreational areas, connecting linear objects of transport infrastructure — there is plenty of opportunity for various combinations of transport and planning decisions of cities of different size and planning structure. In addition, a student is given the opportunity to propose design schemes for the improvement of road network and traffic conditions aiming to obtain the most sustainable decision.

A new mobility concept is the basis for distribution and composition of traffic. The program takes into account today's trend for small vehicles (micro cars) priority in traffic flow as well as focus on the development of passenger modes of transport.

3. Research results

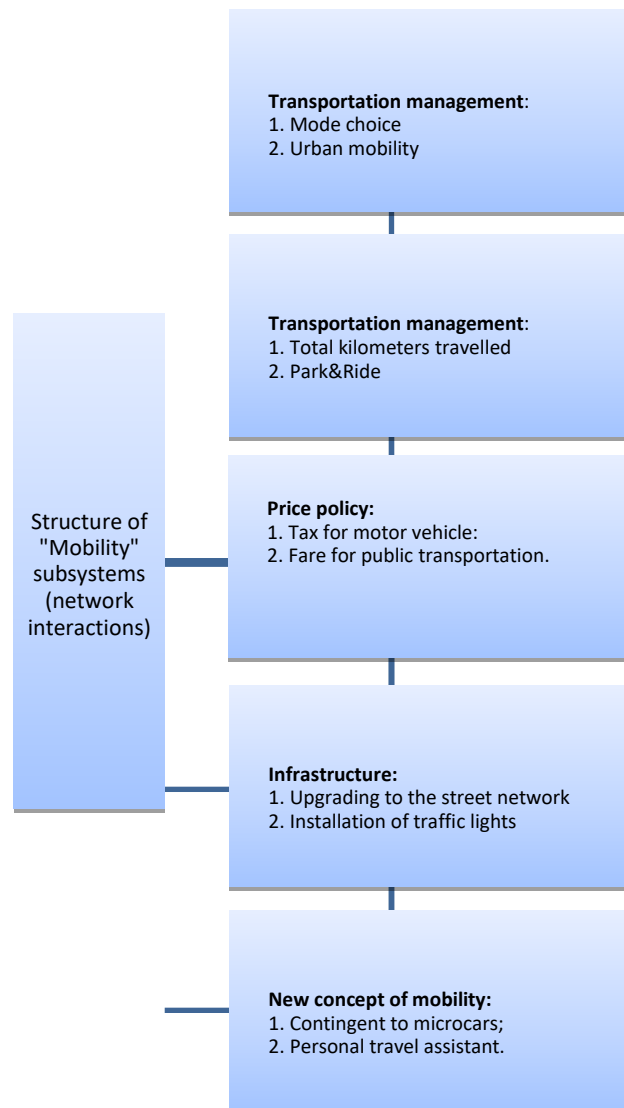


Figure 2. Structure of "Mobility" subsystems

The Mobility game software package has been used in European educational programs since the 2000s and has been introduced in more than 10 countries.

In 2019, within the framework of cooperation between MGSU (NRU) and Bauhaus-Universität Weimar, this software package was tested in educational process of urban planning.

The software package is applied in a practice-oriented approach, when students have the opportunity to experience knowledge of urban processes, mutual influence of various urban, transport, social, economic factors, determining sustainable development of territories.

Students are given the possibility to simulate the urban environment and the operation of the road network and, what is the most important, to study transport behavior of the population by controlling specific parameters of transport supply and demand.

The program structure includes two main modern trends in the development of transport service system of smart cities:

1. Expansion of the passenger transport network and the introduction of measures aimed at increasing the transport demand for passenger transport services during labor trips;

2. Regulation of the number of vehicles and selection of optimal traffic flow parameters by changing planning (setting road network parameters, and parking spaces capacities), controlling (choice of intersection mode), economic (management of transport services costs) transport system parameters to reduce the traffic load on the city's road network.

Let us consider capabilities of the software package through an example of the algorithm designed to solve the problem of urban passenger transport network formation.

Table 1 presents city parameters and related passenger transport system, necessary to solve the transport organizing problem of urban population transit to and from work (labor trips), between residential and industrial areas (areas with high concentration of job places). It is based on statistical parameters of city population mobility, obtained from big data analysis. The use of software package application results in describing essential features of rout network and also visualization of traffic performance in specific urban conditions.

Table 1. Parameters for organization of urban passenger transport system

№	Parameter city / public transport	Unit
INITIAL DATA		
<i>General characteristics of the city</i>		
	Time (simulation year)	Year
	Inhabitants	Thous. pers.
<i>Statistics — public transport</i>		
	Public transport network length	Km
	Passenger kilometers: distance travelled by all public transport users per day	Km
	Average distance of a public transport user per day	Km\ pers. per day
	Average speed of public transport	Km/h
<i>Statistics — traffic</i>		
	Percentage of public transport on all routes travelled	%
<i>Statistics — finances</i>		
	Balance of public transport in the year = revenue minus expenses	Euro
CALCULATED DATA ON THE RESULTS OF MODELING		
<i>Characteristics bus line to the industrial area</i>		
	Cycle time (distance between two consecutive vehicles in minutes)	Min.
	Vehicles (number of vehicles required for the line)	Unit
	Utilization (average utilization of vehicles)	%
	(moved persons carried per a day)	Thous. pers. per day

Education software technology engages students in inquiry process and learning a decision making strategy based on comparison of the initial features of the transport network, set by the student at the building of the city, and final characteristics obtained as a result of assessing the current transport

situation and implementation of quality improvement initiatives. Problem-solving involves monitoring 2D and 3D city traffic models to define and analyze consequence resulting from the choices made by the student derived from the analysis of transport service system parameters, rolling stock selection, setting passenger transport route network parameters, placement of stop points and U-turn lanes.

Thus, the student has a unique opportunity to empirically experience of urban processes related to organization of population mobility, and to get practice-oriented professional competencies in the field of organization and interconnection of spatial planning structure and urban transport system.

4. Conclusion

The growing importance of urban planning education dictates the need of introduction of interactive technology in professional teaching. The software package allows engaging students in attractive semi-game learning process on the organization of city transport services based on the study of factors that determine the transport behavior and model choice in people mobility.

The implementation of the software package in the framework of international cooperation programs between Russia and Germany, including the implementation of the «**Roadmap for cooperation in education, science, research and innovation**», allows the most efficient way to use the best German practices that should increase the quality and competitiveness of Russian education in the world market.

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