Promising Modern Research Areas in Smart Mobility

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ABSTRACT

Contemporary smart mobility technology makes it possible to solve the problems of urban transport, improving quality of urban mobility, increasing availability of transport, and ensuring its efficiency. The objective of the study is to identify key trends of research on smart mobility in recent scientific sources. The author, using VOS Viewer program, carried out a bibliometric analysis of publications indexed in the Web of Science and Scopus databases and containing keywords related to smart urban mobility.

Co-citations, cross-references, shared keywords, co-authorships have been analyzed for the entire set of selected publications. As a result, a map of links between publications in the field of smart mobility was built, defining existing relationships between keywords and authors in this area. Also, a map of clusters was built, which displays proximity of publications to each other. A cluster comprises a group of research closely related via research topics, authors, and keywords. Clustering of publications was conducted followed by identifying six clusters, each of which reflects single promising research area in the field of smart mobility. The results obtained make it possible to identify promising development trends for smart mobility through automated processing of a high-quality array of publications. The results can be used by municipal officials, transportation business and academia to review and analyze emerging smart mobility technologies and to make informed urban transport planning decisions.

Keywords: transport, smart urban mobility, bibliometric analysis, research trends.

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Introduction.

The relevance of the use of smart mobility technology is due to the persevering transport problems in the world cities, usually comprising negative impact of transport on the environment, traffic congestion, excessive use of personal vehicles, congestion of urban infrastructure, etc. The development of smart mobility will make it possible to minimize these problems, and in the future will improve the quality of urban life, availability, and efficiency of urban transportation.

Modern research considers smart city as a specific ecosystem that develops through the widespread use of information and logistics technologies, which are implemented to improve quality of life of citizens through integration of various systems and services. The terms «smart city» and «smart mobility» themselves are used in publications to describe promising directions for development of innovative technology in the daily life of the city, for introducing innovations to urban transport [1].

Smart urban mobility is provided for through introduction of a wide range of modern information technologies into the city life, development of intelligent transport systems, and the use of specialized databases. Intellectualization of the urban transport system helps to reduce traffic congestion, improve safety of urban traffic, and ensure maximum synchronization of urban transport modes. Currently existing technologies allow tracking transport in real time, making it possible to improve efficiency of urban transport management, and help residents to plan their urban mobility.

The *objective* of the work is to identify existing research trends referring to smart urban mobility in the scientific publications. To do this, a bibliometric analysis of publications indexed in the Web of Science and Scopus databases for 2012–2017 was carried out. For the analysis, the *method* of bibliometric research with the help of VOS Viewer program [2] was used. The articles' abstracts for analysis were compiled from the publication database https://app.dimensions.ai/discover/publication.

Results.

For the study, publications that use the concept of «urban smart mobility» in the title, abstracts, or keywords were first selected. Among those publications, the publications with highest impact factor were selected by the criterion of the number of citations. During the analysis, 929 articles were reviewed. Co-citations, cross-references, shared keywords, clusters of related publications were analyzed for the selected array of publications. A map of links between publications in the field of smart mobility was built followed by identification of the existing relationships between the terms and keywords used. Similar studies in related areas have already been carried out, but this field is rather dynamic, which is proved by continuous changing of the trends [3; 4].

Bibliometric analysis of publications was carried out in the following sequence. At the *first stage*, bibliometric information was selected from Dimensions database and preliminary grouping of this information was carried out. The information was converted to a single format, cleared of doubling, iterations, and errors, which made it possible to improve quality of the data used. Then the data was transformed into a *semantic network* of related publications, which made it possible to reveal the existing information links and to form a single publication field. The constructed semantic network was normalized to quantitatively express similarity between the elements included. The *second stage* was processing the semantic network using VOS Viewer to graphically represent the result. At the *third and final stage*, an expert assessment of the results was carried out to identify research trends, describe clusters of publications, and identify factors of scientific and technological development in the selected field of research [5].

Pic. 1 reflects the dynamics of changes in the number of publications per years of research. There is a clear trend of a sharp increase in the number of publications on the topic of smart mobility in recent years, while works written before 2014 are actively cited. On average, each work of those years has got more than 30 citations.

An important research finding is the cluster map, which displays the relationships between keywords and terms that have been used in publications. The cluster consists of a group of thematically related studies. These groups are highlighted in different colors and enumerated on the resulting map. Division of publications into six clusters was identified, 49 publications were used for analysis, each of which had at least 30 citations.

The first cluster includes publications related to the topic of smart methods of urban transport planning [6; 7]. Optimization of urban transport planning is currently a key concept of a smart city; therefore it is often considered in studies related to development of smart city infrastructure, optimization of traffic flows, etc. The problems of
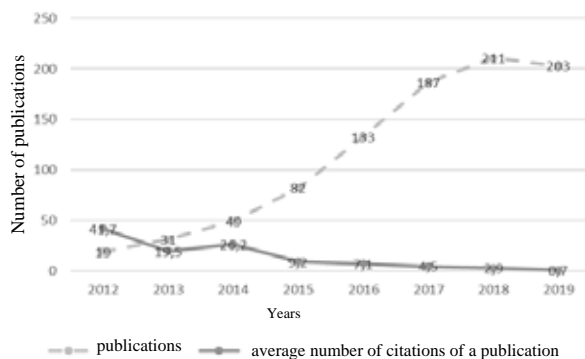
Pic. 1. Dynamics of publications and citations (constructed by the author).
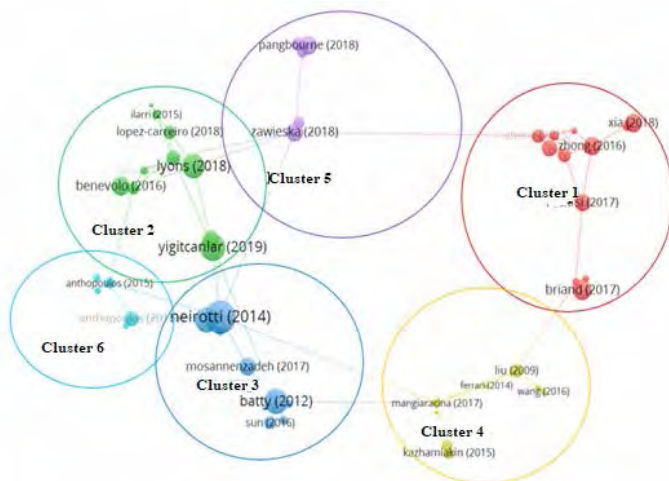
Pic. 2. Bibliographic map of clusters of publications (developed by the author).

urban transport planning are typical of many cities, however, the internal specificity of cities leads to the absence of a single universal planning solution and it is necessary to develop an individual transport plan for each city.

The second cluster is formed by publications related to the topic of smart urban public transport [1; 8]. Researchers are looking at technology trends to address urban public transportation challenges. The city authorities are investing heavily in development of modern public transport systems, including in creation of information and road infrastructure. In this area, the use of intelligent services is actively developing, new practices of using vehicles are being introduced. The publications describe methods of using machine learning to manage public transportation, methods of introducing smart cards into urban practices, and of providing access to various modes of transport using a single card, ensuring respect of timetables, etc.

The third cluster consists of publications on the use of promising innovative technologies in the field of urban transport, (including freight transport and taxis, in contrast to the second cluster) [9; 10]. This topic has been actively investigated in recent years, being at the intersection of information and transport technologies, the proposed solutions radically change the existing methods of urban mobility. For example, the city taxi system has changed significantly, new ways of renting vehicles have appeared, and new markets for rental of vehicles (bicycles, electric scooters) have emerged in the city.

The fourth cluster consists of publications on the topic of intelligent transport systems [11]. This is a developed area of research, which includes topics related to introduction of intelligent technologies in the field of traffic control, urban transport routes management, etc. The purpose of these developments is to improve efficiency of the urban transport system, reduce urban congestion. Modern information technologies make it possible to create specialized intelligent solutions that make it possible to centrally control city traffic, which leads to a decrease in urban traffic, reduces air

51

pollution, and provides more accurate and complete navigation of vehicles in real time.

The fifth cluster consists of publications on development of intelligent solutions aimed at ensuring autonomous mobility [12; 13]. This topic is promising, the use of autonomous vehicles in the future will be an important technology, followed by significant changes that have already been predicted in both public and personal urban transport. In the future, transport management and control technologies will be developed based on introduction of distributed transport regulation systems, specialized intelligent road infrastructure, and autonomous vehicles, while already at present, a positive effect from implementation of such solutions is evident.

The sixth cluster consists of publications that describe methods for modelling urban transport systems and approaches to developing uniform standards for them [14]. These publications consider the issues of information and software support for urban transport modelling methods, the use of various technologies for collecting information from the urban environment to further build transport models. As its important part this cluster contains publications related to the development of specific simulation algorithms based on machine learning, artificial intelligence, and computer vision systems. In the future, these technologies will make it possible to process information, collected using sensors and video cameras, to solve the problem of urban traffic control in real time.

Brief conclusions. Bibliometric analysis is among effective methods for processing voluminous textual information, allowing to get a broad understanding of the problems, which the researchers are facing, as well as to get acquainted with the directions of development of a research topic through automated processing of a high-quality array of publications. The results of the study can be used by city authorities, transportation business and researchers to identify promising trends in smart mobility and justify their own decisions in the field of urban planning.

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