

SMART CITY AND SMART TRANSPORTATION. BUCHAREST CASE STUDY

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Abstract

“Non-smart” cities are particularly challenged today, if we consider transportation problems, meanwhile smart cities are able to find solutions to these problems. In spite of this, the concept of smart city is still undefined, even if there is abundant research on this concept and on the components of the smart city. This study aims to explain the manner in which a smart city offers a sustainable economic development and transportation, as well as a high quality life for its inhabitants. The perception of individuals on the current public transportation in Bucharest represents the main objective of the case study. According to our research, the inhabitants from Bucharest are highly unsatisfied with the public transportation, which results in their desire for better transportation and in solutions proposed for this reason. As a solution, we propose the implementation of a TOD.

1. Introduction

Bucharest is not a smart city. Consequently, its' transportation isn't smart either, which causes great problems to its inhabitants. These transportation problems represent the motivation for this article, especially since there are many smart cities in the world which have solved their transportation problems. This is the main reason why I firmly believe that, Bucharest too, can be converted into a smart city, and this research comes an original one which could help to improving public transportation in our capital and to transform Bucharest in a smart city. The paper is organized on two parts:

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literature review and case study. The first part studies previous research on the concepts of Intelligent City, Knowledge City and Smart City focusing on the six-axes model that characterizes a Smart City, from the point of view of the European Cities Project. Also are being analyzed ITS and transportation systems together with problems related to transportation. The second part focuses on real time transportation problems in Bucharest and the way inhabitants perceive these problems.

2. Literature review

2.1 Intelligent City, Knowledge City, Smart City

Despite its similarity to the U-city concept, the concept of Smart City is more popular in the present. The difference between the two concepts is in the degree of intelligence and therefore the Smart city is actually a more developed post-Ubiquitous city. U-city has an artificial intelligence and it is a city created from the conjugation of various basic facilities and information technology. As afore mentioned, the Smart city is a more developed version of the U-City and this development is due to the introduction of new technologies which make it possible for individuals to be interconnected like a human neural network. Hence, no longer dependent on a certain location, involvement and inter-communication are easier in a Smart city. In comparison with the digital or intelligent cities, the social and environmental capital draws a clear line between the Smart cities and the more technology-based digital or intelligent cities. Moreover, according to the literature on this subject, Smart cities are less dependent on the “physical capital” or what we can call the hard infrastructure and much more on the “intellectual capital and social capital”, the availability and quality of knowledge communication, thus the intellectual and social infrastructure [1].

However, the concept of Smart city remains flexible and continuously adapting to the ever-changing technologies. Undoubtedly, all areas on smart cities such as government facilities, health, traffic, electricity, water,

buildings, and transport are covered by the information of communication technology [ICT].

Nowadays, SMART cities are called MESH cities [2]. MESH is an acronym for: Mobile [the mobile technologies and the informational networks offer the bottom-up, real-time information, feedback about a city, its systems and its citizens, the so-called users of the city], Efficient [sustainable cities that use effectively their resources and also monitor and manage public services like health, energy, traffic, etc], Subtle [discreet, non-intrusive, even invisible systems, user friendly modern city systems], Heuristics [heuristics-based constant development, self-improvement, continuous adapting and citizen-focused].

It is already predictable that the ICT will also enter the soft and warm techniques domain. Therefore, the Artificial Intelligence will no longer be stranger to human emotions and will be developed to act like human beings [3]. Today's Smart cities will be tomorrow's Sense, Soft and Warm Technology City. A classification of the definition of Smart cities from a subjective perspective is presented by Lee and Hancock [4]. The concept of Smart city has a wide variety of definitions and practical and academic views being nearly impossible to present an all-inclusive definition. Table 1 below presents the three categories of definitions. Given the numerous definitions and interpretations of the Smart City, the present study wishes to advance a comprehensive model to better explain the ideas and projects behind the Smart city. In the early years, the Digital cities were build on ICT, but nowadays the more developed and intelligent Smart cities have found new ways to engage technology and restructured in order to provide citizens more effective and efficient public services [5]. In the end, it all comes down to people because no matter the changes and transformations within a municipality, customer-centricity remains the true spirit of a Smart city. Technology is a means to an end, but it all depends on the customers experience with that technology; if the customer doesn't like it he won't use and that e-service will fail despite its innovative nature. Therefore, municipal employees must always focus on their relations with the customers especially if they directly face citizens every day, but even if they don't. On the other hand, citizens also must collaborate with their city authorities and contribute in order to help e-services to deliver its

promises. Citizens that in this case become customers are the main focus of the Smart city and some even joke that there may even be an app to prove it.

Returning to the definition of the Smart city, it can be considered as the next step in the evolution of urbanization and Digital City Development, where the central point remains the ICT infrastructure but other factors become equally important and we must mention Customer Centricity and Governance, Civic Engagement, Human and Social Capital, and Environmental Interest.

Smart City Projects - Mechanisms and approaches to define the concept

The afore-mentioned definitions of the Smart city are only few of the attempts to better explain this concept. Starting from the volatile nature of the Smart city definition, some researchers consider best to methodize the features and characteristics, highlighting the most important parameters of the Smart city project. One of these models described by researchers will be presented further on in this paper.

2.2 Intelligent City, Knowledge City, Smart City

The smart city model presented by European Cities Project defines a Smart City as a city well performing in 6 main characteristics, built on the ‘smart’ combination of endowments and activities of self-decisive, independent and aware citizens.

SMART ECONOMY [Competitiveness]	SMART PEOPLE [Social and Human Capital]	SMART GOVERNANCE [Participation]
<ul style="list-style-type: none"> •Innovative spirit •Entrepreneurship •Economic image & trademarks •Productivity •Flexibility of labor market •Embedded Internationally •Ability to transform 	<ul style="list-style-type: none"> •Level of qualification •Affinity to life long learning •Social and ethnic plurality •Flexibility •Creativity •Cosmopolitanism/ Open-mindedness •Participation in public life 	<ul style="list-style-type: none"> •Participation in decision making •Public and social services •Transparent governance •Political strategies & Perspectives

<p>SMART MOBILITY [Transport and ICT]</p> <ul style="list-style-type: none"> •Local accessibility [Inter-] national accessibility •Availability of ICT infra •Sustainable, innovative and safe transport systems 	<p>SMART ENVIRONMENT [Natural resources]</p> <ul style="list-style-type: none"> • Attractiveness of natural conditions • Pollution • Environmental protection • Sustainable resource management 	<p>SMART LIVING [Quality of life]</p> <ul style="list-style-type: none"> •Cultural facilities •Health conditions •Individual safety •Housing quality •Education facilities •Touristic attractiveness •Social cohesion
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Table 1: *The six-axes model to characterize a Smart City, the view of the European Cities Project*

The table above illustrates a perspective on Smart cities that bring together different economic, social or environmental factors and components. The success of the project consists in optimally integrating these components having the innovative technologies as a binder. To summarize, the main features of a Smart city are:

1. access to enhanced information flow for citizens and services providers;
2. maximizing the use of key resources according to the data collected through high-tech sensors, real time data analytics and widespread communications;
3. systematization of heterogeneous data in order to provide productivity insights and augmentation to its citizens and service providers;
4. maximizing the economies on the different layers of infrastructure using a service delivery platform, for instance Urban Operating System [“Urban OS”];
5. exceeding economic targets by engaging innovative technology and innovation in order to offer its citizens, industry and business environment sustainable, quality of life improvements.

”Smart city” is a label or better yet, a status that many cities around the world aspire to have. In this context, we can draw a series of interesting observations. Firstly, across the world there are numerous acceptances of

the concept of “Smart city” and while all of them are centered on the essential role of ICT and new technologies, these cities apply differently the technologies. For example, most of them use ICT for utilities, transportation, citizen engagement or environmental issues but few of these cities [e.g. Edinburgh, Boston, Nanjing, Syracuse, etc.] have considered urbanism or city planning to be adequate fields of application. Secondly, Smart cities are heterogeneous in terms of evolution, some being more developed than others. While some cities like Stockholm, Singapore, Rio de Janeiro or Amsterdam, have already implemented and are using new systems, others remain in a conceptual phase. Thirdly, approximately one in three cities is collaborating with some of top global technology providers like CISCO, Siemens and IBM. However, not all cities are organized and while some are working with regional or local technology providers and have partnerships with research institutions, others still have to determine such matters. Lastly, researchers claim that all these efforts to become smart have been intensified in the last decade. Even though city planning and management have been using technology for years, the present “smart” trend is focused on cities’ branding as “smart”. Therefore, technology providers are making efforts to establish partnerships with these cities.

Short review on Global Technology Providers

According to ABI Research [6] the market for technologies that feed into and support Smart City programs and projects will grow on a global basis from \$8 billion in 2010 to exceed \$39 billion in 2016”. On the other hand, Pike Research [7] is more optimistic and estimates that "investment in smart city technology infrastructure will total \$108 billion during the years from 2010 to 2020". As research shows, global technology providers are very interested in establishing partnerships with cities. Precisely, top technology providers such as Cisco, IBM and Siemens have intensified their efforts to determine cities in adopting innovative technologies and ICT. The efforts of IBM, Cisco and Siemens focus on sustainable development, improving and enhancing city services, efficient use of energy and resources. Next will be outlined the premises of the partnerships and collaborations between the top technology providers and Smart cities.

The top technology providers: IBM, Cisco and Siemens. Viewing the city a "system of systems", IBM [8] highlights the role of ICTs in facilitating the understanding of these systems and they way they work, therefore enabling better decision-making for planners and policymakers. This idea is based on Harrison's and Donnelly research that argue that ICTs is an useful instrument for observing and measuring and then aggregating the "choices and construction" of city systems [9]. IBM has envisaged and customized solutions for cities in a variety of city sectors such as energy and utilities, transportation, healthcare, airports, communications, education, social services, economic development and public safety. IBM argues that actually "smart is a verb" and therefore encourages decision making processes "based on evidence, not on habit or opinion or gut". They highlight that the successful cities, in particular city leaders, of the future are those "using even more powerful tools, sharpened by ever more precise information and insight,... are creating the big transformational shifts that reverberate through their organizations", and who are "anticipating, rather than merely reacting to events", and "seizing competitive advantage" [10]. Taking it a step further, IBM has created the Smarter Cities Challenge program, a \$50 million dollars program, where together with city leaders are finding more effective and efficient solutions for the cities' stringent problems. An illustrative example is that of Syracuse, New York that was confronted with an outflow of jobs and population leading to an increase of vacant properties and IBM is trying to develop a method to observe, analyze and predict the vacancy phenomenon evolution. In long term, the system proposed by IBM will help city officials in neighborhood planning and development [11].

CISCO [12] presents the solutions cities find to their problems "by using networked information to transform urban centers into networked communities", i.e. "smart + connected communities". One method is with the help of a network "underlying services delivery platform" that "connects everyone to everything". Through this network they create and implement solutions that make citizens, businesses and governments "realize sustainable economic growth", "enable environmental sustainability through resource management and operational efficiencies", and "enhance quality of life". The smart solutions envisioned by

technology providers like Cisco refer to transportation, real estate, utilities, safety and security, housing and government sectors. In Amsterdam, Cisco's "smart work centers" are conference rooms and hot-desk office spaces with high-tech, innovative networked telecommunications systems for working and collaboration, for instance TelePresence [13]. These work centers are accessible to companies and/or workers who can flexibly rent them and were created aiming to minimize and even eliminate commuting. If these work centers prove efficient they will positively impact transportation and land use planning.

The Smart + Connected Communities Institute is another program implemented by Cisco in order to offer a "central hub for city planners, developers, academic institutions, systems integrators and visionary leaders in which to collaborate on the issues involved in the [re]development of sustainable cities" [14]. This Institute brings together online forums and blogs and also releases interesting publications such as reports, case studies, white papers and presentations on subjects like the application of new technologies and the ICTs in city government.

Siemens concentrates its efforts on urban sustainability. Siemens works together with the Economist Intelligent Unit and publish "The Green City Index", a series of studies on over 120 cities and their policies and best practices in achieving urban environmental sustainability. The Crystal is the world's largest exhibition set up by Siemens in London centered on urban sustainability, aiming to offer a "global knowledge hub that helps a diverse range of audiences learn and understand how we can all work to build better cities for ourselves and for future generations" [15]. Taking this into consideration, Siemens presents ICTs as a "fifth utility", an essential component of "smart cities" that "can enable increased efficiency and flexibility to use new resources" to "enable sustainable behavior" [16]. Therefore, the main focus is on integrated technological solutions for sustainable urban infrastructure, in particular, in transportation [e.g. traffic management, electric vehicles infrastructure, high-speed trains], energy [e.g. energy storage, smart grids], environmental, water [e.g. water treatment], green building [intelligent building solutions], healthcare sectors.

2.2.1 ITS - Intelligent Transportation Systems and Services

ITS is an abbreviation for Intelligent transportation systems and services and is starting to be a very important part of a Smart city. In his paper, Salido and his collaborators argue that in the present the traffic is chaotic because of the frequent congestions and accidents, pollution and unpredictability. These are serious concerns worldwide and despite some recent improvements, the overall situation is aggravating [17]. In achieving smart, sustainable growth, intelligent transportation systems have been considered one viable alternative [18]. Mondale [19] also thinks that transportation is essential in the competitiveness of cities and the quality of life. Additionally, he highlights that it can also positively impact infrastructure expenses and also helps businesses and building flourishing neighborhoods. ITS-Finland claims that “Intelligent Transport Systems and Services [ITS] encompass a broad range of information and communications technologies that improve the safety, efficiency, and performance of the transportation system. When integrated into the nation's roadways, vehicles and public transportation network, ITS can help reduce congestion, improve mobility, save lives and optimize our existing infrastructure”. Taking this in consideration, it is a logical development that smart transportations' importance is growing.

Similarly, in his study, Singh [20] argues that the new mega cities resulting from urbanization will radically impact transportation. He predicts that technology-push perspective will turn into a user- pull claiming that in the future cars will be designed around cities, not cities around cars. Therefore, companies and other service providers will rethink their new perspective from market share to “mobility share” because of the new types of business models and services that will emerge [21]. Moreover, as urbanisation continues transport-related infrastructure will be the centre of all infrastructure development and spending [22]. Therefore, there is demand for innovation in transportation solutions and people's transportation routines will also change as the evolution of cities, technologies and smart environments continues.

Even though intelligent transportation has many advantages and benefits the vast majority of citizens, the new solutions aren't so appealing for everyone. For instance, a Finish expert declared at some point that in

respect to intelligent transportation solution plans the user perspective has been disregarded and the city officials as well as technology providers are ideating innovative solutions from a technology-push perspective. Therefore, a strong top-down approach is counterproductive because citizens are unlikely to accept the new solutions when those are almost forced by public administration. Hence, a bottom-up approach, from citizens to city officials, may prove to be more successful in adopting innovations and new technologies. Resistance may be minimum if users, thus the citizens, would be able to express their opinion regarding the design of new transportation solutions. However, if transportation would be design only from the users' perspective, the resulting solutions may not challenge the existing transportation habits or be actually innovative. In this case, a combination of the two approaches should be considered in order to meet both the interests of users and service providers. Nevertheless, users have not traditionally been included in the process of designing intelligent transportation solutions, but now it appears to be demand for user-inclusive approaches.

2.2.2 Transportation Systems and Problems related to Transportation

City centres are predisposed to significant transport problems mainly because mobility requirements exceed transport systems capacity. Productivity is very dependent on the efficiency of the transportation system for taking workers to their jobs and for transporting people and various goods between different destinations. Additionally, ports and airports are important transportation pivots that raise other specific problems. Congestion is one of the oldest problems but new ones appear such as the environmental effects. In the following I will present the most noticeable urban transport problems.

- **Lack of Parking Space and Traffic Congestion:** Congestion is one of the top issues when it comes to transportation in metropolitan areas. The continuous spread of motorized transport and increased number of private cars determined an even larger demand for transport infrastructure. Nonetheless, infrastructure is not able to meet the need generated by traffic growth. Congestion is also related to parking troubles because looking for parking and not being able to find a space creates additional delays and

hinders local traffic circulation. Looking for a parking place may take drivers even 20 minutes in central areas of large cities.

- **More Time spent Traveling:** Nowadays, the transition between the place of residence and place of work is taking a lot more time. This trend is link to housing prices; the most affordable houses are located away from central areas.
- **Inadequate Public Transportation:** Public transport systems don't meet demand and create inconvenience for users during peak hours. Especially in suburban areas, a decrease in passengers' numbers makes public service financially unsustainable and thus incapable to generate sufficient income to cover its operating costs and capital.
- **Environmental Impact and Energy Consumption:** The quality of life and health of urban residents is seriously affected by the pollution including noise generated by the rotation. Another form of pollution is energy consumption by urban transport.
- **Accidents and Safety:** Increased traffic in urban areas generates an increased number of accidents and fatalities, especially in developing countries. Repeated delays are also linked to accidents and with the continuous increase in traffic, people feel unsecure in using the streets. [Jean-Paul Rodrigue, 2013].

3. Case Study

3.1 Research Objectives

The first general objective of this research aims to reveal if there are significant problems in the transportation system in Bucharest. The second general objective of this research aims to highlight significant solutions in improving the transportation system in Bucharest.

3.2 Participants to the study

Subjects on whom research was carried out are 160 individuals living in Bucharest, from either private or government organizations.

Organization	Hierarchical level	N valid
Public organization	Management	7
	Operational Employees	73
	Total	80
Private organization	Management	8
	Operational Employees	72
	Total	80

Table 2: Distribution of participants to the study after "the hierarchical level"

3.3 Questionnaire

The questionnaire is made up of 4 questions addressed to the demographic features of the participants to the research and 6 questions dealing with challenges of a Smart City and a smart transportation.

3.4 Analysis and interpretation of results

According to the research participants, the biggest problem of the transportation in Bucharest is that of traffic congestion, followed by the lack of parking space and the time dedicated to travelling in Bucharest, which is really high.

Traffic Congestion	68
Lack of Parking Space	47
More Time spent Traveling	34

Inadequate Public Transportation	11
Environmental Impact (Pollution)	17
Accidents and Safety	3

Table 3: The biggest problem of the transportation in Bucharest

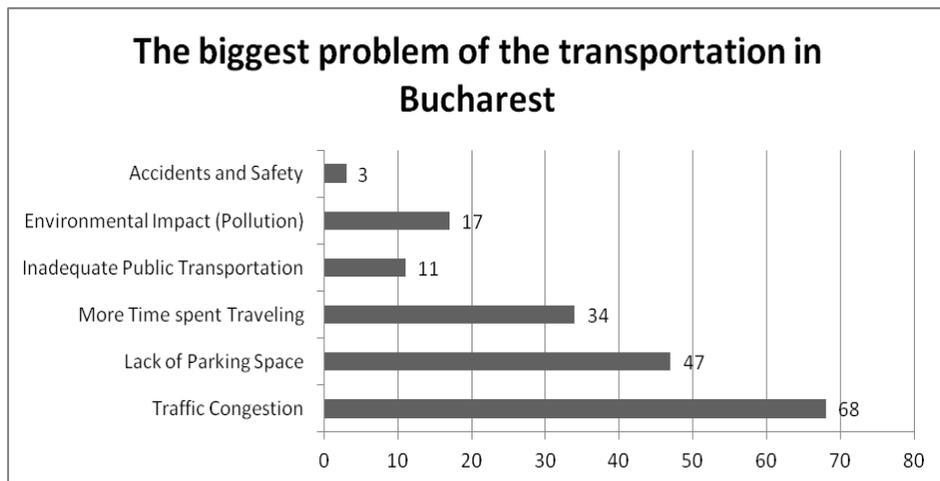


Fig. 1: The biggest problem of the transportation in Bucharest

In terms of solutions to the transportation problems in Bucharest, participants focused on sustainable transport and infrastructure necessary for the achievement of smart mobility, together with intelligent logistics, dynamic traffic management concepts, as well as a network of recharging points for electric vehicles throughout Bucharest. Carpooling, referring to sharing a car to a destination to reduce fuel use, pollution and travel costs is slightly considered by people living in Bucharest.

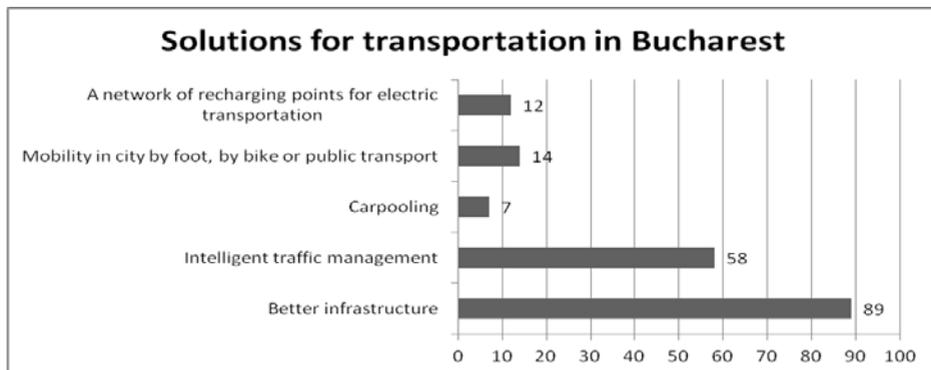


Fig. 2: Solutions to the transportation problems in Bucharest

4. Solutions

For Bucharest, we propose the implementation of the TOD. The Transit Oriented Development (TOD) is a viable model for transportation and land use integration. TOD is a straightforward concept: concentrate a mix of moderately dense and pedestrian friendly development around transit around transit stations to promote transit riding, increase walk and other alternatives to the use of private cars. A new transportation action plan is proposed. This plan is erected on classifying the spatial movement of Bucharest into three-graded hierarchy. Then, a circulation system is drawn to connect each grade with the rest two ones. These grades are:

- Between-neighborhoods circulation (inner district circulation): Local Circulation
- Between-districts circulation (inner city circulation): Major circulation
- Regional circulation: Global circulation

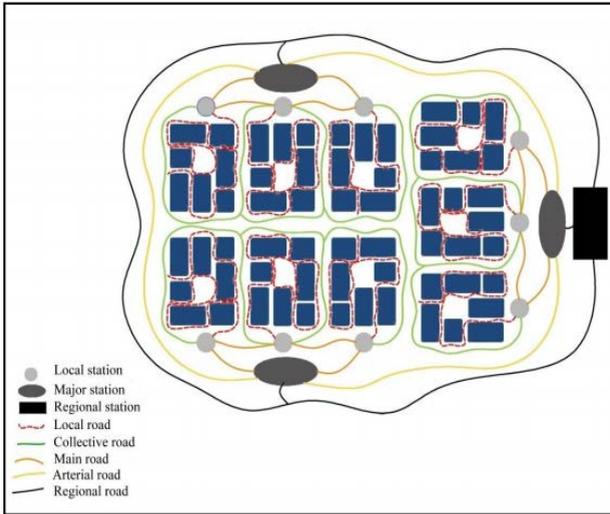


Fig. 3: Solutions to the transportation problems in Bucharest. Proposed circulation. Transit Oriented Development

Total No. of trips for each district's station = No. of districts' station + No. of regional stations - 1 Then, Bucharest has Total No. of trips for each district's station as: $17 + 2 - 1 = 18$. Total No. of vehicles between districts = $(\text{Total No. of stations}) * (\text{Total No. of stations} - 1) \div 2$ Then, Bucharest needs minimum number of vehicles as: $(19 * 18) \div 2 = 171$ This total number can be increased according to any need for more vehicles, especially in peak hours.

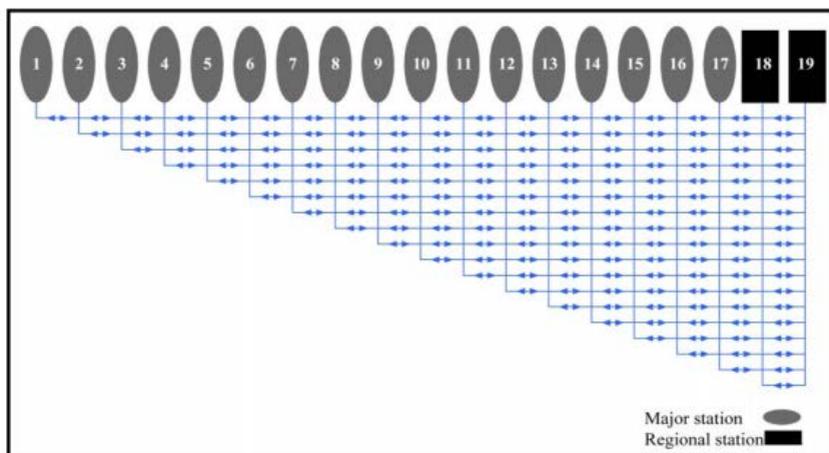


Fig. 4: Calculating number of public vehicles of major circulations

As for the type of vehicles the preferred one is using public transportation means: Microbuses (8 – 10 seats) and Minibuses (24 seats) are two types of vehicles as well as buses (48 seats). They can be used between zones that include many services especially in peak hours. Private vehicles are not supported.

5. Conclusions

From our research, Bucharest is far from being a smart city. The article focused mainly on transportation challenges of the capital, providing several solutions, which, if considered carefully could improve transportation in Bucharest. Among these challenges can be mentioned: infrastructure, time, road maintenance, congestion, bike community, digital softs, public transport, electrical vehicles, traffic management and others. As major solutions proposed by participants are smart mobility, intelligent logistics, recharging points for electric vehicles as well as carpooling. This research can represent a starting point for government authorities, urban

planners, IT&C researchers and policy-makers in the development of cities. As main contributions can be mentioned the analysis of the different challenges in the transportation of Bucharest, as well as the proposal of several solutions, which if implemented could increase the quality of life in Bucharest and to a certain point, even turn our capital into a smart city. In order to implement the TOD, it is recommended to build a united national Geo-database that can be updated by all agencies according to their concerns. This database can be managed and controlled through a national agency and it has to be systematically updated. Also, the data and information have to be available for community, researchers, developers, investors and all interested groups.

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