Smart City Approach in Logistics and Transport in the Czech Republic

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Abstract

The ever-increasing rate of urbanization and population growth in cities requires cities to provide quality transport services, create new transport infrastructure, quality logistics and maintain the overall standard of living in the city. As the population grows, so does the demand for transport and logistics, as does transport itself, including its negative effects. The negative effects of traffic in the city are mainly traffic congestion, air quality pollution by exhaust gases or vibrations and noise. Addressing the increase in traffic and logistics, especially in the city centre, can be very challenging due to lack of space. The problems that arise due to the growing population density of cities can be solved by a relatively new idea of smart city. Smart city represents the solution of these problems using modern computer technologies and acquired data. The aim of the article is an insight into the smart city approach in logistics and transport in the Czech Republic. The article uses resources from publicly accessible databases, such as Scopus database, Web of Science database and other sources of information in the context of smart city approach in transport and logistics.

KEY WORDS: *smart city approach, smart transport, smart city logistics, intelligent transport system*

1. Introduction

In today's world, where the human population on Earth is still growing, it can be observed that the rate of urbanization is also increasing. This phenomenon can be caused by several reasons. The main reason is moving for a better job or for better services for city residents. Cities are vital in social and economic terms around the world and, as a whole, have a huge impact on the environment. To further describe the development of smart city, it is also important to be aware of the development of the human population, which is still growing [1]. For the first time, the population of the Earth was over one billion in 1804. This was preceded by constant growth as it is today. Exceptions were fluctuations caused by plague epidemics or other disasters. Another billion have been added in 123 years. As population growth continues to rise, the intervals have gradually shortened. Billions more were added after 32, 15 and 13 years. From 5 billion, which was reached in July 1987 to October 1999, according to the United Nations, this was the shortest interval, namely 12 years. According to the United Nations, 7 billion people in the world were reached in 2012. The world should exceed the 8 billion mark in 2023. In 2050, the estimated population is nine billion. While in the cities in 1800 lived 3% of the world's population. Today it is already 55%. Furthermore, the percentage of the urban population is expected to continue to grow [2]. In 1950, it was the only metropolis in the world (New York) with a population of more than 10 million. In connection with population growth, it is also logical that as early as 1975, there were five such agglomerations. There are already 23 of them in 2015. This information shows that there is a constant increase in population and also a large migration of people to cities. From these assumptions, it is clear why a large number of scientific institutions are now engaged in smart city research. The growth of large cities has changed the way we think about mobility and transport operations of megacities, which over the years receive a larger population, which will require increased investment in infrastructure, mobility, technology, traffic management, logistics [3-4]. The Desa study [5] revealed that in 2016, 45% of cities had a population of between 5 and 10 million inhabitants. It is estimated that by 2030, 10 of these city centres will become megacities. The same survey found that between 2016 and 2030, the population is expected to increase in all size classes of the city, while for the rural population the estimate will decrease slightly. By 2030, therefore, cities with at least 10 million inhabitants will have an estimated population of 730 million, representing 8.7% of the world's people [6].

The concept of smart city has been seriously discussed since 2008 due to the financial crisis. This is because smart city deals with both the efficiency and optimization of energy use, as well as the improvement of the city administration or transport infrastructure thanks to the public online availability of information and data or services offered by the city. Another possibility is the interest of technology companies, which comes from times of crisis, when they saw the concept as a new source of income. Due to this, it is possible to meet with criticism of the smart city concept. However, it must be said that if there are limits to the extent of smart emotion, then this is a good and beneficial idea [7]. Smart city is a concept leading to the sustainable development of a city or municipality. This is achieved by introducing modern technologies in the management of the city in order to improve the quality of life and streamline the management of public affairs, whether in the field of transport, energy, waste management or water management. Increased efficiency is usually achieved through the use of information and communication technologies [8]. The European Commission describes smart

cities as follows. A smart city is a place where traditional networks and services are provided more efficiently using digital and telecommunications technologies for the benefit of their citizens and businesses [9]. According to the magazine IT Systems, smart city deals with efficiency and optimization of energy use, transport infrastructure or improvement of city administration [10]. An important activity within the smart city is the sharing of collected information across various fields in the city. Information can be collected using sensors and transducers. These are then connected to sensor networks. Based on the amount of data and their subsequent analysis, ideally in real time, it allows the implementation of defined actions to solve problems that may occur. The interconnection of products, services and people into one whole takes place through the so-called Internet of Things. Today is so favourable for the introduction of smart city, because the availability of sensors or hardware is no longer so financially demanding. Furthermore, smartphones, which the majority of the population owns today, can be used in the solution [10].

The movement of goods into a smart city is economically critical. Therefore, understanding the relationship between the logistics of the flow of goods and the operation of smart cities is essential in implementing the policy of future cities. Emerging intelligent logistics is considering the inclusion of disruptive technologies, such as smart sensors in the Internet of Things environment [11]. The growing increase in the need for passenger and freight transport in both interurban and urban contexts over the last two decades has led to profound impacts on the human and natural environment. To mitigate the consequences, decision-makers consider various intelligent logistics solutions that do not always lead to the desired impacts [12]. Nowadays, city urban logistics is undergoing profound changes with the expansion of the urban population and the explosion of e-commerce. Smart urban logistics can not only provide an efficient delivery service, but also reduce congestion, CO_2 emissions, etc. [13]. Academies and the logistics industry have recognized that one of the major challenges of smart urban logistics is the integrated stakeholder involvement and development of effective decision-making tools to improve its global performance [14].

2. Smart City in City Management

One of the most important topics in the field of smart city is the management and administration of the city. In the context of smart city, the management and administration of the city is called Smart Administration and Management or the Smart Government or the eGovernment is used. The smart management of the city is that the citizens of the city have an overview of how the city manages finances and can also influence them. This makes the entire city budget transparent, which makes it possible to prevent overpriced public contracts or corruption. Influencing public finances by the citizens of the city or individual city districts is a necessary part of this concept. Citizens should be able to express what a priority is for them, through referendums, civic associations or public discussions.

Online platforms are beginning to be used to decide on the city budget or new city projects, which aim to improve group decision-making. This process is called participation. It is that people, citizens of the city, should be involved in decisions that affect them. Voting can take place using several voting methods. A frequently used method in this poll is the modern voting system, the so-called Janeček's Method of Democracy 2.1 [15]. In this method, everyone has two positive votes and one negative vote. Thanks to this, it is possible to reduce possible populism or the advantage of the informed voter over the uninformed. Voting can take place directly on the city's website and residents express their vote via computers, smartphones or tablets. Verification via SMS or social networks avoids the risk of re-voting by irresponsible voters. The platform can also be used to send e-mails related to city problems or various alerts. So far, this platform is in the pilot phase of testing. For example, it is used in New York as well as in Czech smaller cities. From this it can be evaluated that the issue of smart city management does not only concern large cities and agglomerations, but also smaller cities [15-16]. Another example of smart city management can be communication between the city administration and citizens via smartphones or tablets. For example, the English city of Bradford has created an application for its citizens that citizens download to their mobile devices. Thanks to the application, citizens can then follow the latest events in the city. There is also an application for advertising vacancies in the city or various sports events that take place in the city. Residents are informed through the application when waste collection will take place and are asked not to forget to prepare waste for collection. The application allows to pay various fees by redirecting to the city's website. Last but not least, the application offers the possibility of reporting a problem. Such as broken roads, sidewalks or broken lamps [17-18].

3. Smart City in Transport and Logistics

Transport is a key factor in the functioning of society and almost every city is affected by its negative effects. In order for transport in the city centre to be as efficient and as environmentally friendly as possible, it is important to manage it effectively. The city aims to improve transport mainly to eliminate time and economic losses in the city, to improve travel comfort or to improve the environment for citizens. Decision support systems for smart cities have been proposed in the world literature because they can face different applications problems such as electro mobility [19], logistics [20], convenience [21], cyber security [22] or transport [23].

3.1. Intelligent Traffic Management

The basic prerequisite for the functioning of efficient transport is the centralization of data from intelligent transport systems. The individual systems are for parking, collection of fees, payment of fares, multimodal movement

of goods and persons, administration and maintenance of roads and so on. This data is processed in one superior system, the traffic control centre, which processes and evaluates it. Up-to-date information is provided to traffic administrators and road users via information boards or a web interface. The data is then stored in a uniform format and is available several years back. The data is then used by traffic engineers and traffic modelling experts. Thanks to data collected in the past, there is no need to perform time-consuming and people-dependent measurements of traffic flows and traffic surveys. This data can then be used to design or dimension a new intersection or road so that the resulting design is as efficient as possible and suits the actual operation [24].

Another important function of the traffic control centre is the possibility of traffic management. During the day, congestion develops in different parts of the city. The most appropriate solution for regular congestion is their early detection and subsequent mitigation of predefined scenarios that are in the system. This may be a change of signalling at traffic lights, where the busy direction will be preferred. Another option is to display the traffic situation on information boards above the road and early warning of drivers against congestion.

The quality and integrity of the input data is crucial for the correct operation of the traffic control centre. If the data is damaged due to a failure, the values can be calculated from previous measurements. However, if the data is damaged by incorrect measurements, it is unusable. Therefore, for subsequent work with data, it is crucial to have all sensors and sensors properly installed, correct initial setup and calibration [24].

3.2. Carsharing

As the name implies, this is an approach to mobility in the city, which consists in sharing cars. Carsharing belongs to the system of gentle modes of transport, which also includes, for example, public or bicycle transport. Unlike a classic car rental, there is the advantage that the car can be rented at any time, while the method of renting is simpler. Cars can be provided either by private companies that lend the car to the end customer, or through car sharing companies where the car owners are individuals and the company is only an intermediary [25-26].

The service is advantageous for those drivers who do not have their own car and at the same time do not drive a large number of kilometres a year. Carsharing works on a system of demand for mobility, which means that the customer only pays for the time and distance when he actually used the car. Thanks to carsharing, it is possible to reduce the number of cars in cities, where one vehicle that is shared can replace ten to fifteen private vehicles. This has a positive effect not only on traffic in the city, but also on the environment, as the amount of exhaust gases in the air is limited. In most cities, vehicles of carsharing companies are also favoured in parking in the city centre [26-27].

In order to be able to use carsharing by Car4Way (in the Czech Republic), it is first necessary to register online, prove the necessary authorization to drive a vehicle and pay a deposit. Based on this, a user card is issued, which is used to unlock the car. The car rental itself takes place through an application on a smartphone. Car4Way provides vehicles of various categories, from small city vehicles to commercial vehicles. The customer will find the nearest vehicle in the application, which he will book for the time that the vehicle will need, this time can be several days. The answer to the reservation is an SMS, which contains the exact location and license plate of the vehicle. The customer unlocks the car with a card and can start driving. Any refuelling takes place via a refuelling card, which is part of every vehicle. At the end of the journey, the customer leaves the vehicle in his destination and is ready for other customers [28].

Carsharing company Re.volt (in the Czech Republic) is a company that provides vehicle sharing only in selected parts of Prague, unlike other carsharing companies that rent vehicles for longer trips outside the city. Specifically, these are Holešovice, Vinohrady, Bubeneč, Dejvice, Hradčany, Malá Strana, Smíchov, Vyšehrad, Staré Město, Nové Město, Josefov, Karlín and Žižkov. The company has electric vehicles. This gives vehicles the advantage of being able to park for free in the residential blue and purple zones. It is a suitable alternative to individual passenger transport, where parking in the city centre is a big problem. Parking is also facilitated by the fact that these are very small vehicles. At present, Re.volt has 20 electric cars, 50 electric scooters and 24 electric motorcycles [29].

The main means of transport used by Re.volt is a small, characteristic yellow electric car. This is a Chinese electric cars from the Jiayun brand, which the company has chosen as the most suitable for homologation in the Czech Republic. The vehicle is simple, minimalist and very small. It is a suitable means of sharing in the city. The vehicles are registered in the L7e category, which means that they are registered as heavy quad bike. It follows that vehicles can be so small because not so much emphasis is placed on safety features. According to the company, however, the safety features are still sufficient for traffic in the city. The vehicle measures 2.2 meters in length, 1.3 meters in width and 1.6 meters in height. The vehicle has space for 2 people and a luggage compartment for two suitcases. The vehicle equipment includes infotainment with navigation, heating or air conditioning, but the use of the equipment negatively affects the range. The maximum range of the vehicle is up to 120 km and the maximum speed is 80 km/h, which is, according to the company, sufficient for city traffic. The vehicle has an easily replaceable battery. This is an advantage, as soon as the company sees a vehicle with less than 30% of the battery, it sends technicians and they replace the battery with a charged one. The vehicle is hidden from the user until the battery is replaced [30].

Borrowing takes place through the Re.volt carsharing application, which is free to download on smart devices. For successful registration, it is necessary to fill in the e-mail, telephone number, enclose current photos of the identity card, driving license together with a photo of the applicant for verification of personality. After activating the account, the user will see a map with free vehicles, the first time he clicks on the vehicle, information such as battery status or license plate will be displayed. After the second click, the application already offers to unlock the car. Then the ride itself is allowed. After driving, the vehicle's battery status must be recorded in the application, the windows must

be closed, the ignition must be switched off and the parking brake applied. After getting out of the vehicle, the user ends the ride in the application, which locks the vehicle and is ready for further use, and at the same time determines the price for the service, which takes place according to the time of car rental [31].

3.3. Bikesharing

Bikesharing in Czech language is known as shared bikes. Compared to the classic bike rental, the advantage of bikesharing is that the bike can be rented and returned at any time of the day. It is a suitable complement to public or individual car transport in the city. The main problem in cities is very heavy traffic. This is related to the creation of congestion and the slowing down of the transport itself or the production of harmful emissions in the form of exhaust gases, noise or vibrations. At the same time, current cities are expected to grow further. The question is how comfortable its population will be able to move around the cities, as there will not be as much space or money to build more bypasses or more jet roads. Bicycle transport is a suitable solution to these problems. It ensures the sustainable development of urban mobility for the city. It is a vehicle with zero carbon footprint. It eliminates urban congestion, building cycling infrastructure is not as costly as road transport and does not require as much space in city streets. It also has a positive effect on the health of the population, both directly, improving the physical condition of users and indirectly as a result of reducing harmful substances from the exhaust gases of road transport vehicles. Modern technologies have also added to the great expansion of bikesharing in recent years, thanks to which bicycles can be tracked and protected from vandals or paid for thanks to them. These are technologies such as GPS, Bluetooth, RFID and mobile payment systems [32-33].

Fourth generation shared bikes are currently in use. This means that all communication with the service provider or bike rental takes place using the application on the smartphone. Alternatively, the bike can be rented via SMS. This can be demonstrated at Rekola (in the Czech Republic). First, the customer needs to register for the shared bike application in the city. After registration, a new customer will usually receive discount coupons. The application then displays a map of the city with marked free bikes that can be rented. After arriving at the given bike, the QR code is read using the application (in the case of renting via SMS, the bike number is written), and a number combination is displayed immediately, which unlocks the number lock. After unlocking the lock, the bike is ready to ride. The customer is required to return the bike after the ride in the zone marked in the application. If he fails to do so, he is invited to do so within two days at the latest, unless another customer does so on his behalf. To return the bike, it is necessary to responsibly lock the bike to something fixed, take a picture and specify the position where the bike is located. Rekola allows to pay for this service either as a lump sum and you pay for the rental period. Or it allows for a monthly or annual subscription, where rides up to 30 minutes are free. The advantage is that the company operates in more than one city and the user is thus not tied to a specific city where he can use the service [34].

4. Conclusion

The primary goal of smart city is to ensure a sustainable model of development, a high level of quality of life, security and the best use of energy in the city. This is to be achieved by using the latest new technologies. The concept of quality of life is very broad, also different in different scientific disciplines. The concept of quality of life can be taken as a set of material aspects of life, such as health, social relations, quality of nature, living conditions and personal well-being of an individual. The article dealt with the historical development of the population and the degree of urbanization in the world up to the present. This geographical development is closely related to the emergence of the smart city concept. Furthermore, the concept of smart city was described and individual industries in the city where it is possible to use smart city technology were analysed and described. The article then focused in more depth on smart solutions in the context of transport and logistics in the Czech Republic; carsharing and bikesharing were given as examples.

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