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MANAGING SUPPLY NETWORKS BASED ON THE SMART CITY CONCEPT – A REVIEW OF GOOD PRACTICES

Abstract : The aim of the article was to present solutions of the Smart City concept, which can also have a real impact on the management of supply networks. One of the two main grounds that make up the Smart City concept are human potential and technological potential, whose components are divided into six functional dimensions. Effective and reliable city management and supply network management depends on a well-chosen strategy and methods used. Benefits and effects of city management based on the Smart City concept can be seen in the ranking of the most intelligent cities. A city has its own centre, and in the case of a supply network, such a centre can be a city that has to cooperate so that the various processes carried out by the various links in the supply chain pass through it correctly, giving mutual benefits.

K e y w o r d s: Concept, Smart City, City, Management

J E L C o d e: L90, O10, O30

INTRODUCTION

At the beginning of the attempt to take up this topic, it is necessary to focus attention on the clarification of this main issue contained in the topic, which is the concept of Smart City. To go into practice you must first have theoretical knowledge of the subject. So what basically is the Smart City? The definition of Smart City is "trivially simple" but it is not universal. It is a concept with a broad scope of reasoning and a dynamically changing spectrum of elements involved, so the definition may change its form from year to year, month to month, etc. It is a concept of the future therefore it has no permanent definition. In Polish it is translated as Intelligent City. A smart city uses all the human and

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technological potential for its sustainable development. Smart City is a concept describing the city of the future, which will be adequate to the changing needs of the society or to the development of the economy, i.e. particular sectors included in it [Ryba, 2017, s. 84]. The introduction of this concept is to make life in cities better, more efficient, more environmentally friendly as well as more comfortable for people. The idea of the Smart City, i.e. the pursuit of cities to apply digital technology and automation to the needs of the local community, the use of autonomy, the widespread implementation of telematics to improve the lives of citizens, the mass deployment of electric vehicles and the development of energy infrastructure. In short, it is an attempt to create a symbiosis between information technologies and people [Drożdż, 2018, p.80]. Cities and the joint functioning of people in a relatively small space are some of the greatest achievements of mankind. "Cities form a network whose key elements are large centers of global importance (macropolis, megapolis and gigapolis), linked into a network of major centers of the world economic system accumulating its functions of management and control and world capital - centers where various services are provided: financial and commercial, information, cultural, etc., and at the same time where global impulses are transmitted "inwards" to each country [Bruska, 2012, s. 10]. Cities play a major role in rapid socio-economic and technological change. In order to adapt to the needs of a society that is changing rapidly, a city needs to evolve, that is, to develop and move forward, for which it needs a good strategy.

1. DIMENSIONS OF THE SMART CITY CONCEPT

Usually, discussions on Smart City focus on the technological dimension, for example, according to Iñaki Azkuna, Smart City is "a smart city that uses information and communication technologies to increase the interactivity and efficiency of urban infrastructure and its components, and to raise the awareness of citizens" [Azkuna, 2012], this dimension can include two aspects:

– Smart economy - a highly efficient and technologically advanced economy, developing new products and services and new business models, fostering local and global connections and international exchange of goods, services and knowledge, building competition,

– Smart mobility - i.e. transport and information and communication infrastructure, including: well-organized public transport, transport accessibility of the city on the national and international level, provision of ICT infrastructure, modern and sustainable transport systems.

The essential element that distinguishes this dimension is mobility. By mobility we can mean a networked transport system that includes; integrated transport and logistics systems, mainly using clean energy [Rześny-Cieplińska, Wach-Kloskowska, 2017, s. 132]opt.

An equally important dimension of the Smart City concept is ecology, which includes one of the six aspects, namely:

–   Smart environment - meaning the sustainable use of natural resources, i.e. striving to increase the use of renewable energy sources.

It leads to optimized and efficient energy consumption and reduced environmental emissions. This goal can be achieved through intelligent management of production and energy consumption. In practice, this means focusing on energy-efficient operations in various sectors of the economy. In energy distribution, the main determinants of energy efficiency are intelligent energy management systems, metering systems and meters. Public transport plays a major role in energy optimization by means of information technology, such as traffic control systems, information systems for traffic participants, and cargo optimization [Kowalczyk, 2015].

Smart city also considers socio-economic aspects such as [Rześny-Cieplińska, Wach-Kloskowska, 2017, s. 132]i:

–   Smart people - a key factor of social and human capital, putting human education at the center,

–   Smart living - high quality of life, which means safe and healthy living in a city with a rich cultural and residential offer, providing wide access to ICT infrastructure, enabling the creation of lifestyles, behavior and consumption,

–   Smart governance - where public participation in decision-making, transparency, quality and accessibility of public services play an important role.

These concepts are mainly related to the transformation of citizens' daily activities such as consumption, work, learning and culture, social relations, entertainment, etc. In particular, it is intended to become an area for creating synergies between innovative ICT applications in each of these areas, provided that these applications are accepted by the urban community and that they are implemented as part of economically viable investment solutions [Bruska, 2012, s. 11].

Creating a smart city, as previously assumed, is supposed to be about choosing a good enough strategy that must include threads in all six dimensions of the Smart City concept. **What does this look like in practice?**

2. REVIEV OF GOOD PRACTICES BASED ON THE RANKING OF THE 10 SMARTEST CITIES

Let's consider Europe, among the smartest cities according to the international ranking IESE Cities in Motion Index 2019 prepared by one of the best postgraduate schools for managers in the world IESE Business School from Europe

in the ranking of the 10 smartest are cities such as London , Amsterdam, Paris, Copenhagen, Berlin and Vienna. These are three cities where the Smart City concept is being introduced and developed. London was chosen as the world's smartest city in 2019, which finally managed to win the ranking, in which they had been in second place since 2016. This is shown in Table 1.

Table 1. 2019 Cities in Motion Index (CIMI)

Ranking	City	Performance	CIMI
1	London - United Kingdom	H	100,00
2	New York - USA	H	94,63
3	Amsterdam - Netherlands	RH	86,70
4	Paris - France	RH	86,23
5	Reykjavik - Iceland	RH	85,35
6	Tokyo - Japan	RH	84,11
7	Singapore - Singapore	RH	82,73
8	Copenhagen - Denmark	RH	81,80
9	Berlin - Germany	RH	80,88
10	Vienna - Austria	RH	78,85
11	Hong Kong - China	RH	78,76
12	Seoul - South Korea	RH	78,13
13	Stockholm - Sweden	RH	77,89
14	Oslo - Norway	RH	77,45
15	Zurich - Switzerland	RH	76,66
16	Los Angeles - USA	RH	76,04
17	Chicago - USA	RH	75,55
18	Toronto - Canada	RH	75,30
19	Sydney - Australia	RH	75,26
20	Melbourne - Australia	RH	75,08
21	San Francisco - USA	RH	75,07
22	Helsinki - Finland	RH	74,08
23	Washington - USA	RH	73,14
24	Madrid - Spain	RH	73,02
25	Boston - USA	RH	72,91
26	Wellington - New Zealand	RH	72,82
27	Munich - Germany	RH	72,71
28	Barcelona - Spain	RH	72,25
29	Basel - Switzerland	RH	70,39
30	Taipei - Taiwan	RH	70,04
31	Bern - Switzerland	RH	70,03
32	Geneva - Switzerland	RH	69,78
33	Frankfurt - Germany	RH	69,39
34	Hamburg - Germany	RH	69,23
35	Auckland - New Zealand	RH	69,10
36	Göteborg - Sweden	RH	68,65
37	Dublin - Ireland	RH	68,19
38	Montreal - Canada	RH	66,82
39	Ottawa - Canada	RH	66,68
40	Miami - USA	RH	66,31

Source: www.geospatialworld.net [access: 03.08.2019].

Being a city located in the United Kingdom, it is an ideal settlement for developers and researchers. The open data platform - London Datastore is not insignificant, it is free and accessible to everyone. It gives res

idents access to around 700 types of statistics, showing such things as the scale of crime, property prices, waste recycling rates or air quality. The database also contains information about the city's projects, such as the distribution of schools in neighbourhoods. In the category of transport and mobility London ranked very high. Due to the number of inhabitants living in the capital and its tourist attractiveness, the city invests a lot in the development of infrastructure and transport network [www.almine.pl, 03.08.2019].

Another city honoured on the podium was Amsterdam, which came in third, just behind New York one of the world's largest cities ranked second. Amsterdam a city located in the Netherlands is an exemplary example of a green city, currently predicted to be the first in Europe with zero harmful emissions. In this city as many as 90% of households own a bicycle, making it known as the bicycle capital of the world. Besides the popularity gained by bicycles, the city stands out by having the most modern parking systems in Europe. These solutions not only improve mobility and travel comfort, they are also a way to reduce exhaust fumes and smog, making it an ideal way to live a healthy life without unnecessary pollution [www.almine.pl, 03.08.2019].

Outside the podium were four cities located in Europe in turn: in fourth place is Paris the city and capital of France where almost half of French companies are headquartered, it is worth including here information about the *Grand Paris Express* project which involves the addition of four more metro lines, 68 new train stations and 200 kilometers of rail lines; in eighth place Copenhagen (Denmark) the city once called Europe's smartest city; in ninth place Berlin the capital of Germany and to finish the top 10, Vienna the capital of Austria a city that stands out for its very strong position in the Mobility and Transport category [www. almine.pl, 03.08.2019].

Among the 100 Smart Cities were Polish cities such as Wrocław, which ranked 95th maintaining its place from 2017, and Warsaw, which ranked 69th compared to 2017 it dropped 15 positions in the ranking. As far as Wrocław is concerned, transport and mobility projects play a big role. The city's goal is to increase the convenience of moving around in a fast and safe way, using technological innovations, which is also followed by environmental protection. Examples of completed projects in Wroclaw are [www.wroclaw.pl, 04.08.2019]:
   – Vozilla's urban electric car rental service;
   – Nextbike urban bike system;
   – Development of Intelligent Transportation System (ITS);
   – new system of making payments in the paid parking zone;
   – innovative in Poland cashless payment system in MPK vehicles;

- Mobill app for routing and paying for public transportation;
- "BLISKO" application for warning notifications (emergencies, weather events) to residents;
- series of robotics workshops for children (foreigners living in Wrocław and children with disabilities);
- Smart Flow - a tool for intelligent management of the water supply network;
- Open Data Wroclaw service - open city data sets for use by citizens.

The city is also working on and implementing projects as part of the CityLab Wrocław program, whose aim is to create areas in the city space where entrepreneurs, startups, scientists and consortia of these entities will be able to test unique and universal solutions in public space using new technologies. Such projects include [www.wroclaw.pl, 2019]:

- project for precise geolocation of public transport vehicles (modification of traffic lights to facilitate the movement of public transport vehicles);
- Improving care for seniors and people with disabilities - a research project to find IT solutions to improve the quality of life of seniors and people requiring remote care (including increased monitoring of the elderly or creation of a system to support caregivers and volunteers);
- Two parking projects: monitoring of parking space occupancy with indication of available spaces and access route in the application (improving parking in the city center);
- Research project connected with installation of weather stations and construction of mobile application indicating air quality together with prediction module and construction of air quality monitoring system in parks in Wroclaw;
- New city services with the use of lighting infrastructure - a project consisting in the replacement of lighting with LEDs along with twilight detectors, additionally it is planned to expand the functions of lighting poles for additional services;
- Installing sensors in the garbage cans and setting up a platform to optimize the passage of municipal cleaning services to improve the management system of municipal waste

In the near future, the city has plans to introduce a new queuing system for City Hall customers and a new parking occupancy management system for tour buses consisting of a mobile app and a platform for managers of parking lots accommodating coaches and vehicles for the disabled.

In conclusion, it can be said that the most important aspects of the Smart City concept relate to such a city, where future solutions are created (vision), the introduction of innovations, projects, programs affecting the creation of relations between the creation of economic and social values and consumption of resourc-

es, contributing to the achievement of objectives. All innovations introduced to cities develop them as well as shape the global economy, leading to sustainable development. It is a way to ensure prosperity for future generations that will not diminish over the years, but even increase. The basis for this is to leave the environment and people in a condition suitable for life as we found it.

With the idea of "Smart Cities" in theory and practice broadly defined, we can focus on the second area that is in the topic, which is "Supply Network Management" to answer the question - Can Supply Network Management be based on the Smart City concept and what will be its role in it?

3. SUPPLY NETWORK MANAGEMENT BASED
ON THE SMART CITY CONCEPT

Supply network management is nothing more than supply chain management, which is the process of moving goods and materials with the aim of satisfying consumer demand for specific consumption needs. This process is related to logistics in its broadest sense "It should be stated that the concept of supply chain management is in fact an extension of the principles of logistics [Dyczkowska, 2012, s. 25].

In the literature, logistics is defined in different ways in relation to the formation of the basic two streams of flows of goods and flows of information. If we consider here the city logistics or urban logistics, we can see that it is based on the concept of smart cities because it includes the same dimensions as: technological dimension, socio-economic dimension and ecological dimension [Bruska, 2012, s. 14].

The primary goals and objectives of city logistics in the literature concern the appropriate configuration of city logistics systems, particularly subsystems such as [Bruska, 2012, s. 14]:
–   public and individual transportation,
–   controlling the flows of material goods and people,
–   transportation of material goods, storage of material goods,
–   transport and storage of municipal waste.

The practical realization of the smart city idea can bring about a transformation in the structure of a city's logistics system on either a large or small scale. The basic change in the smart city model lies in the information and IT integration of all subsystems of the city [Bruska, 2012, s. 14]. Therefore, the main way to increase efficiency and reliability in management is the computerization and automation of all processes related to supply chain activities.

The concept of smart cities is associated with the concept of modern city management, especially with its transportation systems. Currently, many cities

around the world are pursuing strategies that aim to optimize the implementation of smart power systems and smart logistics and transportation systems. These strategies differ in the solutions adopted to improve the city in terms of transport, one of such strategies may even be the introduction of ITS (Intelligent Transport Systems) or Intelligent Transport Systems. The basic elements of ITS are [Zysińska, Krysiuk, Zakrzewski, 2014, s. 11977]:

–   Electronic Toll Collection Systems;
–   Passenger Information Systems;
–   Vehicle Assistance Systems;
–   Traffic Safety Management Systems;
–   Public Transportation Management Systems;
–   Incident and emergency services management systems;
–   Freight Management Systems;
–   Passenger Transportation Management Systems;
–   Vehicle Fleet Management Systems;
–   Route weather information management systems.

Considering these components, it can be assumed that intelligent transportation consists of three systems that work together, they are intelligent vehicle, intelligent road, and intelligent management center [Zysińska, Krysiuk, Zakrzewski, 2014, s. 11977]:.

ITS combines advanced information and communication technologies with the existing infrastructure to improve safety, environmental protection and the efficiency of transport processes. This involves dynamic traffic control through systems that monitor traffic and incidents, the introduction of telematics such as displays at transport stops and the possibility of buying electronic tickets, including parking tickets. ITS also influences driver behaviour by installing devices that measure speed or warn of danger. Additional advantages are Park&Ride systems and GPS receivers in public transport and emergency vehicles [Drożdż, 2018, p.80].

All these solutions result in a number of benefits, which include [Drożdż, 2018, p.80]:

- Increased transport infrastructure capacity by 22.5%
- Increased safety - around 50% fewer accidents
- Reduction in urban exhaust emissions by 40%
- Improved comfort of travel by private, public and pedestrian transport

SUMMARY

All of these Intelligent Transport Systems can significantly affect the level of service in supply chains in a positive way, helping the individual links in the network to develop. Incorporating Smart City aspects into supply chain

management concepts will allow for more efficient delivery processes and the integration of transport into production. The creation of intelligent systems facilitating the contact between the individual links of the supply chain through the introduction of platforms or applications will improve the fluidity of execution and the level of customer service. Including the consumer as a co-decision maker in the management of supply networks may have various consequences, but it may also prove to be an ideal solution to problems that have so far occurred in material and information flows. In Poland, one of the exemplary examples of Smart Cities Transportation in the so-called review of good practice in this area was Wroclaw, whose projects and innovations in this area were mentioned. This city is an example and an impulse to introduce changes, to at least try to modify and introduce new technology, new solutions on a "large" scale, because on a global scale, as it is done by the cities from the Top 10 Smart Cities. In this era of striving to be as environmentally friendly as possible, smart city solutions can have major applications, not only in supply network management, but also in waste management. Furthermore, the solutions used in modern cities have the secondary purpose of reducing congestion and facilitating transport, so that all processes take place faster and pollution, which is an external cost of transport, is significantly reduced.

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