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Crowdsourcing as a tool supporting intra-city communication

Łukasz Przysucha^[0000-0002-1644-1121]

Wroclaw University of Economics and Business
Komandorska 118/120 53-345 Wroclaw, Poland
lukasz.przysucha@ue.wroc.pl

Abstract. All over the world, we observe a trend of people moving from rural and poorly urbanized areas to larger cities and metropolises. This is due to the development of civilization, the need for work, and a greater quality of life. Sudden population growth in cities is associated with many problems that are often quite difficult to locate and repair. The idea of Smart City was created to improve urban processes, create a concept for the development of all areas of the city so that all elements in it are synchronized and harmonized with each other. The article compares Smart solutions from Singapore, Zürich and Wroclaw. The idea of the civic budget and the interaction between local administration, residents and stakeholders were also discussed. The author describes the concept of using crowdsourcing to acquire knowledge by city leaders, as well as the impact of these processes on the development of Smart City.

Keywords: knowledge management, crowdsourcing, smart city, knowledge acquisition

1 Introduction

Current statistics indicate the global trend of population migration from rural to urban areas [1]. In 1950, only 30% of the total population lived in cities, now it is almost 55%, while in 2050 it is over 65% of the population. Although the global population growth rate has dropped from 2.2% a year 50 years ago to 1.05% a year now, it is assumed that the earth will be inhabited by 8 billion people in 2024 and 9 billion people in 2043 [2]. It should be noted that the growth rate of inhabitants in cities is due to both the global migration trend and the population growth on Earth. Along with the increase in the population in cities as well as the size of metropolitan areas, problems arise in the efficient functioning of all elements of the city, starting from traffic jams, pollution, information chaos, ensuring an adequate amount of energy, which is distributed to various sources of obtaining it, as well as the lack of adequate living comfort caused by many other factors. In the 2000s, people began looking for solutions that would solve urban problems and improve their operation. At the beginning, IT companies IBM and Cisco invested a lot of money in projects developing the idea of a city that can be smart.

An extremely important element of every smart city is the management of information and knowledge possessed by residents and stakeholders. The city can acquire knowledge from residents and their needs in many ways. One of them is crowdsourcing which allows the knowledge of the crowd to be shared with the other party - in the case of cities, it can be local governments, presidents, mayors. In this case, the proper mechanism for distributing knowledge and information between all parties - city decision makers, residents, universities, business, as well as specific procedures allowing for effective management of this information and the needs of other parties must be extremely important.

The article consists of four parts. The first one focuses on the description of the Smart City idea. The first chapter describes Smart City, presents the history of the idea's creation and the division into usefulness and generations. The author presents areas in the standard Smart City division and examples of the Smart concept. The next chapter presents the practical use of intelligent solutions in selected cities: Singapore, Zürich and Wrocław. It has described the mechanism of the civic budget and the mechanisms of interaction between residents, stakeholders and local authorities. The last part of the article is devoted to the description of crowdsourcing processes. The author indicates the place of crowdsourcing in the knowledge flow diagram, describes the advantages of crowdsourcing and the scope of direct impact.

2 Smart City

The idea of a Smart City is a relatively new concept implemented and used by central and local government authorities, business entities and urban residents them

A smart city [3-5] is an urban area that uses information and communication technologies to increase the interactivity and efficiency of urban infrastructure and its components, as well as to raise awareness among residents. A city is intelligent if it invests in human capital [6], develops educational institutions, supports residents in managing knowledge and the flow of information inside the city. Recently, the aspect of civic participation and crowdsourcing has also been noticeable as an element activating both residents and other stakeholders operating in the area of a given urban agglomeration.

Smart City has its generations closely related to the development of the idea. The first person to divide Smart City into "versions" 1.0, 2.0. and 3.0 was Boyd Cohen, who dealt with the subject of Smart City and its development. Depending on the initiator of Smart City activities, three types of city development can be indicated: driven by the development and activity of technology companies located in a given metropolis, the intensification of activities of municipal authorities, which themselves are committed to creating new schemes and concepts for Smart City, and thanks to the initiatives of residents who they are the driving force behind Smart City projects (nowadays, quite a popular activity are civic budgets, which focus on drawing up investment tasks by residents and voting for them by others, and the result is the implementation of the most popular ideas).

It is worth dividing cities according to their models and generations [7]:

A. *Smart City 1.0*

Smart City 1.0 is created and inspired by technologies available in a given place and time. The initiator is a technology company that offers new technological solutions and wants to sell them. It is the simplest form of creating a smart city that does not fully solve the problems in the city. Often, offers are not dedicated to a given agglomeration, are not personalized and ultimately do not solve problems. Examples of such cities are Songdo in South Korea and Masdar in the United Arab Emirates. They are widely criticized for focusing too much on technology rather than the lives of ordinary residents.

B. *Smart City 2.0*

The Smart City 2.0 model is based on the development of the city by the administration. It is the local government that sets the pace of the city's technological development and imposes the concepts and paths of Smart City solutions. In this case, the needs of technology companies and the sale of their products are balanced, as well as the needs of residents living in the city and the usefulness of solutions implemented in the process of creating a Smart City. The final effect of the implementation and the obtained results are important. Currently, it is the most popular Smart City model in the world, but this is starting to change and the 3.0 model, which will be described in the next section, is becoming more and more fashionable. The most popular elements of this model are:

- the use of big data,
- use of electric public transport,
- intelligent transport systems,
- intelligent city lighting systems,
- publicly available technologies such as USB chargers, free city internet,
- city transport synchronized with electronic passenger systems.

C. *Smart City 3.0*

The Smart City 3.0 model focuses mainly on the role of citizens in shaping the city. It is a modern approach to the Smart City idea. The main factor determining the speed of urban development in this case is the involvement of residents. It is in this model that crowdsourcing can be used. First, however, it is necessary to determine how much residents can get involved and what factors should be met by the city in order to cooperate with residents to the maximum. The role of local government = creating space and opportunities to use the diverse potential of citizens. All kinds of development of interactions between city authorities, residents and stakeholders such as universities (education) and business are a manifestation of the Smart City 3.0 model.

The Smart City concept covers all areas of the city's development. Each resident lives with Smart City in a different way and with a different frequency. Below is a breakdown

of the main areas of Smart City according to the Author. The table also includes the main aspects of the use of Smart City technology in given areas and examples of implemented solutions.

It is worth noting that despite the fact that all areas are completely different from the others, they are easy to combine and it is possible to create interdisciplinary solutions between modules, e.g. in the area of Smart Mobility, tracking of public transport through electronic boards was used, while in Smart Management it was proposed to create an urban resident portal. By combining these two concepts, it is possible to create a resident application that will include, functionality focusing on tracking vehicles remotely, e.g. on a phone.

Table 1. Smart City areas.

Area name	Topics covering the area	Examples of smart concepts
Smart Mobility	sustainable transport system [8], IT systems supporting the use of urban transport, optimization of traffic in the city	public transport tracking through electronic timetables at stops
Smart Management	activation of residents and stakeholders to participate in public life, civic programs and enabling voting and referenda, clear and transparent government actions	IT system enabling remote voting, resident's on-line portal
Smart Environment	generating environmental awareness, verifying air quality, using renewable energy sources	systems supporting waste removal, creating parks and green areas, measuring air pollution, measuring water purity
Smart People	investing in human capital, cooperation between residents, universities, business and the government, qualifications, knowledge management	knowledge groups, competence bank, intra-city system of interpersonal communication
Smart Business	innovation in business, creating areas of entrepreneurship and business zones, flexible labor market, low unemployment, cooperation with international entities	investor support, lower taxes and reliefs for business, business events
Smart everyday life and communication	health protection, universal access to culture, high level of education, tourist attractiveness	Social media for residents, smart shopping with RFID module, search people by personality

3 Selected Smart Initiatives

Nowadays, all cities in developed countries want to be Smart. There is a fashion for modern technologies, efficient transport, good, fast Internet, healthy lifestyle and clean air and the environment.

In this chapter, the author compared several smart cities and showed the paths for further development of the agglomeration

3.1 Singapore

Singapore is number one in the Smart City category in most rankings. It has held this position for many years and is still in the lead. It is worth checking what the city has implemented and how it has improved the daily activities of its inhabitants.

The city-state that is discussed has a very developed awareness of being "smart". A lot of initiatives are created among the residents (Smart City 3.0). They are implemented in many aspects of life and serve both communication between decision-makers, stakeholders and residents as well as in the daily life of all citizens.

Smart Nation is an initiative of the government of Singapore, which focuses on the use of new technologies, networks of big data, elements of Business Intelligence for the development of civil society and the development of intra-city communication, as well as increasing the comfort of everyday life. The Smart Nation Initiative was presented by Prime Minister Lee Hsien Loong on November 24, 2014. The whole initiative is very money-consuming, but the effects are directly visible, and the government keeps statistics to improve ideas and increase use.

Below is an overview of the most important projects along with the effects of their implementation.

Table 2. Smart initiatives in Singapore.

Project name	Description of the initiative and effects of implementation
MyTransport.SG	The application fully personalizes itself to the user's favorite services. The traveler can locate stops in real mode, get information about taxis, parking places, information about traffic jams and live traffic, information for cyclists. 140 000 commuters enjoy one-stop (personalized journey planning daily).
PayNow	A service supporting money transfers among users. It was launched by the Singapore Banks Association (ABS) on July 10, 2017. It operates on a peer-to-peer basis. It enables free transfer of funds among retail clients in real time. A mobile phone number or a NRIC / FIN number is required.
Healthy365	Healthy 365 is a mobile application for Singapore citizens and residents. Its aim is to encourage users to a healthier lifestyle. The app connects to fitness monitoring devices. It mainly verifies the number of daily steps and the time spent on exercises. According to data from

February 2019 [9], 1.7 million registrations were made in the application. It is quite popular and supports the health of a large part of citizens.

Business Grants Portal	It is a website supporting businesses operating in the country. Offers a straightforward route to grant application. It is very intuitive.
Smart Gravitrap	Devices support the fight against dengue, which is endemic in Singapore. The prototype attracts and catches dengue-carrying female Aedes mosquitoes looking for places to lay eggs. About 50000 traps deployed in HDB estates to monitor Aedes mosquito population
Dementia Friends	The Dementia-Friendly Singapore initiative aims to build a more caring and inclusive society for persons with dementia and their caregivers. More than 40 seniors with dementia assisted through app community

3.2 Zürich

Another example of a Smart city classified at the top of the Smart City Index ranking is Zürich. It is at the major banking and financial centers of the world. In the Smart City Index 2019 ranking, Zürich was second, and third in the Smart City Index 2020 ranking. Below is the ranking of the top 30 places with the highest Smart City Index scores. They are cities from wealthy nations, mainly from Europe, Asia, North America and Australia.

City	Smart City Rank 2020	Change	Smart City Rating 2020	Smart City Rank 2019	Smart City Rating 2019
Singapore	1	— (0)	AAA	1	AAA
Helsinki	2	▲ (+6)	AA	8	A
Zurich	3	▼ (-1)	AA	2	AAA
Auckland	4	▲ (+2)	AA	6	A
Oslo	5	▼ (-2)	AA	3	AA
Copenhagen	6	▼ (-1)	AA	5	AA
Geneva	7	▼ (-3)	AA	4	AA
Taipei City	8	▼ (-1)	A	7	A
Amsterdam	9	▲ (+2)	A	11	A
New York	10	▲ (+28)	A	38	BBB
Munich	11	new	A		
Washington D.C.	12	▲ (+19)	A	31	BBB
Dusseldorf	13	▼ (-3)	A	10	A
Brisbane	14	▲ (+13)	A	27	BBB
London	15	▲ (+5)	A	20	BBB
Stockholm	16	▲ (+9)	A	25	BBB
Manchester	17	new	A		
Sydney	18	▼ (-4)	A	14	A
Vancouver	19	▼ (-6)	A	13	A
Melbourne	20	▲ (+4)	A	24	BBB
Montreal	21	▼ (-5)	A	16	A
Hamburg	22	new	A		
Newcastle	23	new	A		
Bilbao	24	▼ (-15)	BBB	9	A
Vienna	25	▼ (-8)	BBB	17	BBB
Los Angeles	26	▲ (+9)	BBB	35	BBB
San Francisco	27	▼ (-15)	BBB	12	A
The Hague	28	▲ (+1)	BBB	29	BBB
Rotterdam	29	▲ (+7)	BBB	36	BBB
Toronto	30	▼ (-15)	BBB	15	A

Fig 1. Smart City Index by International Institute for Management [10].

The Smart City project in Zürich focuses on 4 main aspects:

A. Focus on target groups and action plans.

The innovations and assumptions created are designed with long-term operation in mind. It is not only the present that counts, but also the future generations living in the agglomeration. Projects are created with target groups and specific utility in mind. People's needs and focused development are extremely important. All solutions are thoroughly analyzed beforehand and they are provided with appropriate, final acceptance.

B. Integration of all groups of people living and working in Zürich.

Creating a network between all groups in the city - establishing cooperation between residents and stakeholders. Promotion of cooperation between business, education, residents, local administration and cultural units working in the area of the Zürich agglomeration. With the use of technology, it is possible to increase the activation of residents and integration of all social groups. Appropriate use of technology can develop people's awareness to create a Smart Society.

C. Reliability, security and openness.

Zürich focused on data security, reliability of its infrastructure and availability of information. Local administration data is publicly available, while personal data has the highest priority of security and is properly hidden. Giving reading attributes and access to appropriate groups is crucial for the development of Smart City.

D. Investments in project development and great flexibility.

The city supports appropriate development, investments and processes that accelerate technological change. Modern applications are tested and implemented depending on the test results obtained and the final usefulness for the community. Modern solutions are introduced relatively early compared to other cities, and there are often project pilots that do not burden the budget too much, and guarantee innovation on a global scale.

"Zürich 2035 Strategies" is a strategy for the Zürich agglomeration assuming the achievement of long-term goals and appropriate development steps by 2035. The city focuses on sustainable development, adequate generation fertility, and implements appropriate programs to optimize energy management, housing policy and mobility.

Below is a diagram presenting the main questions regarding the city's functioning in 20 years (asked in 2015 when the project was launched).

Strategies Zurich 2035 basis for a Smart City Strategy



Fig 2. Strategies Zürich 2035 [11].

Importantly, the strategy is long-term and is continued by successive local governments. What matters is the good of the city and the community, rather than the particular interests of politicians. The first question focuses on what we are doing now and what we will be doing in the future. For Zürich, the financial stability of the city and its inhabitants is extremely important. The city's financial stability and an attractive location for doing business have an impact on credibility and stability (investors decide to open companies in a city that is predictable and stable in terms of politics). The second question concerns caring for the quality of life and choosing the right paths of sustainable development, creating social sensitivity and solidarity, proper use of energy and digitization of the city. The third question "How do we organize ourselves" concerns the wider community surrounding the city, international contacts, perception of the agglomeration in the world, cooperation with business entities located in other cities and countries.

3.3 Wroclaw

The last example of a Smart City is Wroclaw, the largest city in western Poland. The city has been on the Smart City Index list for many years and in many rankings classifying agglomerations that implement innovative projects and focus on Smart Society. As in most Smart City, local administration policy focuses on cooperation between residents, administration and business. Education and culture can also be qualified as stakeholders throughout the scheme. The development strategy assumes 8 main pillars of Smart City:

A. Management.

Management consists of three elements that create a coherent whole: policy and strategies, e-government and open self-government. Thanks to the implementation of these solutions, the office is more open to citizens, the availability of its services and the time spent by citizens on activities performed in it increases.

B. Economy.

Projects to stimulate local entrepreneurship and increase the innovativeness of companies operating in the market, factors stimulating productivity and openness with the global market.

C. Lifestyle.

It is the way people function in the city and use the range of its offers, as well as the way they influence the city themselves. All other pillars influence the level of lifestyle and quality of life.

D. People.

Projects developing the involvement, creativity and awareness of Smart Society in society. Focus on the idea of sustainable living.

E. Education.

Sustainable and integrated development is not possible without investing in education and knowledge, including education of the elderly, elimination of e-excluded and entrepreneurship education.

F. Mobility.

The area of mobility is an integrated transport system, ICT and supporting green transport.

G. Infrastructure.

Projects related to the development of infrastructure and the provision of the latest technologies in this area [12][13].

H. Environment.

Projects supporting the purification of the environment, smog, waste segregation, etc. It is the sustainable development of the city through proper resource management, investments in green technologies, public transport and pedestrians.

Wroclaw as a Smart City introduced the possibility of co-deciding the inhabitants about investments and undertakings in the city. Civic budget (in other words: participatory budget) - is a process that allows residents to discuss and directly influence decisions about allocating part of the public budget to projects proposed directly by citizens.

The main advantages of the Civic Budget include strengthening civic attitudes and shared responsibility for the city, showing the inhabitants the mechanisms of the city's functioning and better understanding of the inhabitants by local authorities.

4 Implementation of crowdsourcing processes

Due to the large development of the agglomeration, cities have problems with proper communication and information flow. Local authorities are wondering how to solve communication bottlenecks and how to meet the needs of residents. Crowdsourcing [14] is a tool that can support the exchange of information in the city. Crowdsourcing is a process by which the organization (company, public institution, non-profit organization) outsources the tasks performed traditionally by employees to an unidentified, usually very wide group of people in the form of open call. Importantly, for many years it was believed that crowdsourcing was possible only in organizations, companies, workplaces in order to obtain information from employees or collaborators. At present, it is possible to allow crowdsourcing in the Smart City area to improve communication between residents, local authorities and stakeholders. In this case, local authorities can obtain information through social media channels, websites, direct actions with residents and many other ways to facilitate communication between the two parties.

The chart below shows the place of crowdsourcing in the knowledge flow diagram.

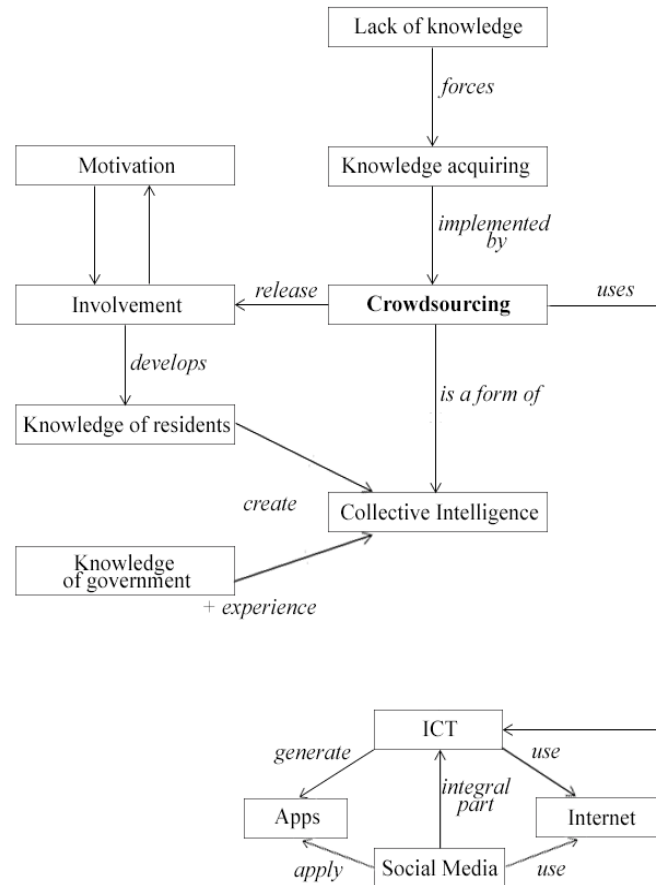


Fig 3. The place of crowdsourcing in the knowledge flow diagram.

In Smart City ventures, the diffusion of knowledge between decision makers and stakeholders leads to a reduction of the information gap. Knowledge gaps in decision-makers in cities force the acquisition of knowledge from residents and stakeholders. It is implemented through crowdsourcing. In turn, crowdsourcing uses modern ICT tools that use the Internet, Social Media as well as stationary and mobile applications. Crowdsourcing forces commitment that is directly related to motivation. Commitment supports and creates the knowledge of residents, which together with the knowledge of an experienced local government creates Collective Intelligence. Crowdsourcing is a form of Collective Intelligence.

The main advantages of crowdsourcing are: [15]

1. saves time and money (the crowd generates ideas much faster and preparing a website is definitely cheaper than paying for the work of a narrow, specialized team).
2. variety of submitted projects and their originality (many perspectives and points of view).
3. obtaining information on the needs and expectations of residents.

4. creating an engaged community.
5. marketing and promotional benefits

Crowdsourcing directly affects: [16]

1. contact between residents and decision makers
2. finding an information gap in the city
3. exchange of knowledge throughout the city
4. better understanding of the residents' needs
5. the ability to influence city decisions
6. creating social units

5 Conclusions

As cities develop, new problems arise. The idea of Smart City [17] is aimed at increasing the comfort of life of inhabitants living in a given agglomeration, optimization of information processes, better knowledge management, proper management of energy and available natural resources, improvement of traffic and public transport, and many others. The author focused on describing the acquisition of knowledge from the inhabitants. This process has many advantages and will certainly improve communication between residents, local decision-makers and stakeholders.

Thanks to crowdsourcing in the area of Smart City, the municipal government can save time and money when making decisions, there is a much greater variety of ideas, knowledge from the crowd results in standardization of expectations and directions, and develops originality of submitted projects. Decision-makers get information on the needs and expectations of residents. The community becomes more involved and motivated. There is a diffusion of knowledge and a full information cycle inside the city. Knowledge is sourcing, processed, modified and shared [18][19]. An important element is bilateral exchange, interaction between decision-makers and residents.

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