# Crowdsourcing as an Open Innovation Strategy in Knowledge-Based Smart City Management

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**Abstract:** A smart city is defined as an area that offers numerous opportunities for learning and innovation, relies on the creative potential of its inhabitants and institutions, and employs digital infrastructure for communicating and managing knowledge. An important related research direction to be considered is knowledge management for smart cities and urban innovation. The idea in this area is to collect and share knowledge in order to arrive at a collaborative approach towards the development of future urban environments. Open innovation is a new paradigm for building smart cities, where governments and software developers take advantage of the experience, skills, and knowledge of citizens to develop digital services that are relevant to users of the urban environment. Citizen involvement is a key to the successful development of cities, but empirical research into the nature and characteristics of this involvement remains scarce. The objective of this study is to explore the potential of open innovation strategies in knowledge-based smart city management and the role of the municipality herein. A limited set of crowdsourcing initiatives has been introduced to illustrate the open innovation strategies. This paper will tackle a part of this problem by adding to the understanding of generating, evaluating and selecting innovative ideas for smart city innovation by means of online crowdsourcing. The case studies research presented in this paper generates some empirical evidence with regards to the usage of crowdsourcing through an online platform in the context of trying to establish a smarter city. The study offers recommendations arising from the empirical research. An improved approach should consider citizens as active actors within the development process of smart cities. Citizens can collaborate in co-creating smart cities together with the private sector, governments, academia and knowledge institutes. One important element however still needs to be researched more in depth is user motivation. It remains an interesting research topic for future studies to investigate the optimal motivation for citizens in order to get them to share their knowledge.

**Keywords:** crowdsourcing, smart city, open innovation, knowledge sharing, knowledge-based urban development, knowledge-based smart city management

## 1. Introduction

Open innovation encourages organizations to search for solutions outside their organizational boundaries to address core management problems. The open innovation paradigm emerged when private firms started recognizing that useful knowledge is widely distributed and that they should use not only internal but also external ideas. As a consequence these roots, most extant open innovation research has studied this paradigm in the private sector (Mergel, 2018). Though significant scholarship has examined open strategies of firms and user communities in the private sector, less attention has been paid to open strategies for innovation in the public sector (Lee and Kwak, 2012; Nam, 2012). Open innovation in the private and in the public sector is different in many ways. While open innovation in the private sector usually has new product development as a main goal, open innovation in the public sector generally focuses on improving service performance and creating public value. Therefore it is a need of detailed analyses that explore the importance of public involvement in the development of smart cities, research on effective strategies for cities to become smarter and on approaches to mobilize the participation and intelligence of citizens, businesses and societal organizations.

The role and significance of social participation in local governance has been emphasized in the literature, but some researchers have also commented on the lack of detailed analyses that explore the importance of public involvement in the development of smart cities (Cortés-Cediel et al., 2021; Gollagher and Hartz-Karp, 2013).

Among the numerous concepts addressing urban development, the smart city concept offers the most comprehensive and multidimensional approach to knowledge-based city management, but none of the numerous definitions of a smart city has been universally recognized. Some definitions focus on technological aspects, some emphasize economic factors, and some highlight the importance of social participation.

Citizen involvement is key to the successful development of cities, but empirical research into the nature and characteristics of this involvement remains scarce.

The aim of this study is to explore the potential of open innovation strategies in knowledge-based smart city management and the role of the municipality herein. This paper will tackle a part of this problem by adding to the understanding of generating, evaluating and selecting innovative ideas for smart city innovation by means of online crowdsourcing. The case studies research presented in this paper therefore generates some empirical evidence with regards to the usage of crowdsourcing through an online platform in the context of trying to establish a smarter city.

## 2. Theoretical background

Crowdsourcing is the use of the crowd to obtain ideas, services, or content from a large group of people, usually from an online community, rather than from traditional channels. Crowdsourcing is a kind of participative online activity in which a large and possibly undefined group of people contribute to the tasks outsourced by requesters through a flexible open call (Estellés-Arolas and González-Ladrón-De-Guevara , 2012).

Inspired by the financial or non-financial benefits, there is a popular trend for firms or individuals to apply and for solvers to make use of crowdsourcing to handle different possible outsourced tasks, especially problem-solving tasks (Bassi et al., 2020). This idea refers to the intelligent decisions which are made when individuals, contrary to the wisdom of crowds, actually do combine their knowledge. Through social interaction, individual knowledge is shared, corrected, opened, processed, enriched and evaluated. This leads to results which are better than the results of a single individual (Schuurman et al., 2012). In the networked society in which we live today, the concept of collective intelligence seems to be more applicable than the wisdom of crowds. In the context of the open innovation-framework, these principles can be put into practice in order to give end-users or citizens, as external sources of innovation, a voice and an active role in the innovation process. The combination of the open innovation-concept of outsourcing with the concept wisdom of crowds leads to the process of crowdsourcing, a term first used by Jeff Howe (Howe, 2006). The rise of crowdsourcing connects the wisdom of crowds and the concept collective intelligence. Howe (2005) describes crowdsourcing as the phenomenon in which everyday people use their free time to help solving problems. The crowd is described as a big and unknown group of people. Using an online crowdsourcing platform, organizations are looking for creative ideas, answers or solutions, or they delegate certain tasks to a broad, diverse and decentralized network of individuals (Piller and Walcher , 2006).

A smart city is defined as an area that offers numerous opportunities for learning and innovation, relies on the creative potential of its inhabitants and institutions, and employs digital infrastructure for communicating and managing knowledge (Zheng and Schachter, 2017). Despite the fact that the smart city concept is already being implemented in many cities as part of projects and programs that rely on smart technologies, such as public Wi-Fi networks and intelligent traffic management systems, citizen-led development should be the next step in the evolution of smart cities. Technological advancement and the availability of modern ICT tools underscore the importance of e-participation as a source of external knowledge. Therefore an important related research direction to be considered is knowledge management for smart cities and urban innovation. The idea in this area is to collect and share knowledge regarding different projects, initiatives and concepts on organizational (Ferraris et al., 2019) and technical level, in order to arrive at a collaborative approach towards the development of future urban environments. Thus, cities are expected to become knowledge hubs for different participants in an urban innovation (Bresciani et al., 2018; Israilidis et al., 2021). The involved stakeholders who are considered for collaboration involve the public and the private sector. This includes city representatives and departments, citizens, companies, universities and research institutes as well as large scale industry such as software power houses or telecom and infrastructure providers (Tcholtchev and Schieferdecker, 2021).

Governments are increasingly looking for different governance mechanisms that open up this process by including interaction with citizens and other stakeholders. Hilgers and Ihl (2010) distinguish three levels of open innovation in the public sector. As a first tier, “citizen ideation and innovation” has been introduced, where citizens are involved through ideation and innovation challenges through online platforms to utilize the creativity and knowledge of the crowd. The second tier is referred to as “collaborative administration”, which means that common administrative tasks are improved through involving external actors in a systematic way. The third and final tier is entitled “collaborative democracy”, where larger groups of people are involved in policy making and implementation processes. Other example of open innovation in the public sector is collaborative innovation. Collaborative innovation refers to an opened-up innovation process, where citizens are integrated into the innovation cycle (idea generation, selection, implementation, and diffusion) from the earliest stage (Torfing ,

2019). In addition, Lee, Hwang and Choi (2012) describe a similar concept, citizen-centered governance, where a collaborative network of citizen experts is harnessed by the government to deal with problems more rapidly and precisely. They highlight that these networks can be both government-led and community-led. In this context of the open innovation-framework can be put into practice in order to give citizens as external sources of innovation. Using an online crowdsourcing platform, organizations are looking for creative ideas, answers or solutions, or they delegate certain tasks to a broad, diverse and decentralized network of individuals. Citizen engagement is now commonly central to smart city definitions and is said to be essential to address urban challenges. Information and communication technologies (ICTs) offer unprecedented opportunities for expanding public participation. Crowdsourcing enables the use of the crowd to obtain ideas, services, or content from a large group of people, usually from an online community, rather than from traditional channels (Cortés-Cediel et al., 2021).

Governments are increasingly looking for different governance mechanisms that open up city management process by including interaction with citizens and other stakeholders. Social participation with the involvement of new technologies is an inseparable element of the smart city concept. A modern smart city recognizes the importance of cooperation between the local authorities, inhabitants, and other users of urban space. The previous generations of smart cities have evolved into the smart city concept, where local residents are not only the recipients, but also the creators of the implemented changes in urban space. One of the theoretical goals of the smart city concept is to promote urban development through social participation and an improvement in the quality of life by engaging local community members in the process of planning urban development, setting directions for change, identifying problem areas in urban space, and proposing solutions (Israilidis et al., 2021; Torfing , 2019).

## 3. Research context and method

A lot of publications try to conceptualize and define the elements and application domains that constitute smart cities, mostly through case studies or comparative case study analysis. However, it is argued that there is a need for research on effective strategies for cities to become smarter and on approaches to mobilize the participation and intelligence of citizens, businesses and societal organizations (Gollagher and Hartz-Karp, 2013). Citizen engagement is now commonly central to smart city definitions and is said to be essential to address urban challenges. Information and communication technologies (ICTs) offer unprecedented opportunities for expanding public participation (Granier and Kudo, 2016) .

The objective of this study is to explore the potential of open innovation strategies in knowledge-based smart city management and the role of the municipality herein. For this purpose, a small sample of different crowdsourcing initiatives has been selected, to study various types of collaborations in order to inform the development of open innovation strategies in city management.

Data and information about crowdsourcing initiatives have been collected from secondary sources. The presented case studies have been explored through desk research using online resources (initiatives' web pages) and, when available, literature describing the initiatives has been included. The presented crowdsourcing examples refer to the concept of knowledge-based city management and provide insights into the dynamics of stakeholder relationships in open innovation process. The most important criterion of crowdsourcing examples selection was the nature of the collaboration of different actors for open innovation. The case studies have been selected on the premise of presenting both: variety regarding stakeholders' formulation of the collaboration and quality in the exchange of knowledge within the open innovation process.

The following case studies of crowdsourcing initiatives in knowledge- based smart city management have been presented and analyzed in this study.

***Case 1.*** Philadelphia used online platform Change By Us to crowdsource ideas for how to improve the city's neighborhoods. Citizens submitted proposals online, which were posted for other users to see. The platform also aggregated similar ideas so that like-minded citizens could organize and initiate projects.

***Case 2.*** New York used crowdsourcing in the Big Ideas challenge in which citizens submitted ideas online for applications that could be developed to improve New York civic services. In addition to citizen collaboration,

platforms like Change By Us and Big Ideas connected citizens with city officials that provided feedback and guidance on proposals.

***Case 3.*** Betri Reykjavik (Better Reykjavik) is an open innovation website that enables citizens to submit, debate, and prioritize policy proposals and ideas. Betri Reykjavik runs on the free and open source platform Your Priorities. Currently Betri Reykjavik is officially recognized and used by the City of Reykjavik as an online consultation forum. Citizens can use the platform to present ideas, view the ideas of others, debate different proposals and show their support for an idea by rating it. The Reykjavik City Council pledged to discuss the top rated proposals from the platform. Every month the top five ideas overall are referred to the appropriate city council committee. Additionally, the top rated idea in each of the thematic areas (e.g. tourism, education, transportation, etc.) is also transferred to the appropriate committee. The city council aims to process each proposal within one month of receiving it. The platform was designed to be easily integrated into social media platforms already used by citizens (namely Facebook and Twitter). Next to the advantages on the technical side, the strong and visible commitment of the city council to discuss and implement citizens' ideas is certainly a motivating factor.

***Case 4.*** Tirana is a city that has experienced a great transformation in the past decades. The city is hoping to improve living standards and the quality of life to rival nearby European cities. One of the city's strategies is to leverage the high number of smartphone users to open a real-time channel of communication with its citizens. To this end, the Tirana Ime (My Tirana) app was developed. Among its various features, Tirana Ime provides real time information to users about traffic, public transportation, pollution, tourism activities, as well as other emergency information and reports. Apart from receiving information from the city, users can also interact with the municipality by using the app to report issues to the municipality. The app allows users to report issues in their urban area, for example related to cleaning, infrastructure, or illegal constructions. For example, a citizen that notices a broken street light can take a picture of it, add details about the location, and send it to the city administration. The report will be followed up and the user will automatically be informed about the status.

***Case 5.*** Decide Madrid is the official open governance website of the Madrid City Council. The platform is based on open source code and can be freely used by other cities. During the proposal phase, citizens suggest, discuss and rank ideas. Top ranked proposals are checked for viability and costs, and if they meet the viability criteria moved to the voting phase. If a proposal does not meet the viability criteria (e.g. legality, within the competence of the city etc.) a report is published with an explanation as to why it was excluded from voting. A cost report gives an estimate of the expected cost for implementation. In the subsequent voting phase, proposals chosen by the citizens are automatically included in the budget of the following year. Any person around the globe with internet access can propose ideas and discuss during the proposal phase. A simple, anonymous user account suffices. The voting, however, is limited to registered inhabitants of Madrid. Residents without internet access or with other barriers to online participation can take part in the proposal phase at offline meetings. For the proposal phase as well as the voting phase, they can receive assistance with using the online platform at citizen service offices located in every district.

***Case 6.*** In Nexthamburg, citizens' ideas for projects are collected on an online platform. An editorial team clusters the submissions and users can comment and discuss the ideas, or express their support by becoming a fan. While taking advantage of online tools, the process also included important offline elements like workshops. The experience in Hamburg has shown that ICT can be very useful in organizing citizen participation, but that it also has its limits. Rates of online participation usually peaked immediately after an offline event, indicating that inspiration and motivation are easier to foster in-person.

***Case 7.*** Other example of crowdsourcing is the city Ghent (Belgium) and its Ghent Living Lab. Through various city channels, citizens were asked to submit their ideas with regards to ICTs and how they could benefit the quality of life of the citizens of Ghent through an online platform. The citizens can submit ideas and also cast three votes on the preferred ideas and discuss each idea. A panel of experts rate both the citizen and the expert selection of ideas on three quality dimensions: innovativeness, user benefit and feasibility.

***Case 8.*** An interesting example of open innovation strategy implementation in city management is Rotterdam. The platform of Qurrent is used to divide the profits of the generated energy. Citizens then collectively buy solar panels for this roof, from which they will receive part of the yield. The motivation to do this is that citizens wanted to create sources of clean energy for themselves. Moreover, they do not want to wait for the

government to act, but they initiate renewable energy sources themselves. The municipality of Rotterdam funded this initiative through CityLab010. The initiative operates on the neighborhood level and has face-to-face interactions with citizens, as well as digital interactions (through the Qurrent platform).

***Case 9.*** Other example from Rotterdam is Happy Streets. It is organization that sets up temporary experiments in the streets of Rotterdam to create a more inclusive and sustainable mobility and to make better use of the public space. The experiments, organized together with the municipality, the residents, entrepreneurs, and researchers, are tactile interventions on the streets to test what type of solutions could work in the long term for the city of Rotterdam. A Happy Streets Index is also being developed by the group, which will be a research-based tool which can help to identify how spaces can be used best to increase quality of life. Happy Streets is a collaboration effort of the City of Rotterdam, the research institute DRIFT, and the urban agency Humankind and Street Events.

***Case 10.*** As part of a larger campaign to promote cycling behavior, the municipality of Rotterdam has implemented several interventions to experiment with ways to make the city friendlier towards bicycle traffic. Input was collected from different sources to define the bicycle program, for example: district committees, stakeholders, and cyclists. A lot of comments are collected, mainly through the platform Fietsfan010 (Fan of Cycling Rotterdam). With this input, some changes were made to the original plan. For example, more attention was given to lighting on bicycle paths. Another example is a sort of traffic light that shows cyclists the shortest way to cross an intersection. This traffic light interventions system has been developed for the improvement of cycling traffic in the city.

Implementing open innovation methodologies in the public sector can have myriad positive benefits, including improved awareness of social problems, more effective practices based on broad citizen experience, and increased trust between government and citizens (Mergel and Desouza, 2013). The involvement of citizens into innovation processes through and with regards to ICTs is a key aspect in cities becoming smarter.

## 4. Results and discussion

For this research, different examples of initiatives with innovative proposals for city development have been selected and studied. This section collects outcome of analysis in the form of comparison of different crowdsourcing solutions, analysed in this study.

The examples of the open innovation have been mapped in two different tables. The first one explains their relation to urban development and urban challenges addressed by the crowdsourcing initiatives. Based on the literature review the following categories of urban challenges have been proposed: quality of life improvement, city innovation development, sustainable development, environment protection, urban development and city problems solving. In the second table, types of stakeholders involved in each initiative have been mapped, as well as their roles in the different initiatives, in order to primarily elaborate upon the different roles the municipality can take in each of the presented examples.

The below tables bring together outcomes of analysis of the initiatives in regards to the urban challenge they address (Table 1), as well as the collaboration that takes place in each instance (Table 2).

**Table 1**: The urban challenges addressed by the open innovation initiatives

| | **Quality of life** | **City innovation** | **Sustainable development** | **Environment protection** | **Urban development** | **City problems solving** |
|---|---|---|---|---|---|---|
| Change By Us Philadelphia | X | | | | X | X |
| Big Ideas New York | X | | | | X | X |
| Betri Reykjavik | X | | | | X | X |
| Ghent Living Lab | X | X | | | X | X |
| Decide Madrid | X | | | | X | X |
| Nexthamburg | X | X | X | X | X | X |
| Tirana Ime (My Tirana) | X | | | X | X | X |

| | **Quality of life** | **City innovation** | **Sustainable development** | **Environment protection** | **Urban development** | **City problems solving** |
|---|---|---|---|---|---|---|
| Happy Streets (Rotterdam) | X | | X | X | X | X |
| Qurrent platform (Rotterdam) | X | X | X | X | | |
| Fietsfan010 (Rotterdam) | X | X | X | X | | |

**Table 2:** The involved stakeholders and their role in the open innovation initiatives

| | **Municipality** | **Citizens** | **Business and Industry** | **Academia** | **Other organisations, institutions and agencies** |
|---|---|---|---|---|---|
| Change By Us Philadelphia | Project initiator<br>Funding provider<br>Project executor | Knowledge provider<br>Project initiator | | | |
| Big Ideas New York | Project initiator<br>Funding provider<br>Project executor | Knowledge provider | | | |
| Betri Reykjavik | Project initiator<br>Funding provider<br>Project executor | Knowledge provider | | | |
| Ghent Living Lab | Project initiator<br>Funding provider<br>Project executor | Knowledge provider | Knowledge provider | Knowledge provider | Knowledge provider |
| Decide Madrid | Project initiator<br>Funding provider<br>Project executor | Knowledge provider | | | |
| Nexthamburg | Project initiator<br>Funding provider<br>Project executor | Knowledge provider | | | |
| Tirana Ime (My Tirana) | Project initiator<br>Funding provider<br>Project executor | Knowledge provider | Project executor | | |
| Happy Streets (Rotterdam) | Project initiator<br>Funding provider | Knowledge provider<br>Project executor | Knowledge provider | Project initiator<br>Knowledge provider | Project initiator<br>Knowledge provider<br>Project executor |
| Citylab010 | Funding provider | Project initiator | Project executor | | |

| | **Municipality** | **Citizens** | **Business and Industry** | **Academia** | **Other organisations, institutions and agencies** |
|---|---|---|---|---|---|
| Qurrent platform (Rotterdam) | | Project executor<br>Knowledge provider | Knowledge provider | | |
| Fietsfan010 (Rotterdam) | Project initiator<br>Funding provider<br>Knowledge provider<br>Project executor | Knowledge provider | | | Knowledge provider |

To understand how these initiatives came to fruition, all stakeholders involved in each initiative have been mapped. Moreover, their roles within the collaboration are described in the table: initiator of the project, provider of the funding, provider of knowledge, and execution of the project. Providing knowledge can be either some form of expert knowledge, or knowledge of citizens on their own living environment. The aim is to understand the possible different roles the municipality takes in collaborations for open innovation for city development. The selected innovative initiatives showed a dynamic variety in collaboration among the different urban stakeholders. Moreover, they showed different roles of the municipality in participating in open innovation in the city. Data collection showed that multiple parties collaborated and contributed to the impact of the project, although, some initiatives were community-led while others were government-led, and in other cases the initiation of the project was the result of an initial collaboration, therefore there was not a defined single initiator. However, the municipality was playing a crucial role in all selected initiatives.

Through exploration, three strategies of open innovation have been identified, depending on the role of the municipality in the collaboration and the impact of this collaboration on the different actors involved.

The first strategy observed, which can be seen as a basic type of collaboration for open innovation. The municipality involves other agents, such as the city locals or an expert, in order to collect input that will be processed inside the local government. In these initiatives, the municipality applies an open innovation approach with the intention of learning from other agents. Among those explored in this study, this level of open innovation has been observed in example of Fietsfan010, where has been elaborated the traffic light interventions system for the improvement of cycling traffic in the Rotterdam. The initiatives that fit within this level are usually temporary experiments or small-scale urban interventions.

The second strategy identified, where the municipality is taking the role of the main funding agency and an infrastructure agent of an open innovation process, without partaking of the learning generated from these processes, or being involved in a co-creation process. Regarding the selected initiatives, the excellent example of this strategy is Qurrent platform. This initiative received funding from the municipality's platform CityLab010. Through an authority such as Citylab010, the municipality of Rotterdam creates fertile grounds for the generation of a participatory climate and for innovative initiatives.

A third strategy for open innovation can be observed in those initiatives where all stakeholders were closely involved along the collaboration process and started to act in a co-creative partnership with other stakeholders. This third strategy of open innovation is highly collective and co-creation plays an important role on multiple levels in the development process. Exemplary initiatives illustrating this third strategy are Happy Streets and Ghent Living Lab, where all stakeholders have an important and clear role towards the shared goal. They also openly share the generated knowledge, whereby interested parties can join or help in this transition. Another significant aspect in the explored initiatives in the third strategy is that the municipality actively supports a co-creative process with their citizens.

Open innovation is a new paradigm for building smart cities, where governments and software developers take advantage of the experience, skills, and knowledge of citizens to develop digital services that are relevant to users of the urban environment. Using open innovation strategies in a city context can also have disadvantages, when not carefully executed. In an open innovation process, it is more difficult to distinguish who is responsible

and accountable for the outcomes of the project and different decision making processes, therefore it can create difficulties in implementation of innovations.

## 5. Conclusion

Whereas the main objective of this study is to explore the potential of open innovation strategies in knowledge-based smart city management and the role of the municipality herein, a limited set of crowdsourcing initiatives has been introduced to illustrate the open innovation strategies.

Citizen engagement is now commonly central to smart city definitions and is said to be essential to address urban challenges. Information and communication technologies offer unprecedented opportunities for expanding public participation. Crowdsourcing enables the use of the crowd to obtain ideas or content from a large group of people, usually from an online community, rather than from traditional channels. Therefore governments are increasingly looking for different governance mechanisms that open up city management process by including interaction with citizens.

The dynamic development of innovative technologies provides opportunities to build smart cities. However, excessive focus on the technological aspect alone leads to many problems in the implementation of the smart city concept. In the current perception of the smart city concept, there is a return to the needs and preferences of the inhabitants. They are the focus, and technical solutions are to serve their interests. This study offered evidence based on how citizen engagement can be embedded to deliver smart city activities of municipalities. Based on the case study analysis the study argued that citizen engagement needs to be at the forefront for co-creating smart cities development.

Smart city is seen as a centre of knowledge and creativity, because the development of smart cities is becoming more and more knowledge based. As a result, knowledge has been perceived as the core component that makes cities smart. Smart cities managers need to adopt proper organisational and managerial practices to effectively create, collect, organise, use, exploit, share, and transfer the external knowledge. The effective strategy in knowledge-based smart city management is crowdsourcing. This strategy highlights the importance of external knowledge sources in public sector management. This study contributes to research streams in open innovation by exploring this strategy in the public sector, distinguished from private business.

The study offers recommendations arising from the empirical research. An improved approach should consider citizens as active actors within the development process of smart cities. Citizens can collaborate in co-creating smart cities together with the private sector, governments, academia and knowledge institutes.

One important element however still needs to be researched more in depth is user motivation. It remains an interesting research topic for future studies to investigate the optimal motivation for citizens in order to get them to submit their best ideas.

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