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Urban Innovation System and the Role of an Open Web-based Platform: The Case of Amsterdam Smart City

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Abstract. *This study discusses an urban innovation system and the role of digital technology using the Amsterdam Smart City as a case. Based on semi-structured interviews and document analysis, this study reveals that Amsterdam Smart City can be considered an example of a new type of urban innovation system. There are nine actor categories involved with either a one-sided or a bi-directional relationship between them in this innovation system. The actors dynamically interact with each other in different innovation phases based on their interests and resources. Besides, the use of an open web-based platform to connect actors and to exchange information in the innovation system makes the information distributed fairly and transparently among actors. Additionally, more actors can be reached to join the innovation system. There is also no geographical limitation between actors to collaborate and innovate on a specific idea. Therefore, dynamic interactions between actors that are facilitated by an open web-based platform can be a new way of developing an innovation system in urban areas.*

Keywords. *Urban innovation system, smart city, digital technology.*

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Abstrak. *Studi ini membahas sistem inovasi perkotaan dan peran teknologi digital, dengan menggunakan Amsterdam Smart City sebagai sebuah kasus. Berdasarkan wawancara semi-terstruktur dan analisis dokumen, penelitian ini mengungkapkan bahwa Amsterdam Smart City dapat dianggap sebagai contoh bentuk baru dari sistem inovasi perkotaan. Ada sembilan kategori aktor yang terlibat dengan hubungan satu-sisi atau dua arah di antara mereka dalam sistem inovasi ini. Para aktor secara dinamis berinteraksi satu sama lain dalam fase inovasi yang berbeda berdasarkan pada minat dan sumber daya mereka. Selain itu, penggunaan platform berbasis web terbuka untuk menghubungkan aktor-aktor dan untuk bertukar informasi dalam sistem inovasi membuat informasi didistribusikan secara adil dan transparan di antara para aktor. Di samping itu, semakin banyak jumlah aktor yang dapat bergabung dengan sistem inovasi ini. Tidak ada batasan geografis di antara para aktor untuk berkolaborasi dan berinovasi pada ide tertentu. Oleh karena itu, interaksi yang dinamis antara para aktor yang difasilitasi oleh platform berbasis web terbuka dapat menjadi cara baru untuk mengembangkan sistem inovasi di wilayah perkotaan.*

Kata Kunci. *Sistem inovasi perkotaan, kota pintar, teknologi digital.*

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Introduction

One of the current urbanization trends is the rapid increase of the urban population. It makes cities face complex issues, especially around environmental management, such as rising of CO_2 emissions (Nam & Padro, 2011; Ojo et al., 2016; Akaslan et al., 2017). To deal with these complex issues, cities must use more advanced environmental management.

At the same time, there is a rapid development of information and communication technologies (ICT) that urban people are using to support their life in the city (Cocchia, 2014; Monzon, 2015). ICT is an important tool for people in the city to satisfy their information and communication needs more effectively and efficiently.

Understanding the potential, impact and importance of ICT in cities, many governments have adopted various technologies to cope with the more complex urban challenges of improving the citizens' quality of life (Nam & Padro, 2011). Governments expect that dedicated ICT can provide them with a way to manage the urban environment more effectively and efficiently.

A fine example comes from Amsterdam. The city government together with specific (private) stakeholders established an organization called Amsterdam Smart City (ASC) and they developed an open web-based platform for the organization. The open web-based platform will be identified as the ASC platform in the rest of this paper. This organization and platform were developed to increase collaboration between citizens and organizations in finding solutions for specific environmental problems in the city, with reduction of CO_2 emissions as one of the key purposes (Amsterdam Smart City, 2011; Winden et al., 2016). Both government and non-governmental parties can initiate a project within this system to deal with particular urban problems affiliated with environmental aspects. It is also an example on how a 'formally-planned city' legitimates and recognizes informal activities in the city (see also Jones, 2017). This informality at a certain scale may also induce 'participatory-based development' to educate and unite actors in the city (Kusumastuti, 2017).

The term 'urban innovation system' refers to networks consisting of a set of companies and organizations with free exchange of information among them in an urban context (Grossetti, 1999). It can be an agglomeration with different outlines, either physical or not. Nowadays, this is supported by the development of ICT, therefore the information exchange can be conducted via digital technologies, i.e. websites, mobile apps, and social media.

As Iizuka (2013) states, innovations systems have shifted from firm-centralized to community-centralized. This means that currently innovation systems are not only used to improve the performance of firms but also to enhance the quality of life of communities. An innovation system appearing in an urban area can be typified as an urban innovation system.

ASC is a suitable case for explaining this shift, as it makes use of a wide range of actors using a unique approach to connect them in a collaborative environment to create innovation in coping with urban issues. This study aimed to identify the role of digital technologies used in Amsterdam Smart City as an urban innovation system. However, to identify it, we had to analyse ASC's innovation system first, because it helps to see whether ASC can be considered an urban innovation system or not. Therefore, two intertwined research questions were raised, namely how does the interaction take place between the actors in Amsterdam Smart City based on an urban innovation system framework? And how can the role of the open web-based platform in Amsterdam Smart City be described as an urban innovation system?

This study confirms and contributes to innovation system theory and practice in which there are different types of relationships between actors in an innovation system, and where they dynamically interact with each other in different innovation phases. An open web-based platform can add value to the innovation system by easily connecting actors and exchanging information among them, making the information distribution transparent and fair. This reveals that currently there is no geographical limitation to implement an innovation system, as actors all around the world can connect with the system using an open web-based platform.

After this introduction, the method used for this research is explained. It will be followed by an explanation of the urban innovation system from a historical perspective, resulting in a framework. Based on this framework, ASC and its platform will be described, including its development, actors and operations of the organization and platform. The next step is to describe the interaction between actors who are involved in the platform using the framework. Additionally, that section also explains the role of digital technology in the ASC platform. Finally, the discussion and conclusion section will present the research findings.

Methodology

A case study approach seems the most suitable strategy to further deal with the research questions. Yin (2003) stated that a case study is a suitable strategy when you want to analyse a contemporary case with no manipulation towards relevant behaviours. Furthermore, a case study is an investigation strategy to deeply explore a program, event, process, or individuals that is bounded in time and activity by using a variety of data collection methods in a limited period to gather detailed information (Creswell, 2009). To find an answer to our research questions we used a specific actual situation. In this paper, we use ASC as a single case study with two units of analyses, the smart city project actors and the open web-based platform, because our focus is more on the actor interaction and the platform as a medium to organize the interaction within ASC. Data were collected through semi-structured interviews and document analysis. Seven persons from partners of ASC were interviewed between October 2017 and January 2018. They told us about the organization and the platform by providing information about bureaucracy, policies and regulations, financial and human resources, and the regular practice of smart city projects. In the following sections, the interviewees will be presented based on their position within the organization. The analysis focuses on the actors involved in and on the open web-based platform technology applied for the ASC platform.

Urban Innovation System

So far, four innovation system approaches have been distinguished in scientific papers, namely national, regional, sectoral, and technological innovation systems (Carlsson et al., 2002; Edquist, 2005; Warnke et al., 2016). However these approaches differ from each other and should be applied within their own context. In this section, each approach will be shortly described to give an understanding of its definition and characteristic.

The national innovation system was first introduced by Freeman (1987). He stated that a national innovation system is a network of public and private institutions functioning as a joint effort to develop new technologies. This approach was adopted by the Organisation for Economic Co-operation and Development (OECD) in 1997 to help the policymakers leveraging the innovation performance in their country. Moreover, OECD (1997) explained that a national innovation system stands for understanding the relationships between the actors in a network as a collective understanding to introduce and extend a new technology into society. The definition

above implies that a national innovation system is an approach to help national policymakers understand the relationships between actors. Various innovations are then developed as an outcome of these well-known relationships. Analysis of the relationships is conducted at national level and the actors are all public and private institutions at the national level, namely governments, industries, firms, universities, research institutes, and other actors who have a focus on the (national) development of science and technology (Carlsson et al., 2002).

The second approach is the regional innovation system, which is derived from the national innovation system (Doloreux, 2002). Therefore, their characteristics are similar. It is argued that a distinction between national and regional innovation system cannot be clearly made (Doloreux, 2002). Consequently, the definition of a regional innovation system is basically the same as that of a national innovation system. However, they can differ in context and focus. A regional innovation system has a specific territory, which is a specialized location for various actors, such as industries, firms, research institutes and other actors, to share their knowledge and support with each other in a systemic way to produce innovative products on a regional level (Lau & Lo, 2015). Hence, it focuses more on a specific innovation of a firm's products in order to put a more competitive product in the market.

The next approach is the sectoral innovation system, which resembles the regional innovation system (Carlsson et al., 2002). However, this approach focuses more on a specific sector or industry, which usually has heterogeneous actors inside it, such as various firms, research institutions and other supporting institutions (Malerba, 2005). The dynamic process of technological development within this approach determines its differentiation from the more static regional innovation system. The idea of a sectoral innovation system is based on the dynamic change of technological use within the sector.

The final approach is a technological innovation system in which the actors and their relationships bring about innovation as their focus. However, its characteristics differ from the other approaches. It does not have a specific spatial and context boundary like the previous approaches (Carlsson et al., 2002; Edquist, 2005). Actors can come from anywhere and join the system to pursue innovation of a specific technology. They can also come and go during the innovation process. Therefore, this approach is more dynamic than the other approaches. Due to its focus on a specific technology, the number of actors involved is smaller than in the national or regional innovation system (Lau & Lo, 2015).

Based on the description of each innovation system above, all approaches have their focus on the analysis of the actors involved and their relationship in pursuing new technology. However, they differ in characteristics. A national and regional innovation system is based on a specific administrative spatial boundary and is more static in terms of the actors involved, mainly because of the policies at the national or regional level, which instruct them to have consistent actors. On the other hand, a sectoral and technological innovation system is not based on a specific administrative spatial boundary but more on a functional boundary, such as an industrial district, an innovation environment, or a technopole (Doloreux, 2002). Additionally, these last two approaches are dynamic because every actor can come and go somewhere during the innovation process. The type of actors in all approaches is the same: actors can be more static or dynamic and be involved in an administrative or functional boundary area depending on the applied innovation system. An organization that uses a national innovation system will have more static actors gathered from a particular boundary area, whereas an organization that uses a technological innovation system will have more dynamic actors from anywhere. Compared to each other, Grosetti (1999) argued that national and regional innovation systems

have a top-down approach, where the innovation system is dictated by national or regional policies. Meanwhile, sectoral and technological innovation systems have a bottom-up approach, where the innovation system grows from a local context and not from policies.

This study attempted to look for an approach with the following characteristics: (1) spatial boundary area; (2) dynamics. Therefore, this research used the approach of an urban innovation system by adopting the characteristic of a national or regional innovation system for the spatial boundary area and a sectoral or technological innovation system for the dynamic system. Next to the administrative boundary, an urban area has many actors who can be involved in all or parts (phases) of the innovation process. Especially the adoption of an open web-based platform stimulates many actors to join and leave an innovation project. For instance, they can be involved only during the idea development phase or in the implementation process. Therefore, a more dynamic system is needed for an urban innovation system in this study context.

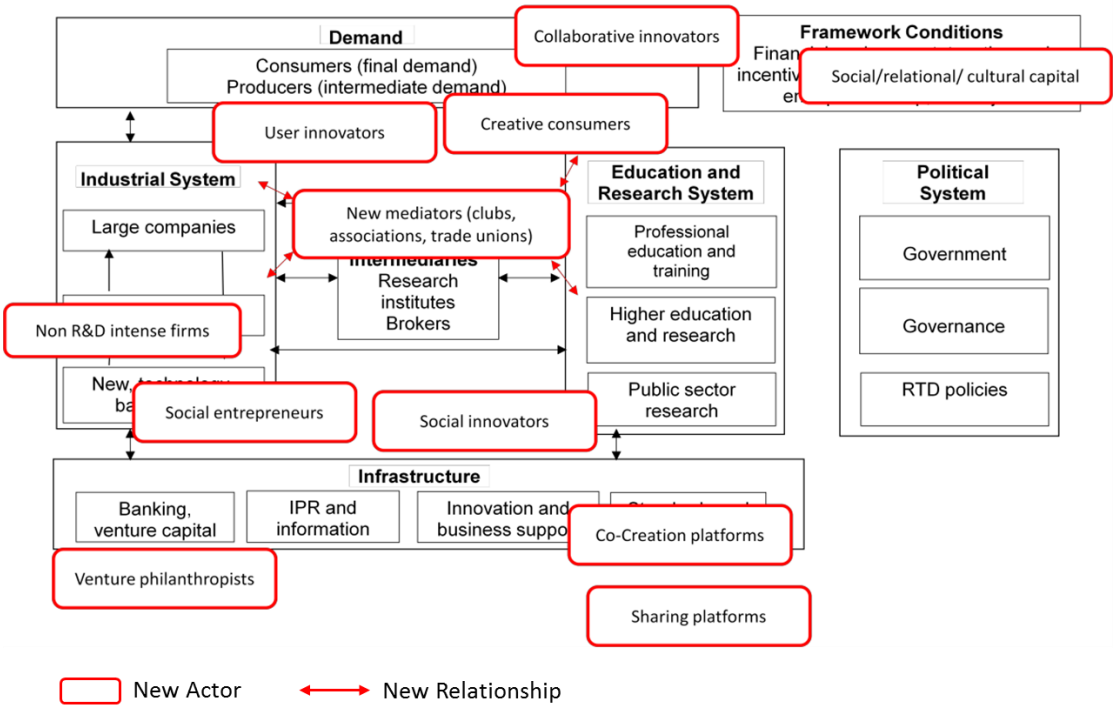

Figure 1. Revised innovation system model (Kuhlman & Arnold, 2001; Warnke et al., 2016) (red boxes and arrows after revision by Warnke et al., 2016)

We constructed a framework for this study based on the national innovation system framework developed by Kuhlman & Arnold (2001), which was revised by Warnke et al. (2016) to be relevant for existing conditions (Figure 1). There are two main elements of the framework relevant to the current condition, namely the emergent actors involved in the innovation system and the shifted definition from an innovation system for leveraging a firm's product to an innovation system for improving the community's quality of life. That relevance will influence how we identify ASC as an urban innovation system, because there are several emerging actors involved in it with the goal to improve the citizen's quality of life. This study analysed the actors involved and their relationship to the urban context by testing the framework using the ASC case. The revised framework is also in line with Iizuka (2013), as in the current situation the innovation process is not only linked to a firm's product and to gain a more competitive

product for the firm, region, or nation. Nowadays, however, an innovation system can also be a way to improve the life of a community. Furthermore, citizens not only can be seen as customers but also as agents of innovation, where they can be innovators who have an idea towards the application and use of a new technology.

Figure 1 shows the actors and their relationships. Warnke et al. (2016) added new actors and relationships in the framework, represented by the red box and arrows, to make it more relevant for the present situation. It reveals that more actors emerge in dealing with specific problems. The most important actor is the group of intermediaries ('new mediators') who are the backbone of the innovation system, as they help to connect actors with the same interests Warnke et al. (2016). Howells (2006) reveals ten general roles of intermediary organizations, namely foresight and diagnostics; scanning and information processing; knowledge processing and combination/recombination; gatekeeping and brokering; testing and validation; accreditation; validation and regulation; protecting the results; commercialisation; and evaluation of outcomes. Each role includes activities of an intermediary in an innovation process. It has to be an active actor to make sure that different actors are accommodated so that the innovation system will keep on going. Other actors that can be involved are the industrial system, education and research system, and demand.[3] They form the sub-system of intermediary actors that are influencing and being influenced by each other through the intermediaries. However, Warnke et al. (2016) state that the industrial system has to have more focus on social entrepreneurs and non R&D intense firms as they emerge as new technology-based firms that focus on a specific urban problem. As such, they offer a specific solution to the problem. Besides, Warnke et al. (2016) also add three new actors with an 'innovator' label, namely user innovators, social innovators, and collaborative innovators, which have a fuzzy interaction with other actors. This addition is also applied to new actors at the infrastructure level, namely the venture philanthropist, the co-creation platform, and the sharing platform. Furthermore, all actors are restricted and shaped by the political system and the framework is based on the conditions of social, relational, and cultural capital of the city.

Amsterdam Smart City Organization

To better understand the relationship between actors in ASC, we first elucidate the term 'smart city'. We then continue with how the smart city concept with its related actors is applied in ASC. There are various definitions of the smart city, which makes it more a contextual than a general term (see Table 1).

Based on the definitions above, it can be summarized that a smart city is a city that uses ICT to increase the citizen's quality of life by sensing, analysing, and integrating information through a multi-dimensional approach and collaboration between policy, citizens, research, and private partners in six dimensions (people, economy, governance, mobility, environment and living).

ASC was started in 2009 as an initiative between Amsterdam municipality (the governmental part and the Amsterdam Economic Board) and (private) companies (KPN and Alliander). It focuses more on citizen-oriented strategies in its operationalization to increase the awareness of citizens towards environmental issues in the city (Dameri, 2017). Eventually, all projects developed via ASC come from the collaboration among citizens, communities, and related

[3] Based on Warnke et al. (2016), the demand formed by consumers is the final demand and the demand formed by producers is the intermediate demand.

companies. And they participate in the platform organisation together with governments, knowledge institutions, and other emerging actors (see Table 2). This illustrates that technology is not the central point of the platform (Winden et al., 2016), while most cities in the world are more focused on technology as a central aspect of the development of smart cities. ASC has defined a smart city as follows:

> *"A smart city is all about the total sum of innovative technology, behavioural change and sustainable economic investments. By bringing partners together and setting up small local projects, it creates opportunities for these initiatives to be tested."* (Amsterdam Smart City, 2011, p. 7)

Table 1. Smart City Definitions (based on Dameri, 2017).

Definition	Reference
"A city that **monitors and integrates** conditions of all of **its critical infrastructures**, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its **preventive maintenance** activities, and **monitor security aspects** while maximizing services to its citizens"	(Hall, 2000)
"A Smart City is a well-performing city built on the 'smart' combination of **endowments** and activities of **self-decisive**, **independent and aware citizens**"	(Giffinger, 2007)
"Smart city is defined by IBM as **the use of information and communication technology** to **sense, analyze and integrate the key information** of core systems in running cities"	(IBM, 2010)
"A city is smart when investments in **human and social capital and traditional (transport) and modern (ICT) communication infrastructure** fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through **participatory governance**"	(Caragliu et al., 2011)
"Smart City is the **product of the Digital City** combined with the **Internet of Things**"	(Su et al., 2011)
"A smart city is a **well-defined geographical area**, in which **high technologies** such as ICT, logistic, energy production, and so on, **cooperate** to create benefits for citizens in terms of well-being, inclusion and participation, environmental quality, intelligent development; it is governed by a well-defined pool of subjects, able to state the rules and policy for the city government and development"	(Dameri, 2013)
Smart city is the **collaboration among policy, citizens, research, and private partners** as an ecosystem **facilitate idea exchange and innovation** by using **media, ICT, and open big data**	(Baccarne et al., 2014)
"Smart city is the **implementation of multi-dimensional approach** which consists of four different approach, namely **smart machines and informated organizations, partnerships and collaborations, learning and adaptation, and investing for the future**"	(Ching and Ferreira, 2015)
"A Smart City is **an integrated system in which human and social capital interact**, using **technology-based** solutions. It aims to efficiently achieve sustainable and resilient development and a high quality of life on the basis of a multistakeholder, municipality based partnership."	(Monzon, 2015)
"Smart city is the **utilization of ICT and innovation by cities** (new, existing or districts), as a means to sustain in economic, social and environmental terms and to address several challenges **dealing with six (6) dimensions** (people, economy, governance, mobility, environment and living)"	(Anthopoulos, 2017)

Based on ASC's definition, the operationalization of a smart city in Amsterdam is more focused on the creation of small local projects by using or creating innovative technology, generating behavioural change, and using sustainable economic investment. The creation of small local projects is steered by the collaboration between all parties, such as the municipality, related organizations,[4] private companies, the community, and also inhabitants. All parties can conduct their project in a collaborative atmosphere, then they can test it directly everywhere in the city. By doing so, the strategy of ASC is 'learning by doing'. They see the city as a living lab, where different projects can be tested and scaled up. The term living lab itself refers to the process of innovation that involves the users as active contributors to the creative and evaluative processes (Scholl et al., 2017). Various projects are initiated by different parties in the city to solve particular urban problems.

Table 2. Actors and Program Partners[5] in the Amsterdam Smart City Organization (Based on Amsterdam Smart City, 2011; Amsterdam Smart City, 2017b).

No	Actors Category	Actors	Role	Status & Current Situation
1	Government	Amsterdam Municipality	- Programme partner - Partly funder	Initiator, active
		Amsterdam Economic Board	- Programme partner - Connector	Initiator, active
		Chief Technology Office Amsterdam Municipality	- Technology developer - Start-up facilitator	Recent partner, active
2	Private company	Amsterdam Innovation Motor	- Programme partner - Connector	Initiator, not active
		KPN	- Programme partner - Partly funder	Initiator, active
		Alliander		Initiator, active
		PostNL		Recent partner, active
		Arcadis		Recent partner, active
		Amsterdam Arena		Recent partner, active
		Engie		Recent partner, active
3	Knowledge institute	TNO	- Programme partner - Knowledge generator	Initiator, not active
		University of Applied Science Amsterdam	- Programme partner - Partly funder - Knowledge generator	Recent partner, active
4	Resident representative	Waag Society	- Programme partner - Partly funder - Knowledge generator	Recent partner, active
		Pakhuis de Zwijger	- Programme partner - Partly funder - Clearing house	Recent partner, active
5	Other emerging actors	User innovators	- Smart city project initiator	Emerging actor, active
		Start-up	- Smart city project initiator and developer	Emerging actor, active
		Social entrepreneurs	- Smart city project initiator - Co-creation platform	Emerging actor, active

[4] 'Related organizations' refers to resident representative organizations, NGOs, start-ups, and other types of organizations that are currently active in the city of Amsterdam.

[5] The program partner categories and actors are based on the year of 2017 version.

ASC aims to look for solutions for better use of natural resources and reducing greenhouse gas emissions through collaboration among citizens and organizations by using an open web-based platform (Amsterdam Smart City, 2017b; Dameri, 2017). To achieve that objective, ASC focuses on six themes, namely infrastructure and technology; energy, water, and waste; mobility; circular city; governance and education; citizens and living. Each citizen, community, and private company can initiate a project related to these themes.

They have four pillars to operationalize the organization of smart city projects. The first pillar is a collective approach, which means that every project implemented under ASC is based on cooperation between all relevant parties to achieve viable results. It also emphasizes high involvement of end-users to achieve a successful project. The second pillar, innovation and awareness, is required in each project. The project has to have not only innovative technology but also needs to induce behavioural change in the end users with its implementation. The third pillar is knowledge dissemination, which refers to knowledge exchange between stakeholders by sharing experiences through the ASC platform. Finally, the project has to be economically viable to have a bigger chance for upscaling. ASC not only wants to implement projects in Amsterdam but also replicates them in other cities.

In 2016, the ASC created an open platform that was launched under the name *Amsterdamsmartcity.com*. This platform was formed to facilitate the rapid growing number of interested people to collaborate within ASC (Amsterdam Smart City, 2017b). From 2009 to 2017, 230 projects were carried out under all themes of ASC. Most of the projects focus on environmentally-related objectives, such as CO_2 emission reduction, renewable energy, and circular resources. However, ASC concentrates its efforts mostly on energy, mobility, and circular-city themes (Winden et al., 2016). Each project has its own indicators for specific development phases, namely initiation, concept, implementation, and evaluation.

Amsterdam Smart City, Its Platform, and Innovation System

In this section we will answer the two research questions stated in the introduction. First, we start with analysing the actor network of the platform by using the urban innovation system framework. This includes the mapping of all actors based on their role and identification of their relationships. Second, we expand more on the role of the open web-based platform in ASC as an urban innovation system. This includes the identification of the use of the open–web based platform and its implications for ASC as an urban innovation system.

Actors Interaction in the Innovation System Model

The actors are a key aspect in urban innovation systems because they connect to each other based on their different roles and contribute to the emergence of the innovation system. Exchanging information creates interaction. Therefore, urban innovation can be developed by expanding the connections and interactions between the various actors. Connections and interactions between actors can be typified as relationships. There are two kind of relationships between actors in an urban innovation system, namely one-sided and bi-directional relations. A one-sided relation is a relationship that has only a one-way direction of connection and interaction. For instance, actor X is connected to and interacts with actor Y, but there is no response from actor Y that connects to and interacts with actor X, however, actor X gets information from actor Y from open information provided by actor Y. Meanwhile, a bi-directional relationship shows a two-way direction of connection and interaction, an active

exchange of information between actors X and Y. In the framework, the actors dynamically interact with each other in different development phases, namely initiation, concept, implementation, and evaluation. The actors can join in a different phase based on their interests and resources. This is in line with the framework used in this study, which is based on dynamic interaction within the innovation system, as discussed in the previous section.

In view of this, it is necessary to analyze the innovation system model of ASC. The actors are program partners of ASC and other possible actors in Amsterdam. Therefore, we re-arranged the framework developed by Warnke et al. (2016) to be more clear and relevant to the case of ASC to map and analyze the relationships between actors in ASC and its open web-based platform, as shown in figure 2. As we have determined that urban innovation systems have a spatial boundary area for the object of innovation and a dynamic system connecting the actors, it is necessary to keep in mind that the interaction between actors is spatially bounded in the Amsterdam urban area and that they dynamically interact with each other in different innovation phases.

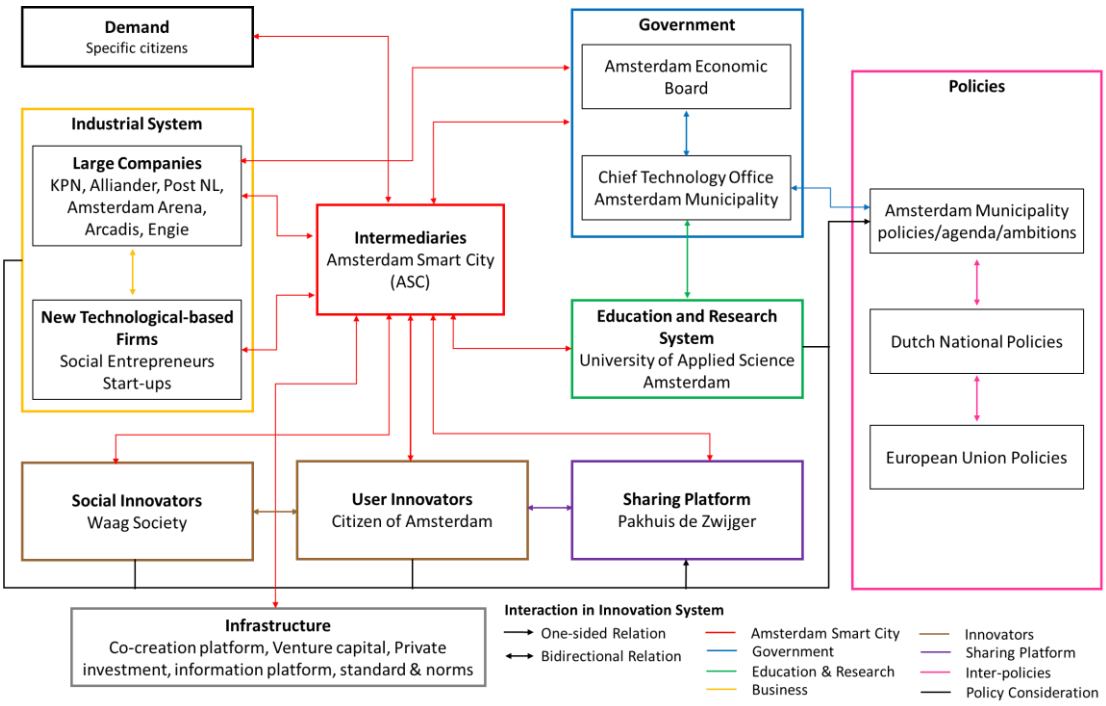

Figure 2. Innovation System Model for Amsterdam Smart City (adapted and modified from Warnke et al., 2016)

ASC is the intermediary actor in the innovation system that plays a role as an active actor to connect various actors. This indicates that every actor has a bi-directional relationship with the organization, because there is an exchange of information from one actor to another through the intermediary ASC platform. This is in line with the statement of Amsterdam Smart City (2017) that ASC is a networked organization that connects and facilitates various parties in Amsterdam to deal with urban problems in Amsterdam. Therefore, the demanders are a particular type of citizen that experience similar societal problems in Amsterdam. The citizens can be people living in a particular area or they can be a category of people. The societal problems are related to current issues in the city, such as environmental degradation, CO_2 emissions, and

crowdedness that have an impact on the citizens. Compared with Howells (2006), ASC seems to have 8 roles, which are foresight and diagnostics; scanning and information processing; knowledge processing and combination/recombination; gatekeeping and brokering; testing and validation; protecting the results; commercialisation; and evaluation of outcomes. ASC does not have a role in accreditation and regulation, because its purpose is not to give an accreditation to an institution or project and it is not a full governmental body that has a right to draw up regulations.

Looking into more detail, the unique part is the governmental actors group in the platform. There are two governmental actors included in the innovation system, namely the Amsterdam Economic Board (AEB) and the Chief Technology Office of Amsterdam Municipality (CTO). AEB seems to have a role as the connector between large companies, ASC and CTO. The large companies sometimes directly connect with CTO as a municipal body to propose a smart city project. CTO also has a role to connect the program partners of ASC to other departments within the Amsterdam municipality. This reveals that not all municipality departments are involved in the innovation system, which means that not all smart city projects that are currently going on in Amsterdam are linked with the agenda of the municipality. However, through CTO the municipality has a high consideration towards the existence of the innovation system. Only CTO as a representative of the municipality legitimates the smart city projects by creating related regulations and requirements that are needed if projects have been successfully tested and validated in the Amsterdam area. Therefore, when projects are being tested and validated, the actors in the system are restricted and shaped by the policies/agenda of the municipality, while there is no legitimation for them from the municipality as a government institution.

Regarding the innovators and sharing platform, we came across unique actors in the system. There is the Waag Society, which focuses on the specific research related to arts, culture, and emerging technologies. As it is a research community, it can be considered a social innovator that brings related innovation to the citizens and the platform. The citizens of Amsterdam can be considered user innovators because they are not only users, they can also develop and propose their own innovative ideas to the platform, even as individuals. They also interact with the Waag Society and the sharing platform, because of their possible involvement with these institutions. Pakhuis de Zwijger is a platform for citizens of Amsterdam to discuss about recent circumstances in the city. They have an annual meeting for which they invite citizens to discuss about their perception of living in the city. The Amsterdam municipality also supports the sharing platform by providing a subsidy to them and by being present in the annual meeting to directly get informed about the citizens' problems, needs, and ideas. In that way, the sharing platform has a tight connection with the municipality.

Another actor is the Amsterdam University of Applied Science, who is a partner of ASC as an education and research institute. The university provides a research-based initiative that is related to the smart city projects in Amsterdam. They conduct research about the organization of ASC itself and smart city projects that can be implemented in Amsterdam. Next to the platform, the university also has a tight relationship with the Amsterdam municipality through CTO. They can propose research projects as a smart city initiative and ask CTO to connect them with other municipal departments.

To implement smart city projects successfully, most of the actors use various infrastructures through ASC, both in the development process and during the implementation of projects. In the development process, most of the smart city projects are developed by creating a co-creation platform, which involves stakeholders in the annual meeting or discussion. For this, people can

give their opinion on a smart city project so the project is in line with the expectations of the users. Then the initiator needs to acquire venture capital or private investment for funding to be able to implement the project. The municipality does not provide subsidies for all smart city projects, therefore the initiators have to look for funding alternatives themselves. For this part, ASC has a role as a marketer of the projects, offering prospective investors an overview of all interesting projects within the platform. The platform is also a source of information as a digital agglomeration of smart city projects, where people can get an overview about different projects easily. Thus, projects may have a higher chance of being funded when they are registered on the platform.

Finally, interaction between actors, their roles, and the smart city projects are restricted and shaped by the standard, norms and policies of the city. Each actor has to consider policies applied by the government. However, the municipality also has to consider other levels of policies, such as national and European Union policies that are related to smart cities. The municipality may gain a positive impact from a higher policy level, such as a grant, or a national/international pilot project on smart cities, thus creating a higher chance of investment and scaling up of the project.

Role of the Open–web based Platform in the Innovation System

With the increasing number of people and partners who participate in the organization, ASC created an open web-based platform in 2016 to reach a larger number of people as well as to professionalize the platform (see figure 3).

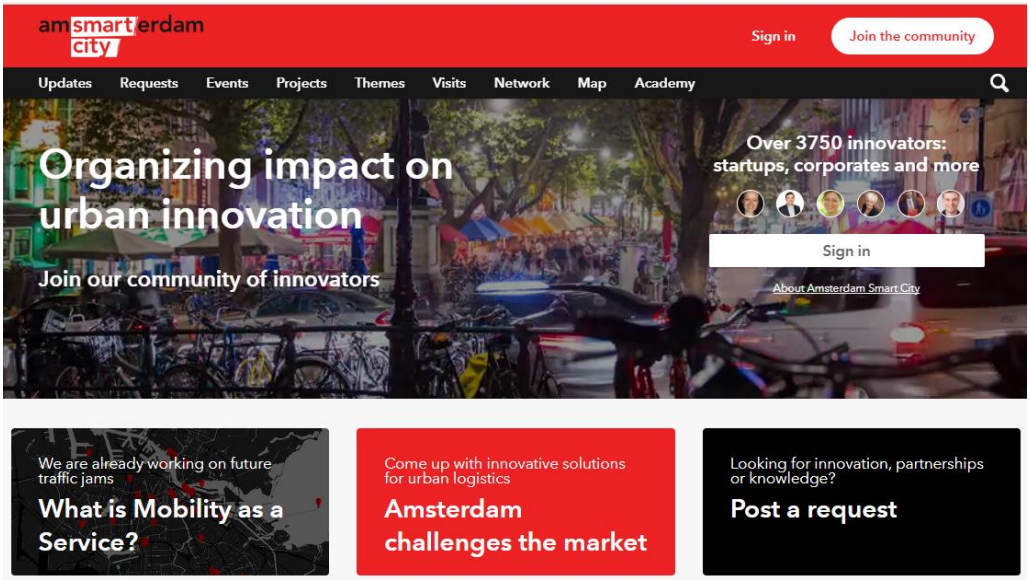

Figure 3. Interface of Amsterdam Smart City Website (Amsterdam Smart City, 2017a).

By using a website as the online platform, ASC wants to facilitate cooperation between various parties to make the city smarter and to inspire cities worldwide. Amsterdam Smart City (2017b, p. 9) states that the online platform can be used by various parties to:

1) "Post a request to ask for inspiration, ideas, or partners to bring more opportunities to realize the smart city project.

2) Share project, experience, good practice to have bigger opportunities to be supported by other people and share knowledge among innovators.
3) Manage an organization page to show the themes that are currently active in and people who are involved in the organization. By this, they can exchange ideas and make an online discussion by commenting.
4) Read and create events about urban innovation.
5) Offer workshops or guided tours."

Based on a survey conducted by ASC (Amsterdam Smart City, 2017b), it can be noted that people who join the platform want to acquire knowledge, find smart city projects, stay up to date of events, find partners, and expand their network. ASC seems to handle these expectations through facilities offered on the platform.

Essentially, the open web-based platform has two main roles, namely as a connector and an information exchanger. Firstly, the website as a connector means that it helps people, not only in the city of Amsterdam but also around the world, to get in touch with others, to contribute to urban innovation, and to gather related information about projects that are currently going on. There are two types of people who use the website, namely suppliers and demanders. A supplier is a person who shares ideas, information, knowledge, and projects via the website. A demander is a person who is looking for ideas, information, knowledge, and projects related to a specific interest in one of the smart city themes. Thus, as a connector, the website brings together suppliers and demanders. Therefore, the urban innovation process can develop more quickly.

Secondly, the website as an information exchanger indicates that it facilitates suppliers and demanders to share their ideas, information, knowledge, and projects. Additionally it creates a knowledge network about recent developments in smart city projects in Amsterdam. Therefore, people can refer to the website when they want to ask and discuss about topics related to smart city projects in Amsterdam. Both roles support the function of ASC as a network organization.

This reveals that the use of an open–web based platform is a prerequisite to build a broader actor network and to accelerate urban innovation. It also has implications for the urban innovation system. Firstly, an open web-based platform offers opportunities to connect more actors in the innovation system. Therefore, more ideas, information, knowledge, and projects can be shared, discussed, initiated, and developed more quickly. The actors themselves will directly refer to the platform when they have information and projects to share and discuss. By doing so, the platform also becomes a digital marketer for any posted smart city project. Secondly, the platform shares ideas, information, knowledge and projects among actors fairly and transparently because every actor can access it. Regarding information fairness, Lievrouw et al. (2003) stated that information is fairly distributed if people can take it without any consideration of their ability-to-pay, there is an open information resource, people are able to use the resources to gather the information and the available information is relevant and meaningful for their context. The ASC platform fulfills all these criteria, providing an open web-based platform where all actors can take and give information through it every time and everywhere easily and for free. Information transparency depends on several factors, namely information availability, the condition of its accessibility, and how it can support the decision-making of its users (Turilli & Floridi, 2009). Based on that, ASC as the facilitator of the open web-based platform has made information via the platform as transparent as possible for all actors by moderating all inputted information from all people joining the platform. Therefore, all actors can access the available information just by entering the website and choose the information from a particular menu. As the menu in the website was developed as

comprehensively as possible to support the innovation system, all actors should be able to choose a wide range of information that can support their decisions and further interact with other actors in several projects.

Discussion and Conclusion

The results of this study showed that ASC can be considered an example of a new type of urban innovation system. The system consists of roles and relationships between different actors in a platform based on a re-arranged innovation framework developed by Warnke et al. (2016). Compared with the framework, the results of this study on ASC revealed that there are nine actor categories involved with either a one-sided or a bi-directional relationship between them in the innovation system. The actors dynamically interact with each other in different innovation phases based on their interests and resources. Further research can also reveal if having another type of urban innovation systems makes a difference by using the framework to analyse the dynamic roles and relationships between actors.

The use of an open web-based platform to connect actors and to exchange information in the innovation system of ASC makes that the information can be distributed fairly and transparently among actors. Additionally, it can reach a broader group of actors to join the innovation system. With that, it seems that there is no real geographical limitation between actors to collaborate and to innovate on a specific idea even though the field of innovation is still bounded spatially, namely by the Amsterdam urban area. Further research may also reveal if different types and uses of digital technologies in an urban innovation platform will influence the way of organizing an urban innovation system. It is necessary to further explore the potency of ICT in leveraging the development of an urban innovation system. All in all, dynamic interaction between actors facilitated by an open web-based platform can be a new way to develop innovation systems in urban areas.

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