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# Innovation Ecosystem and User Involvement

# Building Smart Aarhus

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# Abstract

Smart Cites are managing more efficiently their resources due to the technological advances (ICF 2015). However, governments foster industrial solutions, focusing on solving technical issues (Brynskov 2017) that are not really generating value for their citizens (European Commission 2014). For that reason, citizen involvement is needed for developing smart cities. This is the case of Aarhus, which has developed a smart city model based on partnership (Brynskov et al. 2015).

This thesis has researched the Aarhus innovation ecosystem and the empowerment of user involvement in it. I have explored the topic through an embedded case study method, where Aarhus municipality and particularly the OrganiCity project has been analyzed. Three analytical tools have been used to better understand the user involvement in the innovation ecosystem to build smart cities: firstly, the Porter's Diamond (1990) to identify Aarhus' ability to innovate and the influence of this ability in building Smart Aarhus; secondly, the Quadruple Helix innovation model (Yawson 2009; Arnkil et al. 2010) to identify and study the OrganiCity stakeholders and the collaboration between them; and thirdly, a framework for mapping user-centered innovation processes (Wise & Høgenhaven 2008) to perform a deeper analysis of the OrganiCity users involvement in the OrganiCity innovation process.

This thesis has consequently found that the Aarhus innovation ecosystem is building a co-creative collaboration between the city stakeholders, where the users are citizens and firms from inside and outside of Aarhus. The co-creation is disrupting the stakeholders´ roles. The stakeholders are together transforming Aarhus into a living lab, which allows users to develop their own innovations through virtual communities. The living lab and virtual communities, together with open call processes, face-to-face tools and social media, are used to foster the user involvement and the development of knowledge, ideas and innovation. Moreover, the users present different levels of involvement during the innovation process, having the highest level of involvement during the test and prototype, data collection and pattern recognition steps. The research has also found that Aarhus innovation ecosystem does not have a strong smart solution market nor test market for innovations, which hinders that the users´ innovations become growth valuable companies, because of the lack of strong "business climate and structures" and "factor demands".

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Finally, I wish to thank my boyfriend, friends and family for their immense support throughout the master thesis.

## Definitions

- **Aarhus, Aarhus municipality and Aarhus commune** are used in the present work to refer to the administrative division of the territory.
- **Aarhus city council** is used in the present work to refer to the government as a governmental entity.
- **Smart solution** is used in the present work to refer the innovation developed based on smart technologies, such as open data platforms.
- **LoRaWan [**Low Power Wide Area Network**]** is the protocol used in the narrowband network deployed in Aarhus municipality. The technology allows sending small packets of data over long distances (Smart Aarhus 2017b)
- **Advanced Technology Group [GTS]** is a network consisting of seven independent Danish research and technology organisations. They are named the GTS institutes and together they make up the GTS network. They are: Alexandra Institute, Bioneer, DBI [Danish Institute of Fire and Security Technology], DFM [Danish Institute of Fundamental Metrology], DHI [Water and Environment], DTI [Danish Technological Institute] and FORCE Technology.

## Abbreviations

- Information and communication technologies: **ICT**
- Quadruple Helix: **QH**
- OrganiCity: **OC**
- Experimentation as service: **EaaS**
- Open Data Aarhus: **ODAA**
- Advance Technology Group: **GTS**
- Open & Agile Smart Cities: **OASC**

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# 1. Introduction

In 2015 the world population was 7.3 billion and it is expected to increase to 9.7 billion in 2050. Nowadays, 54% of the population lives in urban areas and this is predicted to increase to 66% in 2050 (UN 2014). Therefore, the sustainable growth of urban areas is one of the most important challenges in the 21th century (UN 2014). City leaders are making use of information and communication technology [ICT] solutions, urban Internet of Things [IoT], and big data solutions to city challenges such as transportation, housing, supplies, and employment, with the aim of meeting sustainability goals, encouraging local economies, and enhancing services. At the same time, technology suppliers have increased their interest to offer these technologies *"to accurately monitor, measure and control city processes ... which goal is saving money, becoming more efficient and delivering better service to the taxpayer*" (ICF 2015). Navigant Research (2016) report identified that the smart city technology market will rise to $27.5 billion annually by 2023 from $12.1 billion in 2016. The market leaders are big firms such as IBM, CISCO, and Microsoft.

Many of these projects have been deployed top-down, focusing on the efficiency of infrastructure through the use of technology (Lea et al. 2015), where solving technical issues became more relevant than building cities for their inhabitants (Brynskov 2017). This kind of approach was for example applied in Glasgow's planned Integrated Operation Centre, and in many other cities such as Songdo in South Korea and Masdar in the United Arab Emirates (Centre for Cities 2014). However, this kind of approach does not boost the local economies, enhance services, or reach sustainability goals, because the citizens are not part of the city development (European Commission 2014). For that reason, cities have started to encourage the citizens' involvement in the development of smart cities. This is the case of Aarhus, which has developed a smart city model based on partnership (Brynskov et al. 2015).

> *"Internationally, Smart Aarhus is considered a Scandinavian third way that offers a model for city development based on the practice of stakeholder and citizen involvement, and which differs from both the more commercial American and the more centrally controlled Asian traditions."* (Brynskov et al. 2015 p 6)

This thesis examines how Aarhus is building its innovation ecosystem to involve the users in the development of Aarhus as a smart city. With an embedded case study method, I analyze the

innovation ecosystem of Aarhus municipality and particularly the OrganiCity project to better understand the user involvement in the innovation ecosystem to build smart cities. The analysis gives insights to policy makers and city stakeholders on how to build spaces where all stakeholders can collaborate to solve the city's issues.

## 1.1. Smart city definition

Different stakeholders have been using the smart city concept with contradictory goals, making the concept confusing (Glasmeier & Christopherson 2015). Hollands (2008) identified smart city as an "urban labeling" phenomenon, which have been used in an inconsistent way, generating lack of clarity in the smart city concept.

This study follows the approach of Schaffers et al. (2012 p 2 ) in which cities should become "*innovative ecosystems empowering the collective intelligence and co-creation capabilities of user/citizen communities for designing innovative living and working scenarios*" through the development of *user-driven open innovation environments* (Schaffers et al. 2011). In this approach, institutions should develop the policies required to create the space where innovation environments could be developed. According to Nam & Pardo (2011 p 7 ) a smart city "*is an organic connection among technological, human, and institutional components. Nowadays the usage of "smart" captures innovative and transformative changes driven by new technologies. However, social factors other than smart technologies are central to smart cities. In this sense, a socio-technical view on smart city is needed".* This means that human factors play a trigger role in innovation.

## 1.2. Research question

This work aims at finding out how Aarhus is creating its innovation ecosystem and how the stakeholders are involved in the innovation process to create the solutions needed to meet sustainability goals, encourage local economies, and enhance services, which allows Aarhus to become a smart city. Therefore, the present work aims at answering the following research question:

**"How is Aarhus creating its innovation ecosystem, which empowers the involvement of users in the smart city development?"**

To answer the main question, I design a set of sub-questions, which are going to help to structure the analyses of this study. The first sub-question helps to understand the innovation ability of Aarhus and its leverage to build a smart city. Therefore, I need to identify and analyze Aarhus' innovation ecosystem determinants and how they are related to building the smart city of Aarhus. Hence the first sub-question is:

1. What is Aarhus' ability to innovate and how does this ability influence the creation of Aarhus as a smart city?

The second set of sub-questions allow me to identify the city stakeholders, the developed innovations, how the stakeholders collaborate between them and the roles played by them. Hence the second set of sub-questions are:

2. Who are the stakeholders involved in Smart Aarhus? What innovations are the stakeholders creating? How are the stakeholders collaborating? What roles do the stakeholders have?

The last set of sub-questions helps to understand the users' involvement during the innovation process. They are as follows:

3. How are the users involved during the innovation process? What levels of user involvement exist during the innovation process?

By answering these sub-questions, I will be able to answer the main question **"How is Aarhus creating its innovation ecosystem, which empowers the involvement of users in the smart city development?"** in chapter 7.

## 1.3. Research purpose

First, this thesis aims at empirically studying the innovation ecosystem of Aarhus municipality to detect its ability to innovate, the stakeholders, how the stakeholders collaborate, what innovations the stakeholders are developing and what roles the stakeholders have. Second, it attempts to discover how the users are involved in the innovation ecosystem and what level of involvement the users have.

## 1.4. Structure

This work is organized in 7 chapters. They are as follows:

Chapter 1 is a brief introduction of the research in this thesis.

Chapter 2 describes the methodology used to achieve the purpose of this research.

Chapter 3 describes the study case – Aarhus and the OrganiCity project - of this thesis.

Chapter 4 portrays the theories and analytical frameworks that are used to guide the analysis.

Chapter 5 presents the analysis of the gathered data and summarizes the main findings.

Chapter 6 discusses the main findings and gives answers to the research questions.

Chapter 7 provides the conclusion, gives an answer to the main research question and suggests lines of future research of this work.

# 2. Methodology

This chapter specifies the methods used to perform the research that allows to reach the goal of this study. The goal is to understand the construction of Aarhus municipality´s innovation ecosystem that empowers user involvement in the development of smart solutions to meet sustainability goals, encourage local economies, and enhance services; which transforms Aarhus into a smart city. It is necessary to answer "how" to reach this goal by explaining the way to answer the research question **"How is Aarhus creating its innovation ecosystem, which empowers the involvement of users in the smart city development?"** (Kavale 2008). When answering the "how", I will be based on the so-called research onion designed by Saunders (et al. 2016). In this chapter, I use this framework to describe the research philosophy, the theory development, the methodological choices, the research strategy, the time horizon, and the techniques and procedures utilized in this work. Figure 1 shows the different paths to follow in the research onion; the options marked with a red circle show the way followed in this work.

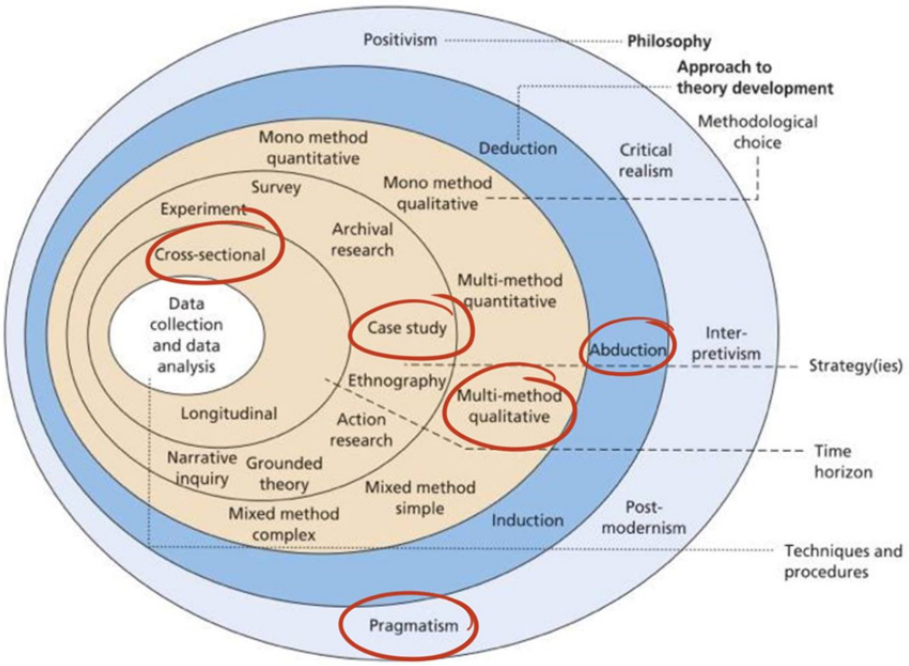


Figure 1: Research process "onion" [Adapted from (Saunders et al. 2016)]

## 2.1. Philosophy

"***Research philosophy*** *refers to a system of beliefs and assumptions about the development of knowledge*" (Saunders et al. 2016 p 124), which influence how we interpret the studied subject. The adopted research philosophy helps to support the selected "*methodological choice, research*

*strategy and data collection techniques and analysis procedures*" (Saunders et al. 2016 p 125). Saunders et al. (2016) defined five main research philosophies in Business and Management: positivism, critical realism, interpretivism, postmodernism and pragmatism. This research follows the philosophy of **pragmatism** because it admits that there is more than one way to understand and analyze the world, consequently giving the flexibility necessary to use relevant data and methods, to be focused on the main research question of this work (Saunders et al. 2016). However, interpretivism is also used in large part of this research, because I make subjective interpretations of a large portion of the data collected from the participants within this research (Saunders et al. 2016). Overall the main goal of this research is to understand the construction of Aarhus municipality´s innovation ecosystem, which empowers user involvement. Consequently, I need a flexible philosophy that allows me to use different data and methods adapted to answer my research question.

## 2.2. Theory development approach

The theory development approach followed in this work is **abductive**, which is the combination between the two other approaches: deduction and induction (Saunders et al. 2016). In deduction, the verification of premises gives the answer to the research question [theory to data]. In induction, the results of analyzed data generate the premise [data to theory] (Saunders et al. 2016). This work used the theory as a guide, giving a focal point for the research and limiting its scope (Tashakkori & Teddlie 2010). In addition, the abductive approach fits with the pragmatic philosophical line used in this work, because the collected data gives the versatility "*to explore a phenomenon, identify themes and patterns, locate these in a conceptual framework and test this through subsequent data collection and so forth*" (Saunders et al. 2016 p 145). This helps me to gain a better understanding of Aarhus municipality´s innovation ecosystem and the involvement of users in it. Therefore, the research process helps to find out "surprising facts", which can happen in any step of the research process (Van Maanen et al. 2007).

## 2.3. Process of research design

In the next three subsections, I will expose the methodological choices, the research strategy and the time horizon of my research project, transforming *"my research question into a research project"* (Saunders et al. 2016 p 163).

### 2.3.1. Methodological choices

I previously indicated that this work is based on the pragmatism philosophy, which influences in the selection of the methodological choices (Nastasi et al. 2010). Under this philosophy, quantitative and qualitative methodologies can be applied. I use a combination of both [mixed method approach], due to the nature of my research (Saunders et al. 2016). Mixed methods "*combine the use of quantitative and qualitative data collection techniques and analytical procedures*" (Saunders et al. 2016 p 169). Moreover, mixed methods are in line with the abductive theoretical approach, because as I said, theory is used as a guide of the research (Tashakkori & Teddlie 2010). However, despite of using mixed methods, I classify the present work as **qualitative research** because I largely use qualitative data.

Saunders (et al. 2016) also describe five research design purposes: exploratory, descriptive, explanatory, evaluative, or a combination of them. My approach is related to the **combination of them** because using one approach does not allow me to develop accurate analyses. I need the exploratory approach for its flexibility and adaptability to changes, which permits me to answer open question about "how" and "what" (Saunders et al. 2016). I also need the descriptive approach to describe for instance Aarhus´ innovation ecosystem, and the explanatory approach to explain the relation between determinants of the innovation ecosystem and the user involvement within the ecosystem (Saunders et al. 2016).

### 2.3.2. Research strategy

The research strategy is defined as the plan about how I will answer the main research question (Saunders et al. 2016). Although there are multiple research strategies, Saunders et al. describe 8 research strategies to accomplish the research plan: experiments, surveys, archival and documentary research, case studies, ethnography, action research, grounded theory, and narrative inquiry. The present work designs a **case study** research strategy that allows me to develop a deeper understanding of the innovation ecosystem and the user engagement within the ecosystem in a real-life context (Yin 2014). Moreover, this research strategy together with the use of a mixed method gives me a detailed flow of analytical data (Saunders et al. 2016). This strategy is also in line with the pragmatism approach, because positivism [objective] and interpretivism [subjective] researchers have been using it (Saunders et al. 2016). Therefore, it is flexible for both

of them, and also with the abductive approach because case studies admit the use of both inductive and deductive approaches (Saunders et al. 2016). Moreover, case studies encompass exploratory, descriptive and explanatory approaches (Saunders et al. 2016), which make the case study research strategy the suitable option for this project.

To structure my case study, I follow Yin (2014) whom defines two dimensions: first, single case versus multiple cases, and second, holistic versus embedded case. This work presents a single case, which is **Aarhus municipality**. I select this city because it offers me the opportunity to observe its innovation ecosystem.

According to the second dimension, my case study is embedded, which means that I do not have a unique analysis unit. I analyze **the OrganiCity project** in order to gain a better understanding of Aarhus' stakeholders and their involvement with Aarhus´ innovation ecosystem. Later on, I will explain the case study in detail.

### 2.3.3. Time horizon

This research is based on a **cross-sectional time horizon** because the analysis of the phenomenon is executed in a particular period of time (Saunders et al. 2016). A longitudinal time horizon also exists, which implies that the research analyzes the change or development of the phenomenon (Saunders et al. 2016). However, due to time constraints, I consider this outside of the scope of this research (Saunders et al. 2016).

## 2.4. Techniques and procedures of data collection and analysis

This section describes the tactics and procedures used to collect and analyze the data for this work. This represents the heart of Saunders´ onion in figure 1.

### 2.4.1. Data collection

This research work collects data from primary sources using interviews and observation techniques and procedures, and from secondary sources using relevant reports, blogs and statistics websites.

#### *2.4.1.1. Primary data collection*

Interviews and participant observation techniques are suitable for a qualitative data source and for an interpretivism philosophy. It gives the flexibility to select the techniques and procedures

necessary to comprehend the meaning of the primary data collected and analyzed (Saunders et al. 2016).

### *Interviews*

There are three groups of interviews: structured, semi-structured, and unstructured (Saunders et al. 2016). This work uses **unstructured** and **semi-structured** interviews. In unstructured interviews, the dialog between the interviewer and the interviewee is free. In semi-structured interviews, the interviewer prepares a series of topics and questions, but they do not necessarily have to be addressed and new questions could come up during the interview. They have the goal of obtaining a deeper knowledge of the research topic (Saunders et al. 2016). In summary, I conducted nine interviews [see appendix 9.1]. Three of them are unstructured and six semi-structured interviews. All the interviews proceeded with a similar approach:

- ✓ The interview lasted between 5 and 45 minutes.
- ✓ Communication tools were Skype, Hangout or face-to-face.
- ✓ All interviews were recorded.
- ✓ The transcription and the analysis were made in the same way.
- ✓ Two interviews have been performed in Spanish. The quotes used have been translated into English.

### *Participant observation*

Participant observation is a technique where the researcher actively participates in the activities developed by the group of members that are under research (Saunders et al. 2016). This technique permits to better understand the social situation or research setting (Saunders et al. 2016). The scope of the participation could vary from pure observation to full involvement. In this work, I participated as a participant in the event "Co-creating the Smart City" organized by OrganiCity, and attended the panel "From Nano to Global Scale: Cities Creating Change" organized by Open & Agile Smart Cities during the Denmark Internet week in Aarhus. These events permit me to better understand the user roles, the involvement of the users in the innovation process, Aarhus as smart city and its ecosystem of innovation, etc. Audio recordings and pictures were taken during the event. I transcribed and analyze three of the presentations during the events.

### *List of primary data sources*

Figure 2 shows the source of primary data located in the specific spaces of sources.

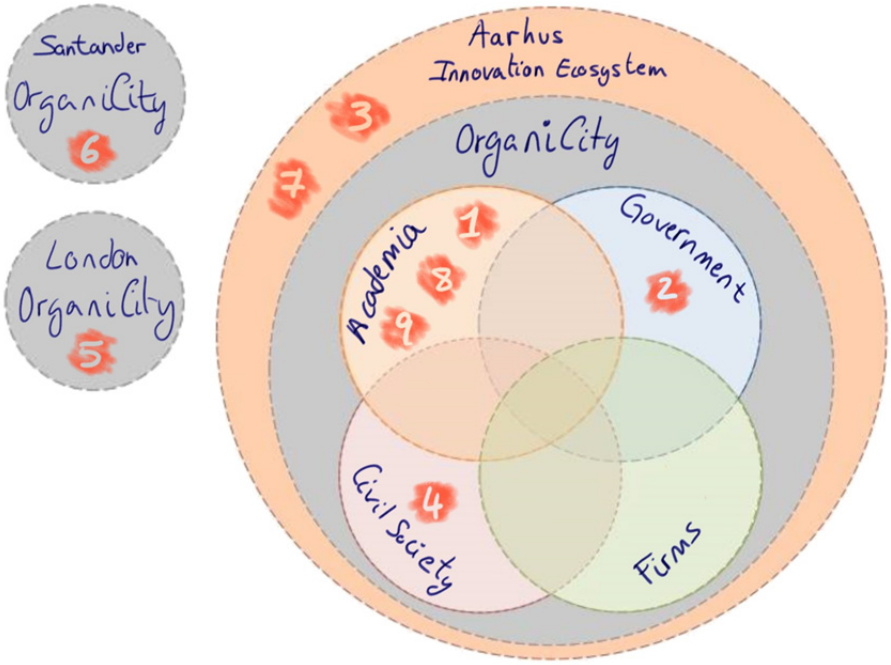


Figure 2: Source spaces of this master thesis [Own elaboration].

1. Two interviews with the OrganiCity project manager at Alexandra Institute in Aarhus [First interview (Vestergaarde 2017a); second interview (Vestergaarde 2017b)]
2. One interview with the OrganiCity project manager at Aarhus City Council (Christophersen 2017)
3. One interview with Aarhus Smart City coordinator at Aarhus City Council (Gerstrand 2017)
4. Three interviews with citizens that took part in the Co-creating Smart City event organized by OrganiCity in Aarhus. (Citizens 2017)
5. One interview with the OrganiCity project manager at Future Cities Catapult in London (Palacios 2017). Interview performed in Spanish.
6. One interview with the OrganiCity contact lead at Santander Municipality (Cuenca 2017). Interview performed in Spanish.
7. Presentation by Niels Højberg, CEO of the Mayor's Department at Aarhus Municipality (Højberg 2017)
8. Presentation by Martin Brynskov, Associate Professor in Interaction Technologies at Aarhus University and coordinator of OrganiCity. (Brynskov 2017)
9. Presentation by Lasse Steenbock Vestergaarde, project manager of OrganiCity at Alexandra Institute in Aarhus (Vestergaarde 2017c)

#### *2.4.1.2. Secondary data collection*

The use of secondary data implies analysing data that have been collected or created for a different purpose (Saunders et al. 2016). However, secondary data is useful to triangulate with the primary source data. By doing this, I can develop a more accurate analysis that strengthens my research. In total, I use 15 main secondary sources: three are quantitative [Danish Statistics database, European barometer and Eurostat] and the rest are qualitative sources, where four are websites [The websites of Aarhus City Council, Business Aarhus and OrganiCity, Smart Aarhus] and the rest are reports or documents, where four are about Aarhus and four are about the OrganiCity project [see appendix 9.2].

### 2.4.2. Data analysis

This section describes the techniques chosen to analyze the qualitative and quantitative data, and the reliability and validity of this data.

#### *2.4.2.1. Qualitative data analysis*

The abductive approach allows the concurrent use of inductive and deductive approaches to analyze the data (Saunders et al. 2016). Consequently, I use a deductive approach to develop the theoretical framework, while I apply an inductive approach to check it through the collected data (Saunders et al. 2016). Moreover, the selected philosophy of pragmatism gives me the flexibility to choose the most suitable analysing techniques. Therefore, I use the **Template Analysis** technique because it is "*not tied to a particular philosophical position or research approach*" (Saunders et al. 2016 p 595). This technique is based on the analysis of themes detected in the data set. Consequently, the researcher needs to code the data set to detect the themes (Saunders et al. 2016). In my case, I first use existing theories – prior codes – of systems of innovations and user involvement during the innovation process (Saunders et al. 2016). Secondly, I use terms that are used by the participants themselves – codes in vivo (Saunders et al. 2016). As a result, I developed a series of codes that guides the analysis.

#### *2.4.2.2. Quantitative data analysis*

The secondary quantitative data is used to support the qualitative analysis, which means that the quantitative analysis follows the codification created in the qualitative analysis. The quantitative analysis is necessary because it helps to better explore, describe and explain the research; support the findings; and facilitate an accurate answer to the research question (Saunders et al. 2016). The

data used[1] is grouped in three groups: (1) time series data from R&D expenses and the evolution of public opinion about environmental issues in Denmark; (2) enterprise distribution in the Central Denmark Region, and job and population distribution by age in Aarhus Municipality; and (3) citizens' incomes by city in Denmark and business taxation by country. The graphs used are time-series graphs, pie charts, population pyramids and data tables.

#### *2.4.2.3. Reliability and validity of the data*

The research reliability is based on the replication and consistency of the study (Saunders et al. 2016). However, the present work reflects "*the socially constructed interpretations of participants in a particular setting at the time it is conducted*" (Saunders et al. 2016 p 205). Consequently, it is not planned to be replicated, but it could be replicated due to the deep description of "*research design, context and methods*" (Saunders et al. 2016 p 205). Moreover, this work use data from different sources and triangulate them to give a high grade of validity to the present work.

## 2.5. Limitations and reflections

I recognize that the present work has three main limitations. The first limitation is the generalization of the findings and conclusions, which is one of the critics of case studies as a research strategy. I am aware that if another case was used the findings and conclusions could be different. The second limitation is the number of interviews conducted, which should be larger due to the large number of stakeholders involved in my case study. This especially applies to the firm stakeholders, where I tried to contact them but because of their over-researching status they could not attend me (Palacios 2017). However, due to availability of some stakeholders I could conduct interviews to other relevant stakeholders for the analysis of the case, but I acknowledge that more interviews would have allowed me to reach a deeper knowledge about the innovation ecosystem and its user involvement. The third limitation is the time and resources constrains, which required me to limit my research to specific theoretical frameworks in relation with systems of innovation and user involvement. In conclusion, this research has been developed truthfully and the process has been thoroughly explained. I therefore acknowledge the validity of this research work.

[1] *Central Denmark Region data have been used where Aarhus Municipality data were not available*

# 3. Case analysis

This chapter describes the case analysed in this work. The chapter is divided into two sections; the first one is about Aarhus municipality and the second one is about the OrganiCity [OC] project that is a part of the Smart Aarhus projects.

## 3.1 Aarhus municipality

Aarhus has the second biggest concentration of population in Denmark, reaching 335,684 inhabitants in 2017. It is part of Central Denmark Region with 1,304,253 inhabitants in 2017 (Statistics Denmark 2017b). The municipality is located in the east cost of Jutland peninsula and it covers an area of 468, 87 $km^2$, of which the city of Aarhus covers 91 $km^2$ (Wikipedea 2017). Aarhus also has a young population where the largest groups are concentrated between 20 and 30 years (Statistics Denmark 2017a) [see figure 3].

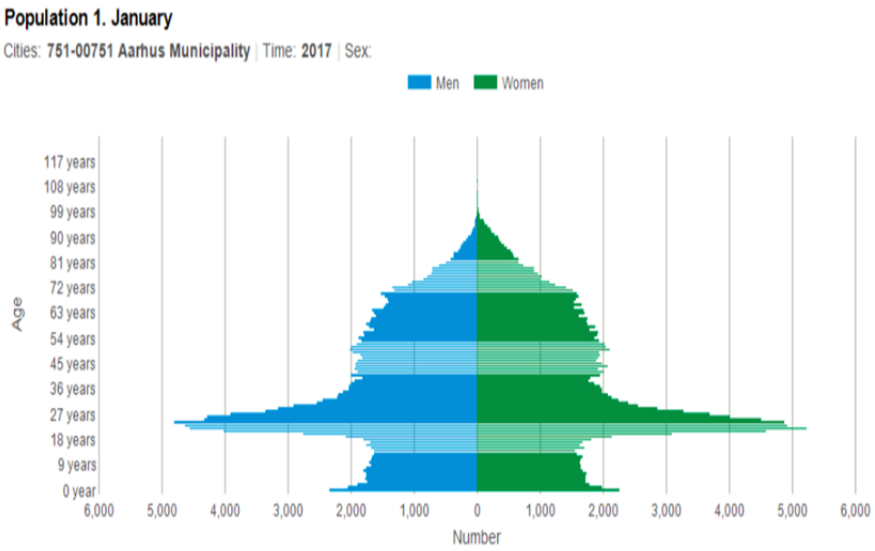


Figure 3: Aarhus municipality age population [Statistics Denmark 2017a]

The young population of Aarhus is due to the concentration of students in the municipality. Aarhus has 9 higher education centers, with nearly 52,000 students (Aarhus City Council 2017). Standing out is Aarhus University, which is largest university in Denmark with 44,500 enrolled students in 2017 (Aarhus University 2017).

Aarhus University has a large impact on the economy of Aarhus, fostering its knowledge-intensive economy together with some multinational firms, such as Arla Foods, one of the big dairy groups in Europe; Dansk supermarket, the largest retailer in Denmark; Jysk, a multinational firm

specialized in household goods, furniture and interior design; and Vestas, one of the biggest wind energy producers in the world (Aarhus City Council 2015b).

> "*The business sector in Aarhus has very successfully and increasingly focused on the production and sale of innovative, knowledge-intensive and globally oriented products and services*" (Aarhus City Council 2015b)

In addition, Aarhus city council is promoting a close network collaboration between the city´s stakeholders, with the aim of building an "*international-class knowledge cluster*" (Aarhus City Council 2015b). The fruit of this labor is the Smart Aarhus partnership, which was created 5 year ago (Gerstrand 2017). The model is based on a partnership between Aarhus City Council, Central Denmark Region, Alexandra Institute, Aarhus University, VIA University College, IT-Forum, Creuna, and Systematic (Brynskov et al. 2015). This model aims at creating collaborations between public and private sectors, citizens, the business community, and knowledge institutions (Brynskov et al. 2015). The heads and members of each partner form the Smart Aarhus Board and Secretariat, which coordinates efforts to launch and support a large range of smart city projects. At this moment, Smart Aarhus is executing 39 projects (Smart Aarhus 2017c). Some of them are key as in the case of "Open Data Aarhus" [ODAA] that provides a large amount of data from public institutions, educational institutions, and firms. The platform was launched in 2013, being the first Open Data portal in Denmark (Smart Aarhus 2013). Another relevant project is my case study, the OC project, because it "*aims at making future cities more sustainable by combining citizen-driven innovation and digital technology*" (Smart Aarhus 2014). The OC project is described deeper in the next section.

## 3.2 OrganiCity project

The OrganiCity project is creating Experimentation as a Service [EaaS], which puts the ICT, IoT, and ODAA infrastructures at the service of the citizens (European Commission 2015). The goal is to develop new markets and modified services through the development of sustainable digital solutions that are adapted to the socio-economic reality of each city (European Commission 2015). Its approach combines top-down management with flexible bottom-up activities (European Commission 2015).

The European Union's Horizon 2020 research and innovation program launched the OC project in 2015, with € 7,266,582 in funds that will last until June 2018 (European Commission 2015). This case study covers the period since the launch in 2015 until August 2017. The OC project is organized through a consortium of 15 institutions [see appendix 9.3], where Aarhus University is the official coordinator of the project. The project is implemented in three clusters: Santander (ES), London (UK), and Aarhus (DK). The Santander and London clusters are out of the scope of this study. However, I take into consideration information from these two clusters in order to gain a deeper knowledge about the project's development and execution, and thus develop more accurate research.

OC performs three main lines of work. Firstly, they are creating a loyal audience – a community – using online and offline tools where different stakeholders are involved, such as citizens, SMEs, research institutions, and the municipality. Secondly, they are developing a platform and tools involving the users. Lastly, they are organizing open calls to finance users that are willing to use the OC platform and tools to develop their smart solutions (Vestergaarde 2017a). As a consequence, the stakeholder involvement is crucial for the project (European Commission 2015).

In the next chapter, I introduce relevant concepts and tools necessary to perform the analysis of this research study.

# 4. Theoretical framework

This chapter details the theoretical framework used in this research work. It introduces and defines the main concepts, theories and analytical tools needed to execute the analysis that allows to answer the main research question. The chapter is structured in 6 sections. The first section specifies the definition of the "innovation" concept and the second one specifies the definition of the innovation ecosystem. I consider these definitions relevant because they clarify and limit the objective of my analysis. The next three sections [3, 4, 5] describe the theories and tools necessary to perform the analysis of this study, which are the Porter´s Diamond (1990) in section 3, The Helix model in section 4, and the user involvement in section 5. The last section describes the analytical framework.

## 4.1 Innovation

Innovation is the sum of invention, which is the result of novel solutions, and its exploitation, creating economic and/or social value (Franke et al. 2014). Innovation begins with new creative ideas. However, not all creative ideas are innovations, because to generate innovation the creative idea must be useful and exploited (Norn 2015).

Individuals are the source of creativity and their ability to create is affected by their intellectual skills, knowledge, way of thinking, character, reasons for acting, and personal circumstances (Sternberg & Lubart 1999). Moreover, "knowledge" is considered the "raw material" of creativity and innovation, and is in constant expansion, which can be stimulated through for example education or collaborations (Norn 2015). In the next section, I define the concepts of system of innovation and innovation ecosystem.

## 4.2. Innovation ecosystem

According to the innovation linear model, innovation can emerge from two directions. The first direction is called technology push, where innovation is generated from the R&D departments and introduced to the users. The second direction is called market pull, where innovation emerges from the necessities of the users, which stimulate the innovation (Lundvall 2010). These linear models are narrow approaches of innovation, because they are only based on R&D functions of public and private institution, such as firms and universities, showing a top-down innovation model – science-based knowledge (Lundvall 2010). Nowadays, innovation comes from diverse

sources such as individuals, private firms, universities, governments, and non-profit organizations. Moreover, the collaboration network developed between these sources of innovation is considered another source of innovation (Schilling 2013). "*Probably the most significant source of innovation does not come from individual organizations or people, but from the collaborative networks that leverage resources and capabilities across multiple organizations or individuals. Collaborative networks are particularly important in high-technology sectors*" (Schilling 2013 p 37). Thus, the sources of innovation are components of the same complex system, where any innovation could come out from one or several of its components or from the collaboration between them (Schilling 2013).

According to Boulding (1985) a "*system of innovation is constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge*" (see in Lundvall 2010). It shows a wide definition of system of innovation that includes the learning process, as an interactive process. All the features of the economic structure and the institutional structure create the framework which influences *in processes of interactive learning, sometimes resulting in innovations* (Lundvall 2010 p 9). This definition differs from the previous linear model of innovation; innovation systems in the 90´s were seen "*as static structures regulated by government bodies*" (Smorodinskaya et al. 2017 p 1). Therefore, the definition of system of innovation should be enriched with the innovation ecosystem concept to fit with the reality of a knowledge-based economy.

> "*Innovation ecosystem symbolizes the newly emerging, network mode of arranging business activity and economic governance, which enables companies and territories to master innovation-led growth and benefit from rapid technological changes*" (Smorodinskaya et al. 2017 p 7).

These innovation ecosystems are special spaces that have been designed to give way to "*co-creation of value through collaboration*" (Smorodinskaya et al. 2017 p 8)

This study will use the term system of innovation enriched by the concept of innovation ecosystem, which means that I use the two concepts equally. Although I can appreciate differences between the two concepts, it facilitates the development of this work.

## 4.3. Porter´s diamond

The aim of this section is to introduce the concepts necessary to understand national and regional systems of innovation, the definition of clusters, the determinants that influence in clusters' innovation abilities, and the government roles in an innovation system; based on Porters´ Diamond (1990).

As stated in the previous section, a "system of innovation" is formed by the relationship of different actors that are all involved in the innovation process. The innovation is the result of these interactions. The innovation performance depends in part on how these actors are connected, forming a *collective system of knowledge creation* (Lundvall 2010), and the use of technology. This specific way to connect the users and the use of technology "*are either located within or rooted inside the borders of a nation state*." (Lundvall 2010 p 2).

Freeman introduced the concept National System of Innovation [NSI], which is defined as "*the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies*" (Freeman 1987, see in OECD 1997). According to Lundvall (2010), nations execute an important role as supporters and leaders of the innovation and learning process. Moreover, to learn and innovate will be easier due to the fact that part of the knowledge is local and tacit – the *national culture and social norms tend to … affect the process of innovation* (p 354). This makes it easier to transmit and communicate knowledge and innovations. However, NSI is limited by two phenomena. The first phenomenon is the **globalization of the world**, where innovation tends to be more global and the innovation process is less tied to a specific location, in particular in high tech industries such as the pharmaceutical or electronics sectors. The second phenomenon is **regionalization**, where innovation depends on the technological specialization or on the networking between the different private and public firms in a specific area (Doloreux & Parto 2004). In this case, the system of innovation is regional [Regional System of Innovation (RSI)]. This approach is similar to NSI because the knowledge is local and tacit (Lundvall 2010). However, in this case the administrative limits of the region are smaller than a nation. Although not all definitions of RSI include the territorial definition, for the purpose of this work I use the definition of RSI given by Cook (2001 see in Doloreux & Parto 2004 p 14) who described it "*as a geographically-defined, administratively-supported arrangement of innovative*

*networks and institutions that interact heavily with innovative outputs of regional firms on a regular basis*". RSI develops innovation policies that strengthen the collaborative network between the different actors involved in the innovation process (Edquist 2011) and innovation policies are considered key for economic growth (Lundvall 2010).

These two phenomena [globalization and regionalization] are linked because a strong regional network is the root of the globalization (Lundvall 2010). Porter (1998) maintains that regionalization is more powerful than globalization because the *economy lies increasingly in local things—knowledge, relationships, and motivation—that distant rivals cannot match.* His argumentation relies on the concept of cluster. He defined it "*as geographic concentrations of interconnected companies and institutions in a particular field*" (p 3). In general, the cluster is inside of some political boundaries, although there are examples where a cluster exceeds such boundaries as in the case of the chemical German cluster that crosses the Swiss boundaries (Porter 1990). The cluster's creation and development have to be supported by strong local competitiveness and governments that set up the necessary conditions to boost its development.

Porter´s paper "The Competitive Advantage of Nations" (1990) states that a strong network improves the competitiveness of the industry, which in turn improves the competitiveness of the region. According to him "*national prosperity is created not inherited*" (p 1). He concludes that companies manage to obtain a competitive advantage through acts of innovation. The ability of a nation to innovate is affected by four determinants that work as a system – the "diamond" of national advantage.

Figure 3 shows the government's influence over the four innovation determinants and the relation between the determinants. The determinants are working as a system because each determinant can influence the rest of them.

1. **Factors conditions** refers to specialized production factors such as technological and educational infrastructures that are scarce and difficult to replicate by foreign competitors, and require sustained investment to create them.
2. **Factor demands** refer to the characteristics of domestic demand. Porter states that the size of domestic demand is much less important than the nature of that demand. In other words, it is a

great advantage for the industry if the buyers of the product are informed and demanding high quality standards in the industry, which will stimulate the innovation of firms.

3. **Networks and partnerships**: this determinant refers to the presence of related sectors and support sectors that collaborate or provide their services to the reference sector. The established partnerships and business relations create competitiveness through close relationships between these sectors by exploiting short lines of communication, a rapid flow of information, and a constant exchange of innovations and new ideas. However, I will limit my analysis of this determinant to the identification of relevant networks and partnerships.

4. **Business climate and structure** refers to business conditions and the structure of the industry. According to Porter (1990), the presence of strong domestic rivalry is a definitive and powerful incentive for the creation and persistence of competitive advantages. He states that "*among all the points on the diamond, domestic rivalry is arguably the most important because of the powerfully stimulating effect it has on all the others*" (p 29).

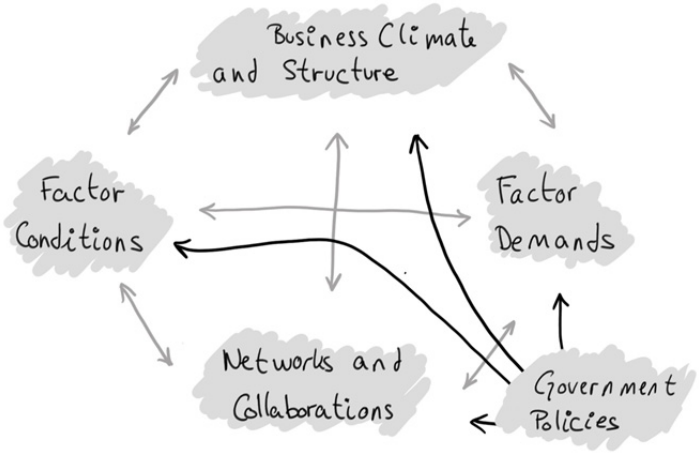


Figure 3: Porter´s diamond (1990)

Porter (1990) introduces "government" in the framework as a catalyst and supporter of the competitiveness. However, it is not considered another determinant because governments cannot create competitive advantages; only firms can do it. He states that "*government policies that succeed are those that create an environment in which companies can gain competitive advantage rather than those that involve government directly in the process, except in nations early in the development process*" (p 34).

The purpose of Porter´s Diamond is to help to analyze the factors that influence in the innovation system, allowing to understand the nation's or region's innovation abilities.

In this section, I explained the system of innovation limited by political borders or as a geographical concentration, and the importance of innovation policies to stimulate the economic growth. I also defined the 4 factors that influence the innovation ability of nations/regions and I identify the government's roles as supporter and catalyst of the innovation.

The next section explains the collaboration between the different stakeholders and their roles based on the Quadruple Helix innovation model [QH]. I add this model, because the theory of national/regional systems presents a lack of societal involvement in the innovation process (Almirall & Wareham 2008). Moreover, these systems could have a narrow interpretation, promoting just science-based institutions (Lundvall et al. 2002).

## 4.4. Helix models

The previous section explained the national and regional systems of innovation and the four innovation determinants defined by Porter´s diamond. In this section, I continue with an innovation ecosystem approach, but focus more on the roles of the different stakeholders involved in the innovation ecosystem. For this I rely on the Quadruple Helix model [QH].

QH is the result of a new trend perceived by Hippel (2005). According to him, the progress in ICT has enabled skills for the innovative user to develop innovations related to their own special needs. He states that firms should systematize the search for user innovation in their internal innovation process and governments should implement user-centered innovation systems, since user-driven innovation is a key factor for the success of enterprises and public organizations (Lundvall et al. 2002; Thomke & Hippel 2002). Later on, I will further explain the terms user-centered, user-driven and user oriented innovation.

Before explaining the QH innovation model, I introduce the Triple Helix Model [TH] (Etzkowitz & Leydesdorff 1995) because it is the predecessor of QH.

### 4.4.1 Triple helix model

TH relies on the collaboration between three spheres: (1) the "government sphere"; (2) the "academia sphere", which traditional role is to create knowledge; and (3) the "firm sphere", which traditionally were responsible of the innovation (Etzkowitz & Leydesdorff 1995). The goal of the

model is to develop innovation environments that allow the spread of innovation (Etzkowitz & Leydesdorff 1995).

The TH model has evolved from a more top-down approach in TH model 1, where the government dictates the relation between the academia and industry spheres, to less top-down approaches such as in TH model 2 and 3. In TH model 2, the spheres have a clear division of their roles and the government does not dictate the relation between them, because the relations are already well defined. In TH model 3, innovation policies arise as a result of the overlapping of the three spheres, and consequently each sphere can assume roles from the other sphere (Etzkowitz & Leydesdorff 2000), which brings the appearance of tri-lateral networks and new hybrid organizations (Etzkowitz & Leydesdorff 2000). This means that the innovation policies are the result of the collaboration between the spheres (Arnkil et al. 2010).

The science-based technology developed by academia acquired a strong role in the TH innovation model, because academia is transformed into a contributor to economic growth by selling research and making business, in addition to its traditional educational and research roles (Etzkowitz & Leydesdorff 2000). Moreover, due to the educational role, academia has helped to increase the number of people with scientific and technological knowledge in society. As a consequence, "*scientific and technological knowledge production are now pursued not only in universities but also in industry and government laboratories, in think-tanks, research institutions and consultancies, etc*." (Gibbons et al. 1994 p 11).

The TH model is useful when explaining innovation based on science-based knowledge and hi-technology (McGregor et al 2009, seen in Arnkil et al. 2010). However, this model is based on a narrow approach to innovation, where innovation just emerge from R&D functions of public and private institutions, firms, and universities, showing a top-down innovation model [science-based knowledge] (Lundvall 2010). For that reason, this study will be based on QH, because it has a wider approach to innovation.

### 4.4.2 Quadruple helix model

As I mentioned above, TH is the predecessor of QH. The QH model emerged from an extension of TH, adding the civil society sphere into the model as the fourth helix. As such, QH is based on the

collaboration between government, academia, firms and civil society (Yawson 2009). Yawson (2009) refers to civil society as the public. He states that "*the triple helix of state, university and industry is missing an essential fourth helix, the public*." (p 10). He defined "public" as user-driven innovation, and as I indicated above, user-driven innovation is indispensable for companies and public-sector organizations, because it allows them to generate competitiveness advantages (seen in Arnkil et al. 2010). The QH model is shown in figure 4.

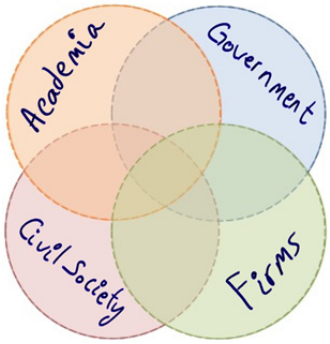


Figure 4: The QH model

According to Yawson (2009 p 10), "*knowledge creation is now trans-disciplinary, more reflexive, non-linear, complex and hybridized*". This has been possible in part because of the enabling effect of ICT that has helped to boost the bottom-up participation of civil society (Yawson 2009). As a consequence, top-down knowledge production systems that generate and organize the knowledge are no longer dominant (Yawson 2009). Instead, top-up and bottom-up systems are combined, which allows "*for both top-down government, university, and industry policies and practices and bottom-up civil society and grassroots movements, initiatives and priorities to interact and engage with each other toward a more intelligent, effective, and efficient synthesis*" (Carayannis & Campbell 2009, seen in Cavallini et al. 2016).

Civil society expands their roles; they are not just demanding innovation through products or services, they also employ and apply knowledge and become a dynamic piece of the innovation system (Cavallini et al. 2016).

Carayannis & Campbell (2010) further expand the QH model into the Quintuple Helix model, in which the QH, and therefore also the TH model, is embedded. The Quintuple Helix model adds natural environments as a fifth helix, which is a new element to consider in knowledge and innovation systems. "*So 'nature' becomes established as a central and equivalent component of*

*and for knowledge production and innovation*" (Carayannis et al. 2012 p 5). Although it could be interesting to analyze the role of this fifth component and its connections with the rest of the components, I leave it out of my analysis because it exceeds the scoop of this research, which is focused in users as a component in knowledge and innovation systems. Furthermore, Carayannis & Campbell (2009) define civil society as the "*media-based and culture-based public*" (p 206), which means that the fourth helix is related to "*media, creative industries, culture, values, 'life styles, art,* and perhaps … creative class" (p 206). Instead of using this definition of the fourth helix, my research is based on the definition by Yawson (2009).

According to Arnkil et al. (2010), the QH concept is wide and complex due to the large number of involved activities and actors. For this reason, Arnkil et al. (2010) developed four QH models [figure 5] that are represented by the owner of the innovation process and by the user engagement.

The models are based on the Living Lab approach, which implies changes in respect to the traditional involvement process. The changes are not only the involvement of users in the development process, but also the easier cooperation between stakeholders such as government, universities, firms, civil society, etc. (Ståhlbröst 2008). In the following section, I define this further, together with open innovation and social computing approaches.

| | **Innovation goal** produces … | **User engagement** | **Owner of the innovation** |
|---|---|---|---|
| **TH + USER** | high tech products and services. | Systemized collection of user information | University or Industry sphere |
| **Firm-centered living lab** | services and products to the firm and customers. | Design WITH users | Industry sphere |
| **Public sector-centered living lab** | services and products to public authorities and their users of public services. | Design WITH users | Government sphere |
| **Citizen-centered QH** | services and products to citizens. | Design BY users | Civil Society sphere |

Figure 5: The QH model defined by Arnkil et al. (2010).

The following section introduces the theories and concepts needed to evaluate the involvement of the users during the innovation development process.

## 4.5. Involvement of the user

In the previous section, I indicate the importance of including users in innovation process and the necessity to systemize the user-innovation search (Hippel 2005), because user-driven innovation is a key factor for the success of enterprises and public organizations (Lundvall et al. 2002; Thomke & Hippel 2002). According to Wise & Høgenhaven (2008 p 21), "*User-Driven Innovation is the process of tapping users' knowledge in order to develop new products, services and concepts. A user-driven innovation process is based on an understanding of true user needs and a more systematic involvement of users*". However, the user-driven innovation concept generates doubts about the level of involvement of the user during the innovation process, suggesting a greater level of user involvement than there actually is (Arnkil et al. 2010). According to Bergvall-Kåreborn et al. (2009), the user-driven innovation concept is referring to the innovation process in which users truly have started this process. He aligns user-driven innovation with the "design by user" involvement category, one of the user involvement categories defined by Kaulio (1998). Kaulio classifies the user involvement into three categories – design for user, design with user, and design by user – where "design for user" presents the lowest grade of involvement and "design by user" presents the highest. So, user-driver innovation covers only the highest grade of involvement. For that reason, there are authors that prefer to use the concept of "user-centered" innovation (Bergvall-Kåreborn et al. 2009), because this cover a greater spectrum of user involvement levels. I use the user-centered innovation concept to perform the analysis of my case study, because "*the user involvement in the QH innovation model can range from systematic collection and utilization of user information to development of innovation by user themselves*" (Arnkil et al. 2010 p20).

What does user involvement mean? Ives & Olson (1984) states that it is the participation of users in the innovation process as representatives in a target group, which goal is to increase the probability of success for the innovation. However, Barki & Hartwick (1989) argue that participation and involvement are concepts that should be separated. They state that participation is related to the action executed by users during the development process, while involvement is connected to the psychological state, wherein users are more concerned about the innovation.

In the following subsections, I first define and classify "users", I then present three user-centered

approaches, and finally I explain the innovation process and user involvement framework that I use to analyze the user involvement.

### 4.5.1. User definitions

The concept of "user" can be defined in many ways; "*depending on the context users can be ordinary or amateur users, professional users, consumers, employees, residents, citizens, hobbyists, businesses, organizations or civil society associations*" (Arnkil et al. 2010 p 17). For instance, Hippel (2005) defines users as all individuals or firms that obtain a benefit through the use of products or services. Some users are innovators [user-innovators], which means that they modify or develop products or services into new ones in order to customize them according to their needs. Jeppesen & Frederiksen (2006) name the individual user-innovator a hobbyist when the developed innovation is not their main income and they reveal their innovation for free into the public. However, when the hobbyist tries to make business of their innovation, then they are called a user-manufacturer (Baldwin et al. 2006). We can also refer to user-manufacturers as entrepreneurs, because they are risk takers (Kihlstrom & Laffont 1979) and innovators.

> *"There are two distinctive views. The first is the popular view: entrepreneurs are people who run their own companies, the self-employed or small-business people. The second is Joseph Schumpeter's view that entrepreneurs are innovators: people who come up with ideas and embody those ideas in high-growth companies."* (A.W. 2014)

Furthermore, Hippel (2005) also classify some users as "lead users", defined as individuals who perceives needs that are not know to the rest of the public – they are in the "*leading-edge of an important market trend"* (p 22). The solutions obtained from their innovation have a high probability of success in the market – "*they anticipate relatively high benefits from obtaining a solution to their needs*" (p 22). Other common ways to refer to a user are as a "consumer" – "*person or firm who pay and use the product and services*" (Ståhlbröst 2008 p 11, 12) – and as "citizen" – "*person who is a member of a state or country, and has legal rights there*" (Cambridge Dictionary 2017).

Figure 6 shows the classification of users that I use in the analysis. Users are citizens and firms that are classified into two categories: first, as innovators when they modify products and services

consumed according to their needs; and second, as non-innovators when they benefit through the consumption of products or services, but they do not perform any direct modification on these products or services. Furthermore, user innovators are sub-categorized into hobbyists, lead users and entrepreneurs.

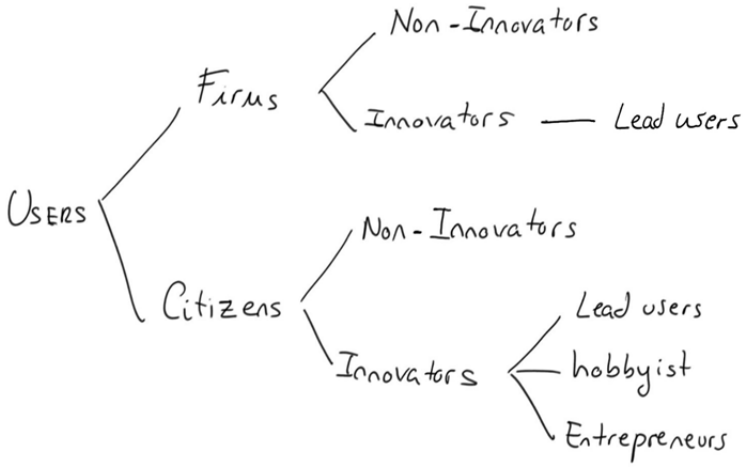


Figure 6: User classification [own elaboration]

As mentioned previously, there are multiple ways to characterize users. This fact together with the diversity in forms and grades of participation makes the user involvement even more multidimensional (Arnkil et al. 2010). The following sub-section explains three approaches to user-centered innovations.

### 4.5.2. User-centered innovation approaches

At the end of section 3.4, I introduced the concept of Living Lab, which is one of three main approaches related to the user-centered innovation concept (Pascu & van Lieshout 2009). The other two approaches are open innovation and social computing.

The open innovation concept is created by Chesbrough (2003). This approach is based on the thought that valuable ideas can come from inside the company as well as from outside the company. Consequently, firms should also aim to capture the external value. This approach is the opposite of the traditional R&D department, where valuable ideas just come from inside of the firm. The approach can be interpreted as firm-centered, where firms are in the center of sharing knowledge and a cluster of firms cooperate in the open innovation process (Chesbrough 2003); or

user-centered, where users share their ideas, knowledge, and innovations with other users (Hippel 2005) .

The social computing concept is based on the existence of virtual communities that are the platform for innovation activities (Pascu & van Lieshout 2009). The number of users involved in the communities is variable because it is relativity easy to get involved and leave them. Furthermore, it is easy to identify the group of users that lead the virtual community. The advantage of this innovation model is its large number of lead users, which can drive the creation of very interesting ideas and innovations. Moreover, the innovations are created and designed by the user.

The last approach is living lab (Bergvall-Kåreborn et al. 2009). It emerged from the new relation between user and technology. Additionally, the approach boosts the involvement of users in the development process and makes easier the cooperation between stakeholders – such as private sector, universities, public sector, and civil society. One of the most relevant differences between the living lab approach and the traditional involvement process is the real-world context in the living lab, where "*users are involved in their own private contexts all day round. Hence, when a Living Lab approach is applied, the aim is to create as authentic use situations as possible*" (Bergvall-Kåreborn et al. 2009 p 2), while in the traditional involvement process the environment is set up for the experimentation and users are asked to participate in the designed environment (Preece, J et al. 2002, seen in Bergvall-Kåreborn et al. 2009). Living labs allow "*citizens to design and create their own solutions, the resulting services find faster and improved acceptance, with end users gaining a greater sense of empowerment and ownership*" (Eskelinen et al. 2015).

In the following subsection, I introduce the innovation wheel and user-centered framework for mapping the involvement of users during the innovation process.

### 4.5.3. Mapping user-centered innovation processes

To analyze the features of a user-centered innovation process I use the framework elaborated by Wise & Høgenhaven (2008), which helps to map the steps of the innovation process by level of user involvement. I divide this subsection into two parts. The first part describes the innovation

wheel model, which characterizes the innovation process, and the second part describes the framework to analyze a user-centered innovation process.

#### *4.5.3.1. Innovation wheel*

The innovation wheel model depicts a firm´s innovation process. It originated in Rosted's work (2008). However, its description is collected in Wise & Høgenhaven's report (2008). It is based on eight steps divided into two phases with four steps each. Note that not all companies execute the eight steps and neither execute them consecutively.

The first phase is "WHAT", which is focused on what to produce. It is subdivided into four steps: (1) **opportunity identification**, where business opportunities are discovered by internal employees or from outside users; (2) **data collection**, where different types of data are gathered to understand users´ articulated and unarticulated needs; (3) **pattern recognition**, which is the analysis of the data recollected; and (4) **concept ideas**, which is any new concept or idea that resulted from the previous steps. A concept idea can be physical or non-physical.

The second phase is "HOW", which is focused on how to produce the service or product. It is subdivided into another four steps: (1) **conceptualization**, where the idea is described in detail to economically assess it; (2) **prototype step**, where a specific example of a new product or service is developed and, in case of services or non-physical products, a description or experiment takes place; (3) **test**, where users can test the prototype; and (4) **implementation**, where the innovation team works together with other departments in the firm to launch the new service or product into the market.

#### *4.5.3.2. Mapping user-centered framework*

Here I introduce the user-centered framework used to analyze the level of user involvement, mapping the innovation steps described above into the user-centered framework designed by Wise & Høgenhaven (2008)

The model is characterized by three determinants. The first determinant is the user needs, which are divided between acknowledged and unacknowledged needs. This factor is important to detect methods and techniques needed during the different steps of the process. The second determinant is the user involvement level during the innovation process. This model is based on

two levels of involvement: direct and indirect. The third determinant is the innovation wheel described above.

Figure 7 shows the framework, which is divided into four quadrants to map the innovation process. The two quadrants on the right are related to the "WHAT" phase of the innovation process. The **bottom-right** quadrant represents "user observations"; in this case, users are indirectly involved as a source of information. Here the innovation team observes the users, but they do not talk with them directly. Typical methods used here are ethnographic methods such as shadowing, user self-observations, guided tours in users' homes, etc. The **upper-right** quadrant represents "experiments with users". In this case, users are directly involved in the innovation process, but although the innovation team talks with users directly, users are not part of the innovation team. Some of the user involvement methods that could be used are for instance personal interviews, role-playing and living labs.

The two quadrants on the left are related to the "HOW" phase of the innovation process. The **bottom-left** quadrant represents "user test". Here, users are not part of the innovation team but their "*articulation is taken at face value"* (Wise & Høgenhaven 2008 p 25). Some of the user involvement methods related to this quadrant are focus groups and test users. The **upper-left** quadrant represents "user innovation", where users are directly involved as partners to the innovation team and their needs are taken into account in the innovation. Here, typical user involvement methods are the lead user method (Hippel 2005) and co-creation.

The framework introduces two lines. The first line is the **participation line**. Only the upper-left quadrant is above this line, where users are directly involved with the innovation team. The rest of the quadrants are under this line, where users are not part of the innovation team. However, the innovation team still taps from the users' knowledge by asking, observing or experimenting on them. The second line is the **articulation line**. Only the bottom-right quadrant is under this line, where the innovation team gains the users' knowledge just by observing. The rest of the quadrants are over this line, where the innovation team taps the users' knowledge by letting them articulate it.

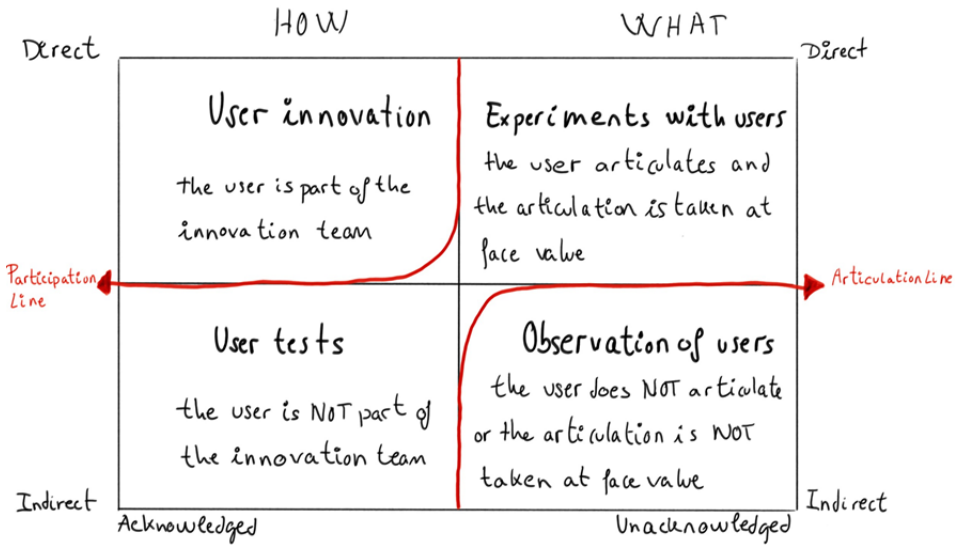


Figure 7: User-centered framework by Wise & Høgenhaven (2008).

## 4.6. Analysis tool

Figure 9 illustrates the analysis framework used to perform the research to answer the main research question of this work: **"How is Aarhus creating its innovation ecosystem, which empowers the involvement of users in the smart city development?"** The top figure depicts the different research spaces. The numbers inside indicate the different analysis tools used during the research.

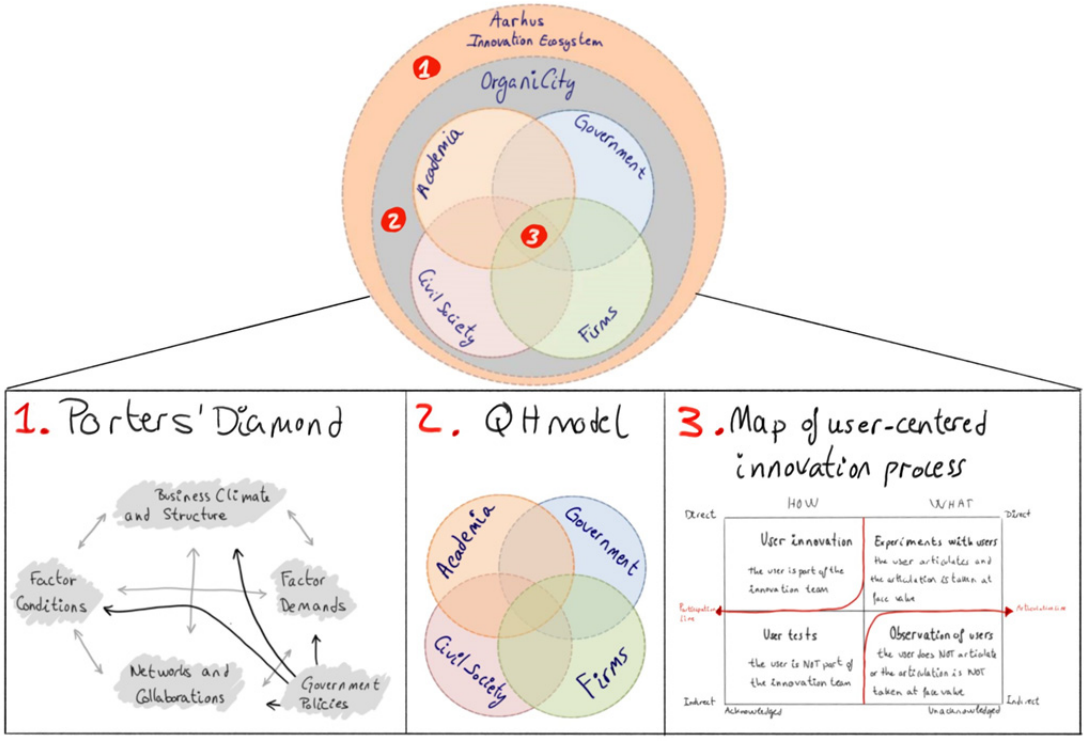


Figure 9: Analysis tools [own elaboration].

The three main tools used are illustrated under the top research spaces graph. Each one is related to a specific goal. The first one is **Porters´ Diamond** (1990) through which I analyze the Aarhus regional system of innovation. The analysis goal is to answer the sub-question: What is Aarhus' ability to innovate and how does this ability influence the creation of Aarhus as a smart city? However, this tool presents a lack of societal involvement in the innovation process Almirall & Wareham (2008) For that reason, I use the second tool, **QH**, that allows me to perform a deep analysis of the city stakeholders. The analysis goal is to answer the sub-questions: Who are the stakeholders involved in Smart Aarhus? What innovations are the stakeholders creating? How are the stakeholders collaborating? What roles do the stakeholders have? However, QH covers a large range of user involvement, giving only a general view of the involvement (Arnkil et al. 2010). For that reason, I use the third tool, **the map of user-centered innovation process**, which allows me to perform a deeper analysis of the user involvement in the innovation process. The analysis goal is to answer the sub-questions: How are the users involved during the innovation process? What levels of user involvement exist during the innovation process?

In sum, the combination of three tools guides the analysis path of this work, which allows to reach the purpose of the master thesis.

# 5. Analysis

This chapter contains the research analysis of my case study. The research aims at understanding the Aarhus municipality innovation ecosystem and the involvement of users within it, with the purpose of finding the answer of the main question in this thesis. To this end, the chapter is divided into three analysis sections. The first section is named "Aarhus innovation ability". It contains the analysis of the Aarhus innovation ecosystem through the Porter´s Diamond (1990) framework. Its goal is to identify the innovation ability of Aarhus and this ability's influence on the development of Smart Aarhus. The analysis of the second and the third sections are narrowed down to Aarhus' OC project. The second section contains the analysis of the OC innovation ecosystem through the QH model (Yawson 2009; Arnkil et al. 2010). The goals are to analyze the OC stakeholders, their roles, and their collaborations between them. The last section is focused on the analysis of OC users' involvement in the OC innovation process. To this end, I use Wise & Høgenhaven´s (2008) user-centered innovation framework. The goal is twofold: first, to understand how OC are involving users in the OC innovation process; and second, to identify in what level the OC users are involved.

## 5.1. Aarhus innovation ability

This is the first of three sections of the analysis. The goals are, first, to find out the Aarhus innovation ability and, second, how this ability influence the development of Smart Aarhus. To this end, I use Porter's Diamond (1990). The section is divided into seven subsections; the first five subsections contain the description and analysis of the four innovation determinants and the Aarhus city council policies [factor conditions, factor demands, network and collaboration, business climate and structure, and governmental policies]. The sixth subsection contains the Aarhus innovation ecosystem analysis and the last subsection contains the Smart Aarhus innovation ecosystem analysis based on the OC case study.

### 5.1.1. Factor conditions

The Aarhus city council has created "*the new axis of knowledge*" (Aarhus City Council 2010 p 19), wherein the light rail system is the backbone that connects many important facilities in Aarhus. It connects Aarhus´ five innovation hubs [see appendix 9.4] where firms, scientists, and students can work together. The hubs are specialized in *food, healthcare, cleantech, ICT and creative industries*

(Aarhus City Council 2016 p 20). It also connects several of the nine higher education centers (Aarhus City Council 2017) , such as VIA University College, Aarhus School of Architecture, and Aarhus University, which is the largest university in Denmark with 44,500 students enrolled, 11,500 staff members, and a €840 million budget in 2017 (Aarhus University 2017). Lastly, it connects Advance Technology Group [GTS] that is formed by seven independent Danish research and technology organizations, where four of them are located in Aarhus such as Alexandra Institute (Aarhus City Council 2016).

Furthermore, Aarhus city council has built Dokk1 as a part of the Urban Mediaspace project. This library infrastructure is going beyond a simple library, offering space for citizens to learn and explore (Smart Aarhus 2017a). Aarhus city council also has an open data platform infrastructure that is called ODAA and it has installed the LoRaWAN around the city. Both of them are essential for the development of Smart Aarhus (Højberg 2017).

> "*So first of all, we created the open data platform, ...., we created it in an EU standard and open data base standard, which could be used across cities in Denmark but also internationally … Secondly, … we are proud to say that the LoRaWAN installation in the city of Aarhus is probably the most comprehensive in any city in the world. We cover all the areas in the city and we can use it to monitor things …"* (Højberg 2017)

Because of these infrastructures, Aarhus became a suitable platform for private firms, entrepreneurs, research organizations, academia, etc., to develop their innovations.

> *"Aarhus provides an ideal platform to develop and deliver innovative products and services. Within this compact geographic area, there are strong companies, knowledge and innovation hubs within food, healthcare, cleantech, ICT and creative industries with a focus on film, fashion, design and architecture. The high concentration of advanced knowledge, internationally-oriented innovation hubs and talents from the universities gives companies the right conditions for cutting-edge innovation and development"* (Aarhus City Council 2016 p 20).

However, according to a survey made by EPINION in 2017 to measure the business climate, 41% of the interviewed firms identified infrastructures as a weak point in the business environment in Aarhus city and municipality. On the other hand, the identified infrastructures

were the city airport, take-off roads, and parking spaces, which are not directly related to R&D infrastructure, although they are also important to increase the innovation capacity of Aarhus municipality.

Figure 10 shows the evolution of R&D expenses in the five regions of Denmark between 2009 and 2014. Central Denmark Region, which includes Aarhus, is the region that spends second-most in R&D, showing a slow growth from 2009 until 2014. Furthermore, Central Denmark Region spends 1% more of its GDP than any other Danish region except the Capital Region. The Capital Region, which includes Copenhagen, spends around 2% more of its GDP than Central Denmark Region, although the distance has been reduced gradually from 2,80% in 2009 to 1,98% in 2014. In addition, the R&D expenses of Central Denmark Region does not reach the 3% of GDP that has been purposed as the Europe 2020 strategy target (Eurostat 2017).

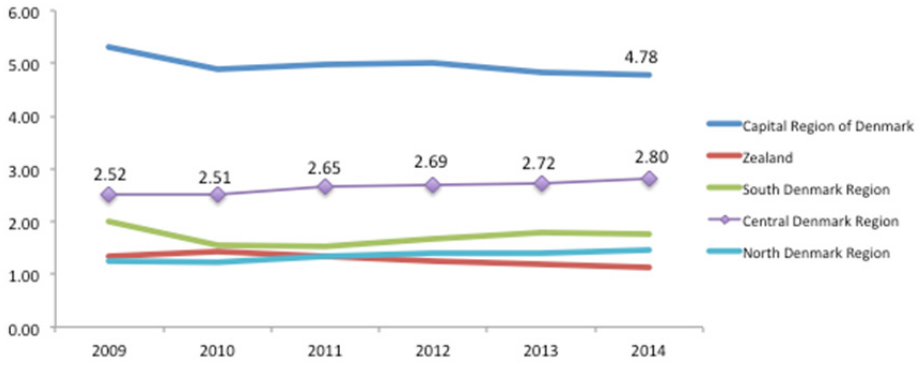


Figure 10: Evolution of the R&D expenditure in % of GDP by Danish region [Eurostat]

In sum, good knowledge institutions, such as Aarhus University, Via University, and Alexandra Institute, and five innovation hubs are based in Aarhus. They form part of the "new axis of knowledge", which is connected through a light rail system. Furthermore, Aarhus also has good technological infrastructures such as ODAA and the LoRaWAN network. However, it presents a lack in mobility infrastructure such a parking space, airports, and roads. Moreover, although its expenditure in R&D is relatively high and constant through time, it is not reaching the Europe 2020 target. Moreover, the Capital Region of Denmark is spending around 2% more of GDP than Central Denmark Region. In conclusion, Aarhus is developing a particular knowledge infrastructure that is difficult to imitate for other clusters, and its expenses in R&D have been constant and relatively

high. Despite that, it is not the region that spends the most in R&D in Denmark and it has not yet reached the goal targeted by the EU.

### 5.1.2. Demand conditions

According to Niels Højberg (2017), the size of Aarhus is not one of Aarhus' strong factors, despite the fact that it is the second biggest municipality in Denmark with 335,684 habitants (Statistics Denmark 2017b). He states that this makes it difficult to attract and maintain companies and well-qualified labor.

> *"I think, we also are very much aware of the fact that size matters, in our case in a negative way. Really, we must be very very precise not to lose critical mass and things actually could work, not only here, but probably even in a global context."* (Højberg 2017)

The Aarhus population is characterized by its youthful inhabitants, as I indicate in the case study chapter, and their high level of education, where Aarhus together with Copenhagen have the highest rate of well-educated people with 39% and 42,1% of the population respectively, followed by Odense with 31,5% and Aalborg with 31,3% (Statistics Denmark 2017a) [see appendix 9.5].

Furthermore, Danish citizens enjoy a high disposable income, where Aarhus citizens have the highest with DKK 220,011[2] as can be seen in figure 11.

| Kr. | Aarhus | Odense | Aalborg | Esbjerg | Randers | København |
|---|---|---|---|---|---|---|
| Indkomst pr. person i alt | 303.066 | 277.392 | 284.504 | 294.849 | 280.907 | 304.699 |
| Indkomst pr. person disponibel | 220.011 | 201.180 | 203.080 | 210.319 | 201.261 | 209.991 |

Figure 11: Income by Danish municipalities (Statistics Denmark 2017a)

The Aarhus population's characteristics and high income could be a reason why Aarhus has good R&D abilities and, also, why it is a good place to test new products and services (Aarhus City Council 2016) . In fact, Danish citizens are characterized as "the world´s fastest adopters of new products and technologies" (Aarhus City Council 2016 p 12). However, this characteristic is all Danish. Therefore, it does not differentiate Aarhus from the rest of Denmark.

Furthermore, Danish citizens' opinion about environment, climate and energy issues is relatively

[2] *2015 last data available at Statistic Denmark Database*

superior compared to the average European public opinion [see figure 12]. Again, this data is referring to all Danish citizens; therefore, it does not imply any difference to the rest of Denmark. However, I detect differences in the path developed for solving these issues. Aarhus has a holistic approach to the smart city development, trying to solve the environmental issues together with other city issues. In contrast, Copenhagen has linked the development of a smart city to a specific goal.

> "*I am also thinking in.... that being environmentally responsible is part of the package. But it has not been a specific goal like it is in Copenhagen, because they brand the smart city very much on the green. We have a broader more holistic view on smart cities. So, it can also be digital culture or so on....* "(Gerstrand 2017)

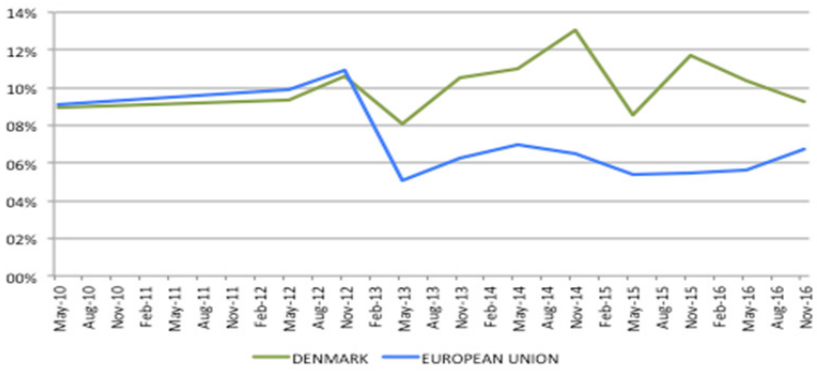


Figure 12: Opinion evolution about environmental issues 2010-2016 (Eurobarometer)

In sum, Aarhus is the second biggest urban area in Denmark, but still small enough to have difficulties in maintaining well-qualified workers and attracts new firms. Its population is principally young, well-qualified, and with high income, which make it a suitable market to test new products and services. However, all Danish citizens are fast adopters of new products and services. Therefore, other cities in Denmark could be good test markets as well. Moreover, Aarhus presents the same level of awareness about environmental issues than other Danish cities, but they are facing these issues with different approaches. In conclusion, Aarhus citizens are sophisticated and Aarhus can be a good test market, but it does not necessarily present any real advantage with respect to other urban areas in Denmark. However, the holistic approach in developing a smart city to face environmental issues together with other city issues makes the difference with respect to other municipalities.

### 5.1.3. Networks and collaborations

Aarhus municipality has a multitude of networks and collaborations between private firms, governmental organizations, citizens, and academia that work to address issues in relation to energy, the climate and environment, food and agriculture, ICT, health, education, etc. (Business Aarhus 2014). The development of these collaborations is part of the business plan of the city model.

> "*Over the course of 20 years, the City of Aarhus and the Board of Business has established a strong working relationship for developing and implementing business and urban policies. This so-called "Aarhus model" of cooperation.*" (Aarhus City Council 2010 p 8)

The model is characterized by the cooperation, which is close and binds together businesses, organizations, knowledge institutions, and local and regional government (Aarhus City Council 2010).

The smart city partnership is the result of the city model described above. It was launched by Aarhus city council five years ago (Gerstrand 2017). The Aarhus Smart City model is called the Scandinavian third way and it is based on close collaboration between firms, academia, citizens and government, and especially focused on the citizens to become an active part in the smart city development.

> *"Scandinavia is more focused on the user. We have four parties working together on city development, which is the public sector, private sector, academia and citizens. But citizen have been invited into Smart Aarhus from the beginning. So, we started the process 5 years ago with creating 35 working groups with all kinds of public and private participants on the future smart cities. So we are all into this collaboration between the four parties."* (Gerstrand 2017)

I identified several networks, and I classify them into three groups:

- The first group is in relation to R&D. It is the axis of knowledge, with the 5 innovation hubs, GTS and the main educational institutes of Aarhus, where Aarhus University stands out with its 418 partnership agreements in 2015, such as the Lundbeck foundation, Arla, and Novo Nordisk (Aarhus University 2017).

*"We believe that clustering businesses, research and education within a specific field optimizes the flows of knowledge and enhances innovation."* (Aarhus City Council 2016 p 25)

- The second group is in relation to start-ups. I identified INCUBA, which facilitates collaborative environments to firms. It has 200 firms in its network and a start lab for start-ups (INCUBA 2016). I also identified the #AARSOME platform that facilitates the connection between existing and new start-ups in Aarhus, and Væksthus Midtjylland that facilitates business services to entrepreneurs, start-ups and mature firms (Business Aarhus 2014). Additionally, Aarhus has located 18 different business accelerator services at the same location, which makes it easier for entrepreneurs to get information (Aarhus City Council 2016). There are also several platforms to help entrepreneurs to get capital, such as Kapitalcoach, Connect Denmark, Vækstfonden, and Innovationsmiljøerne (Business Aarhus 2014).

- The third group is in relation to geographical areas. I identified the Aarhus Business Region, which consists of 11 eastern Jutland municipalities (Business Aarhus 2016).

*"Business Region Aarhus will expand cooperation and strengthen the city region geographically by working for more East Jutland municipalities to join the cooperation. The goal is for the Business Region Aarhus at the end of 2014 to cover an area of more than 800,000 inhabitants"* (Business Aarhus 2014 p 26)

In sum, Aarhus has created collaborations and networks between city stakeholders to overcome environmental and city issues. In fact, Aarhus city council has developed a city business plan based on a collaborative model. Smart Aarhus is an example of this model. Moreover, Aarhus has several relevant networks for triggering innovation, which I group into 3 categories [R&D, start-ups and geographical areas]. Although all of them are relevant, I point out the Aarhus Business Region collaboration as an attempt by Aarhus city council to overcome the size issue of Aarhus. In conclusion, Aarhus has strong networks and collaborations inside and outside of the municipality, fostered by Aarhus city council as an essential tool to overcome different city issues such as environmental or city size issues.

### 5.1.4. Business climate and structure

The fourth innovation determinant is shaped by the business climate and the industry structure. In respect to the Aarhus business climate, I analyze three growth drivers:

- The first growth driver is Aarhus´ high level of R&D competence, which has made many firms locate their center of excellence in Aarhus (Business Aarhus 2017e).

- The second growth driver is Aarhus' well-qualified labor market, which is also characterized for its high level of motivation according to IMD's "*Denmark is Nº1 in the world on worker motivation*" (seen in Business Aarhus 2017e). Together with the flexibility of Danish employment law (Business Aarhus 2017d) and the relatively low corporate taxation [22%, see appendix 9.6] (Aarhus City Council 2016), this makes the Aarhus labor market suitable for firms. However, these characteristics do not differentiate Aarhus from many other Danish cities, as the characteristics are fairly similar in Denmark as a whole. On the other hand, Aarhus' high concentration of students [50,000 university students in the municipality, in a municipality with 335,684 inhabitants] should guarantee an easy access to the well-qualified labor market for firms. Nevertheless, the survey "Business Climate Measurement 2017" by EPINO reveals that 20% of the firms in Aarhus are not satisfied with the availability of high qualify workers, especially big firms and the industry. This fact is relevant because the percentage has increased with respect to previous years.

- The third growth driver is the Aarhus entrepreneurial conditions, where Denmark has excellent conditions for starting a new company, for instance all new firms can start to run after just a few hours of being registered [easy plug-and-play registration] and the cost of starting a new enterprise is just DKK 1 of sharing capital. Moreover, Online Denmark holds the second position in EU for business efficiency (Business Aarhus 2017c). Again, these conditions are the same in all of Denmark, so they do not represent an advantage in respect to any other municipality. However, Aarhus has some particularities; for instances, Aarhus "*has the largest number of co-working spaces for startups per capita in Denmark*" (Business Aarhus 2017c). Moreover, Aarhus has support services for entrepreneurs, such as #AARSOME and Væksthus Midtjylland. In any case, these characteristics does not seem to be enough to increase the number of new companies and to support their growth, because the number of new enterprises has fallen from around 2,500 in

2008-2009 (Business Aarhus 2014) to 1,778 in 2015 (Statistics Denmark 2017a). At the same time, only a few companies in Aarhus develop into high-growth companies.

> "*But we are ... 22nd in Europe among 60 cities when we are talking about start-ups, but we are only number 30 when we talk about scale-ups. So that means that we are relatively good at facilitating talent, but we still have somewhere to go to create real winners in a real market*" (Højberg 2017)

In respect to Aarhus industry structure, 7 clusters have been identified: food, cleantech, healthcare, ICT and media, production, creative and experience industries, and education and research (Business Aarhus 2014). The clusters include the presence of some multinational corporations such as Arla foods, AarhusKarlshamn, DuPont, Danish Crown, Vestas, Grundfos, Siemens Wind Power, Kamstrup, Schmidt Hammer Lassen, and Designit (Business Aarhus 2017b). However, two thirds of private jobs are in small and medium sized companies (Statistics Denmark 2017b).

Central Denmark Region has 67,440 firms (Statistics Denmark 2017a). 22% of these firms belong to the trade and transport sector, which is because the Aarhus port is the biggest "*container port with a market share of nearly 60%"* in Denmark (Business Aarhus 2017a). The smallest sectors are "finance and insurance" and "information and communication", both with 4%. However, these 4% represent 2,497 firms and 2,629 respectively [see appendix 9.7]. This implies that there are large numbers of firms in each sector. Therefore, I can assume that there exists a good level of rivalry within Central Denmark Region. However, comparing to the 98,022 firms in the Capital Region, the number of firms in Central Denmark Region is significantly smaller, with 45% more firms in the Capital Region. However, Central Denmark Region is still the second largest region with a major concentration of firms in Denmark (Statistics Denmark 2017a) [see appendix 9.8].

In sum, of the three analyzed growth drivers, just R&D competence can be considered as an Aarhus characteristic. The other two, labor market and entrepreneurial conditions, are not really distinguishing the Aarhus business climate from other municipalities. Moreover, Aarhus has 7 clusters that show a diversified economy, which is mainly focused in the R&D value chain, and with the presence of some multinational firms, although medium and small sized firms are the majority. In addition, Central Denmark Region has the second largest concentration of firm after

the Capital Region of Denmark. In conclusion, Aarhus' R&D competence is the only distinguishing business climate determinant. In addition, Aarhus presents a diversified industry structure with fairly high level of rivalry, although it could be larger.

### 5.1.5. Governmental policies

The Aarhus city council has 12 groups of policies and plans, which implementation shape the four innovation determinants analyzed above. Based on the interviews and the information from the attended events, I identify 4 relevant policies:

- First, the climate policy that is part of the climate, energy, waste, and supply group of policies, which influences each project developed in Aarhus (Gerstrand 2017).

> *"Actually, we are taking this for granted a lot of time because we have very strict rules considering the environment. We also have this climate policy, where we want to be $CO^2$ neutral in 2030. So yes, environment influences all the rules that we do..."* (Gerstrand 2017).

- Second, the citizen involvement policy that is part of the innovation and citizen policies group, where citizens become an active part of the city, not only expressing their necessities but also giving solutions to city issues.

> *"If each of us participates with ideas and debate, active citizenship in Aarhus will generate good ideas to build on – to everyone's advantage."* (Quote: citizen group, seen in Aarhus City Council 2015a p 8)

- Finally, the third and fourth are business and urban policies, which are part of the business and employment policies and urban development policies respectively. Aarhus city council and the Board of Business worked together in order to develop and implement the urban and business policies. As a result, the Aarhus Business Plan was created, which is based on the "Aarhus model" of cooperation (Aarhus City Council 2010) that has been identified during the "network and collaborations" innovation determinant analysis.

The Aarhus Business Plan was reviewed in 2014, and a new plan emerged with some new initiatives. I am analyzing its policies due to the strong impact they have, shaping the innovation system of Aarhus and the development of Aarhus as a Smart City. Figure 13 shows the 14 focus

areas of the plan. Each area has its own vision, goals and initiatives to implement during 2014-2017. Seven of them are growth drivers that cross all industrial clusters, which I already identified in section 5.1.4, and the other seven are the industrial clusters. The drivers and clusters cannot be independent of each other, because the clusters rely on competences from other clusters. For instance, the food cluster relies on competences from other clusters, such as the ITC and media cluster (Business Aarhus 2014).

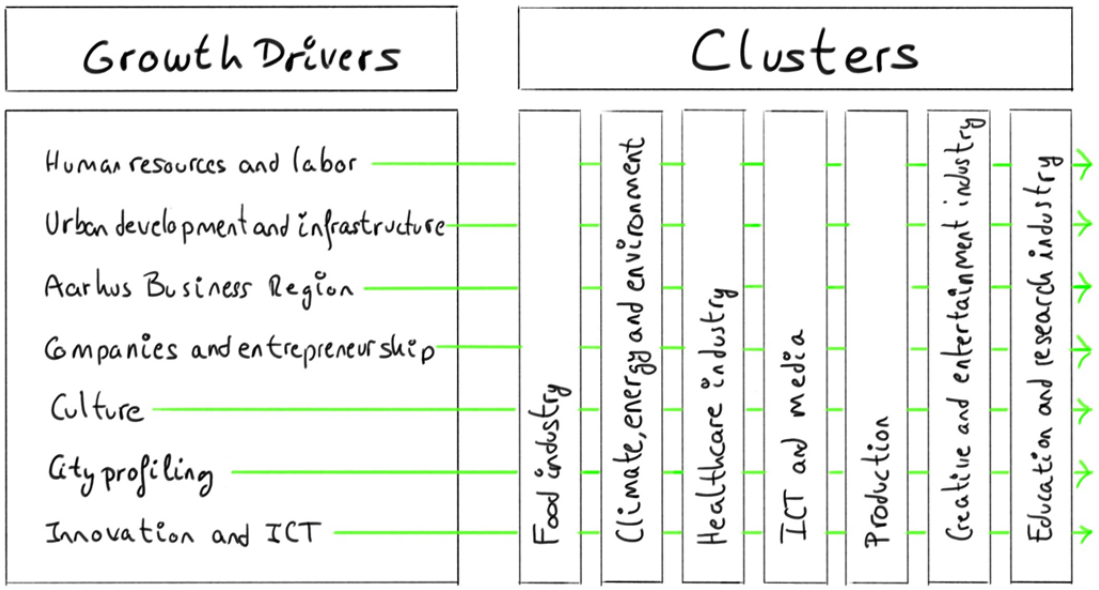


Figure 13: Aarhus growth drivers and clusters (Business Aarhus 2014)

Overall, the business plan develops and implements a close collaboration between relevant partners – businesses, organizations, research institutions, citizens, authorities, and academia – in a local, national and international level. Moreover, the policies have the goal of supporting, creating and developing the clusters´ competitiveness, not only by concentrating firms and their suppliers "*but also by the business framework of institutions that can secure workforce and talent, access to new technology, finance, advanced communications, physical infrastructure, attractive regulation and business environment As well as generally good living conditions"* (Business Aarhus 2014 p 15). In sum, the business and urban policies are boosting the development of a suitable market place where firms, entrepreneurs, and start-up can research organizations, academia, etc., and where they can play in a competitive framework, as they for instance are doing in the Smart Aarhus partnership.

*"That is Long Range Low Power Wide Area Network. It is not broad band, it is a narrow band, ... that is the investment we have made to invite to everybody to take part in what we have been doing."* (Højberg 2017)

In sum, Aarhus has 12 groups of policies, where four stand out: citizen involvement policies, which encourage the involvement of citizens to solve city issues; environmental policies, which influence in each project developed in Aarhus; and business and urban policies, which are boosting the collaboration between city stakeholders and the development of a suitable market place where firms, entrepreneurs, and start-up can research organizations, academia, etc., and can play in a competitive framework. In conclusion, the policies of Aarhus are catalyzing the citizen involvement in the development of city issue solutions through the collaboration between all city stakeholders as a way to face environmental issues, and creating a suitable space where city stakeholders can play in a competitive framework.

### 5.1.6. Aarhus innovation ecosystem

Figure 14 illustrates the Aarhus innovation ecosystem based on the Porters´ Diamond (1990) framework. It shows the influence of Aarhus´ governmental policies over the innovation determinants, which are catalyzing the citizen involvement in the development of solutions for city issues. Moreover, the policies are promoting the development of collaborations and networks between all city stakeholders as a way to face environmental issues and overcome Aarhus' size issue. Furthermore, they are also creating a suitable space where city stakeholders can play in a competitive framework.

Figure 14 also depicts the correlation between the four innovation determinants that define the Aarhus innovation abilities. In the innovation ecosystem of Aarhus, I identified extraordinary knowledge infrastructures that are difficult to imitate for other municipalities, such as Aarhus University or Aarhus Axis of Knowledge. In addition, Aarhus expenses in R&D has been constant and relatively high, even though it is not the region that spends more in R&D and it has not yet reached the R&D expenses target purposed by Europe.

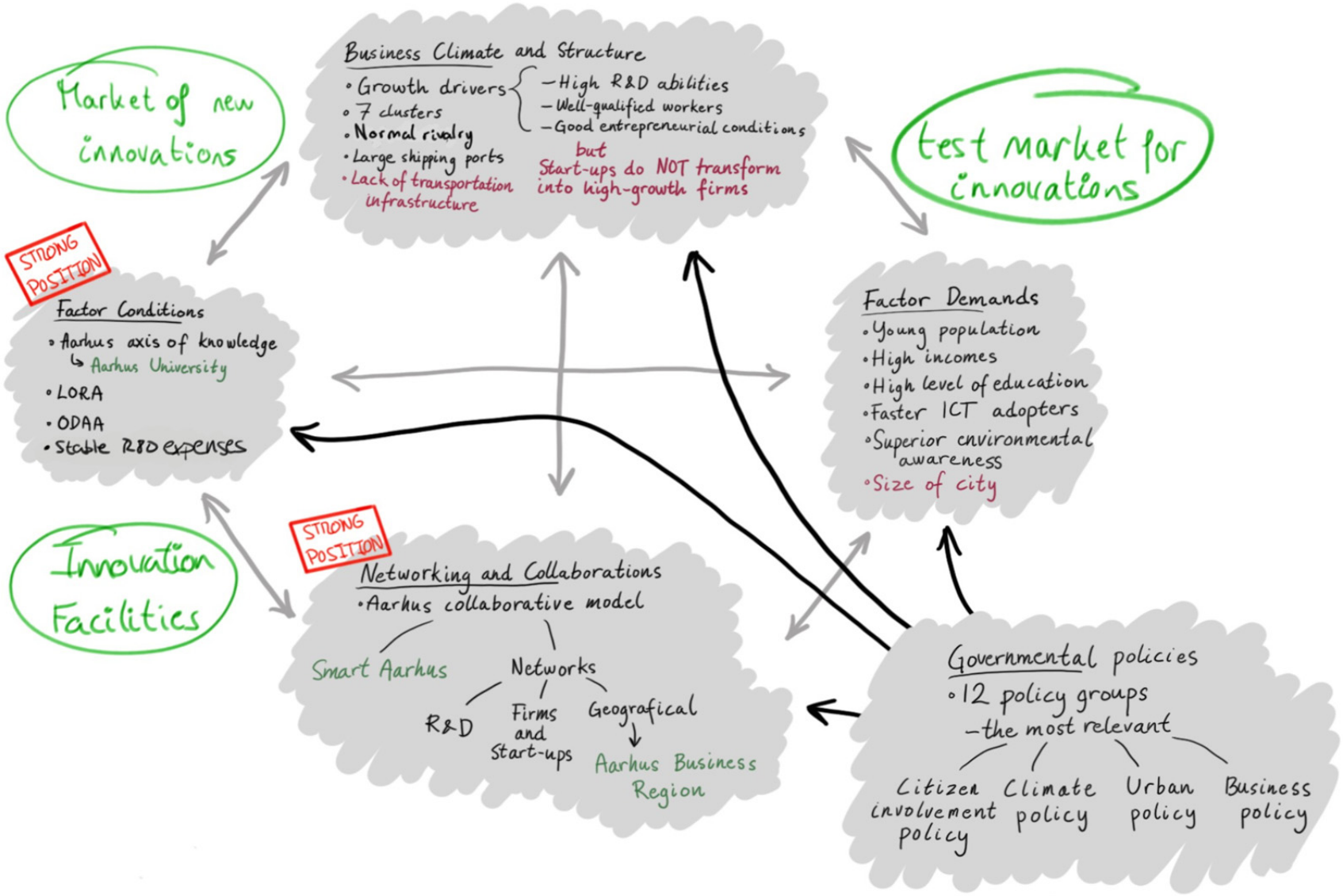


Figure 14: Aarhus municipality Porters´ Diamond (1990) [own elaboration]

Furthermore, Aarhus is also building strong networks and collaborations inside and outside of the municipality, fostering the Aarhus innovation facilities. Aarhus also has sophisticated citizens and can, thus, become a good test market. However, it does not present any special characteristic that can be distinguished from other test markets in Denmark. Its industry is diversified and present a certain level of rivalry, although the Capital Region presents a greater level of rivalry than Central Denmark Region. Moreover, the only identified distinguishing business climate determinant is the Aarhus R&D competences, which makes sense due to the extraordinary knowledge infrastructures that Aarhus has.

Therefore, the correlation of the four innovation determinants, together with the influence of the Aarhus city council policies, is creating strong innovation facilities with a good knowledge infrastructure and based on strong networks and collaborations. Consequently, Aarhus shows a good capacity to generate new knowledge. However, the markets where stakeholders can play in a competitive framework are not generating more innovation capabilities than other markets in other municipalities in Denmark. The same situation happens in the test market, where Aarhus also does not present any advantage in respects to other municipalities. This could be one of the reasons why Aarhus is creating fewer new companies by year than previous years and why there are only a few companies in Aarhus that develop into high-growth companies.

In conclusion, the combination of the four determinants and the influence of the Aarhus city council policies determine the Aarhus innovation ability. In light of the analysis results, I can state that Aarhus innovation ecosystem has a high capacity to generate and transmit new knowledge, but it has certain difficulties to transform this knowledge into growth valuable innovation.

### 5.1.7. Smart Aarhus innovation ecosystem

In the previous analysis, I already described how the correlation of the innovation determinants together with Aarhus city council policies determines Aarhus´ innovation ability. In this subsection, I again apply Porter's Diamond, but now to OC with the aim of finding out how the Aarhus innovation ability influences the development of Smart Aarhus.

Figure 15 illustrates the influence of the EU Horizon 2020 framework[3] (European Commission 2015) over the four innovation determinants. It is creating a market for smart cities through an experimentation as a service [EaaS] facility, based on open data platforms and citizen-grown smart solutions (OrganiCity 2015b).

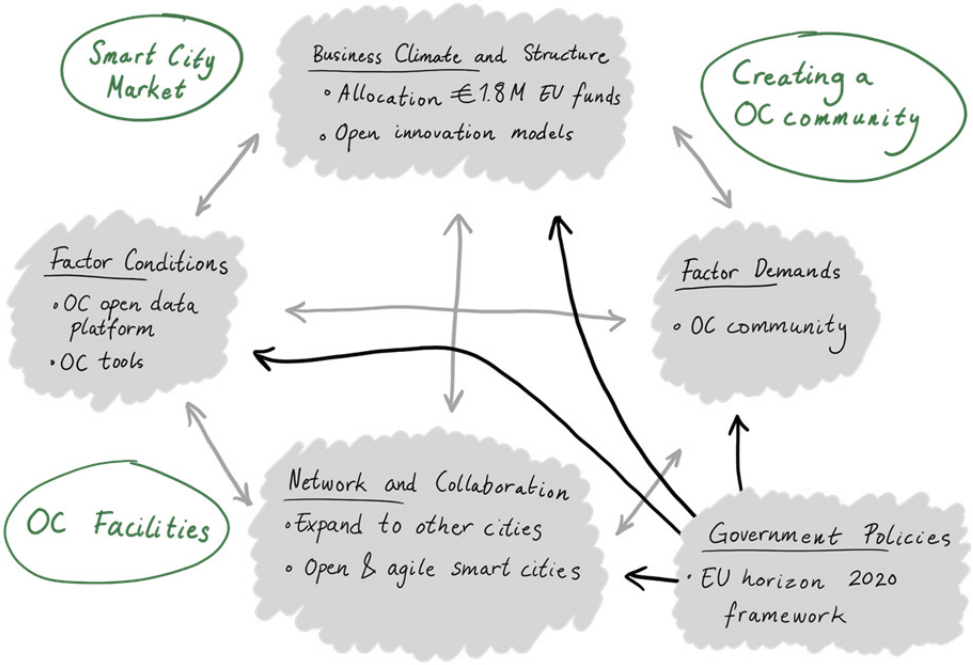


Figure 15: OrganiCity Porters´ Diamond (1990) [own elaboration]

The figure also shows the dependencies of each innovation determinant, defining the Smart Aarhus innovation ecosystem. This ecosystem is based on the development of an open data platform, based on urban data and 13 tools to prototype and test smart solutions (Vestergaarde 2017c) [see appendix 9.9]. It is also creating and strengthening networks and collaborations by establishing relations with local and international networks with common ambitions that can generate synergies between them, such as OASC and Aarhus Data Drinks [see appendix 9.10], and by expanding the learned OC knowledge into other cities (Brynskov et al. 2016). Moreover, OC aims at fostering the involvement of citizens, firms, etc., in order to tap into their ideas (Vestergaarde 2017b).

*"So, in essence, the municipality would like to tap into the knowledge and ideas ... let us call it the novelty fact that exist between citizens or in the citizen group, but all that connection has*

[3] *Horizon 2020 framework is the European Union Framework Program for Research and Innovation*

*not really been established, but it is happing from the bottom-up perspective."* (Vestergaarde 2017b)

In order to involve the citizens, the project is using open innovation models (Chesbrough 2003), using open calls, as tools to allocate €1,8 millions of EU funds (European Commission 2015).

"*we provide them with a sort of infrastructure, as the platform and software and hardware tools for them, to actually develop the experiments. And on top of that, you could apply from the money in the open call …*" (Vestergaarde 2017b)

The OC platform and tools are connected with the technological infrastructures that I identified above, such as ODAA and the LoRaWAN network. Furthermore, OC is using already established networks and collaborations in Aarhus to develop and create its own community, such as Smart Aarhus partnership, OASC and Aarhus Data Drinks [see appendix 9.10]. The OC´s EaaS facility allows to systematize the experimentation process in the cities where it is implemented, which means that OC is systematizing the involvement of citizens, firms, etc., in the innovation process of Aarhus. Furthermore, the deployed technology allows users of the facility to prototype and test their smart solutions in a real context, boosting the efficiency and safety of the experiments (Brynskov 2017).

"*If you are a city, and if Luis and the guys are making a lot of experiments that they actually are doing on behalf of a whole community, you need to do it efficiently, you need to do it in a safe way, and you need to run as you do it.*" (Brynskov 2017)

Consequently, OC is transforming Aarhus into a living lab, where citizens and firms in Aarhus can prototype and test their ideas in a real context, through a systematic experimentation service. The OC project fosters and supports the development of new knowledge and innovations. However, it does not support the further development of the newly created innovation. This is in line with the results obtained in the previous subsection, where Aarhus has a high capacity to generate new knowledge and transmit it, but it has certain difficulties to transform this knowledge into growth valuable innovation.

In conclusion, Aarhus is transforming into a living lab through the systematization of the involvement of users in the Aarhus innovation process, which is based on open innovation models.

In addition, the Smart Aarhus innovation ecosystem fosters and supports the development of new knowledge and innovations. However, it does not support the further development of the newly created innovation.

The next section performs the second block of my research analysis. The analysis is based on the QH innovation model. It aims at analyzing the stakeholders involved in the OC project and the collaborations between them.

## 5.2. OrganiCity stakeholders

This second section contains the study of the Aarhus stakeholders, analyzing the OC case study. The goal is to identify the roles and collaborations of the OC stakeholders. The section is divided into 3 subsections; the first one is the stakeholders' identification, which includes their description and classification. The second subsection is the analysis of the stakeholders' collaborations. Finally, the last subsection is the analysis of the Quadruple Helix model.

### 5.2.1. Stakeholders' identification

The Arhus stakeholders that are in charge of OC are Aarhus University, Alexandra Institute and Aarhus city council. They are building the OC facility in order to create a professional experimental service for citizens, through the triangulation of the wants and needs of the city stakeholders (Vestergaarde 2017b).

Each institution has a different function in the project. **Aarhus University** is the coordinator of the project in Aarhus and OC on the EU level, with Martin Brynskov as head of the OC project (Christophersen 2017). **Alexandra Institute** is in charge of developing the OC platform, tools and community engagement (Vestergaarde 2017b). **Aarhus city council** is in charge of facilitating the citizen engagement and the open calls (Christophersen 2017). Moreover, Aarhus University and Alexandra institute[4] have a major role as researchers and developers, due to their research nature, while Aarhus city council fundamentally has a facilitator role because it represents the public service. The three of them are together building the facility and at the same time giving support for using it to OC users. For instance, they apply to EU for receiving EU funds (Gerstrand 2017) and they distribute these funds between OC users (European Commission 2015). They also

[4] *Alexandra Institute is a research-based limited company affiliated to Aarhus University* (Wise & Høgenhaven 2008)

communicate initiatives, educate about the OC platform and tools, organize workshops, and give technical support (OrganiCity 2015b).

> *"That means, we are going to have like physical workshops, interviews, doing networking, face-to-face meetings, ... let us say triangulate needs and wants in the entire stakeholder group. And then it is our job to sort of condense this into one page.*" (Vestergaarde 2017b).

The rest of the stakeholders involved in OC are all individual citizens, firms, professionals, etc., from "the *European Union or in an H2020 associated country or in a developing country"* (OrganiCity 2016; OrganiCity 2017e p 4). All of them are potential users of the OC facility. Therefore, the OC facility includes a large range of city stakeholders, from citizens as individuals or entrepreneurs to big firms and professionals (Brynskov et al. 2016). They can be from Aarhus, but also from outside of Aarhus. However, OC is referring to all of them as citizens, regardless if they are citizens or firms (Vestergaarde 2017b).

> "*The participants to our activities ranged from individuals/citizens to representatives of big companies, from students to established professionals. The community included both non-technical citizens and power users of technology.*" (Brynskov et al. 2016 p 30)

> *"I mean, in general, it turns out that a lot of citizens, where a citizen also can be a company, so citizens have a lot of ideas."* (Vestergaarde 2017b)

Figure 16 illustrates the OC user classification. It shows two groups of users: "experimenters" and "participants".

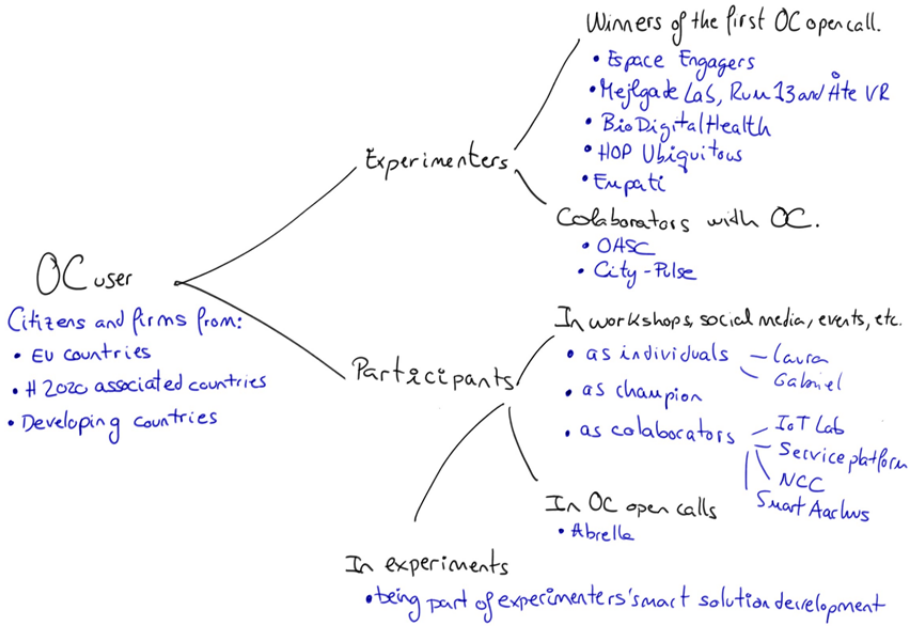


Figure 16: OrganiCity user classification [own elaboration]

The first group is **user-experimenters**, which can be both citizens or firms. They can be participants that have won an open call, where they are prototyping and testing their ideas in the OC facility, or they can be collaborators that help OC develop its platform and tools.

At this moment, Aarhus has 5 experimenter teams that won the first open call launched by OC. They are: "Space Engagers", which is a research unit and social enterprise from the School of Architecture, Planning and Environmental Policy at University College Dublin (Space Engagers 2017); "Mejlgade Lab, Rum13 & Åte VR", which is a volunteer organization (Mejlgade Lab 2017); and three firms – BioDigitalHealth Ltd, HOP Ubiquitous, and Empati (OrganiCity 2017a) [see appendix 9.11].

The idea that a citizen can prototype and test their ideas, in order to develop city services and profit from them, implies a transformation of the citizen into an entrepreneur (Vestergaarde 2017b).

> "*But the interesting thing is: when you have a citizenship creating a service in the city then the citizen becomes a provider for other citizens, so it is twofold: one where citizens are actually creating what they want and need, and, then becoming a producers like a company.*" (Vestergaarde 2017b)

Moreover, the collaboration between established communities and OC has been identified, as in the case of OASC that influences the technical standards used by the OC platform and tools (Vestergaarde 2017b), or the City-Pulse community, which Alexandra Institute is part of (City-Pulse 2017), that influences OC with its previous experiments and its already establish community.

> "*Pre-existing adjacent communities and networks have contributed to OrganiCity Aarhus both by recruiting relevant companies and organisations, and by being active experimenters.*" (Brynskov et al. 2016 p 29)

 The second group is **user-participants**, which are citizens and firms that participate or collaborate in OC events [workshops, interviews, and face-to-face meeting], in OC open calls, in social media, or by being part of the experimenters´ smart solution development. Their participation generates ideas of possible smart city solutions and knowledge about citizen issues, and spreads information about OC, smart cities, and co-creation. They are enablers of innovation. However, they are not generating innovations as the experimenters do, because they are not developing any smart solutions through the OC platform and tools, and neither are they modifying directly the OC platform and tools.

In this group, I identified **firms,** such as the "Abrella" start-up that applied for the first open call, but did not won (Brynskov et al. 2016), and the NCC group, which presented its work about building sensors [Building data "proof of concept"]; as well as **individual citizens** such as Laura and Gabriel, whom are students at Aarhus University and winners of the "Co-creating Smart Cities event" [see appendix 9.12].

"*So, we have spend a long time in brainstorming about what people have done and in discussion with other people to come with an idea that I think is very nice that we will present.*" (Citizens 2017)

I also identified one user that is assuming more roles than other participants, whom makes an intensive use of social media to disseminate OC posts and tweets, such as through re-tweets and OC Facebook posts. OC has fostered his participation in the OC events by giving him more responsibilities (Brynskov et al. 2016). OC categorize this kind of users as **champions**.

"*He liked and frequently shared posts with his network on Facebook, where he was a subscriber to several OrganiCity channels (including @OrganiCities and @smartarhus). During the clinics, he played a facilitating role by encouraging other participants to collaborate with one another.*" (Brynskov et al. 2016 p 29)

Furthermore, I identified collaborations between established communities and OC. However, these collaborations have not had a direct impact on the OC platform or tools. These collaborations are based on joint organization of events. For instance, OC, IoT-Lab and Service Platform organized a smart city event during the "Internet Week Denmark 2015" (Brynskov et al. 2016) under the Smart Aarhus partnership umbrella. This kind of collaborations helps the OC network to grow and OC can leverage from the knowledge that the communities already have acquired. Moreover, members of these communities have helped to spread information about the OC project, smart cities and co-creation (Brynskov et al. 2016).

To conclude, citizen stakeholders perform an active role, either through their participation or by directly developing innovation as experimenters in OC, assuming an R&D role. OC influences them to become entrepreneurs, because their innovations can be commercial solutions for the market. In comparison, firm stakeholders also perform an active role, for the same reason as citizens. However, they are not assuming the R&D role as new role, but OC leverages them by giving access to experimentation facilities. In addition to the R&D role, OC is also expanding other roles into the citizens and firms, as in the case of the champion user, which also assumed a facilitator role. In fact, the aim for the OC facility is to become self-sustainable. According to Vestergaarde (2017b), the idea is to create online tutorials for users, after which they could develop their own tools. However, this stage has not arrived yet and the discussion is ongoing about the future sustainability of the OC project (Palacios 2017).

"*We only have two rounds of open calls, in order to put it on live, to get some use cases that we can show later on. But the idea is that people should do this voluntarily to some extent.*" (Vestergaarde 2017b)

In sum, three institutions [Aarhus University, Alexandra Institute and Aarhus city council] are in charge of building, supporting and facilitating the OC facility. The other stakeholders are citizens and firms, which do not necessarily have to be from Aarhus. They are the potential users of OC.

Citizens and firms are involved in the Aarhus innovation process as participants or experimenters. In the case of citizens, they can assume an R&D role, having the possibility to become entrepreneurs, because their smart solutions can become commercialized services or products. In the case of firms, they are not assuming R&D as a new role, but OC facilitates their access to R&D resources. Besides R&D roles, OC is also developing facilitator roles for citizens and firms to foster the voluntary maintenance of the OC platform by users. In conclusion, OC expands the R&D role to all stakeholders involved in the OC project. Furthermore, the project is building new roles in order to encourage the voluntary maintenance of the facility by users.

### 5.2.2. Stakeholders collaboration

In the first section of this analysis, I found out that OC is transforming Aarhus into a living lab, which facilitates the collaboration between the stakeholders (Bergvall-Kåreborn et al. 2009). Therefore, it is facilitating the collaboration between the stakeholders identified in the previous subsection. Højberg (2017) states, during his presentation in the event "From nano to global scale: cities creating change", that "*today, we will call it: how to build an ecosystem that can actually have enough of both competence and resilience to coordinate and to facilitate things that are coming bottom-up and not top-down*", referring to the construction of Smart Aarhus. Therefore, Aarhus is trying to build a system where "things" (referring to ideas, innovation, knowledge, etc.) come bottom-up, that is from citizens and also firms (as I indicate above, OC considers firms and citizens as the same thing). Here, the top-down stakeholder, which is Aarhus city council, should have enough competence to manage and tap into these ideas, innovation, knowledge, etc., coming from the bottom.

Furthermore, Christophersen (2017) identified co-creative collaboration "*as a Scandinavian way of doing public service*".

> *"It is like 28,000 employees working in the city and all departments. Some focus in co-creating the services with the citizens. It is really a Scandinavian way of doing public service. That you are really taking the citizens' needs from the beginning, integrating them in every aspect of the city."* (Christophersen 2017)

Co-creation is also in the roots of the OC project, understood as learning by doing, where the managers of the OC projects work together to prototype the OC facility at the same time as OC users are using it. This allows them to improve the facility while developing it (Palacios 2017). According to Vestergaarde (2017b), co-creation allows OC to triangulate needs and wants of all city stakeholders in a more efficient way.

"*Now, at this precise moment in which we are, where the co-creation comes from doing these experiments, then the* [experimenters] *are helping us to improve how we are giving the service.*" (Palacios 2017).

Moreover, this collaboration disrupts the traditional roles of the stakeholders, giving new roles to the stakeholders. (Brynskov et al. 2016)

"*In the case of OrganiCity, citizens seemed to appreciate the municipality's courage to communicate the smart city agenda as "We develop as we go". With this agenda, the municipality disrupted its usual role and opened up the idea that a part of the decision-making processes was given to citizens.*" (Brynskov et al. 2016 p 31)

However, the OC facility is not the only innovation that emerges during the co-creation. A second type of innovation appears when citizens are collaborating with Aarhus OC. A clear example of this innovation type is the smart city solutions, based on urban data, that emerge when citizens and firms are experimenting on the OC facility (Palacios 2017) . For example, the "Green Biking Routes Through Aarhus" app, developed by BioDigitalHealth Ltd, used data about Aarhus air pollution to show "green" routes for cyclists (OrganiCity 2017c) [See appendix 9.11].

I also identify that new ideas are generated through workshops, education seminars, and the tutorial portal about the OC tools (Vestergaarde 2017b). The new creative ideas are used to define use cases and open calls (OrganiCity 2015b).

*"Even creating the open calls themselves, setting up at least some of the rules, … setting up that process, even the open call text,… what kind of cases we should focus on, all of that is created in direct dialog, in communication, interaction with the citizens themselves."* (Vestergaarde 2017b)

The two identified innovation types differ in whom initiate the innovation. The OC facility innovation is initiated by Aarhus University and Alexandra Institute (Gerstrand 2017), while the innovation that comes from the use of the OC facility is initiated by citizens (OrganiCity 2015b).

"*I think, the OrganiCity project came from Aarhus University and Alexandra Institute, where they approached the city, and we made the application together.*" (Gerstrand 2017)

Another difference is based on the ownership of the innovation; in the case of the OC facility, the owner is Aarhus city council because it is a public service. In contrast, in the case of the smart city solutions, the owner of the innovation is the citizen who initiated the experiment (Palacios 2017). This aspect of ownership is crucial in the OC project in order to build a secure space, where citizens can experiment without being afraid of losing their ideas (Palacios 2017).

"*The Intellectual Property Right are understood as …. if I fund an idea, it does not mean that I own the idea, this idea is still in hand of this person. This person can experiment in a secure environment, where he is not going to lose his ideas because he put them into practice.*" (Palacios 2017)

Nevertheless, some aspects of the projects have to be public, such as the experiment description and the process of the experimentation (Palacios 2017). OC fosters the experimenters to contribute with the data they collected during the experiments to the OC open database, although it is not mandatory (Vestergaarde 2017b).

*"We also want the data they collected in the experiment. We would like that to go back into OrganiCity in that form, so it becomes sort of open data for everyone. But I think that it is not mandatory either, or it is just that we would like it."* (Vestergaarde 2017b)

In sum, Smart Aarhus is building a system, where top-down stakeholders should have enough competences to manage and tap into the innovations, ideas, and knowledge coming from bottom-up. At the same time, the system stimulates the bottom-up generation of knowledge, innovation and ideas. The identified collaboration between all the stakeholders is "co-creation". This concept is understood as "learning by doing", and it allows to triangulate needs and wants of all city stakeholders. I further identified that its use implies the disruption of stakeholders' roles, the generation of innovation and knowledge, and issues in relation to the ownership of the generated

innovations. In conclusion, Aarhus is building a balanced system between top-down and bottom-up competences, which is based on co-creative collaboration in a living lab context.

### 5.2.3. Quadruple helix model

In the previous subsection, I indicated that OC is generating two kinds of innovations; one is the OC facility initiated by Aarhus University and Alexandra Institute, and the other one is smart city solutions initiated by citizens or firms, where the smart city solutions are prototyped or tested through the OC platform and tools. Both kinds of innovations are a result of co-creative collaboration between the stakeholders in a living lab context.

Therefore, two layers of innovation constitute the Aarhus innovation ecosystem. This subsection analyzes them through the QH innovation system (Yawson 2009). Figure 17 illustrates the two layers of the innovation system. The **QH on the left** depicts the layer of the OC facility innovation, which owner is Aarhus city council, because it is a public service. In this QH, the circle in the middle represents the academia helix that is formed by Aarhus University and Alexandra Institute. They are the initiators of the OC facility innovation. The upper circle is the government helix that is represented by Aarhus city council, which function is to facilitate the involvement of users and the open calls. These two helixes are in charge of the research and development of the OC facility. The bottom right and left circles are the citizen and firm stakeholders, which perform similar roles; they are testing the facility through their participation and experimentation.

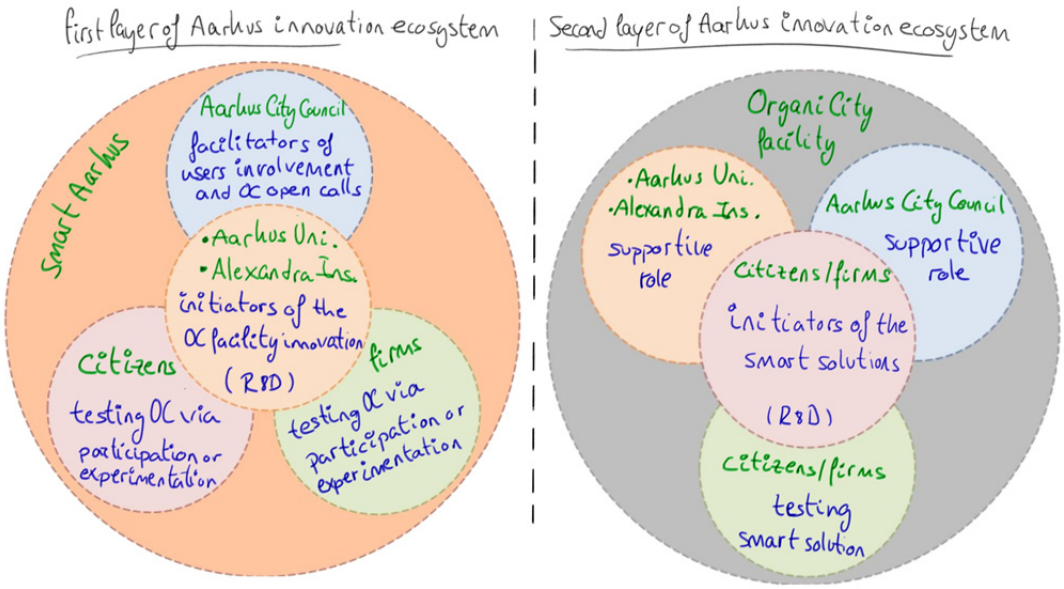


Figure 17: OrganiCity innovation ecosystem based on QH (Yawson 2009; Arnkil et al. 2010) [own elaboration].

The **QH on the right** represents the layer of the smart solutions, which owner is the user who develops the innovation. In this layer, the middle circle represents citizens and firms, because they perform the same roles. In this circle, they are the initiators of the innovations; they are the researchers and developers of the smart solutions. The bottom circle again represents citizens and firms, but here they are the testers of the smart solutions. The upper right and left circles are academia and government. In this layer, they are assuming supportive roles to boost the development of the smart solutions. They are distributing EU funds through open calls, communicating initiatives, educating, organizing workshops, giving technical support, etc.

Therefore, OC is building a new public service. For its development, the academia and government helixes, which are top-down stakeholders of the Aarhus innovation ecosystem, are in charge of OC facility as researchers, developers, supporters and facilitators. On the other hand, citizens and firms form the bottom-up face of the Aarhus innovation ecosystem. They are developing smart solutions based on urban data, so they are also researchers and developers. The two innovations emerge due to co-creative collaboration between all city stakeholders. As I stated in the previous subsection, co-creating collaboration implies a disruption of stakeholder roles; as in the case of champion users (Brynskov et al. 2016) or when the Aarhus city council disrupt their own roles, communicating the *smart city agenda as "We develop as we go"* (Brynskov et al. 2016 p 31). These results show that co-creative collaboration reduces the role boundaries between stakeholders, showing that roles are not related to a specific stakeholder, and the roles can move from one stakeholder to another.

In the light of these analysis results, I can state that top-down [academia and government] and bottom-up [firms and citizens] stakeholders constitute the Aarhus innovation ecosystem. Together they are co-creating a new public service and innovations that belong to the user who develop it. The co-creative collaboration is disrupting the user roles, expanding researcher and developer roles into all city stakeholders including citizens, and in addition develops new roles.

In the next and last section of the analysis chapter, I analyze the involvement of OC users in the innovation process of OC. The analysis is based on the OC user classification identified in this subsection of the analysis.

## 5.3. User involvement

This third section of the analysis aims at discovering how the users are involved in the innovation ecosystem and what level of involvement the users have. I divide this section into two subsections; the first one contains the description of the OC innovation process and the second one contains a mapping of the OC innovation process based on Wise & Høgenhaven's (2008) framework for mapping user-orientated innovation processes. Note that this chapter makes use of the user classification identified during the analysis of the OC stakeholders in section 5.2.1.

### 5.3.1. OrganiCity innovation process

The previous chapter concluded that Aarhus University, Alexandra Institute and Aarhus city council are building the public service of the systematic EaaS facility of OC where users, which are citizens and firms, can test and prototype their own smart solutions. These innovations are created in co-creative collaboration. Therefore, the involvement of users during the innovation process is essential. For this reason, OC has created the "OC engagement journey" (OrganiCity 2015b), a framework in which the "*participatory relationships between the OrganiCity and groups within the city*" are defined (OrganiCity 2015b p 4). Table 18 illustrates the strategy, divided into three main phases: discussion, co-creation, and experimentation. These phases are defined around two process stages: the definition of use cases and the launching of open calls.

- The **discussion phase** includes the creation of a network and a community development, by establishing communication with Aarhus communities [see appendix 9.10], creating awareness about OC and the EaaS facility, informing about the co-creation of open calls and the OC platforms and tools, and recollecting data about issues and challenges in Aarhus of its citizens and firms. In this phase, OC participates in workshops, conferences, meet-ups and online media.

- The **co-creation phase** covers the education activities, strongly focused in training in and support of the technical features of the OC tools and platform. Moreover, co-creation activities are launched to boost new ideas created by users, which can be used to participate in OC open calls. The open calls are a result of "*creative inputs of the community during the engagement journey*" (OrganiCity 2015b p 50), which are included in the open calls as challenges that need to be solve. In this phase, OC organizes workshops and hack events, creates online tutorials and articles, and participates in relevant conferences.

The **experimentation phase** includes open call facilitation, support of experiments by OC and the OC community in a technical level but also about disseminating them into the community, and the return of the learned knowledge into the community.

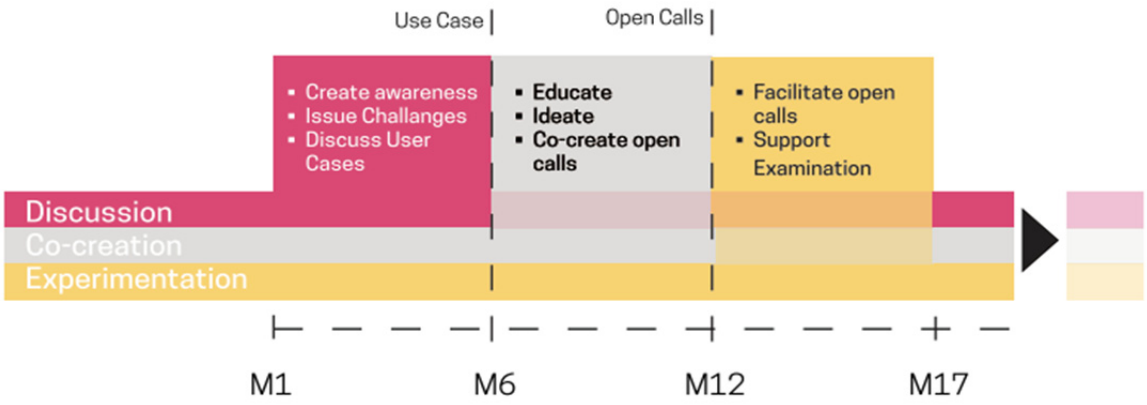


Table 18: OrganiCity Engagement Journey (OrganiCity 2015b)

This strategy is fostering the user involvement in order to systematize the recollection of ideas, to transform them into smart city solutions (Vestergaarde 2017b).

In sum, OC has designed a strategy to involve users, which is divided into three steps. The first one is to develop the community and establish communication with other Aarhus communities. The second one is to co-create the ideas and the open calls, and at the same time foster users to participate in OC open calls. The last one is to launch the open calls, support experimenters and return the learned knowledge to the community. In conclusion, OC has designed a strategy to involve the users during the innovation process, to systematize the recollection of ideas and to transform them into smart city solution.

### 5.3.2. Mapping user-orientated innovation processes

This subsection contains: first, the analysis of the OC innovation process, using the innovation wheel framework; and second, the user-oriented map of the OC innovation process, which is based on the results of the innovation wheel analysis and uses the framework for mapping user-orientated innovation process (Wise & Høgenhaven 2008).

#### *5.3.2.1 OrganiCity innovation wheel*

As I mentioned in subsection 5.3.1, the OC engagement journey is subdivided into three phases [discussion, co-creation and experimentation]. The innovation wheel (Wise & Høgenhaven 2008) is

divided into two phases: the “what phase” and the “how phase”. I consider the first two phases of the OC innovation process as being inside of the “what phase”, because both are focused in identifying users´ issues and challenges in the city, which are presented in the OC open calls and in fostering the users’ creativity to find solutions for those issues and challenges. In contrast, the experimentation phase of the OC innovation process is related to the “how phase” of the innovation wheel (Wise & Høgenhaven 2008), because in this phase OC launches the open calls and gives support to the experimenters in their development (OrganiCity 2015b).

- The “**what phase**” is divided into 4 steps [opportunity identification, data collection, pattern recognition, and concept ideas]:

**1. Opportunity Identification.** OC identifies city challenges based on a co-creation process with the citizens of Aarhus.

> “*We have talked on social media, in focus groups, in real life during workshops and meetings and, on that basis, we have revealed three challenges that citizens face in their everyday life.*” (OrganiCity 2015a)

Three challenges were identified for the first open call: the extension of your living room, green lungs, and time management (OrganiCity 2016). They were developed in close collaboration with the citizens in two focus groups, where 12 individuals took part in total (Lynch et al. 2016), and in an Instagram contest, where 25 users participated (Lynch et al. 2016).

> “*For example, the city of Aarhus, for promoting the Instagram event which consist in uploading pictures of the city with an improvement comment, gave two tickets for visiting a museum.*” (Cuenca 2017)

However, in the case of the second open call, the challenges came directly from the Aarhus city council (Vestergaarde 2017c), which means that Aarhus OC did not involve any user to detect the challenges.

Hence, OC is involving users through a co-creative process, using workshops, meetings, and particularly social media and focus groups, although in the second open call user involvement has not been detected.

**2. Data Collection.** OC involves users indirectly [without direct face to face contact] and directly [with direct face to face contact] to collect data. Indirect user involvement happens when the data is collected through sensors [IoT, LoRaWAN] around the city. For instance, OC integrates five dataset sources from the ODAA: real time traffic data, the number of visitors at DOKK1, Events in the City of Aarhus, Events in the Libraries in Aarhus, and Data about Outdoor Activities in Aarhus (OrganiCity 2017f).

In contrast, direct user involvement occurs in three different ways. The first way is through OC user-experimenters that are collecting data about Aarhus citizens for their experiments. However, it is not mandatory that they contribute with this data to the OC platform (Vestergaarde 2017b). The second way is through OC events and workshops, where data is collected from user-participants with the goal of documenting and making the data available to everyone through the OC website (OrganiCity 2015b). The third way is from user-participant-collaborators during the events or workshops that they organize together, such as IOT-Lab and Service Platform (Brynskov et al. 2016).

Hence, OC is involving users indirectly, using ODAA and sensors [IoT, LoRaWAN] to collect the data, and directly, when OC is organizing or participating in workshops and events to collect data from the user-participants. Moreover, OC collects data through user-experimenters, but in this case the experimenters is driving the data collection.

**3. Pattern Recognition.** In this step, I identify two different situations; the first one is related to the data analysis to develop the OC facility innovation. In this case, OC itself drives the analysis.

> "*That means, we are going to have like physical workshops, interviews, doing networking, face-to-face meetings, ... let us say triangulate needs and wants in the entire stakeholder group. And then it is our job to sort of condense this into one page.*" (Vestergaarde 2017b).

The second situation is the analysis performed by user-experimenters. In this case, they are driving the analysis of the data. Each experiment can involve other users, although not necessarily. However, the results obtained by the experimenters can be used by OC (OrganiCity 2017b). Therefore, I consider this step to be driven by user-experimenters as part of the OC innovation process.

*"Rights for others to use your experiment results – While the experiment results will be owned by you, the OrganiCity Partners and their affiliates will have a royalty free right i) to use and permit use of your experiment results that are changes and additions to the OrganiCity Facilities for any purpose; and ii) to use and permit use of any other of your experiment results if needed for implementation of the OrganiCity research project."* (OrganiCity 2017b)

In sum, OC involves users in this step, but this is mainly driven by user-experimenters.

**4. Concept Ideas**. OC organizes open workshops to support and boost the creativity of OC users and encourage them to apply for OC open calls (OrganiCity 2017d), such as the Co-creating smart city workshop that was held during the Internet week Denmark (2017). This event took an entire day, starting with several presentations [from OASC community and NCC firm], where the OC project and tools were introduced. Smart city challenges were also presented, which were used as enablers of innovation (OrganiCity 2015b). The participants that selected the same challenge worked together to solve the challenge. After several hours of work, the smart solutions were presented to the jury, whom evaluated them. The winner got one month of free support and office space in Alexandra Institute to further develop the idea, and OC helped them to apply for the second open call [see appendix 9.12]. However, this prize does not imply that the winner's idea will go further in the development process. That depends on the team, whom creates the concept of the solution, if they want to apply for the open call, and if the idea will be selected between all the applicants of the OC open call. For instance, from the three participants interviewed in the event, just one expressed his clear intention for applying to the open call, while the other two had different motivations, such as finding a topic for a master thesis or just having fun. The citizen interviews also showed the impact of the prize on user involvement. The two participants, with different motivations than applying to the open call, implied that they would change their motivation in case of winning. Furthermore, although they did not directly express the idea of applying, they showed the intention of being further involved with OC (Citizens 2017).

- ✓ In case of winning: "*Definitely, yeah. I think I will... want Alexandra Institute and definitely use it and talk with the people and try to work more on the idea and connect with the people.*"

✓ In case of not winning: "*Well, ..., my motivation* [find a topic for her master thesis] *is still there because I have to start next year, early 2018. I still have a little bite of time to come with something else."* (Citizens 2017 answers from the same user)

Therefore, OC is involving user-participants during the concept ideas step. OC organizes workshops, using challenges as enablers of the idea creation. They also use the co-creation process between the user-participants to develop ideas between the participants. However, the concept ideas step is driven by OC. In addition, the best idea is rewarded with a prize in order to foster deeper user involvement.

The "**how phase**" is divided into two steps [conceptualization, and prototype and test]:

**5. Conceptualization**. In this step, OC evaluates the users´ applications for the open calls, in order to allocate funds to the higher evaluated solutions. The participation in previous OC events is not necessary to be selected. Therefore, face-to-face relation is not required, because potential users can be from "*European Union or in an H2020 associated country or in a developing country*" (OrganiCity 2016; OrganiCity 2017e p 4). Furthermore, the selected solutions do not have to involve users-participants in the development of the proposal. However, as table 19 shows, OC has applied changes between the first and second open call in order to foster the involvement of users in the experimenters' application plans.

| | First Open Call | Second Open Call |
|---|---|---|
| *Prepare and Submit proposal section* | The ways you have co-created or plan to co-create with citizens, companies or other stakeholders for whom your idea is relevant or who will benefit from your experiment. This must include any consideration on ethics and privacy (max. 3.000 characters) | Explain your planned co-creation with citizens, companies or other stakeholders for whom your idea is relevant or who will benefit from your experiment. **If you have already engaged with these groups explain to what extent.** |
| | Your Experiment Group: organisation, skills and resources you have (max. 3.000 characters) | Describe your Experiment group. How are you organised? What skills and resources do you have? What experience do the team members bring to the experiment? For example, **what is the balance between co-creation and technical skills in your group?** |
| *Evaluation criteria section* | Is there a strong co-creation strategy or co-creation elements in the activities you outline? | Is there a strong co-creation strategy or co-creation elements in the activities you outline? **Is your project plan open to evolve as a result of the co-creation activities? Are the relevant external stakeholders involved in your co-creation activities?** |

Table 19: "prepare and submit proposal" and "the evaluation criteria" sections from the first and second open calls [(OrganiCity 2016) / (OrganiCity 2017e), own elaboration].

In conclusion, OC is involving user-participants in this step, where face-to-face relation is not necessary, using open call tools in order to select the most valuable smart solutions. In contrast, the user-experimenters do not necessarily have to involve users in this step, but OC has raised the user-involvement requirements in the second open call.

**6. Prototype and Test**. In this step, OC involves user-experimenters through a co-creative process. As I already explained in section 5.2.2, users are developing their innovations using the OC facility and OC is developing the OC facility while users are using it (Palacios 2017).

"*Now, at this precise moment in which we are, where the co-creation comes from doing these experiments, the* [experimenters] *are helping us to improve how we are giving the service.*" (Palacios 2017)

Furthermore, in this step, user-experimenters have to involve user-participants during their experiments, due to the co-creation strategy which is required in the open call applications. However, the open calls are not requiring any specific level of involvement nor a specific tool for involving them (Vestergaarde 2017b).

"*We have put that entirely into the hands of the citizens who have been funded for creating experiments. What we did was .... when you perform and experiment you need to put in the concept of co-creation. So that means that we sort of put bones on the experiment itself. So when they develop, they somehow need to prove they have done some collaboration with the end users or second layer citizens.*" (Vestergaarde 2017b)

I have also identified the involvement of experimenters-collaborators in this step, which influence the development of the OC platform and tools. For example, in the case of OASC community, they influence the set-up of the OC platform and tools in order to make them compatible with the technological standards used in Aarhus as well as other cities around the world (Brynskov 2017).

"*So, OrganiCity project is highly influenced by the initiative called Open & Agile Smart Cities* [OASC] *that Martin has presented briefly now.*" (Vestergaarde 2017b)

Hence, OC involves user-experimenters through a co-creative process where user-experiments drive the OC facility innovation as well as their smart solutions. In addition, user-experimenters

are also involving users in this step, although each user-experimenter can involve them as they want.

In sum, OC is using four types of tools to foster the user involvement and knowledge gained; firstly open calls, in order to select the best solutions to solve smart city challenges, secondly, face-to-face tools, such as workshops, to foster the creation of knowledge and ideas, thirdly, social media, such Instagram or facebook profiles, that is mainly used as a communication or dissemination tool between users and OC, where OC is the main driver of the communication, although it has also been detected its use for gaining user knowledge, and the last tool is online platform and tools used for developing users´ innovations. However, these platform and tools are used once the user is an experimenter, which happens in the last step of the innovation process.

In the next subsection, I place each step of the innovation wheel in the framework of Wise & Høgenhaven (2008), based on the results obtained in this innovation wheel analysis.

#### *5.3.2.2. Map of user-oriented innovation process*

Table 20 illustrates the OC innovation process steps placed on a user-orientated map. Two red lines divide the map. One of the lines, the **participation line**, divides the framework into two areas. Above the line, users are part of the innovation team, driving the innovations of the OC facility and smart solutions. Under the line, users are not part of the OC innovation team. Here, they are not developing any innovations for OC, but their inputs are used to identify challenges, create the open calls, and select the best ideas. As can be seen in the map, it is just during the "test and prototype" step that users have the highest level of involvement. The second line is the **articulation line**, which also divides the framework into two areas. Under the line, OC gains access to user information without the articulation of the users' knowledge. Over the line, OC is gaining user knowledge through the users' articulation, which is taken at face value. So, the "data collection" through technological infrastructure [IoT, LoRaWAN] is the only step where OC is not gaining articulated user knowledge.

Consequently, only user-experimenters present the highest level of involvement, because they are the users involved in the "test and prototype" step. Their involvement is direct as part of their innovation team, collaborating through a co-creative process where they are driving their own

innovations [smart solutions] at the same time as they are using the OC facility. In the rest of the steps, user-participants are involved, presenting three different levels of involvement. The first level is represented in the **top-right** quadrant, where user-participants have a direct relation with OC and in which the user-participants´ opinions, ideas, and personal experiences are considered valuable for OC. However, they are not part of the innovation team; OC is just experimenting with them in order to collect information and co-create ideas. Three steps of the OC innovation process ["opportunity identification", "data collection" driven by OC, and "concept ideas"] have this level of user involvement. The second level is represented in the **lower-left** quadrant of the map. It contains the "conceptualization" step, where user-participants are indirectly involved because it is not necessary to have a face-to-face relation to apply for the open call. The applications are evaluated and the best ideas are rewarded with EU funds. However, in this step, the users are not part of the OC innovation team, because OC is just selecting the best smart solutions to provide with EU funds. The last level of involvement is represented in the **lower-right** quadrant, which only includes one of the paths in the "data collection" step. Here, users have an indirect involvement with OC, because data is collected through technological infrastructures such as LoRaWAN.

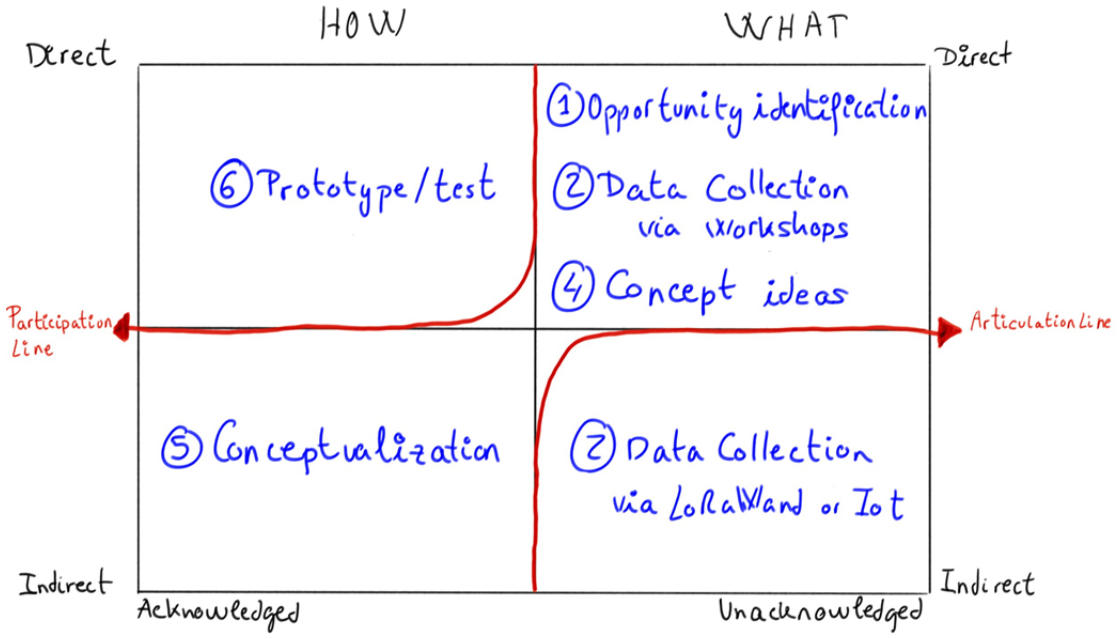


Table 20: User-oriented map of OrganiCity innovation process [own elaboration].

There are two steps ["pattern recognition" and "data collection" driven by users] that cannot be placed on the map, because they are driven by users as part of the OC innovation team, but these two steps are part of the "what phase", which means that users cannot be part of OC innovation

team. Therefore, this framework does not allow the capturing of all levels of user involvement during the innovation process. Furthermore, I observed that the co-creation process is used to create ideas with user-participants and also for the development of the OC facility with user-experimenters. Consequently, co-creation covers a large range of user involvement. In addition, I observed that co-creation encourages a push towards the highest level of involvement, fostering the creation of ideas, knowledge, open-data platforms, innovations, etc., between all city stakeholders.

In sum, OC has designed a user involvement strategy [OC engagement journey] to systematize the gain of user knowledge using: open calls to identify the best ideas; face to face such as workshops to create ideas, knowledge, etc; social media although it is mainly driven by OC team; and online platforms and tools, but just in the last step of innovation process. Moreover, users are involved during the entire innovation process of OC due to the technological infrastructure. However, the level of involvement changes during the process. Four levels of involvement have been identified, where the user-experimenters present the highest level, while the user-participants present three different levels [direct and articulated, indirect and articulated, and indirect and not articulated]. In conclusion, the Aarhus innovation ecosystem involves users through open calls and co-creative processes and it presents four different levels of involvement.

# 6. Discussion

This chapter contains the discussion of the findings from the three analysis sections. Each analysis section has a particular purpose, which is why each section is based on a specific framework. However, the three frameworks jointly form a holistic picture of Aarhus innovation ecosystem and the involvement of city stakeholders in the development of a smart city.

In the first section of my analysis, I used **Porters´ Diamond** (1990), which allows me to identify the innovation ability of clusters. This framework's application to analyze Aarhus innovation ecosystem identified that Aarhus has strong factor conditions, and networks and collaborations (two of the innovation determinants in the framework), which together create good innovation facilities. According to Porter (1990), strong networks improve competitiveness. Therefore, Aarhus has good competences to generate and transmit new knowledge or ideas. On the other hand, the other two innovation determinants [business climate and structure, and factor demand] do not present any special characteristics that make Aarhus innovation ecosystem stand out. In the case of the factor demand, Aarhus has a sophisticated demand, but it has issues in relation to its size. According to Porter (1990), the nature of the demand is more important than the size. Therefore, Aarhus should present advantages in the factor demand. However, its demand is not more sophisticated than other demands in Denmark. Thus, this is not creating any advantage in respect to other Danish municipalities in fostering firms to test their innovations in Aarhus. In the case of business climate and structure, Porter (1990) claims that the level of rivalry is key, in order to generate competitiveness between firms, which is translated into the development of innovation. This explains why Aarhus innovation ecosystem has difficulties to transform knowledge and ideas into growth valuable innovations, because Aarhus has a normal level of rivalry.

The analysis of the OC case study through Porter's framework shows the transformation of Aarhus innovation system into a living lab, where citizens and firms in Aarhus can prototype and test their ideas in a real context. According to Bergvall-Kåreborn et al. (2009), the real context is the most relevant difference between a living lab approach and the traditional involvement process. Moreover, Aarhus city council is using user-centered open model approaches (Hippel 2005) to encourage users to share their ideas, knowledge and innovations with other users. Therefore,

Aarhus innovation ecosystem is fostering the integration of users into the ecosystem, as a way to generate competitive advantages. This fact shows that it is not only firms who can create competitive advantages, as Porter states. In fact, according to Arnkil et al. (2010), it is indispensable that public sector organizations adopt user-centered approaches to generate innovation, because this generates a competitiveness advance. Therefore, Porter´s Diamond presents a limitation in explaining the innovations created by users, creating a narrow interpretation of the innovation creation, based on science-based institutions (Lundvall et al. 2002).

Consequently, this discussion guides the answer to the first sub-question ***what is Aarhus' ability to innovate and how does this ability influence the creation of Aarhus as a smart city?*** by concluding that Aarhus innovation ecosystem has a high capacity to generate new knowledge and transmit it, but it has certain difficulties to transform this knowledge into growth valuable innovation. Therefore, Aarhus is fostering and supporting the development of smart solutions through the transformation of Aarhus into a living lab, and through using a user-centered open innovation approach to involve users in the Aarhus innovation process. However, it does not have a strong smart solution market nor test market for these solutions, which makes it difficult for smart solution innovations to become growth valuable companies.

 In the second section of the analysis, I used **QH,** which allows me to analyze the different city stakeholders of Aarhus innovation ecosystem. The analysis shows that academia [Aarhus University and Alexandra Institute] and government [Aarhus city council] stakeholders represent the top-down of the innovation ecosystem. Firms and citizens, on the other hand, represent the bottom-up face of the ecosystem. However, according to (Etzkowitz & Leydesdorff 2000), the collaboration between academia, government and business stakeholders represent the top-down of the innovation ecosystem (Etzkowitz & Leydesdorff 2000). Nevertheless, in this case study firms and citizens are the same, because both are users of the OC innovation process. The analysis shows how citizens assume researcher and developer roles, which were traditionally in the hands of firms (Etzkowitz & Leydesdorff 1995). However, all citizens and firms are not researchers and developers. Two groups of users have been identified: experimenters that are considered innovators, because they modify products and services consumed according to their needs (Hippel

2005); and participants when they benefit through the consumption of products or services, but they do not perform any direct modification on the products or services (Hippel 2005).

A second discovery during the analysis is the co-creation of value through collaboration (Smorodinskaya et al. 2017). As a result, two innovations emerge, which are useful and exploited (Norn 2015). Although they are not economically exploited yet, they are generating social value (Franke et al. 2014). The analysis also identified the generation of creativity and new ideas as a result of the co-creative collaboration. However, these are not considered innovations, although they are useful for creating new innovations (Norn 2015). The first innovation is the public service, initiated by top-down stakeholders, and the second innovation is the smart solutions, initiated by users. According to Arnkil et al. (2010), the public service innovation represents a public-sector-centered QH**,** where a government stakeholder designs the service with users. However, in this case, it is the academia stakeholders who are the initiators of the public service innovation. Moreover, the QH analysis does not reveal if the design of public service is made "with users" or "by users". According to Arnkil et al. (2010 p20), "*the user involvement in the QH innovation model can range from systematic collection and utilization of user information to development of innovation by users themselves*" (Arnkil et al. 2010 p20). The second innovation [smart solutions], on the other hand, depicts a citizen-centered QH**,** because it is designed by users and owned by the user who developed it. Therefore, co-creation is disrupting the stakeholders' roles by expanding roles, such as the researchers and developer role, or developing new ones.

Consequently, this discussion guides the answer to the second sub-questions group ***Who are the stakeholders involved in Smart Aarhus? What innovations are the stakeholders creating? How are the stakeholders collaborating? What roles do the stakeholders have?*** by concluding that, based on the OC case study, Aarhus innovation ecosystem is formed by top-down [academia and government] and bottom-up [firms and citizens] stakeholders. Together they are co-creating a new public service and smart solutions, which belong to the user who develop them. The co-creative collaboration is disrupting the user roles, expanding researcher and developer roles into all city stakeholders, including citizens, in addition to developing new roles.

The last section of the analysis is focused on the user involvement. The analysis is founded on a framework to map the user-centered innovation process (Wise & Høgenhaven 2008). This

framework is based on the results obtained from using the innovation wheel as a structure for the third part of the OC case analysis.

The analysis identified that OC has designed a user involvement strategy [OC engagement journey] to systematize the gain of user knowledge. The strategy is mainly based on four tools; open calls, face-to-face tools, social media and online platform and tools. Firstly, the "open calls" are used to identify the best ideas between users to solve smart city challenges. Hipple (2005) defines lead users as the "*leading-edge of an important market trend"* (p 22). Therefore, the users selected with the best solutions are lead users of the OC innovation process. Hipple (2005) also states that "*they anticipate relatively high benefits from obtaining a solution to their needs*" (p 22). However, this statement cannot be demonstrated in this analysis, because OC is only giving service for the testing and prototyping of the smart solutions. So, further research about the smart solutions after the prototype and test stage would be necessary. Furthermore, the selected users are not just lead users of smart solution innovations, they are also lead users of the OC facility innovation, because the open calls require them to solve smart challenges by using the OC platform and tools. Secondly, "face-to-face" tools such as workshops and interviews are used to foster the creation of ideas. Thirdly, "social media" such as Intagram or Facebook profiles are used by OC mostly to communicate with the users or disseminating info about experiments, workshops, etc. The last tool is the "online platform and tools" that are used by user-experimenters to develop the smart solutions. Pascu & van Lieshout (2009) define social computing as virtual communities that are platforms for innovation activities driven by users. Therefore, the OC online platform and tools are forming a virtual community. According to the authors, a virtual community is a good tool to identify lead users. However, in this case, all users are already lead users, because they already have been selected between the user-participants. Moreover, Pascu & van Lieshout state that it is relatively easy to get involved and to leave a virtual community. However, in the OC case, the user-experimenters have received EU funds, which hampers their departure.

A second main finding is the involvement of users during the entire innovation process, because of the detected technological infrastructure in the first section of the analysis, where it was uncovered that Aarhus is transforming itself into a living lab. According to Bergvall-Kåreborn et al.

(2009 p 2), living labs allow "*users are involved in their own private contexts all day round"* (p 2). Therefore, all users are involved in the OC innovation process.

The last finding is that the level of involvement changes during the innovation process between four different levels of involvement. The first level is held by user-experimenters and the other three levels are held by user-participants [direct and articulated, indirect and articulated, and indirect and not articulated]. The map of the user-centered innovation process (Wise & Høgenhaven 2008) illustrates that the highest level of involvement is just possible during the design phase [the HOW phase], once the necessities of the users are acknowledged. However, in the OC case, the highest level of user involvement goes beyond the "HOW" phase; it is also identified during the process of the identification of what to produce [the WHAT phase], where the needs are not acknowledged yet. Therefore the highest level of involvement has been identified specifically in the test and prototype, the data collection and pattern recognition steps.

Consequently, this discussion guides the answer to the third sub-question group ***How are the users involved during the innovation process? What levels of user involvement exist during the innovation process?*** by concluding that, based on the OC case study, Aarhus innovation ecosystem is systematizing the gaining of user knowledge, by using: virtual community, although it is only used in the last step of the innovation process; open calls to identify the lead users; face-to-face tools such as in workshops and social media mainly driven by OC team to boost the creation of knowledge, ideas and innovation. The users are involved during the entire innovation process of OC, because Aarhus is a living lab. However, the level of involvement changes during the process. Four levels of involvement have been identified, where user-experimenters represent the highest level, while the user-participants represent three different levels [direct and articulated, indirect and articulated, and indirect and not articulated]. The highest level of involvement is present during the design phase of how to produce, but also during the identification phase of what to produce. In conclusion the highest level of involvement has been identified specifically in the test and prototype, the data collection and pattern recognition steps

# 7. Conclusion

The technological advances allow cities to have a better management of their resources (ICF 2015). However, governments have deployed industrial solutions, focusing on solving technical issues instead of being focused on the stakeholders that are living in the city (Brynskov 2017). Yet, Aarhus is developing a smart city model based on a partnership model (Brynskov et al. 2015).

The present work has studied the Aarhus innovation ecosystem, focusing on the user involvement for developing Aarhus smart city. The research question **"How is Aarhus creating its innovation ecosystem, which empowers the involvement of users in the smart city development?"** was designed to study the issue described. This research has mainly used a qualitative approach, although quantitative data has been used to enhance the analysis of the case study, analyzing Aarhus and particularly the OrganiCity project. From the research, it can be concluded that Aarhus innovation ecosystem is built based on a co-creative collaboration between "academia and government" stakeholders, which represent the top-down face of the ecosystem, and users, which are "firms and citizens" stakeholders, from inside and outside of Aarhus, that represent the bottom-up face of the ecosystem. The co-creation is disrupting the stakeholders' roles, expanding researcher and developer roles into all city stakeholders including citizens, transforming stakeholders' roles and building new roles. All the stakeholders are together transforming Aarhus into a living lab, where users can test and prototype their own smart solutions in a real context and through virtual communities, which facilitate the involvement of the users in the Aarhus innovation ecosystem. Furthermore, the ecosystem is using open calls, to detect lead users, and face-to-face tools, such as workshops and social media, to involve users and encourage the development of new ideas, knowledge and innovations. The level of user involvement changes during the innovation process between four identified levels, from the highest level, where users are user-innovators and part of the innovation team, to the lowest level, where users have an indirect relation with the ecosystem, but it is part of it because the technological infrastructures collect data about their habits. Moreover, the study has discovered that users are highly involved, not just in the test and prototype step in the design phase of "how" to produce, but also during the data collection and patter recognition steps in the identification phase of "what" to produce. Furthermore, the study shows that Aarhus innovation ecosystem does not have a strong smart

solution market nor test market for the smart solutions, which hinders that smart solution innovations become growth valuable companies. This is because Aarhus innovation ecosystem does not have a strong business climate and structure nor strong factors demands.

The obtained results are based on a specific case. For that reason, I acknowledge that the findings could change for different cases embed in Aarhus municipality. Therefore, I encourage further investigation, using other smart Aarhus projects. I also suggest three additional paths that would be interesting to investigate. The first path is a longitudinal analysis, to analyze the evolution of the OC project over time. During this research, it was discovered that the OC facility would like to become self-sustainable, being managed voluntarily by user. So, it would be interesting to explore the evolution of the user and the other stakeholder roles. I also would find it interesting to analyze the evolution of the smart solutions tested on the OC facility, to identify the impact of the innovations on Aarhus. The second path is based on the co-creative collaboration finding. Its disruptive effects on the stakeholder roles has been detected. Moreover, the co-creation collaboration was also observed to cover several levels of involvement, at the same time that it fosters the user involvement towards the highest level. Therefore, I recommend further analysis of the co-creative collaboration effects during the smart city development. The last path is based on a comparative analysis between the three clusters [London, Santander and Aarhus] involved in the OC project. It would be interesting, for instance, to perform an evaluation of each cluster's innovation ecosystem and user involvement.

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# 9. Appendix

## 9.1. List of interviewees / speakers / interviews

List of Interviewees

**Lasse Steenbock Vestergaarde**

He is Specialist Smart Urban Designer, Data Science and Engineering Lab, working at Alexandra Institute in Aarhus. The firm is focus into IT research and innovation, providing consultancy and development of new innovative products and services based on the newest IT research, user participation and business development. It is one of OrganiCity consortium members, where Lasse is on charge of developing the OrganiCity platform and its technological tools.

**Belén Palacios**

She is a concept designer, working at Future Cities Catapult in London. Firm focus into boost the collaboration between universities, business and city leaders and specialized in urban strategies, connected cities and urban data science. It is one of OrganiCity consortium members, where Belen Palacios is a content lead in OrganiCity project.

**Juan Echevarria Cuenca**

He is an expert of European Projects in the new technologies department of Santander Commune, which is one of OrganiCity consortium member, where Juan is the contact lead zone, facilitating the development all the initiatives based in Santander.

**Citizens**

They are three European citizens that are studying at Aarhus University. They participated in Co-creating Smart City event organized by OrganiCity during the Internet Week Denmark 2017

**Sebastian Christophersen**

He is a project manager at ITK lab in the Aarhus Commune, which is one of the OrganiCity members. He was participant at Co-creative

**Line Gerstrand**

She is consultant at Aarhus city council in the Mayors department of Aarhus city council, which is one of OrganiCity consortium member. She is working in the strategic Aarhus city and business development. Where she is the Smart City coordinator of the Aarhus city.

## List of speakers in the event analyzed

**Martin Brynskov**

He is Associate Professor in Interaction Technologies at Aarhus University, chair of Open & Agile Smart Cities, research director of AU Smart Cities, director of Digital Design Lab, co-director of the Digital Living Research Commons, founder of the Danish Smart City Network, coordinator of SynchroniCity and OrganiCity, co-founder of Smart Aarhus and research fellow at Participatory IT Centre and CAVI.

**Lasse Steenbock Vestergaarde**

He is Specialist Smart Urban Designer, Data Science and Engineering Lab, working at Alexandra Institute in Aarhus. The firm is focus into IT research and innovation, providing consultancy and development of new innovative products and services based on the newest IT research, user participation and business development. It is one of OrganiCity consortium members, where Lasse is on charge of developing the OrganiCity platform and its technological tools.

**Niels Højberg**

He is the CEO of the Mayor Department in the Aarhus City Council.

## List of interview organized by date of execution

**First interview with Lasse Steenbock Vestergaard 02-02-2017**

Interview goal

The interview´s aim is to get a first approach with a specific project, which is focus in engagement citizen, developing smart city solution base data and IoT. Moreover to have overview of OrganiCity project, identify some possible issues that could interesting to analyze and gets some contacts.

Interview characteristics

The interview is unstructured and its duration is 23:12 minutes, the language is English and the communication tool is Skype.

**Second interview with Belen Palacios 14.02.2017**

Interview goal

The interview´s aim is to get deeper knowledge about the OrganiCity Project. Specifically in relation with the general engagement strategy, which Belen Palacios was took part in its elaboration.

Interview characteristics

The interview is unstructured and its durations is 33:32 minutes and the language is Spanish and the communication tool is Hangout

**Third interview with Sebastian Christophersen 20-04-2017**

Interview goal

The interview´s aim is understand the collaboration between the citizen and the Aarhus commune, and the commune roles under collaborative framework.

Interview characteristics

The interview is unstructured and its durations is 8 minutes, the language is English and the communication is face to face

**Fourth / Fifth / Sixth interviews with citizens 20-04-2017**

Interview goal

It is to identify the level of involvement with OrganiCity, in what way the collaborate with OrganiCity.

Interview characteristics

The interviews are semi-structured, their total duration is 10 minutes the language is English and the communication is facet to face.

Question proposal

- What are you? Student, worker, unemployed, retired etc...
- How did you know about OrganiCity? - Did you participate frequently in OrganiCity events or it is the first time? And online?
- What are your motivations to participate in OrganiCity events?
- Could you explain me what are your tasks in OrganiCity project? Did you participate as subject of the experimenters?
- Do you think that you together with the rest of the people who are part of OrganiCity community are triggering the innovation?

**Seventh interview with Lasse Steenbock Vestergaard 21-04-2017**

Interview goal

The interview aim is to understand better the OrganiCity management, the engagement process – community development -, the OraniCity role and impact in Aarhus, and the collaboration between the stakeholders.

Interview characteristics

The interview is semi-structured and its duration is 34:15 minutes, the language is English and the communication is facet to face.

Questions proposal

*OrganiCity project management*:

- How many workers OrganiCity has in Aarhus? How many Aarhus´s institutions are involved in the project? What institution or who take the final decision?
- When experimentation of the projects is working, how and what kind of support OrganiCity give?
- What are the purposes of the events? It is educate about IT? Is it generating solution to specific issues? Is it to understand the issues of the citizens?
- Who provide the facilities that are used by the project for experiments, meeting etc…?
- The project economical resources come just from EU? Or they have another economical supporters

*Roles:*

- What is the OrganiCity role in Aarhus? How is transforming the city? What kind of impact is doing in the city? Do you have some way to measure if the innovation has increased or the economical impact of OrganiCity in Aarhus?
- How does OrganiCity change or influence in the role played by Citizen / Municipality and firms?
- What is it exactly the role played of citizen during the engagement journey created by OrganiCity?.
- In the project the main concept is the co-creation with citizen. What does it mean? It is mean are they who create the open call? Are they who select the winners? Can they influence in the experiments? How the citizen help to increase the innovation?
- What is the role of the firms in the OrganiCity engagement? They are just in the experimenter process? What kind of firms coming?

*Community*

- How did you build the OrganiCity community? How is it maintained live or working? What incentives OrganiCity give to citizen to maintain live?
- According with the OrganiCity report Aarhus OrganiCity community had an issue because any of the project proposed by Aarhus community was selected in the open call. How did affect in the OrganiCity community? How did you solve it? Is the citizen participation the same or different after this situation?

*Collaboration*

-How is the OrganiCity collaborative framework with citizen / firms / universities? On which is base this collaboration?
- Which are the main collaborators? Is it any big private company involve?
-Are there more projects similar to OrganiCity en Aarhus?

*Impact of the project in Aarhus*

- Do you can measure the economic impact of OrganiCity in Aahurs?
Is real an increment of the innovation through the OrganiCity model?
- Do you think the performance of the innovation is higher due to co-creation under open innovation context?

**Eight interview with Line Gerstrand 28-04-2017**

Interview goal

The interview´s aim is to understand the Smart Aarhus initiative, which is its goal, how it is working, and what kind of smart city model they are implementing.

Interview characteristics

The interview is semi-structured and its duration is 24:23 minutes, the language is English and the communication tool is Skype.

Questions proposal:

- What is your role in the deployment of Aarhus Smartcity strategy?
- In the "Smartaarhus website" is indicated "Smart Aarhus is considered a Scandinavian third way that offers a model for city development". What is exactly this third way?
- Referring to the website again, Aarhus is collaborating with Universities, Firms, citizens etc... How is de municipality doing it? What kind of activities or policies Aarhus is implementing to encourage this collaboration?
- How is the Aarhus municipality organized to deploy the Smart Aarhus strategy? Is it one department? or it was policies and guideline that effect the entire municipality organization?
- Do you know what are the main policies to develop smart Aarhus? Do you know how does it impact?
- What is the role played by the municipality? And Is it the municipality who is pushing to change the role of the rest of stakeholders (citizen, firms etc..) or it is the rest of the stakeholder who push to change the role municipality and Aarhus is just adapting to the new context?
-To create a smart city the municipality should to invest in Information and technology technologies (physical infrastructures, smart technologies, mobile technologies) and in Human capital. How is the Aarhus municipality making this investment? What are the main lines?
- Have you listen about the three, fourth and fifth Helix model? What do you think is Aarhus between these three models?
- One of the goals of transform a city into Smartcity is boost/encourage the creation of knowledge which generate innovation. With the idea that this innovation will transform into firms, and generate jobs for the community. Do you think that strategy followed by Aarhus is

obtaining this impact in Aarhus. Are there some successful cases which a some firm is born as result of Aarhus strategy? What do you think that Smart city strategy is impacting in the Aarhus innovation.

**Ninth interview Juan Echevarria Cuanca 04-05-2017**

Interview goal

The interview aim is to understand better the OrganiCity in Santander and the collaboration created between Santander, London and Aarhus and information about Aarhus but from outside. Although Santander OrganiCity is out of the scope of my research, I consider it relevant to get better understand of the project implementation in Aarhus.

Interview characteristics

The interview is semi-structured and its duration is 42:26 minutes, the language is Spanish and the communication tool is Skype.

Questions proposal

- What is your role in the OrganiCity in Santander and in the whole project?
- How many Santander´s institutions are involved in the project? What institution or who take the final decision? Do you have to communicate your decisions to the rest of the teams in other cities?
- What are the purposes of the events? It is educate about IT? Is it generating solution to specific issues? Is it to understand the issues of the citizens?

*Roles:*

- What is the OrganiCity role in Santander? How is transforming the city? What kind of impact is doing in the city? Do you have some way to measure if the innovation has increased or the economical impact of OrganiCity in Santander?
- How does OrganiCity change or influence in the role played by Citizen / Municipality and firms?
- What is it exactly the role played of citizen during the engagement journey created by OrganiCity?

- In the project the main concept is the co-creation with citizen. What does it mean? It is mean are they who create the open call? Are they who select the winners? Can they influence in the experiments? How the citizen helps to increase the innovation?
- What is the role of the firms in the OrganiCity engagement? They are just in the experimenter process? What kind of firms coming?

*Community*

- How did you build the OrganiCity community? How is it maintained live or working? What incentives OrganiCity give to citizen to maintain live?

Collaboration

- How is the OrganiCity collaborative framework with citizen / firms / universities? On which is base this collaboration?
- Which are the main collaborators? Is it any big private company involve?
- Are there more projects similar to OrganiCity in Santander?
- How do you collaborate with Aarhus and London? Is it just specific meetings? Or do you have more constant communications
- Do you have to communicate your decisions to the rest of the teams in other cities?
- In the case of the experimenter who experiments in 3 cities or 2, How do you give the support?

## 9.2. List of secondary sources

Quantitative sources

1. Danish Statistics database: http://www.dst.dk/da/Statistik
2. European barometer: http://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/Chart/index
3. Eurostat database: http://ec.europa.eu/eurostat/data/database

Qualitative sources

4. Aarhus City Council website: http://www.aarhus.dk
5. Business Aarhus website: http://www.businessaarhus.dk
6. OrganiCity website: http://organicity.eu
7. Smart Aarhus website: http://www.smartaarhus.eu/

8. Aarhus business plan for the city of Aarhus, vision 2030, initiatives 2010-2012 (Aarhus City Council 2010)

9. Aarhus Business Plan 2014 -2017 (Business Aarhus 2014)

10. Aarhus climate business 2017 (EPINION 2017)

11. Do business with Aarhus 2016 report. (Aarhus City Council 2016)

12. OrganiCity – Co-creating smart cities of the future by European commission (European Commission 2015)

13. We are all OrganiCitizens -Engagement Strategy (Initial). OrganiCity document (OrganiCity 2015b)

14. Co-Creating Smart Cities of the Future - We are all OrganiCitizens Interim Engagement Strategy. OrganiCity document (Brynskov et al. 2016)

15. Co-Creating Smart Cities of the Future -Dissemination and Impact Plan Year 1-. OrganiCity document (Lynch et al. 2016)

## 9.3. OrganiCity consortium members list

### Coordinator

AARHUS UNIVERSITET
NORDRE RINGGADE 1
8000 AARHUS C
Denmark

Denmark

**EU contribution:** EUR 2 602 531

**Activity type:** Higher or Secondary Education Establishments

### Participants

INTEL CORPORATION (UK) LIMITED
PIPERS WAY
SN3 1RJ SWINDON
United Kingdom

United Kingdom

**EU contribution:** EUR 589 038,75

**Activity type:** Private for-profit entities (excluding Higher or Secondary Education Establishments)

ALEXANDRA INSTITUTTET A/S
AABOGADE 34
8200 AARHUS N
Denmark

Denmark

**EU contribution:** EUR 523 000

**Activity type:** Research Organisations

FUTURE CITIES CATAPULT LIMITED
WORKSPACE LEATHERMARKET UNIT 2 2 1 WESTON STREET
SE1 3ER LONDON
United Kingdom

United Kingdom

**EU contribution:** EUR 582 052,50

**Activity type:** Research Organisations

IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE
SOUTH KENSINGTON CAMPUS EXHIBITION ROAD
SW7 2AZ LONDON
United Kingdom

United Kingdom

**EU contribution:** EUR 346 251

**Activity type:** Higher or Secondary Education Establishments

TECNOLOGIAS SERVICIOS TELEMATICOS Y SISTEMAS S.A.
PARQUE CIENTIFICO Y TECNOLOGICO DE CANTABRIA, CALLE ALBERT EINSTEIN 12, PLANTA 1A
39011 SANTANDER
Spain

Spain

**EU contribution:** EUR 232 500

**Activity type:** Private for-profit entities (excluding Higher or Secondary Education Establishments)

LULEA TEKNISKA UNIVERSITET
UNIVERSITETSOMRADET PORSON
971 87 LULEA
Sweden

Sweden

**EU contribution:** EUR 305 875

**Activity type:** Higher or Secondary Education Establishments

INSTITOUTO TECHNOLOGIAS YPOLOGISTONKAI EKDOSEON DIOFANTOS
N KAZANTZAKI ODOS
26504 PATRAS
Greece

Greece

**EU contribution:** EUR 272 810

**Activity type:** Research Organisations

UNIVERSITAET ZU LUEBECK
RATZEBURGER ALLEE 160
23538 LUEBECK
Germany

Germany
**EU contribution:** EUR 264 270

**Activity type:** Higher or Secondary Education Establishments

INSTITUT D'ARQUITECTURA AVANCADA DE CATALUNYA
CARRER PUJADES 102
08005 BARCELONA
Spain

Spain
**EU contribution:** EUR 239 250

**Activity type:** Research Organisations

COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES
RUE LEBLANC 25
75015 PARIS 15
France

France
**EU contribution:** EUR 440 878,75

**Activity type:** Research Organisations

UNIVERSIDAD DE CANTABRIA
AVENIDA DE LOS CASTROS S/N
39005 SANTANDER
Spain

Spain
**EU contribution:** EUR 568 125

**Activity type:** Higher or Secondary Education Establishments

ARHUS KOMMUNE
RADHUSPLADSEN 2
8100 ARHUS C
Denmark

Denmark
**EU contribution:** EUR 132 500

**Activity type:** Public bodies (excluding Research Organisations and Secondary or Higher Education Establishments)

AYUNTAMIENTO DE SANTANDER
PLAZA DEL AYUNTAMIENTO 1
39001 SANTANDER
Spain

Spain
**EU contribution:** EUR 167 500

**Activity type:** Public bodies (excluding Research Organisations and Secondary or Higher Education Establishments)

UNIVERSITY OF MELBOURNE
PARKVILLEOFFICE OF THE VICE CHANCELLOR
3010 MELBOURNE
Australia

Australia
**EU contribution:** EUR 0

**Activity type:** Higher or Secondary Education Establishments

**Last updated on** 2016-11-29
**Retrieved on** 2017-02-14

**Permalink**: http://cordis.europa.eu/project/rcn/194291_en.html


Source: (European Commission 2015)

## 9.4. The new axis of knowledge map

The first imagine describes the 5 innovation centers, the three main universities in Aarhus and GTS - Advance Technology Group – connected by light rail system. The second imagine shows the geographically location of each one and how it will be connect through the light rail system.

## 1 Food

**Agro Food Park**

Agro Food Park is the international business park for companies, students and scientists, which can deliver growth and competitiveness in the Danish agriculture and food sectors. Agro Food Park is one of Europe's strongest centres for innovation and the distribution of knowledge within the agriculture and food sector. Agro Food Park is the centre of the Danish Food Cluster, which is the 3rd largest in the world and employs 200,000 people.

## 2 Health

**Aarhus University Hospital**

The completion of the hospital is expected by 2019, and it will form the centre of a new healthcare cluster where Aarhus University and VIA University already offers education and research and Incuba have a Business and Science Park.

## 3 ICT

**Katrinebjerg**

Katrinebjerg is Aarhus' ICT powerhouse and home to a unique hub for ICT-based development and innovation. There are over 21,000 ICT jobs in Aarhus. The area's degree programmes and research are internationally recognised, and several international companies such as Google, Uber and WM Ware have established development centres here.

## 4 Cleantech

**Navitas**

Navitas is Denmark's innovation and education centre within cleantech, energy and related technologies. Navitas houses energy- related education, research, development and businesses. The vision for Navitas is to create an international icon for the development and application of sustainable energy technology.

## 5 Creative industries

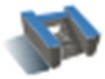
In Aarhus, the creative industries such as fashion, film, architecture and design is evolving. Within fashion, powerful brands like Bestseller, Hummel, Minimum and SMAC, as well as educations at VIA University College and the fashion hub at Headstart Fashion House provides a prosper environment. With architecture and design, flagship companies as C.F. Møller, Schmidt Hammer Lassen, Arkitema and Designit and the Aarhus School of Architure creates a fantastic stepping stone for further development. Film City Aarhus is strengthening the visual digital industry and linking their growth and competences to other industries.

## Aarhus University

Aarhus University has more than 44,000 students and 11,000 employees. Among the 17,000 universities in the world, Aarhus University is ranked in the top 100.

## VIA University College

VIA University College offers a wide range of degree programmes in subjects including health, social education, technology, trade, design, business and animation. There are 9,000 students at two campuses in Aarhus.



## Aarhus School of Architecture

The Aarhus School of Architecture has about 1,000 employees and students. A new campus is being built in the creative district around the old freight yard. The school is scheduled for completion in 2020.

## GTS – Advanced Technology Group

Denmark has a network consisting of seven independent Danish research and technology organisations. They are called the GTS institutes and together they make up the GTS network. Four of the seven organisations are located in Aarhus. These are: Alexandra Institute, DHI – Water and Environment, DTI – Danish Technological Institute and FORCE Technology.


Source: (Aarhus City Council 2016)

## 9.5. Educational attainment (15-69 years) by sex, age, region, highest education completed and time

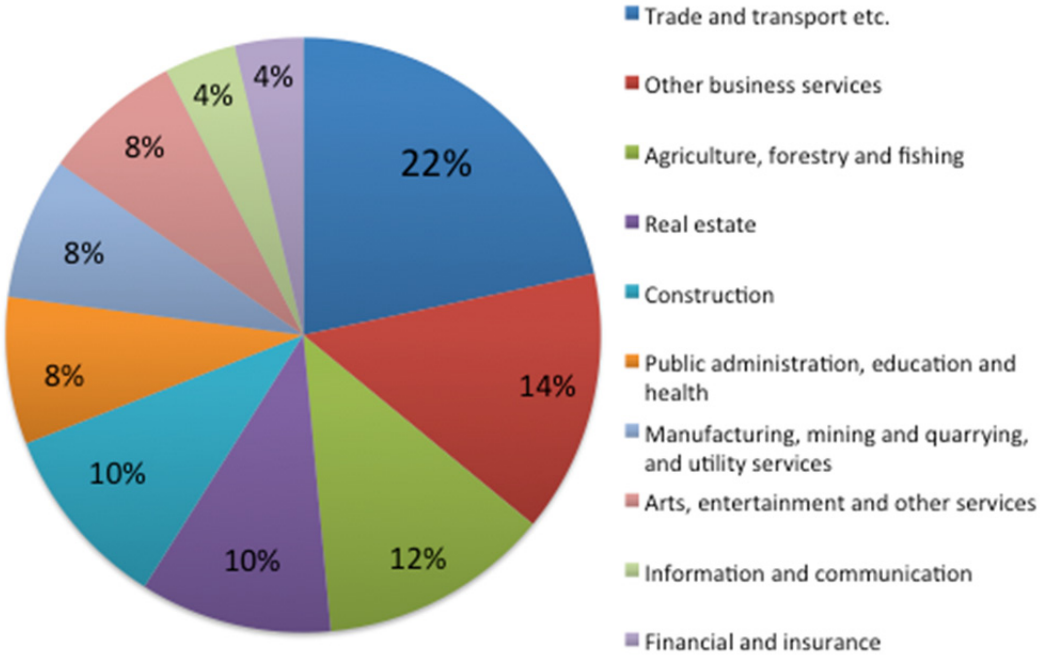
| | Aarhus Municipality | | Copenhagen Municipality | | Odense Municipality | | Aalborg Municipality | | Esbjerg Municipality | | Randers Municipality | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | **250.098** | **% of population** | **469.055** | **% of population** | **144.991** | **% of population** | **153.521** | **% of population** | **81.057** | **% of population** | **68.259** | **% of population** |
| **H10 Primary education** | 45.812 | 18,3% | 79.540 | 17,0% | 34.299 | 23,7% | 34.647 | 22,6% | 22.848 | 28,2% | 19.698 | 28,9% |
| **H20 Upper secondary education** | 42.059 | 16,8% | 71.042 | 15,1% | 20.512 | 14,1% | 20.396 | 13,3% | 6.402 | 7,9% | 5.603 | 8,2% |
| **H30 Vocational Education and Training (VET)** | 49.382 | 19,7% | 71.517 | 15,2% | 36.802 | 25,4% | 42.090 | 27,4% | 27.251 | 33,6% | 24.483 | 35,9% |
| **H35 Qualifying educational programmes** | 809 | 0,3% | 295 | 0,1% | 260 | 0,2% | 365 | 0,2% | 134 | 0,2% | 69 | 0,1% |
| **H40 Short cycle higher education** | 11.529 | 4,6% | 17.736 | 3,8% | 6.477 | 4,5% | 6.937 | 4,5% | 3.604 | 4,4% | 3.681 | 5,4% |
| **H50 Vocational bachelors educations** | 37.737 | 15,1% | 60.570 | 12,9% | 21.515 | 14,8% | 20.988 | 13,7% | 12.450 | 15,4% | 8.232 | 12,1% |
| **H60 Bachelors programmes** | 12.729 | 5,1% | 31.639 | 6,7% | 5.271 | 3,6% | 5.406 | 3,5% | 838 | 1,0% | 668 | 1,0% |
| **H70 Masters programmes** | 32.571 | 13,0% | 82.156 | 17,5% | 11.373 | 7,8% | 13.763 | 9,0% | 3.237 | 4,0% | 2.728 | 4,0% |
| **H80 PhD programmes** | 3.002 | 1,2% | 5.491 | 1,2% | 1.010 | 0,7% | 933 | 0,6% | 124 | 0,2% | 132 | 0,2% |
| **H90 Not stated** | 14.468 | 5,8% | 49.069 | 10,5% | 7.472 | 5,2% | 7.996 | 5,2% | 4.169 | 5,1% | 2.965 | 4,3% |
| **Total population with higher education (H40 + H50 + H60 + H70 +H80)** | 97.568 | **39,0%** | 197.592 | **42,1%** | 45.646 | **31,5%** | 48.027 | **31,3%** | 20.253 | **25,0%** | 15.441 | **22,6%** |

*Source:* (Statistics Denmark 2017a)

## 9.6. Benchmark for corporate tax in Europe


*Source:* (Aarhus City Council 2016)

## 9.7. Distribution of Central Region Denmark´s firms (in 2015)




Source: (Statistics Denmark 2017a)

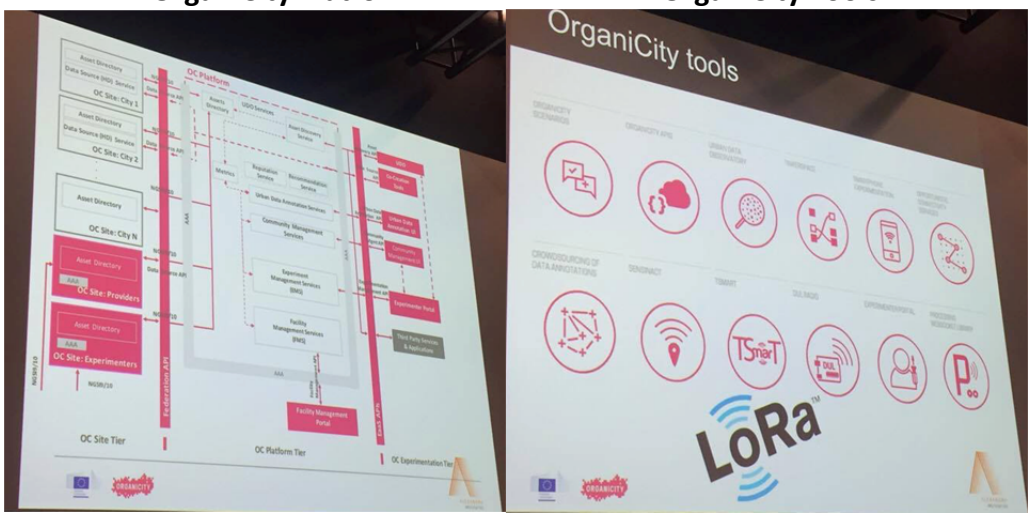
## 9.8. Total number of firms by Danish regions (in 2015)

| | Total Number of firms (in 2015) |
|---|---|
| Capital Region of Denmark | 98022 |
| Central Denmark Region | 67440 |
| South Denmark Region | 59900 |
| Zealand | 41544 |
| North Denmark Region | 30329 |

Source: (Statistics Denmark 2017a)

## 9.9. OrganiCity technological infrastructure

**OrganiCity Platform** **OrganiCity Tools**




Source: (Vestergaarde 2017c)

## 9.10. Aarhus OrganiCity network

OrganiCity joins force with:

- Digital Bydel/Digital Neighborhood. OC has leart from their experiences with connecting and engaging with a large number of citizens in different neighborhoods. (Lynch et al. 2016 p 15)
- Sager der Samler is both an organization and a social enterprise. Their focus is to support citizens who take part in volunteer work and help create solutions to everyday problems. (Lynch et al. 2016 p 15)
- The network Aarhus Data Drinks is one of the stronger communities focusing on Open Data in Aarhus. (Lynch et al. 2016 p 15)

- Open and Agile Smart Cites is a city network where they are *shared methods set of methods to develop systems and make them interoperable across a single city as well as between multiple cities* (OASC 2015)

## 9.11. Aarhus experiment list

- **Green Biking Routes Through Aarhus**
  - Team: BioDigitalHealth Ltd
  - Data used: Air Pollution data
  - About: it is an app that shows the "green routes" [less polluted] cycling lines.
- **Siidi**
  - Team: HOP Ubiquitous (HOPU)
  - Data used: from IoT network in the city and citizens suggestions
  - About: It is an app where citizens participate in creating, enhancing and improving existing public spaces (green zones, gardens, squares etc.). The app identifies locations that can be improved and informs citizens about the opportunities to redesign the urban public space.
- **City Experience Probe**
  - Team: Empati
  - Data used: citizen data
  - About: They transforming citizens experiences, feeling into urban data, through number of physical, wireless and digitally-connected probes where citizens can interact, then they make the data available to business, municipality, transport etc.
- **Opportunity Spaces**
  - Team: Space Engagers
  - Data used: citizens data and IoT data
  - About: It is an app where citizens can identify under used spaces - flat roofs, spaces leftover after infrastructure planning or rarely used public spaces – and trying to use them through solving urban challenges and co-create solutions.
- **The City as a 1:1 Green Laboratory**
  - Team: Mejlgade Lab, Rum13 & Åte VR

- Data used: anthropological study on local citizens, citizens participation data and urban data
- About: The use of a Virtual Reality system [VR] to impact in urban green spaces. The idea is that citizens can place green elements in the VR and see the impact in the neighborhood. The experiment was driven in Nørre Stenbro Aarhus neighborhood.

Source: (OrganiCity 2017a)

## 9.12. Co-creating smart city event

Picture of NCC presentation in Co-creating Smart City event


Picture of the winner team in co-creating smart city event.