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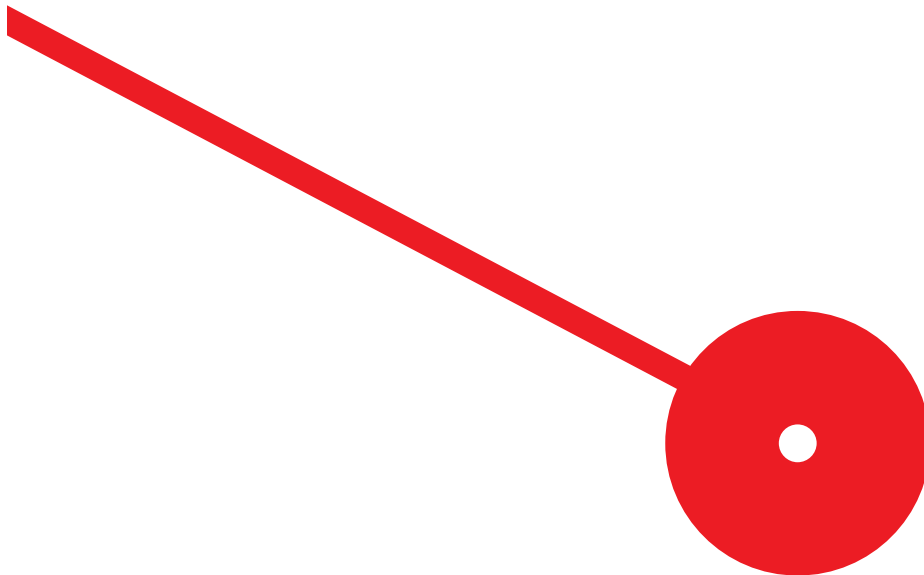
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in Entrepreneurship and Internationalization

Impact of Open Innovation in Smart Cities: Köln's City Case Study

Mafalda Rafaela Viana Vieira

07/2022



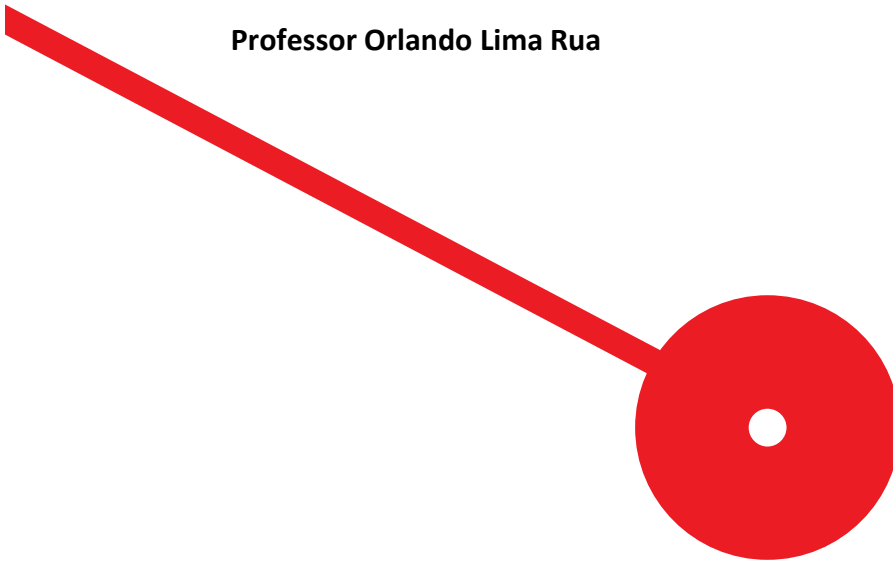


Master's degree
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Impact of Open Innovation in Smart Cities: Köln's City Case Study

Mafalda Rafaela Viana Vieira

Master's dissertation presented to the Instituto Superior de
Contabilidade e Administração do Porto to obtain a master's degree
in Entrepreneurship and Internationalization, under the guidance of
Professor Orlando Lima Rua



Acknowledgement

“Voar nas asas da determinação, perseverança, imaginação e ponderação levar-te-á a conquistar o inimaginável.” (Cristina Paulo Viana)

The writing of this Master's final dissertation brought me many challenges and I would not have successfully overcome them without the true and unconditional support of the people who accompanied me on this journey.

I would like to express my deepest appreciation to my professor Orlando Lima Rua for his invaluable patience, calmness and motivation throughout the last months. I also could not have undertaken this journey without my master coordinator professor, Maria Clara Ribeiro, who generously provided enlightenment and calmness, as well, whenever necessary. Thanks should also go to the professors Inês Pereira, António Barros and Susana Bernardino, who impacted and inspired me.

Additionally, this endeavor would not have been possible without the generous support from Kristina Kebeck and Dirk Blauhut, who participated in my research.

I am also grateful to the unexpected classmates who, even though sometimes overloaded or with little time to spare, never left and always gave their insights and supportive words – Luís Leça and Joana Moreira.

I would like to acknowledge the friends that I have met in Köln who comforted me whenever my heart squeezed – Lara Öettlin, Ruxi, Stefania, Paola, Katia, Mara, Cassidy, Marisa and Emília, Lea and Matthias, Natascha and Lucas.

I would also like to acknowledge to the friends who, even far away, remained present and tireless – Inês Ribeiro and her parents, Carina and Rafael, Ana Pinto, Mariana Monteiro and Diana Soares.

I would be remiss in not mentioning my grandparents that, eventhough separated by two worlds, continue to give me strength and also the rest of my family who always receives me with care.

Words cannot express my gratitude to my mom, my sister and my brother in law. They always believed in me and that kept my energies and motivations high during this process far away from them.

Dankeschön an alle!

Resumo

As cidades estão a mudar e os elementos que as constituem são diretamente influenciados por essas mudanças. A qualificação destas como *smart city*, com os contributos da *open innovation*, fomenta a criação de iniciativas à medida das necessidades e do bem-estar dos cidadãos. Para tal é necessário analisar a *smart city* nas suas seis dimensões – *smart economy*, *smart people*, *smart governance*, *smart mobility*, *smart environment* e *smart living*.

O objetivo fundamental deste estudo é compreender o papel da *open innovation* nos projetos implementados na cidade de Köln (Alemanha) – e observar em que dimensões esta tem um impacto superior. São apresentadas as iniciativas desenvolvidas na cidade que resultam em soluções inovadoras e sustentáveis para melhorar a qualidade de vida dos cidadãos.

Neste estudo utilizamos uma abordagem metodológica qualitativa, com recurso ao método de estudo de caso único da referida cidade. Para recolha e análise de dados, a entrevista semi-estruturada foi utilizada como instrumento e procedeu-se à análise documental de páginas web, relatórios e notícias.

Deste estudo foi possível concluir que a *open innovation* tem influência na implementação de iniciativas nas diferentes dimensões. A dimensão pessoas, mobilidade e ambiente são aquelas onde essa influência é superior e a dimensão governamental a que apresenta uma menor influência, quando comparadas com as restantes dimensões.

Palavras chave: Inovação Aberta, Cidade Inteligente, Estudo Caso, cidade de Colónia.

Abstract

Cities are changing and their constitute elements are directly influenced by these changes. The definition of these cities as smart cities, with the open innovation contributions, encourages the creation of initiatives adapted to the needs and well-being of the citizens. For this, it is necessary to analyse the smart city in its six dimensions – smart economy, smart people, smart governance, smart mobility, smart environment and smart living.

This study aims to understand the role of open innovation in the projects implemented in the city of Köln – Germany –, and to observe in which dimensions it has a superior impact. The initiatives developed in the city that result in innovative and sustainable solutions to improve the citizens' life quality are presented.

We used a qualitative methodological approach, with the use of the single case study method of the aforementioned city. For data collection and analysis, the semi-structured interview was used as an instrument, and we proceeded to the documentary analysis of web pages, reports and news.

The main conclusions are that open innovation has an influence on the implementation of initiatives in the different dimensions. The people, mobility and environment dimensions are those where this influence is higher and the government dimension presents a lower influence when compared with the remaining dimensions.

Keywords: Open Innovation, Smart City, Case Study, Köln City.

Abstrakt

Städte verändern sich und deren Bestandteile werden direkt durch diese Veränderungen beeinflusst. Die Kategorisierung dieser Städte als intelligente Städte bzw. Smart Citys zusammen mit Beiträgen zu der offenen Innovation fördern die Entstehung von Initiativen, die auf die Bedürfnisse und das Wohlbefinden der Bevölkerung ausgerichtet werden. Dafür ist es nötig, die sechs Dimensionen einer intelligenten Stadt zu analysieren, und zwar deren Wirtschaft, Menschen, Verwaltung, Mobilität, Umwelt und Gebäude.

Die vorliegende Arbeit zielt darauf, die Rolle der offenen Innovation bei den in der Stadt Köln umgesetzten Projekten zu verstehen und zu überprüfen, in welchen Dimensionen die offene Innovation maßgebliche Auswirkungen hat. Darüber hinaus werden die in der Stadt entwickelten Innovationen vorgestellt, die zu innovativen und nachhaltigen Lösungen für die Lebensverbesserung der Bürger*innen führen.

Wir haben einen qualitativen methodologischen Ansatz durch die Anwendung einer einzelnen Fallstudie der bereits erwähnten Stadt verwendet. Für die Datensammlung und die Analyse wurde ein teilstrukturiertes Interview geführt. Weiter haben wir eine Dokumentationsanalyse von Webseiten, Berichten und Nachrichten durchgeführt.

Die Hauptschlussfolgerung ist, dass die offene Innovation Einführung von Initiativen in die verschiedenen Dimensionen beeinflusst. Wenn wir die Dimensionen Menschen, Mobilität und Umwelt mit den übrigen Dimensionen vergleichen, stellen wir fest, dass diese stärker dadurch beeinflusst werden als die Dimension Governance.

Schlüssel Worte: Offene Innovation, Smart City, Fallstudie, Köln Stadt.

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List of Abbreviations

AWB – Abfallwirtschaftsbetriebe

CEO – Chief Executive Officer

DCTs – Digital and Communication Technologies

HGK – Hotel und Gastronomie Kauf

ICE – InterCity Express

ICTs – Information and Communication Technologies

IT – Information Technology

KPI – Key Performance Indicator

KVB – Kölner Verkehrs-Betriebe

LEVC – London Electric Vehicle Company

OI – Open Innovation

RQ – Research Question

SC – Smart City

VDL – van der Leegte

INTRODUCTION

The cities' reality is changing; as urban population grows the cities are left with a lack of infrastructure and resources situation necessary to meet the needs of those who live there (Tambelli, 2014). These open space events for the introduction of the smart city concept, which is characterized by working in different areas of the community with different actors; “from the central and local administration, to academia, (...) companies and civil society” enabling the response to challenges that differ according to territorial scales (Covas, 2020, p. 13). Although not all cities are the same, with adaptation, it is possible to implement strategies created once and adapt them to the realities faced, meaning that global challenges have to be solved locally. Solutions are precise, innovative, and sustainable (Caragliu et al., 2009) to delete or at least minimise already present urban problems. Thus, the citizens' quality of life will improve since (1) the provision of public services will also prosper (European Communities, 2011); (2) environmental impact will be reduced (European Communities, 2011); and on the whole, (3) there will be an accurate response to the needs of the population (Fontana, 2014).

Along with the personas, there is also the input of technologies, which should be seen as a means used with transparency and social participation to contribute to citizens' quality of life and business quality, and innovation that takes place in creative cities where the environment is creative and collaborative (Francisco et al., 2021). As Esposti and Ciofalo (2020) state that cities can recover themselves through new things and by recycling what they already have. Therefore, smart cities are seen as being able to solve or prevent urban problems with the support of technological devices and platforms that intend to improve the people's quality life; this is reflected in better mobility in cities, the conscious use of energy, and the safety of people and goods, along with other aspects (Bernardino et al., 2020). Despite the technologies input, a “creative process whereby new or improved ideas are successfully developed and intend to produce outcomes that are practical and of value” (Seaden & Manseau, 2001, cited by Taylor, 2017, p. 4) are needed. So technologies, solutions or improvements can be implemented through the aforementioned process, called innovation.

Esposti et al. (2020) defend that technology in place will lead cities to much more immediate and intense impacts and changes. Once cities start their actions, they can take different approaches: (a) vertical approach focused on specific problems and objectives, and (b) holistic approach that looks at the city as a whole and links the multiple fields, giving rise to a platform that completes each other. This link between several fields is made of internal innovation and external knowledge acquisition, leading to open innovation.

Once these relationships are closer together, and despite open innovation being considered the new management paradigm of the 21st century (Paskaleva et al., 2018), it allows all members of society to participate in the creative process and therefore be co-producers. Hameed et al. (2021) state that external knowledge participation comes from linking with customers, suppliers, and service employees. The same scholar (2021) reinforces the importance of companies screening the right information from the external knowledge inside the company to carry out the innovation process.

Although Chesbrough (2003), cited by Hameed et al. (2021), was the first to relate external knowledge with open innovation. Several researchers (e.g., Brunswicker et al., 2015; Hannen et al., 2019; Teirlinck et al., 2008; West et al., 2006) have confirmed that this type of knowledge is a crucial component of the process of the generation of new ideas, which has a positive influence in the organization's internal innovation. Turning the external knowledge that brings new ideas into more refined internal innovations. Internal communication and interaction have an important role, opening place to better collaboration between the employees through meetings, discussion sessions and seminars (Hameed et al., 2021).

From these perspectives, Manville et al. (2014) explain that smart city initiatives implemented by several elements lead to the development of projects essential to the smart city that is intended to be established. Since the development of these activities requires the interaction of public and private elements and civil society – a hybrid approach – technology makes it possible to bridge the gap between those in charge and society and make it easier to implement the projects.

Innovation is perceived by as one of the main sources of growth and adaptation for city dynamics, putting opportunities into practice and available for public use (Fernandes et al., 2019). Both smart city and open innovation have managers, entrepreneurs, public and

private organizations and society as key figures in the collaborations (Barchil et al., 2018). Understanding how innovations can be applied to the world that people live in can deliver benefits that improve people's lives (Taylor, 2017). Ojasalo et al. (2016, p. 49) reinforce the need for cities "to initiate, foster, and enable innovation that offers solutions to their needs and problems".

Several scholars cover "Open Innovation in (young) SMEs", "Market Reaction to Open Innovation Announcements", "Open Innovation and Performance in Service Sector", "Smart Cities: Challenges, Opportunities, and Prospects", "Growing Smart Cities", "Privacy in Smart Cities" (Kraus et al., 2020; Szutowski, 2018; Vincenzi et al., 2021; Esposti et al., 2020; Garnett, 2019; Samudio, 2019), among others. Thus, it is seen "the evolution of open innovation in its various forms but (...) further discussions are needed for its understanding and implementation due to few academic studies" (Musiello-Neto et al., 2021, p.1). It is also visible that few studies rely on two concepts together – open innovation and a smart city. This shows the gap in open innovation and a smart city studies. According to Ojasalo et al. (2016), which deserves attention from researchers since cities are in charge of large-scale problems that require holistic solutions and, consequently, input from different industries. This leads to collaboration with actors from other areas, said the scholar above. In other words, the market dynamics bring intensive competition and "create new solutions for products, processes, shorter product and service life cycles, flexibility for market-service, new inputs, and changes in production organization patterns" (Musiello-Neto et al., 2021, p. 2). All of these build the open innovation concept.

For Vives (2018), Barcelona became the European capital of innovation and the benchmark for the following global cities that might want to start this movement in building a smart city. This author state that the ex-US President Barack Obama mentioned once that if there is "anyone interested in the improvement of cities in the world had to visit Barcelona" (2018, p. 10). This study focuses on giving the research community one more sample of a city as a benchmark for smart cities. Thus, the more observed realities, the better the knowledge of open innovation's influence on creating a smart city, also enabling the imitation of some techniques in other cities, considering the necessary adaptations to the location.

In this study, the aim is to bring a clear and better understanding of how open innovation and smart city connected can benefit the cities. To this end, a brief study on innovation, open innovation, smart city and the dimensions of a smart city took place. Enabling the understanding of the link between the concepts: open innovation and smart city by addressing the following research questions:

RQ1: What is the impact of Open Innovation on Smart City Köln through the Smart Economy dimension?

RQ2: What is the impact of Open Innovation on Smart City Köln through the Smart People dimension?

RQ3: What is the impact of Open Innovation on Smart City Köln through the Smart Governance dimension?

RQ4: What is the impact of Open Innovation on Smart City Köln through the Smart Mobility dimension?

RQ5: What is the impact of Open Innovation on Smart City Köln through the Smart Environment dimension?

RQ6: What is the impact of Open Innovation on Smart City Köln through the Smart Living dimension?

The present paper is organized as follows. First, the theoretical background for the study is presented, leading to the elaborated research questions. The following chapter covers the methodology, including the research design and the interview guide. Then, the case study and highlights of the main findings are shown. Ends with a discussion of the results and limitations and a further research outlook.

This chapter seeks to understand the different concepts covered in this study, which are necessary to comprehend the issue under study. Firstly, the concept of innovation and the emergent concept of open innovation, smart city and the six characteristics that support the transformation to a smart city are presented – economy, people, governance, mobility, environment and living –, and its advances over, embracing the different points of view on this subject by several authors. The third part of chapter 2 addresses the nexus that open innovation and smart city have, establishing a link between the two concepts allowing them to walk towards the aim of the study. The review of these concepts proves to be fundamental and relevant to the analysis and interpretation of the results obtained in the case study.

1 Innovation

1.1 Concept

In the mid-twentieth century, innovation was seen as an element for economic growth, which also meant economic support for companies (Taylor, 2017). Godin (2008) said that at the end of this same century, it was possible to have a new perspective on the term and it was found to be part of several areas, such as technological, social and knowledge changes, among individuals and in each one at an individual stage.

Taylor (2017) reinforces that, nowadays the term innovation can be explained in several ways and encompasses different meanings, taking into consideration its applicability at several levels: industry, government, services, among others. This scholar also states that since it embraces areas that, although connected, rely on innovation in different ways, several definitions for innovation started to emerge.

Some of the innovation definitions refer that (1) it is the moment of introducing and applying a job, work team or ideas, processes, products, or procedures that are an awakening moment for that job or company, intended to benefit the job, the work team, or the organization (West & Farr, 1990), (2) enable organizations to extend their markets (Lauritzen & Karafyllia, 2019), (3) it is the introduction of new goods or new forms of production (Schumpeter, 1934), (4) the linkage of ideas and the process and development to bring solutions to problems (Taylor, 2017).

Although it would be more effective to establish a single concept of innovation. Wolfe (1994) argues that innovation is employed in different realities with different purposes and, therefore, it would not be fair to establish a single definition. Nevertheless, innovation is widely seen as a growth orientation and it is considered a “critical factor” for companies seeking better positions in the market (Fernandes et al., 2019, p. 580), once that an opportunity can become a “practical utility”, says the author mentioned above. Reddy (2014) reinforces that creative ideas can become real milestones of change for the market through the innovation process, as it allows to create a path of benefits in the market. The following are seen as complementary meanings that made the concept emerge such as (1) Grassroots Innovation, (2) Inclusive Innovation and (3) Frugal Innovation (Emerging Concepts in Innovation, 2022).

(1) Grassroots Innovation: The concept intends to bring solutions for the local situations, interests, and principles of the communities involved, showing that the solution focuses more on being sustainable and not on being profitable. Those solutions are built by local people already in touch with the social innovations type using greener technologies.

(2) Inclusive Innovation: The term seeks to include organisational social responsibility in the strategical and operational level. This innovation and Reverse Innovation show what should be done, but it does not explain how or in which way to be done.

(3) Frugal Innovation: Described as rethinking products and processes to decrease unnecessary costs. This supports a fourth concept intitled Jugaad Innovation which brings the mindset of coming up with creativity, putting the quality into question. It upholds the quality standards and the customers’ expectations – looking for a balance between traditional and alternative practices and bringing all the personas together, solving their problems and sharing the same solutions for other social improvements.

The four approaches are mutually complementary and create a standard, objective and higher-level approach, which brings out the focal point into innovation for humanity (Emerging Concepts in Innovation, 2022). Woszczyna (2021) maintains that great strategies come up with managers who can make changes. Furthermore, this happens through their awake for creativity, innovation, learning and reaching synergies to come out with projects that can bring competitive advantage for the companies. The management, human capital, and competencies are equally necessary to build a stronger company position in a competitive market (Woszczyna, 2021). This scholar also defends

that innovation is fundamental for keeping the market position and for the companies survival. Thus, this term is also seen by the same author as “the ability to generate, adapt and implement both technological and organisational innovation.” (p. 2).

1.2 Open Innovation

Until the mid 2000’s, organisations exclusively carried out innovation activities internally (Stal et al., 2014). The door to sharing and exchanging ideas within the company’s external environment, which means a collaborative approach to innovation with several parts, has promoted open innovation’s arrival (Brockman et al., 2018). In addition to internal ideas, this new concept allows companies to inflow and outflow stakeholder’s knowledge (Chesbrough et al., 2006), such as their customers, suppliers, and organisations primarily involved in research, for example, universities and research institutes. Brockman et al. (2018, p. 2050) state that this practice’s growth – externally and internally generated ideas – shows “an effective way for companies to innovate.”. This scholar also explains the benefits of this open approach, such as (1) speeding up the innovation process, (2) reducing the launching time and (3) creating new revenue streams. Nambisan et al. (2018) further add (4) the research costs reduction, and (5) shared risks. Despite the advantages for the companies, Fernandes et al. (2019, p. 579) refer that “the change in the usage, management and application of intellectual property”, and the input of intellectual property oriented to technology and research bring impact to the industries, consumers, and society (Bogers et al., 2018). They can also “share the risks and rewards of research, development, and commercialisation” (Nambisan et al., 2018, p. 356). External bodies are part of the innovation activities, enabling a faster process once there is an open innovation performance where inflow and outflow of knowledge and ideas are circulating (Hameed et al., 2021). Thus, organisations can take advantage of the interactions that they have been having with other work areas (Barchil & Greco, 2018).

Although these transformations were initially developed for the business sector, they can include creative consumers and communities of innovative personas to the development of innovation (Berthon et al., 2008). For Nambisan et al. (2018, p. 356) “The OI framework can be applied in many industry contexts, such as health care and IT, as well as in key public policy issues”, which means the academic, government and social contexts. This can be equally applicable in city settings (Hauser et al., 2017) through urban solutions in co-creation with stakeholders and fostered by infrastructure through

education, innovation (Schaffers et al., 2011), and testing in real-life usage environments (Hauser et al., 2017). According to S&C Research Team (n.d.), such as the case with open data enables citizens' innovation and enhances their participation and co-creation. That itself has been increasing and it will lead to the cities' well-being (Schaffers et al., 2011), because of the changes in the citizens' mindset, enabling their contributions along with other stakeholders to "be the backbone to the smart city innovations" (S&C Research Team, n.d.) that also believes "in an ecosystem where all stakeholders and the environment have a symbiotic relationship.". The current reality shows that perfectly, as COVID-19 brought some changes globally, many observers concluded that "cities will change in a positive direction because citizens have shown new solidarity during the crisis." (Kunzmann, 2020, p. 22).

Nambisan et al. (2018) explain that OI can then occur at different levels and fulfil multiple aspects: (a) extra-organisational level related to users and communities for OI, (b) inter-organisational level focuses on how OI can reshape companies, their development, and outcomes, and (c) industrial and societal level. It offers valuable insights and interactions regarding the outcomes that the OI enables. Despite that, OI is also seen in three approaches (Chesbrough et al., 2006; Huizingh, 2010; Mazzola et al., 2012): (i) inbound OI or also named outside-in what represents the information that an organisation holds, comes from the external environment; (ii) outbound OI or also called inside-out that drives the knowledge of a company to the outside environment, resulting in probabilities' improvements; and (iii) couples OI represents the combination of both ways – inflow and outflow knowledge.

2 Smart Cities

2.1 Concept

The increasing studies on smart cities show that there is no well-defined concept that gathers consensus, giving rise to many perspectives with different motivations (Lanza & Rezende, 2021). Cocchia (2014) states that the urbanisation growth and the use of ICTs, in practice, influence the smart cities emergence and implementation. The European Commission, according to Bernardino et al. (2020) in a study related to the importance of the human being and social entrepreneurship in smart cities, understands that a city, by relying on DCTs, obtains more benefits for citizens and businesses than traditional networks. On the other hand, it is essential to remember the need to balance social

development and economic growth in a scenario where increasing urbanisation is the main driver for the smart cities implementation (Letaifa, 2015). Therefore, once the services' implementation makes a difference, ICTs are not enough to build a SC (Rodríguez-Bolívar, 2015). For this to occur, alongside technologies, some people and institutions contribute to implementing services (Letaifa, 2015). This means that there is a need for different actors and their interconnection.

Moreira (2015) has a more holistic perspective that focuses on the sustainability and improvement of the citizens' life quality. Esposti and Ciofalo (2020, p. 34) advocate the existence of “three macro phases” – from the year 2000 until nowadays – to describe the meaning of smart city: (1) the word intelligent is related to a digital city, more specifically to the hardware factors, (2) the focus goes to the SC seen as a socially inclusive place, where it is found the city's software factors, human and social resources and the participation level as well and, (3) the third phase – post 2010 – came to connect the key points of the city to the life quality that the citizens have, finding a balance between the hardware and software factors, which leads to the combination and adjustment of the infrastructures, technologies and economy with the human resources and the dynamics that are intended to have place. With a supportive perspective of the European Parliament (2014), successful initiatives were defined based on objectives and issues, that can lead to results and, consequently, to the possibility of reproducing the same ones in other realities to emphasize those smart activities are made up of broad support.

2.2 Smart Cities Dimensions

Pinto (2017) argues that crucial factors such as those presented in Table 1 are needed for the city's development. According to Giffinger et al. (2007), six main characteristics were introduced, allowing a city to develop its activities to review itself as a SC. Those components that support the construction of a smart city are (1) Smart Economy, (2) Smart People, (3) Smart Governance, (4) Smart Mobility, (5) Smart Environment and (6) Smart Living.

(1) The Smart Economy: It is interconnected to the economic sector of the city, portraying as factors the labour market, industry, innovation and entrepreneurship, productivity, and flexibility of the labour market to promote the integration between the local and the global economy (Giffinger et al., 2007). This dimension is directly associated with the city's competitiveness (Hauser et al., 2017).

(2) The Smart People: Smart citizens, which Hauser et al. (2017) claim to be the most critical dimension since citizens are the main characters in building a SC. Well-informed people committed to retaining more knowledge enable the development of innovations in different areas, such as “citizens’ open minds” (Esposti & Ciofalo, 2020, p. 35). People open to taking part in public life make their needs known to those in charge of local governance, and thus SCs are more responsive in balancing the needs of the various communities (Hauser et al., 2017).

(3) The Smart Governance: Hauser et al. (2017) sustain that a smart government deals with public management and government issues, including public and social services and government transparency through policy strategies and perspectives. The author mentioned above that smart governance influences the decision-making of the population using ICT, enabling the interaction between the community and the government.

(4) The Smart Mobility: It includes the infrastructures through which local access is provided to carry out activities in cities, including physical – streets, bridges, accesses, among others – and digital infrastructures – ICT (Hauser et al., 2017). To complement the infrastructures, it is necessary to have a safe, sustainable, and innovative transport system, both nationally and internationally (Giffinger et al., 2007).

(5) The Smart Environment: It covers key issues supporting environmental protection, such as pollution, management, and proper use of natural resources (Giffinger et al., 2007), contributing to the reduction of atmospheric contamination and improving the organisation and control of waste disposal (Esposti & Ciofalo, 2020).

(6) The Smart Living: It can vary due to the presence and relevance that some aspects have in the citizens’ daily life, such as access to education, culture and leisure, social cohesion, health, and housing conditions, among other essential aspects of the human being’s life quality (Giffinger et al., 2007).

Finally, Giffinger et al. (2007) explain that each characteristic is made of 33 factors, and 74 indicators further describe each factor (see Table 1). The characteristics are shown to be complete with their respective factors, consequently evaluating the city intelligence, having as references the six characteristics presented above (Giffinger et al., 2007).

Table 1 - Smart City Characteristics and Factors

<p>Smart Economy: Competitiveness</p> <p>Innovative Spirit</p> <p>Entrepreneurship</p> <p>Economic Image & Trademarks</p> <p>Productivity</p> <p>Flexibility of Labour Market</p> <p>International Embeddedness</p> <p>Ability to Transform</p>	<p>Smart People: Social & Human Capital</p> <p>Level of Qualification</p> <p>Affinity to Lifelong Learning</p> <p>Social and Ethnic Plurality</p> <p>Flexibility</p> <p>Creativity</p> <p>Cosmopolitanism/Open Mindedness</p> <p>Participation in Public Life</p>
<p>Smart Governance: Participation</p> <p>Participation in Decision-making</p> <p>Public and Social Services</p> <p>Transparent Governance</p> <p>Political Strategies & Perspectives</p>	<p>Smart Mobility: Transport and ICT</p> <p>Local Accessibility</p> <p>(Inter-) National Accessibility</p> <p>Availability of ICT – Infrastructure</p> <p>Sustainable, Innovative and Safe Transport Systems</p>
<p>Smart Environment: Natural Resources</p> <p>Attractivity of Natural Conditions</p> <p>Pollution</p> <p>Environmental Protection</p> <p>Sustainable Resource Management</p>	<p>Smart Living: Quality of Life</p> <p>Cultural Facilities</p> <p>Health Conditions</p> <p>Individual Safety</p> <p>Housing Quality</p> <p>Education Facilities</p> <p>Touristic Attractivity</p> <p>Social Cohesion</p>

Source: Adapted from Giffenger et al. (2007, p.12).

This means that with a good performance and a focus on the future, an intelligent dynamic can be built based on the six dimensions, involving all stakeholders – the public sector, the market and the society in general. These can most affordably provide a significant contribution to the development of information based on an urban, interactive and participatory environment since the ideal is to involve all stakeholders from the outset (Mechant et al., 2012), creating “a functional and creative communicative network” (Esposti & Ciofalo, 2020, p. 35).

3 Linking Open Innovation and Smart Cities

Innovation is made of interactions and relationships, considered a social phenomenon (Woszczyzna, 2021). The open innovation approach has gone beyond just the business environment (Hernández-Dionis et al., 2022). The research fields are generally receiving more attention due to the emerging need for an open approach (Khan et al., 2022). That can be seen in the healthcare system when the COVID-19 pandemic emerged, and institutions were forced to adapt, change and innovate to respond to the problem and open up (Hernández-Dionis et al., 2022). The term external knowledge, mentioned in the introduction, was used to advance the cities' transformation, which impacted the OI's performance when in practice (Hernández-Dionis et al., 2022). With a supportive perspective of Paskaleva and Cooper (2018), several cities are looking forward to applying open innovation approaches and new technologies to build a SC with better services for the community.

Once the services are created to assist the citizens, “the most under-used road to innovation is through asking ‘customers’ not just to assess how services are delivered, but also to help to (co)produce them” (Paskaleva & Cooper, 2018, p. 4). This cooperation can happen not only by questioning but also by the users that inform the service providers or manufacturers about what needs to be changed. This happens more often due to the digital reality that society lives in (Turon, 2022). Ojasalo and Kauppinen (2016) highlight the contribution of collaborative innovation as ordinary citizens and stakeholders are also seen in a more global and active world. The collaborative innovation shows to be present in a “multi-actor networks” that leads to a “more effective and innovative public services which will provide greater levels of citizen and community satisfaction” (Paskaleva & Cooper, 2018, p. 5).

As the innovation focuses on the public department, the emerging benefits will also be public and “it must obtain public approval” says Woszczyzna (2021, p.2). The same happens to the innovation used in the private sector to develop and gain a competitive advantage (Paskaleva & Cooper, 2018). However, in the public sector, the network actors go from government to common organisations, from profit and nonprofit sectors, focusing on public purposes (Ojasalo & Kauppinen, 2016). The citizens are also seen “as a critical resource”; therefore, the OI can take place in a SC (Paskaleva & Cooper, 2018). According to Tukiainen et al. (2015), collaborative innovation can happen in different city areas, such as improving everyday life and activities, creating creative consumer experiences, implementing new technologies, and creating or re-creating new business.

This co-creation takes cities and companies to “a mutual commitment relationship from the level of value creation, through external openness to its capture” (Turon, 2022, p. 2), which drives the stakeholders to a common interest win to the author above. Despite this aspect, Turon (2022) also mentioned that (1) local governments could contribute to reducing problems, use indirect solutions or give the input to improve the society’s life quality in the cities regarding the sustainable development; (2) the customer and community values are crucial to creating innovations and opening space for the customer to become part of the process; and (3) research organisations and universities should have the trust from the other stakeholders. Besides that, Khan et al. (2022) state that there are opportunities in the educational system, and it represents the potential growth and the cultural innovation of any city, where the path is to observe, experiment, measure, and adapt whenever necessary with the current means (Radziwon et al., 2022). According to the same scholar, the path includes bringing people and organisations to reason and making them join in all these efforts that will contribute to building a SC through the OI to improve the citizens’ life quality.

4 Research Objectives

Fernandes (2016) states that all the factors are essential to analyse a smart city performance and activities, once that they all support and interact with each other when implemented. This scholar also says that it helps to understand the success of different smart city initiatives integrated into different settings and with different purposes. Thus, the following steps are to observe, experiment, measure, and adapt to what is already integrated and convince people and organisations to be part of the process – knowing that the innovation process brings collaborative advantages and responsibilities (Radziwon et al., 2022).

Giffinger et al. (2007) establish six dimensions to build a smart city – (1) Smart Economy, (2) Smart People, (3) Smart Governance, (4) Smart Mobility, (5) Smart Environment and (6) Smart Living. These components focus on essential areas needed for a good city performance and work that combines local circumstances and actions taken by the politics, businesses and citizens. On the other hand, open innovation provides new approaches to a smart city through the use of new technologies that will deliver better services to the community (Paskaleva & Cooper, 2018).

Based on the concepts discussed/presented and to cover this gap in the field, this study aims to primarily understand the input of open innovation brought to a smart city.

Specific Research Objectives (RO) were defined to understand the following:

RO1: Linkage between Smart Economy and Open Innovation.

RO2: Relationship between Smart People and Open Innovation.

RO3: Effects of Smart Governance on Open Innovation.

RO4: Impacts of Smart Mobility on Open Innovation.

RO5: Linkage between Smart Environment and Open Innovation.

RO6: Relationship between Smart Living and Open Innovation.

The problem that needs to be covered is how the impact of open innovation can contribute to a smart city – Köln. This matter brought out the literature investigation and, due to the researcher's possibility of living in the current city under study, it enables the researcher to analyse the current conditions of Köln.

Once the study intention is known, the study model consists of two main variables: (1) the independent variable (IV) which is presented as open innovation and (2) the dependent variable which is presented as smart city (DV). In other words, the independent variable is correlated with the six dimensions designed by Giffinger et al. (2007): smart economy, smart people, smart governance, smart mobility, smart environment and smart living.

5 Research Questions

From the theoretical framework that was developed the following Research Questions (RQ) emerge:

RQ1: What is the impact of Open Innovation on Smart City through the Smart Economy dimension?

RQ2: What is the impact of Open Innovation on Smart City through the Smart People dimension?

RQ3: What is the impact of Open Innovation on Smart City through the Smart Governance dimension?

RQ4: What is the impact of Open Innovation on Smart City through the Smart Mobility dimension?

RQ5: What is the impact of Open Innovation on Smart City through the Smart Environment dimension?

RQ6: What is the impact of Open Innovation on Smart City through the Smart Living dimension?

The linkage of the research questions with the theoretical framework is displayed in Table 2.

Table 2 - Research Questions

Dimensions	Research Question	Authors
Smart Economy	What is the impact of Open Innovation on Smart City Köln through the Smart Economy dimension?	Giffinger et al., (2007); Hauser et al., (2017).
Smart People	What is the impact of Open Innovation on Smart City Köln through the Smart People dimension?	Giffinger et al., (2007); Hauser et al., (2017); Esposti & Ciofalo (2020, p. 35).
Smart Governance	What is the impact of Open Innovation on Smart City Köln through the Smart Governance dimension?	Giffinger et al., (2007); Hauser et al., (2017).
Smart Mobility	What is the impact of Open Innovation on Smart City Köln through the Smart Mobility dimension?	Giffinger et al., (2007); Hauser et al., (2017).
Smart Environment	What is the impact of Open Innovation on Smart City Köln through the Smart Environment dimension?	Giffinger et al., (2007); Esposti & Ciofalo (2020).
Smart Living	What is the impact of Open Innovation on Smart City Köln through the Smart Living dimension?	Giffinger et al., (2007);

Source: Own elaboration.

6 Methodology

6.1 Methodological Approach

As previously mentioned, this study aims to understand the contribution of open innovation in the smart city concerning Köln. In this regard, it was chosen to carry out a qualitative empirical study through the case study. Thereby, the reality of Köln concerning the use of open innovation contributing to a smart city may be observed, along with the theoretical field, which was developed earlier as literature review, to support what will be observed and, subsequently, analysed.

According to Godoy (1995), the qualitative methodology is a suitable way of working in the social sciences, knowing in advance the nature of the problem, the questions to be studied and the study's objectives. When carrying out the study, the researcher has the responsibility to focus on treating the study “with as much as objectivity, ethical diligence, and rigor as possible” (Jackson II, et al., 2007, p.21). Intending to do so, this methodology proposes to observe which problems are worth investigating and where to place them to be studied, by setting up a path of action: problem – information gathered – analysis – conclusions, states Jackson II et al. (2007).

A qualitative study can take descriptive or exploratory approaches. Since the research of this study is dedicated to the transcription of an interview, with possible field notes and several document types, the research faces a descriptive study, says Godoy (1995). It considers that all the reality data is important and could be examined, including the environment and people, in an integrated way, meaning to have a holistic perspective on the elements (Godoy, 1995). The aim of this study, as Godoy (1995) states, is to analyse how this phenomenon occurs in daily activities, procedures and interactions in the city through the participants' perspective. This approach enables the researcher to perceive the “internal dynamism of situations, often invisible to outside observers” (p.63), resulting in interesting and revealing data for what is sought to be observed.

It is essential to clarify the difference between two concepts: method and methodology. Jackson II et al. (2007) argue that method focuses on “how to” and methodology on “why to” collect data in a certain way.

6.2 Data Collection Procedures

Since the concept of smart city is widely discussed and does not have the same solution for the different presented realities, "the intensive study of real cases can be beneficial to reinforce the existing knowledge base" (Bernardino et al., 2020, p. 205). This methodology embraces a range of information sources – documents analysis, interviews, and observations – and how that information can be selected and analysed for the case study (Yin, 2009).

The collected information for the study was obtained through different sources of information that resulted in the triangulation (Eisenhardt, 1989), and, in this case, two sources were chosen: documentation and interviews.

The use of a documental analysis allows the researcher to guarantee the success of the research and the acquisition of stable results to the study (Wallace & Glen, 2018), regardless of the linguistic limitations that she is facing due to the fact that she is living in a foreign country – Germany.

The mentioned technique intends to “identify point information in documents based on questions or hypotheses of interest” (p. 538). Toward, a desk research was performed and several support networks were found to understand the dynamics and efforts made by the Köln city. On the organisation's website that seeks to foster smart activities for a smart city (<https://www.smartcity-cologne.de/>), supports can be found, such as reports and project exhibitions. These initiatives focus on climate protection and energy transition, and the information is updated as new projects are launched. The data was collected through documents and brochures of the organisation available on its website and specialised publications. As the researcher was in the area, she could gather perspectives on “the researched phenomenon” through observation and be closer to the reality of the facts, where there is a more descriptive part - description of the subjects, places and activities - as well as a more reflective part - personal observations and speculations (Wallace & Glen, 2018). Once the researcher “does not interact with the researched group” – total observer (p. 536) – the research through the available digital platforms proves to be necessary to understand the purpose of the city projects.

To clarify some aspects of the projects and activities that the organisation carries out that need a deeper analysis, the researcher investigated online the possible key people to conduct an interview. Using the interview as a data collection technique for qualitative

research has advantages and limits. The interview is the most common procedure adopted in the fieldwork process to collect data on a current phenomenon (Edwards & Holland, 2013). Although it is not the only resource in qualitative research, according to Batista et al. (2017) it is considered a quality technique for gathering data that “requires very careful methodological planning” (Alves, et al., 2021, p. 25) and it is understood that there is an interaction between two or more people, where an “immediate and current information capture” occurs (Wallace & Glen, 2018, p.357). When this tool is under use, descriptive data of a specific reality is analysed, which brings the researcher’s direct contact with the reality under study (Batista et al., 2017). That leads to new perspectives and concepts throughout the research (Minayo, 2010). Among the several advantages, the interviewer can adapt to the interviewee and the circumstances in which the person is at the moment (Gil, 2008). The possibility to not only find answers – verbal communication – but also analyse reactions and expressions from the interviewed – non-verbal communication; and to repeat, clarify, reformulate questions and discuss certain disagreements found in the answers – strong reversibility (Alves, et al., 2021).

There are several interview models – informal, focused, opinion survey, structured, open, telephone, face-to-face, individual and group (Minayo, 2010). This study, it will be used a semi-structured interview that embraces closed and open questions simultaneously. For the interview to reflect on the objective(s) and purpose(s) of the study (Alves, et al., 2021), it requires a script with questions that allow the interviewee to speak openly according to how they find it most suitable (Fernandes, 2016), without denying the clarity, sequence and logic of the questions (Alves, et al., 2021). The previous authors also state that contacting respondents can take two forms: in person or through digital means. Even though the interview through digital means may cause constraints due to available internet access and adequate instruments on the interviewee's part; it was considered to be the most suitable mean for this study, bringing with it the advantage of being cheaper and the possibility of embracing a wide geographical area (Alves, et al., 2021).

Based on the six dimensions of a SC, an interview was used to qualitatively understand concepts and factors that characterise smart city initiatives and how to make a city a better place to live. For a more concise and focused interview on the subject under study. The first research was conducted on the projects developed and released on the SmartCity Cologne online platform. This first step is crucial as it allows the interviewee to be aware

of details that the interviewees may mention. It guides the conversation to the topics most relevant to the study, which help validate and clarify the questions.

6.3 Instrument

The following interview script was structured to interview the organisation SmartCity Cologne. This script follows a funnel sequence – open to closed questions – that is “useful when the questioner wishes to be by openly addressing broader issues before gradually addressing more factual ones” (Subedi et al., 2021, p. 1). Besides that, the researcher was capable to “rely on the flow of interaction with the interviewee” enabling the researcher to build questions if necessary.

The referred script is organised as follows: initially, information about the interviewee followed by the questions that will enable to answer the research questions, duly organised. The first questions understand the organisation’s dynamics and the following questions seek to answer the research questions for the study, which were made up based on the authors referred to in the literature review, ending with a global question regarding the six dimensions of a SC. This interview proves to be relevant to the study as the organisation plays an important role when projecting actions that support the development of a SC and, in fact, “the greatest attribute of questioning is that it stimulates thinking” for both sides (Subedi et al., 2021). Thus, the keywords that are related to the research factors were defined and presented in the following table:

Table 3 - Interview Script

Dimensions	Questions	Authors
Socio Demographic Characterisation	Q1. When was SmartCity Cologne established?	---
	Q2. What is the legal form of the organisation? And the main founders?	---
Smart Economy	Q3: In what way do climate protection and energy transition contribute to a Smart Economy? Q4. Concerning Smart Economy, is there a chance that a strategy applied in another city, could be redesigned for Köln?	Giffinger et al., (2007); Hauser et al., (2017).

	<p>Q5. Does SmartCity Cologne have international partners? If so, what economic competitive advantage do these partnerships bring to the Köln?</p> <p>Q6. Are the partnerships established more of a financial or knowledge character?</p>	
Smart People	<p>Q7. How can climate protection and energy transition impact on Human Resources qualifications?</p> <p>Q8. The referred international partnerships, can enhance Smart People? Through which projects/activities?</p> <p>Q9: Are knowledge partnerships important for Smart People? In what levels?</p> <p>Q10. How are the citizens involved in the projects?</p> <p>Q11. As the stakeholders/participants can be diverse – people, civil society, business organisations and business initiatives –, how does the first approach come out? Top-down or bottom-up approach?</p>	<p>Giffinger et al., (2007); Hauser et al., (2017); Esposti & Ciofalo (2020, p. 35).</p>
Smart Governance	<p>Q12. Has the technology applied in the local services contributed to a more sophisticated organisation and a more efficient service for citizens?</p> <p>Q13. What are the barriers or challenges to using technology for the initiatives associated to the Governance? How are those challenges overcome?</p>	<p>Giffinger et al., (2007); Hauser et al., (2017).</p>
Smart Mobility	<p>Q14. What are the elements that constitute the mobility network? Does the Köln's mobility network provide high standards of life quality?</p>	<p>Giffinger et al., (2007); Hauser et al., (2017).</p>

<p style="text-align: center;">Smart Environment & Smart Living</p>	<p>Q15. In what way did the initiatives carried out for the climate protection and energy transition contribute to an improvement in the population's life quality?</p> <p>Q16. As you work with educational partnerships, is there any contribution from you to these institutions? If yes, which one?</p>	<p style="text-align: center;">Giffinger et al., (2007); Esposti & Ciofalo (2020).</p>
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Source: Own elaboration.

The interview script is presented on Appendix 1.

6.4 Participant Selection

According to Alawadhi et al. (2011), the smart initiatives that each city carries out are different due to the several fields that also differ from city to city, such as population, demographics, economy and location. Hence, it is important to analyse an organisation that focuses on these issues, so the study can clarify what is Köln doing in line with smart city initiatives. Also, as Edwards and Holland (2013) state, qualitative research is theoretically driven. This means that the sample must provide the right data to obtain the right answers to the research questions (Edwards & Holland, 2013). The author above also says that the same happens “to the construction and selection of the sample in a qualitative interview study” (p. 6). Regarding that, the sample selection is based on the relevance it has for the study, enabling an interactive process between the theory and the data (Edwards & Holland, 2013), which means that the sample selected is theoretical and purposive simultaneously.

This paper focuses on one city in Germany: Köln. To follow the theoretical part, the organisation SmartCity Cologne was crucial to answer the research questions as its projects centred on climate protection and energy transition. The selection of these participants was not only theoretically and purposefully defined but also determined after some observation done by the researcher. Edwards and Holland (2013) named this process as an integral part of ethnography, once it is necessary to be in the field under study. After that, according to the information available on the organisation's website, although the researcher had conducted an online search and contacted a team member to access the organisational chart, she could not obtain one. This situation was also addressed during the interview in an attempt to find a different answer. After sending

several e-mails and making several phone calls, contact was established with an organisation's individual, who directed the e-mail to other colleagues who would be available to participate in the interview.

It was given the opportunity to the researcher to select the suitable key people for selecting the interviewees. Thus, we have selected two key people: one that took part in a relevant project the Köln City – “The Smart City Köln Innovation Fund” –, and that is currently a member of the Department VIII – Environment, Climate and Real Estate of the Stadt Köln; and the second one from the Department IX – Urban Development, Economy, Digitization and Regional Affairs. The fact that these two people work in different departments of the Stadt Köln enhanced the research with crucial insights that, although from other fields, are complementary.

To record the information, the interviewer preferred direct recording as it gives a full event report (Freitas Silva et al., 2006), and also because both participants were willing to share their data. The direct reporting was made through the researcher's personal mobile phone and laptop, simultaneously enabling the interviewer to be fully concentrated on the interviewee. The laptop report granted to have the video recording as well – the facial expressions, gestures, body posture changes (Freitas Silva et al., 2006) are presented. After that, the researcher transcribes the recorded interview to a digital document, which takes longer than expected due to the information appearing in a more or less undifferentiated whole. This makes it difficult to distinguish the least important information from the main information (Freitas Silva et al., 2006). As Freitas Silva et al. (2006) argue, the researcher used the recording to set priorities with the aid of researcher memory. The interview took place on June 9th, 2022 and lasted between 40 to 50 minutes.

After recording the interview content, the researcher proceeded to explore the content to code the content, taking into account the research questions and theoretical references (Sousa & Santos, 2020). Thereby, we proceeded to the fragmentation, grouping or regrouping of the registration units of the text, enabling the treatment and interpretation of the results (Sousa & Santos, 2020). As the previous author stated (2020), this phase allows finding meanings of the messages through “intuition, reflective and critical analysis. This phase is the logical operation, by which a proposition is admitted under its connection with other proposals already accepted as true.” (Bardin, 2010).

The primary floating reading (Sousa & Santos, 2020) of the interviews had the aid of documents that characterize and complement the projects referred to along the interview and allow "the construction of the analysis' text of this research.

Thus, the data was presented by presenting a synthesis that clarifies the main links on the issues covered in the questions. The study closes with the conclusion, showing each dimension of the SC's influence on the Köln city.

In the next chapter, these patterns are used to present an account of the contribution of the SmartCity Cologne project – together with the Stadt Köln and RheinEnergie – to the smartness of Köln's city.

7 Case Study: Köln City

7.1 Case Study Method

The research should have clear methods in all the stages (Ranieri & Capellato, 2020). Although this method might have potential limitations, the case study enables the researchers to investigate and understand the realistic context of the phenomenon to be observed, which means retaining the holistic and meaningful characteristics of real-life events (Yin, 2009). Despite that, it should be found a balance between finding interesting cases – “where the subject and object interact in a dynamic relationship” – and selecting a representative case so that new hypotheses can be found, once the previous ones could not find it (Rebolj, 2013, p. 35). Besides, the case study can observe one or more cases; a singular case study refers to one case, and several cases represent multiple case studies (Rebolj, 2013). Even though Germany is not in the Top Smart City Group, German smart city initiatives are considered better than the European average (Steinbrecher et al., 2018). For this study, a singular case study is taken, and the Köln city is used as the selected case for observation.

7.2 Köln City Case Study

According to Germany in Numbers (n.d.), Germany is seen as the Europe’s largest economy, it is constituted by sixteen states and it has urban areas that attract larger and denser populations – 83,517,046 citizens (Staffa et al., 2021), specially in the far western part of the industrial state of North Rhine-Westphalia. These facts drive the country to play a key role in the continent’s economic, political, and defense organisations. Berlin is the largest urban area in Germany, and Köln is ranked in the fourth place – 1 119 000 (Staffa et al., 2021). Concerning the German government, it is a Federal Parliamentary Republic (Staffa et al., 2021). For a better context of the country with the study area covered here the same authors argued that Germany has a very high level of human development – ranks 6 out of 189 countries and territories in 2019 –, and has the 7th highest CO emissions – in 2019 – and has a higher share in renewables – in 2019.

Köln is integrated in the state of North Rhine-Westphalia, and its population has been growing faster than in the other cities in this region on average (+4.7% from 2021 to

2030) (Staffa, et al., 2022). According to City of Köln (2017), more than 85% of the people working in Köln are in the service sector. It is also seen as a cosmopolitan metropolis in this state because more than 30% of its residents have immigrant backgrounds. Besides being known as one of the oldest German cities, it is also known for crossing the Rhein river, making it a centre of culture, commerce, and the first choice for several companies to settle down (Greif, n.d.). The same author believes this motivation comes from its good location and connections to the rest of Europe through roads, railways, airways and waterways. Despite that, “the continuous expansion of the efficient fibre optic networks, digital connections are also ensured via the strong data network” makes companies feel attracted to establish themselves in a dynamic industry (City of Köln, 2017, p. 7). The same author also states that the media and creative industries are well set up because of the creative environment and the excellent infrastructures they can find in the city.

7.3 Köln SmartCity Project

In 2011, the SmartCity Cologne initiative was launched by two institutions - Stadt Köln and RheinEnergie AG, a regional energy supplier. This initiative emerged from the need for this supplier to find new answers to the consequences of more efficient technology regarding energetic terms and the increasing expansion of renewable energies, enabling a sustainable energy transition. On the other hand, these changes also lead to the search for new business models.

The development of these pilot projects transforms places in the city into real laboratories for testing innovations and technologies and providing experiences through which to measure, evaluate and develop reports on the eight fields of action that the initiative works on: buildings and housing, energy, mobility, climate and environment, economy, health and safety, ICT and data, as well as policy and administration. The final result is a more liveable, resilient, environmentally friendly, innovative and competitive city.

8 Results

Below, we present the results to the questions in the interview script. Q1 and Q2 are descriptive questions for the characterisation of the studied organisation. To help us answer the questions Q3 to Q15, we rely on the input of Kristina Kebeck (Member of the Environment, Climate and Real Estate of the Stadt Köln – Department VIII – and also Associate Research Manager of SmartCity Cologne) – I1. The answer to the questions Q8 to Q15 – except for Q7 – were provided by Dirk Blauhut (Head of the Digitization Department of the Stadt Köln) – I2.

8.1 Descriptive Analysis

Q1. When was the SmartCity Cologne implemented?

The interviewer mentioned having seen on the online website from the SmartCity Cologne that the project had been founded in 2011, questioning in more detail. Although I1 could not confirm this, the I1 was willing to provide documents at a later stage to answer this question (Table 4).

Table 4 - Synthesis of the Response to Q1

Interviewee	Evidenced Answer
I1	“Well, some say 2011 and others 2012. So, that is where all started. We cannot even precisely say “this is the moment it started”. I actually do not have a written paper with a contract between us and the RheinEnergie. So, I can check one german study and maybe I will find the date there and I can send you some information afterwards.”

Source: Own elaboration.

According to the document provided by the I1 after the interview, it was possible to confirm that the Initiative SmartCity Cologne started in 2011 by, as it was said, the Stadt Köln and RheinEnergie (Hertzsch & Heuser, s.d.).

Q2. What is the organisation’s legal form? And the main founders?

The I1 made the point that SmartCity Cologne is an initiative, not a legal company or organisation. The founders are the Stadt Köln and the city’s power supplier –

RheinEnergie –having members from both parties who contribute to the development of SmartCity Cologne projects (Table 5).

Table 5 - Synthesis of the Response to Q2

Interviewee	Evidenced Answer
I1	<p>“It is not a legal company, our SmartCity Cologne is a network, is a initiative, is a platform, if you wish. So, it is an initiative founded by the Stadt Köln and RheinEnergie (the local energy supplier) and well, it started 10 years ago for climate protection and energy transition. It had a different focus but there is not, at least as I know, a contract that says the status. If there would be a contract, we would really make use of it. So, we are a team on our side and RheinEnergie side, a small group of people exchanging on a weekly bases on topics and activities.”</p>

Source: Own elaboration.

According to some research, when the I1 mentioned that the SmartCity Cologne “had a different focus”, it means that the true reason for this initiative to be founded is due to the need to find new answers to the consequences of increasingly energy-efficient technology and the relatively intensive spread of renewable energies as part of their contribution to shape a sustainable energy transition (Hertzsch & Heuser, n.d.).

Later, the interviewer also asked: “So, you would also say that there is not an Organogram?”

Even though elements are eligible to contribute to the initiative, I1 confirmed not having an official organizational chart (Table 6).

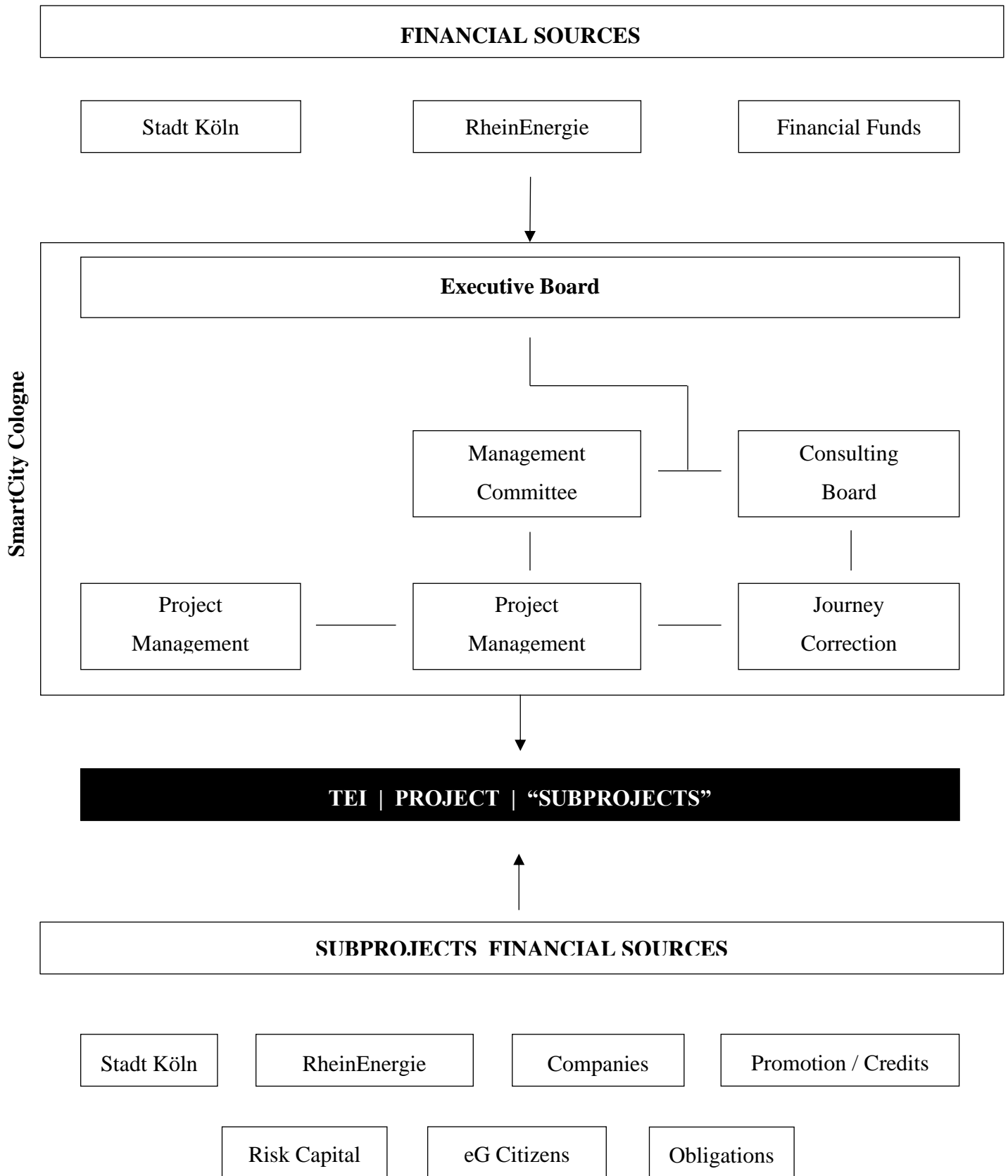
Table 6 - Synthesis of the Response to the complementary Question

Interviewee	Evidenced Answer
I1	<p>“No, well we have not got one. It is just in the Stadt Köln, we have the department and in there, there is the Climate Protection and coordination office, which is in English the executive department. Within this, SmartCity Cologne is located from the organization structure, so it is not within the city organogram.”</p>

Source: Own elaboration.

Still, the researcher could design the organizational chart based on Möhlendick (2017), as seen in Figure 1.

Figure 1 – Organizational chart



Source: Adapted from Möhlendick (2017).

8.2 Smart Cities Dimensions

Smart Economy

Q3: In what way do climate protection and energy transition contribute to a Smart Economy?

I1 mentioned the importance of climate protection, technology and energy reduction and emissions. Regardless of the technology's contribution to this process, the population will always have jobs, different from the past but with even more possibilities (Table 7).

Table 7 - Synthesis of the Response to Q3

Interviewee	Evidenced Answer
I1	“Economy has to change and only this is the future. Having this climate protection and reduction of energy and emissions that are in place. Some people say that some of the jobs will not be there in like 20-30 years time, because the technology will do it all. I think this is true, but only for some jobs. I think there will always be people needed and, in general, the economy and the orientation to what it is this smartness and smart city they will just create new jobs. Surely, different from the past, but there will be more jobs and not less.”.

Source: Own Elaboration

Q4. Concerning Smart Economy, is there a chance that a strategy applied in another city, could be redesigned for Köln?

The I1 did not find herself very comfortable going deeper into this topic, as the SmartCity Cologne is not the main responsible for observing the external environment to catch applied strategies in other cities that might work in Köln City. However, from the I1’s perspective, this initiative would be 100% interested in such opportunities (Table 8).

Table 8 - Synthesis of the Response to Q4

Interviewee	Evidenced Answer
I1	“In general I would be fully open to it, but I can’t give you a precise answer to that due to the fact that the SmartCity Cologne is a network and a platform and, the SC strategy of the City of Köln is something above. Where different departments and offices are involved in, at the

	<p>SmartCity Cologne are more a communication platform. We are also supporting to some extent projects on a financial way or we organize the SmartCity Cologne Conference for instance. But we are not directly dealing with this part, our colleagues' office at the digitization department are. So, they are much more focused on: "okay, what do they do in Düsseldorf? Do they have a great strategy?". But of course they are more in this technical issues, in the competition between cities like this 5G Network, digital twin...we, at the SC Cologne, are more a communication platform."</p>
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Source: Own elaboration.

After some documental research, the interviewer found that there are more projects related to this question:

(1) The GrowSmarter Project aims to bring cities and industries linked "to integrate and demonstrate "12 Smart City Solutions"" to reduce the gas emissions, increase the share of renewable energy and increase the efficiency energy (GrowSmarter Highlights, s.d.). This project is applied in three "lighthouse cities" – Köln, Barcelona and Stockholm – and to bring more "cities, industry and citizens to test smart solutions and business models" other five cities were used as the "follower cities" – Cork, Suceava, Valletta, Graz and Porto (GrowSmarter Highlights, s.d.). This provides "other cities with valuable insights on how they work in practice and opportunities for replication" (Our Vision, n.d.).

Q5. Does SmartCity Cologne have international partners? If so, what economic competitive advantage do these partnerships bring to the Köln?

To give more context and orientation to the interviewee, the interviewer pointed out a particular detail related to the question: "For example, I know for the Black Caps London, the kind of taxis Köln has...there is still a few, but we can already see them around the city and, I know the producer is international. So, despite this one, do you have knowledge of more partners?"

It confirmed the presence of international partners and points to their relevant importance in different projects, as well as the visibility and support those partners bring to Köln and the SC Cologne (Table 9). This enables the initiative to make up the projects through the resources provided by the international partnerships.

Table 9 - Synthesis of the Response to Q5

Interviewee	Evidenced Answer
I1	“International partners, there are many within Köln. We had projects with Ford for instance, or the Talako Project, you just mentioned. And this is something that we promote, of course. The GrowSmarter Project made the SmartCity Cologne to go forward due to the collaboration with the EU – Horizon 2020 – and there were several partners involved as well.”

Source: Own elaboration.

To get more context about the GrowSmarter Initiative, the researcher asked I1: “Is this GrowSmarter Project finished or...?”.

The I1 (Table 10) confirmed that the project in question was finished in 2019.

Table 10 - Synthesis of the Response to Q5

Interviewee	Evidenced Answer
I1	“Yes, yes it was finished in the late 2019, but there are still articles published about the results. Although the official project ended, I just received one publication last week on this GrowSmarter Project. If you wish, I can also send you some information about GrowSmarter.”

Source: Own elaboration.

Regarding the projects mentioned above (Table 9):

(2) SmartCity Cologne Conference is related to climate protection, work and health, politics and the economy bringing new strategies, measures and projects that are needed to the several sides of Köln (First Virtual SmartCity Cologne Conference: Startup Einhundert is Cologne's KlimaStar 2021, n.d.). This event invites all citizens and companies in the city, representatives of the science department and associations to show them the city’s transformation and potential projects for the future, as mentioned by the previous author.

(3) The Geofencing and Blockchain Model Project of Ford intended to provide the Stadt Köln with nine Ford Transit Custom Plug-in Hybrid – PHEV – panel vans and a Ford Tourneo Custom PHEV (Cologne model project started – test fleet picks up speed, s.d.), that with a specific technology can “automatically ensure that the vehicle automatically switches to battery-electric drive when entering an environmental zone” (Cologne model

project started – test fleet picks up speed, n.d.). The partners are constituted by SmartCity Cologne, the automobile manufacturer Ford, the Stadt Köln, the RheinEnergie, the Köln Transport Authority – KVB –, the Köln/Bonn Airport, the waste management company in Köln – AWB – and the ports and freight traffic in Köln – HGK – (Cologne model project started – test fleet picks up speed, n.d.).

(4) The Talako Project – which started on October 1st, 2019 – is based on a taxi charging concept for electric taxis in public places (TALAKO – Taxi charging concept for electric taxis in public spaces, n.d.). For that, a wireless alternative had to be developed as an electric taxi could not be charged while standing in line and constantly moving forward. This led to the creation of an inductive charging system that is integrated into the floor of the taxi rank, which enables the taxi to be charged through energy that is transferred between the charging plate integrated in the floor and a charging plate in the taxi (Taxi Charging Concept for Public Spaces (Talako), n.d.). That said, the Chair for Business Administration and International Automotive Management from Ms. Prof from the University of Duisburg-Essen – another city close to Köln – came into the initiative. The project vehicle is produced by a foreign partner, which operated the production of electric vehicles for the taxi industry, in black caps models typical of London – Levc, English producer (Talako – Taxi charging concept for electric taxis in public spaces, n.d.).

(5) The KVB added a new offer called Isi. In addition to the already existing transport services, it came as an on-demand service, without fixed routes or specified timetables. As the project mentioned before, these offer uses the “London Taxi” (Pilot Project "Isi" - KVB introduces new on-demand offer, n.d.).

(6) The KVB-Rad offers the citizens a bicycle rental system (KVB - Rad, n.d.). This offer came together with a partner called Nextbike – a German company that develops and operates public bicycle sharing systems (nextbike - original bike sharing, n.d.).

(7) The VRS, in collaboration with the GoFlux, offered private rides, helping rural areas to be better connected with the city centre and reinforcing the importance of public and shared means of transport.

It is also relevant to mention that the GrowSmarter Project was part of an EU’s research and innovation funding programme from 2014 to 2020, called Horizon 2020.

Q6. Are the partnerships established more of a financial or knowledge character?

I1 acknowledged having difficulties explaining how the financial and knowledge partners' side works. In this regard, I2 interceded to clarify – for the researcher who has no association/contextualisation to/with the German system – how the funding of the activities takes place. It was clear that it is a financial transition through the available money in the annual budget from the municipality of Köln, which provides funds for projects from different departments (Table 11).

Table 11 - Synthesis of the Response to Q6

Interviewees	Evidenced Answers
I1	“Well, the ones that we have from our SmartCity Cologne initiative, which was regarding within this GrowSmarter, it was of course knowledge exchange. So, basically knowledge exchange. Besides the RheinEnergie we do not have any other partners involved...It is a little bit hard from the outstanding to understand the way we work and cooperate...”.
I2	“We as a government are responsible for the city situations here in Köln. Where as the RheinEnergie and NetCologne and the so called Ottos are responsible for the digital infrastructure, the mobility infrastructure and they pay us (by contract)...just very shortness...to make it really easy they pay us at the end of the year to, no...how to explain that properly? We get money from them (by contract) but they have to fulfill their original duties/services. We are being payed by them at the end of the year for the next year, it is a financial transactions which is really, really important for both of us but within this money that goes into the Hall of the City budget, we pay some projects, some SmartCity projects as well as digitization projects. So, I guess it is very easy but not 100% correct but...”.

Source: Own elaboration.

(8) The exchange of ideas regarding the smart city concept in Köln takes place in the Renewable Energies degree at TH Köln – University in Köln. This exchange comes from the demand for solutions to issues presented by the teachers who will contact the initiative to contribute to the initial problem or assist in the final project presentations.

(9) The Project Cologne – OI platform for all Köln students – aims to get young minds with new ideas to take the first step towards implementing innovative projects – together

with RheinEnergie, KölnBusiness and SmartCity Cologne. Both sides benefit from this exchange, students gain practical and professional experience, and companies receive new and young solutions (ProjectCologne, n.d.).

Smart People

Q7. How can climate protection and energy transition impact on Human Resources qualifications?

As mentioned in Q3, I1 referred the relevant role of jobs from the past and future, which made the interviewer decide to ask the Q7, directly. I1 confirmed the influence that further innovations in climate protection and energy transition will bring to the human resources qualifications, highlighting the importance of job places from people to people and the technology’s field (Table 12).

Table 12 - Synthesis of the Response to Q7

Interviewee	Evidenced Answer
I1	“Yes, yes! I think there will be jobs which will still focus on people and interact with people, but also within a SC of course there will always be this IT’s side, let’s call it like this.”.

Source: Own elaboration.

Q8. The referred international partnerships, can enhance Smart People? Through which projects/activities?

I2 highlighted (Table 13) the importance of including the citizens’ opinions and ideas to improve the citizens’ life quality. Through a participatory budget, the Digitization Department could ask people what they wanted. The participation of these public elements at an European scale is relevant for exchanging ideas and solutions between countries and cities. The importance of the citizens’ participation in public life is evident through what I2 exposed. Despite that, when the citizens are asked about what can be changed in the future to improve their life quality, they show their creativity through their ideas, for further decisions about their future reality and available services or products.

Table 13 - Synthesis of the Response to Q8

Interviewee	Evidenced Answer
I2	<p>“From the digitization point of view, specially the communication and the openness is really important, just to get them involved. Just to try to understand what their needs are and try to work with these issues or needs just to improve the life of the citizens. It is part of our main business. We started in 2008 with a participatory budget just to ask the people what they wanted us to spend money on. And that was the beginning of a very successful digitization project, to include people and their ideas, on what to spend money on, and I think the starting point was increased by other projects, like planning projects which we asked them to join and asked them for their opinion, wherever we should build something like, or to spend more money on children’s places or in schools , or whatever. That goes on until now, that’s the point I am here. We joined the Federal Ministry of Interior Affairs and we are payed by one idea we had which is getting ideas from the citizens, regarding digital projects to enhance the quality of life here in Köln, not only in Köln because the ministry is very kin about learning course, and they want us to spend our knowledge now, that we are going to create with others cities and others countries. We are part of an European community, where we try to share our ideas and solutions with them just to show them which of the ideas would work or would not. This project started in 2021 and it will go forward for 7 years and after that we try to establish this communication with the city environment.”.</p>

Source: Own elaboration.

The GrowSmarter Project – (1) – can be seen as a beneficiary of the knowledge exchange with the other cities in the study.

Q9: Are knowledge partnerships important for Smart People? In what levels?

To give more context and orientation to the interviewees, the researcher pointed out a particular detail related to the question: “When you reach the knowledge partners, for example, in universities, in Köln. Is it a way to get closer to the people, especially the young people, because they will build the next company, the next ideas...?”.

Both interviewees recognised the importance of these younger members of society. They emphasize that not everything is in their power, but they have moved to expand this participation through universities and the learning exchange between decision-makers and citizens (Table 14).

Table 14 - Synthesis of the Response to Q9

Interviewees	Evidenced Answers
I1	“Yes, surely it is and surely we have to be better! We have some connections with them but only always with one or two professors, or one or two projects. We know this is something really important for us, to have this exchange and we do have cooperation projects, for instance a small speech and interns from Köln’s universities. We have asked a design university to redesign their view of how we should design our online page. There are some steps taken to get into more cooperation and interaction.”
I2	“It will be a learning process, we have to learn from both sides. We have to learn and understand what people want us to do and people should be aware of their needs and, the problems we are facing as a Government, so it is very important to bring these aspects together and learn from each other.”

Source: Own elaboration.

Q10. How are the citizens involved in the projects?

As referred to in the Q8, the I2 mentioned the relevant role of the citizens. The interviewer decided to ask a more detailed question: “Do you think the citizens are more involved at the beginning like you said, when you ask what should we improve, where should be the money used for, or do you think they are also involved during the process?”

The member of the digitization department – I2 – mentioned that the following stages of the project they will be in will be to work on how to communicate and discuss ideas. A study conducted earlier showed that only a minority of the population in Köln gave their input. The I2 reinforced the importance of engaging people to join them in this process and that the applicability of the money is focused on the citizens’ needs and not only on creating projects. The I1 states that the main focus should always be the people (Table 15).

Table 15 - Synthesis of the Response to Q10

Interviewees	Evidenced Answers
I2	<p>“We just started the project because we have to work on the strategy. Just how to work in these next phases, which are going to be about communicating and the discussion ideas and preparing money for the ideas. It would be very important for us that we have a clear communication concept because what we learned in 2008 with the first participatory budget was we only got 2% of population (here in Köln), which is not that much. We want to increase this participation up to 25%. That is our main goal but to reach that goal we have to communicate the idea of the project, specially we have to engage people to join us and bring us good ideas and talk to us because it is not about spending money for digital projects, it is more about communicating and trying to understand what their needs are and what we can do about the ideas or issues, try to bring different groups together and share ideas and solutions. That is the main point: reach more than this 2% of citizens.”</p>
I1	<p>“...added that people are key and working within the smart city means that our guiding principle are the people centered in smart city, so we do not want to do something just “to do” something but we want to do the right things to the people. That is why we try to get in touch with them and communicate with them. When we started our funding programmes for instance, the SmartCity Cologne funding programme CCG – Cologne Center for Genomics – is designed for people, easily accessible and so on. That is our main focus, to have people centred.”</p>

Source: Own elaboration.

Regarding the projects mentioned above (Table 15):

(10) The UnBox Project aims to get to know the citizens’ needs based on the public opinion, bringing all of them together, making “business, science and society to come together under the umbrella of the city of Köln to make digitization and innovations tangible” (Digital Hub Cologne supports the city of Cologne on its way to becoming a Smart City, n.d.).

The SmartCity Conference, TH Köln and ProjectCologne open space for citizens and professional members to exchange opinions, bringing the real public’s concerns to the organisations that can implement new solutions. Before the GrowSmarter Project was implemented, the citizens must be taken as a part of the dynamic once that actions are only possible if there is a meaningful dialogue with the users, ensuring that the initiative is accepted by the inhabitants (Möhlendick, 2017).

Q11. As the stakeholders/participants can be diverse – people, civil society, business organisations and business initiatives – how does the first approach come out? Top-down or bottom-up approach?

As through the Q8, Q9 and Q10, both interviewees mentioned key phrases based on their previous feedback, explaining that, in general, the first approach is top-down (Table 16).

Table 16 - Synthesis of the Response to Q11

Interviewees	Evidenced Answers
I1	Q10: “(...) That is why we try to get in touch with them and communicate with them.”
I2	<p>Q8: “There are some steps taken to get into more cooperation and interaction (...) planning projects which we asked them to join and asked them for their opinion, (...)”</p> <p>Q10: “(...) we have to engage people to join us and bring us good ideas and talk to us (...) trying to understand what their needs are and what we can do about the ideas or issues, try to bring different groups together and share ideas and solutions.”</p>

Source: Own elaboration.

Once the SmartCity Conference, Project Cologne and UnBox Project are implemented, they open up space for the people interested to come to them. While TH Köln sees itself both ways, it receives contact from SmartCity Cologne and makes contact initially.

Smart Governance

Q12. Has the technology applied in the local services contributed to a more sophisticated organisation and a more efficient service for citizens?

To give more context and orientation to the interviewees, the researcher pointed out a particular detail related to the question: “I am here since September and I had to register myself for the residence, and I saw it is everything online and useful. But would you say that there are more things you could do, like digital stuff for the citizens to make their routines easier when they need to reach the Stadt Köln?”

According to what I2 said about this reality, the Stadt Köln is at a low level regarding the digitization curve, mentioning that part of it happens due to the government regulation. The Stadt Köln already has some participation with the technology in the public services and, through their feedback, the improvements that still should be made are understood (Table 17).

Table 17 - Synthesis of the Response to Q12

Interviewee	Evidenced Answer
I2	“Your opinion is right. There are a lot of good services online but to be honest, in comparison to other European cities we are just really down, nearly to zero in this digitization curve. The main problem here – in Germany – we face a lot of governmental restrictions and not everything what we want to optimize is possible due to the legal aspects from the governmental side.”.

Source: Own elaboration.

In addition, the researcher pointed out a particular detail related to the question: “I have to say that I noticed some differences between Germany and Portugal, because even with this legal stuff, when you live somewhere and you need to talk with the Stadt of the city, they easily send you the documents and the information by e-mail in Portugal and, here it is everything by post. This also includes paper, so more trash and more recycling (...) here, I mean, they could also do it. But I guess it goes above your position, right?”

Regarding this topic, even though both interviewees know how flexible it would be to have more technology applied in the local services. They believed that the signing documents, the online conferences, and the data sharing are not entirely safe, as the main institutions do not know where it can be hosted, once it is transmitted online. Despite that, the Federal Law was mentioned as the leading cause of the situation (Table 18).

Table 18 - Synthesis of the Response to the complementary Question

Interviewees	Evidenced Answers
I2	<p>“The main problem is that the legal aspects specially the signing of documents. The only way of communicate correctly by signing something is doing a Fax and, a Fax is absolutely out of our future aspects. We have to really work hard on this ideas to create safe environmets for communication and for responding. We recognize that is a big problem here but due to our history and different legal powers and responsibilities – because of the several Federal States in Germany – is always different from Federal State to Federal State.”.</p>
I1	<p>“So, it is not easy to change the legislation and, on top of that, there are also requirements regarding the data protection. We are not allow to use usual Zoom Meetings or others, because we do not know where this data is hosted so it might be somewhere else and not in the german system, and that is why the Stadt Köln does not accept it. It is always an issue of legal requirements and safety issues. From our own board seems that we are slow and unflexible but it has a reason and in this case it is safety and security.”.</p>
I2	<p>“Just remembered, the Federal Government tried to do a survey on how many legal lwas we could change our way of signing and they identified nearly to 1000 laws but they changed only 23 or 24 out of nearly 1000. Here you can see that, that is the main problem. Even though we want to be more flexible or online or digital, because we know how easy it is to use Amazon and Paypal, we are stragling to use that on our business because we are not allowed to. But we are not alone in this field because we have to respect the Federal Laws.”.</p>

Source: Own elaboration.

Q13. What are the barriers or challenges to using technology for the initiatives associated to the Governance? How are those challenges overcome?

Concerning Q12 both interviewees mentioned key phrases (Table 19), making it understandable from their previous feedback (Table 17 and 18). Government Laws, safe personal data, different legal powers and responsibilities are the main setback to moving

forward with a more online cities digital service. However, the departments are focused on finding different solutions for future possibilities.

Table 19 - Synthesis of the Response to Q13

Interviewees	Evidenced Answers
I1	Q12: “(...) it is not easy to change the legislation and, (...), there are also requirements regarding the data protection. (...) because we do not know where this data is hosted (...) It is always an issue of legal requirements and safety issues. (...) From our own board seems that we are slow and unflexible but it has a reason and in this case it is safety and security.”.
I2	Q12: “The main problem here – in Germany – we face a lot of governmental restrictions and not everything what we want to optimize is possible due to the legal aspects from the governmental side.” “We have to really work hard on this ideas to create safe environmets for communication and for responding. We recognize that is a big problem here but due to our history and different legal powers and responsibilities – because of the several Federal States in Germany – is always different from Federal State to Federal State.”.

Source: Own elaboration.

Smart Mobility

Q14. What are the elements that constitute the mobility network? Does the Köln’s mobility network provide high standards of life quality?

I1 underlines that the mobility department of the Stadt Köln is well aware of that, and the past strategies do not apply anymore, resulting in different expected needs from now and in the near future. This is observed when the I2 refers to the accident occurred when trying to build a new tram line and to the history that the city possesses nowadays after years of destruction due to the II World War. Despite that, the I2 also mentioned that nowadays, the tram’s strategy is not suitable to the present, but back in the day, it was an innovative project (Table 20).

Table 20 - Synthesis of the Response to Q14

Interviewees	Evidenced Answers
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I1	<p>“The Köln’s mobility network is in transition to get better high standards of life quality. It is also not easy to change but the mobility department very well knows that requirements from today and for the future are different from the ones from the past. So, this monitorized transport focus is well on the agenda. It is also very hard to do this transition, to promote more cycling and walking, to use more public transports. They are doing this, this is exactly what the mobility department is doing and how the future of Köln looks like. It is also hard for people to accept that we take away their motoways or so, to build another line.”</p>
I2	<p>“Köln was really destroyed after the II World War and when they rebuilt it, the trams standard was up to the time, was really brilliant. We really learned that in international aspects is not as good as in other countries.”</p> <p>Line 1 → “Köln is very old city and specially the line 1 is very near to the very famous cemetery – taking a lot of underground space –, so there is some problems due to the history that the city carries with itself. We have to be in the surface just to keep the tram alive. That is the main reason why it is so difficult to build transport underground. At the moment, they are actually discussing about building the line 1 underground, for example, a tunel under the Aachener Straße. Not to mention the big Köln Archive Collapse, due to the new underground tram line project that included a tunel and which caused the huge tragedy.”</p>

Source: Own elaboration.

Although the town areas mentioned by the interviewees (Table 20) were not unfamiliar to the interviewer, it was necessary to carry out a short documentary research on the abovementioned cemetery – Melaten Cemetery – which is over two centuries old and the largest in town with over 55 000 grave sites (Melaten Cemetry, n.d.); and about the Köln Archive that collapsed in March 2009, in a tram construction accident. This accident resulted in the death of many people and in the destruction of historical documents (Cologne opens new city archive, 12 years after fatal collapse, n.d.).

Through the desk research, the researcher found out that:

(11) The Park Pilot Project, created by the RheinEnergie and the smart parking provider Cleverciti Systems, builded the most innovative and modern parking guidance system through the use of smart sensors, artificial intelligence and LED displays attached to lanterns, avoiding unnecessary traffic of people that are looking for a parking space (ParkPilot - that's how smart Nippes parks, n.d.).

(12) The e-buses, that have charging infrastructures builded by KVB, contribute to a better climate and environmental protection and provide a better living for the citizens (KVB is building charging infrastructure for 53 more e-buses, n.d.).

(13) The Car Sharing concept by Cambio, ShareNow and Miles brands is seen as the new option to drive around the city, and even though the SmartCity Cologne does not make it up, it integrates the city's improvements.

(14) The E-Scooters and E-mopeds by Tier and Dot are seen as the previous car-sharing services presented. They offer easy, accessible and affordable mobility for all the citizens. These initiatives – (13) and (14) – (5) Isi, (6) KVB-Rad and (7) GoFlux enable citizens to use Apps to book the service.

(15) Development (2018) understands that Köln has one of the most important railway hubs in Europe, with international high-speed rail links to Amsterdam, Brussels, London and Paris. The French high-speed train – Thalys – has reduced the commute to Paris to three hours, and the ICE trains run on the Cologne-Berlin, Cologne-Hamburg and Cologne-Munich lines every hour. By airway, three international airports can be reached near the Köln City: Cologne Bonn Airport, Düsseldorf and Frankfurt am Main.

Smart Environment and Smart Living

Q15. In what way did the initiatives carried out for the climate protection and energy transition contribute to an improvement in the population's life quality?

To make it a broader question and get more input, the researcher also pointed out the following: "I also would say the quality of the Rhein, also because of the boats, for example, that bring a lot of environmental issues to the city."

Both interviewees mentioned the importance of KPI's, so that they can measure the performance of the projects. The Climate Department has been making efforts in this direction. The I1 pointed out that citizens are influenced by environmental protection

actions and efforts to raise awareness about this topic. It is also possible to reach the citizens through the SmartCity Conference, where the students exchange their knowledge, and the citizens are questioned about what they want to do for the city (Table 21).

Table 21 - Synthesis of the Response to Q15

Interviewees	Evidenced Answers
I2	“From my point of view, what I can say is that our projects are working in KPI’s and we have no idea for now what KPI’s will be. We are thinking about that but maybe in an year we will have some results. But we are very aware of that!”
I1	“Regarding the KPI’s and climate protection the Climate Department is actually finalizing the status of Köln...People already have been influenced by the environmental protection or raising awareness. We don’t have figures right now, but I am sure we have been able to influence people to make them aware of what we do, to ask them which way we can improve. As I said before, it is people centered, so we try to interact and exchange with them. One way, for instance, is this SmartCity Cologne Conference or exchange with students or people. But we do not collect figures now, we will do it from next year on. Regarding the precise environmental issues, for instance.”

Source: Own elaboration.

(16) The Shore Power Project – clean and silent, its main aim is to provide municipal and 100% renewable "shore power" to ships that are moored in the Rhein river and that can now use this service from the Stadt Köln instead of the diesel engines (Möhlendick, 2017).

(17) Visdom is a software that informs the citizens about the course and effects of an approaching flood or heavy rain (Visdom software visualizes complex flood scenarios, n.d.). The municipalities also make decisions related to disaster protection plans, structural measures for flood protection and evacuation plans (Visdom, n.d.).

(18) The StEB Water Risk Check provides citizens with specific data on floods, groundwater and heavy rain, and the appropriate recommendations for countering it. It is also helpful to prevent the city from suffering more substantial impacts from climate change.

Both projects – (17) and (18) - have been an official SCC project since November 2021.

(19) The Stadt Köln owns a wide range of parks across the city, offering around 50 green spaces where citizens and animals can coexist (Parks and Gardens, n.d.).

Once the mentioned GrowSmarter initiative aimed to reduce the gas emissions, and increase the share of renewable and efficient energy, it worked on the low energy of the heating facilities, on the integration of infrastructures. At the same time, the city expands, such as smart street lighting and big data management, and on the sustainable urban mobility with alternative fuel driven vehicles. Despite that, this project also enables the inhabitants of the Mülheim neighbourhood to power their electricity from the grid or consume it themselves, as they can also use electric vehicles – bicycles, or conventional vehicles – which are provided to the residential area for sharing. The Ford, Talako, Isi, KVB-Rad, ParkPilot, E-buses, Car Sharing and, E-Scooters and E-Mopeds contribute to the improvement of the environment as well, through their technologies’ application.

Q16. As you work with educational partnerships, is there any contribution from you to these institutions? If yes, which one?

As through the Q9 and Q15, the I1 mentioned key phrases, making it clear that there is a link with the student body made of meetings or internships, enabling the interaction and exchange of knowledge, concepts, solutions and new perspectives with them (Table 22).

Table 22 - Synthesis of the Response to Q16

Interviewee	Evidenced Answer
I1	<p>Q9: “(...) to have this exchange and we do have cooperation projects, for instance a small speech and interns from Köln’s Universities.”</p> <p>Q15: “(...) so we try to interact and exchange with them(...) or exchange with students (...)”</p>

Source: Own elaboration.

Smart Cities Dimensions

Q17. From the six Smart City Dimensions – Economy, People, Governance, Mobility, Environment and Living – which one(s) do you consider to represent the biggest weakness? What are the (new) projects that you intend to develop to improve that situation?

The interviewee – I1 – says that the governance dimension is the one that needs to be worked on the most, in Köln (Table 23). The reasons that drives I1 for this choice were addressed in the questions related to the governmental dimension – Q12 and Q13.

Table 23 - Synthesis of the Response to Q17

Interviewee	Evidenced Answer
I1	“I would say Governance. Yes, it is the Smart Governance where we have the biggest issues to tackle.”.

Source: Own elaboration.

9 Discussion

This study aims to understand the role of open innovation in smart cities and observe in which dimensions it has more impact in the city of Köln.

The research questions will now be answered and discussed, considering the results presented above.

RQ1: What is the impact of Open Innovation on Smart City Köln through the Smart Economy dimension?

It was found that technology will transform cities not only at the current time but also in the future, considering the current jobs and those that will eventually be created. The need for human capital, regardless of the scale of technological evolution, is always a factor to be considered because it also makes it possible to create new jobs. Apart from the mentioned direct impact on citizens, the relationship with international partners will bring changes at a business level. Through them, several initiatives have been carried out by SmartCity Cologne. As mentioned in Q5, in all three projects – (3), (4) and (5) – there is evidence of a commonality: access to international partners, with end goals for the three different projects - output resulting in the vehicles provided in the three projects and finally funding and knowledge sharing through the Horizon 2020 Programme (1). The SmartCity Conference – (2) – has a moment of greater visibility that may attract the attention of international entities, both financially and in terms of knowledge.

To create space for a more open innovation-oriented approach and validate the characteristics mentioned in the literature (Khan et al., 2022; Paskaleva & Cooper, 2018; Hauser et al., 2017). Köln has made efforts to adopt and implement these environments in many areas with different individuals and with effects at the level of citizens, business

dynamics, transformation and competitiveness of the city globally, where stakeholder's inflows and outflows are established (Chesbrough et al., 2006).

RQ2: What is the impact of Open Innovation on Smart City Köln through the Smart People dimension?

As mentioned in the interview, the open innovation brought to climate protection and energy transition a place for new jobs – focused on people and more technology – and, consequently, a different dynamic in the citizens' qualification level, also due to the technology applied on it. This reality reinforces that well-informed people committed to retaining more knowledge enable the development of innovations in different areas (Esposti & Ciofalo, 2020). Hauser et al. (2017) state that smart citizens are the most relevant dimension, since they are the main actors in building a SC. The interviewees in this study prove that their actions regarding the exchange of knowledge with the international network, with the young net through the universities and with projects that encourage the sharing of citizens' needs and ideas, make them the centre of the dynamics, which is in line with the principles of Hauser et al. (2017) and Giffinger et al. (2007). The same is the case for the Talako project, which was guided by the University of Duisburg-Essen and the University of Wuppertal, among others. As this one, the SmartCity Conference, and the already mentioned projects by the interviewees – (9) Project Cologne and (10) UnBox – prove that Stadt Köln and SmartCity Cologne have combined efforts and established strategies to reach out to the community, portraying themselves as an inbound OI approach (Chesbrough et al., 2006; Huizingh, 2010; Mazzola et al., 2012). This led them to establish contact with the city's environment, bringing new insights and not just reaching them to deliver the services but also to help to (co)produce them, as stated by Paskaleva and Cooper (2018). Hernández-Dionis et al.'s (2022) and Reddy's (2014) perspective are also represented by these actions that make use of external knowledge and creative ideas to transform the city, making citizens and other stakeholders the “backbone” of the SC innovations (S&C Research Team, n.d.).

RQ3: What is the impact of Open Innovation on Smart City Köln through the Smart Governance dimension?

As mentioned by the interviewee – I2 – “the Stadt Köln is at a low level when it comes to the digitization curve” (Table 17), which results in the delay in the implementation of more up-to-date and digital methods. Interviewees pointed out that this situation is due to

Government Regulation and Federal Law. However, there is a willingness to improve, “not everything what we want to optimize is possible due to the legal aspects from the governmental side” – stated by the interviewee (Table 19). Based on the studies of Hauser et al. (2017), the smart governance uses ICT to enable the community to interact with the government. This, together with the efforts of the Stadt Köln, means that there is still a long way to go so that public services can be better delivered to the community and participation in the decision-making process is favoured. The collaborative innovation shows precisely that, a “multi-actor network” that leads to a “more effective and innovative public services which will provide greater levels of citizen and community satisfaction” (Paskaleva & Cooper, 2018, p. 5). It should be noted that, although the ParkPilot project makes use of advanced technologies, it also highlights the “strict data protection guidelines” – no pictures of people or vehicles (ParkPilot - that's how smart Nippes parks, n.d.) – as mentioned in the interview when analysing the Köln Governance situation, the regulation is very strict when it comes to what is accepted or not by the law.

RQ4: What is the impact of Open Innovation on Smart City Köln through the Smart Mobility dimension?

About local accessibility, the interviewee – I2 – stated that they were “in transition”. This confirms that the city's connections could be improved. The same interviewee pointed out that the city is aware of the requirements of the past, the present and the future, and that these do not appear to be the same, so the challenges will be different. Still, on local accessibility, security is mentioned by Giffinger et al. (2007) as one of the factors to be considered. The strategies under consideration by the Stadt Köln showed, in 2009, that they did not meet this requirement at the time of the accident at the Köln Archive Collapse, due to the new underground tram line project that included a tunnel. Therefore, studies on future planning must be given extra attention, so that situations like those that happened in the past will not repeat.

These last innovative transportation possibilities – (5) Isi, (6) KVB-Rad, (7) GoFlux, (11) ParkPilot, (12) E-buses, (13) Car Sharing and (14) E-Scooters and E-Mopeds – focus on the current challenges: safety means, mobility transition and climate. The same holds for the evidence of Giffinger et al. (2007), when innovation has been put into practice through applying technologies. The initiatives mentioned above can work due to the ICT that

connects the company to the people – via App. Some of the projects – (4) Talako, (11) ParkPilot, (12) E-buses – are perceived as a collaborative innovation that shows up to be made of a “multi-actor network” (Paskaleva & Cooper, 2018, p. 5), where the opportunities from the university were taken into consideration. It represented the potential growth and cultural innovation of the city (Khan et al., 2020), implementing new technologies and re-creating new business, according to Tukiainen et al. (2015). The inter(national) accessibility – mentioned by Giffinger et al. (2007) as one of the revealing factors for the mobility dimension – of Köln has broad coverage due to the various accesses enabling connection with international entities, providing a more robust engagement with the abroad countries.

The correlation between the different partners and contributors to the projects mentioned shows the “mutual commitment relationship from the level of value creation, through external openness to its capture” (Turon, 2022, p. 2).

RQ5: What is the impact of Open Innovation on Smart City Köln through the Smart Environment dimension?

Besides the initiatives mentioned above bringing results to the mobility dimension, they are also reflected in the environment dimension because the dynamics are directly related. Finding a balance between the hardware and software factors leads to combining and adjusting the infrastructures, technologies and economy with the human resources and dynamics intended to have a place (Esposti & Ciofalo, 2020).

Therefore, initiatives that influence the mobility of the city express advantages for citizens with smoother journeys, a climate-neutral approach that is quieter and cleaner than the conventional means, which reflects in green mobility, enabling more sustainable resource management and reduced pollution (Giffinger et al., 2007). Many parks in Köln contribute not only to those mentioned above, but also to the attractiveness of the city’s natural conditions (Giffinger et al., 2007).

As the GrowSmarter project was also putted into practice in other two cities, regards energy, infrastructure and transport enables the sharing of risks, achievements and developments to be shared between them, relating to what Nambisan et al. (2018) argue; finally, the Shore Power project enables less noise, better air for crews and city residents, as well as reduced CO2 emissions (Möhlendick, 2017).

These approaches align with Esposti and Ciofalo (2020) findings on contributing to the reduction of atmospheric contamination, in this specific case, the Köln city. Despite that, the interviewees mentioned that they do not have any tool to measure the project's impacts. However, they are working on KPI's for the future, enabling the Stadt Köln to have a precise analysis of their actions, promoting a change in the "usage, management and application of intellectual property", as stated Fernandes et al. (2019, p. 579).

RQ6: What is the impact of Open Innovation on Smart City Köln through the Smart Living dimension?

Based on the study of Giffinger et al. (2007), it was possible to identify that housing quality was taken into consideration at the time when two tools in Köln, emerged – (17) Visdom and (18) The StEB Water Risk Check. In this way, faster decisions can be made according to the situation, putting security as one of the main elements.

The importance of individual safety, mentioned by Giffinger et al. (2007), is covered by the several initiatives that also contribute to the environment and the mobility dimension since they not only have the perspective of making the city better by a single goal. It also interconnect each area to the others, that supports Radziwon et al. (2022) literature.

With a supportive perspective of Paskaleva and Cooper (2018), cities are looking forward to applying open innovation approaches and new technologies to build a SC with better services for the community. As this study proves, the cities and their own elements have to work in different directions, making all of them be linked to each other, considering the jugaad innovation (Radziwon, 2022). As Fernandes et al. (2019, p. 579) mention, "the change in the usage, management and application of intellectual property", and the input of intellectual property oriented to technology and research impact the industries, consumers, and society. However, as seen in Köln, some of the dimensions are more advanced than others, such as strongly developed mobility that directly influence people and environment. At the same time, the lead on legislation remains in the hands of higher authorities. This restricts municipal actions and, in part, conditions the evolution of other dimensions, for example, the people dimension.

In conclusion, it is essential to consider all the dimensions and the respective factors mentioned to understand the performance of the dimensions and their separate initiatives. This monitoring should be constant and frequent, enabling the discovery of new initiatives and the optimisation of those already implemented to improve the strategies

and the projects' performance. The results obtained in this thesis project converge with the theories analysed and defended by several authors in this study.

10 Conclusions

10.1 Final Remarks

The empirical study of the Köln city reveals directions and new ways of action for the transformation of a city into a smart city. The theoretical foundation is confirmed, as well as the primary research question: How the impact of Open Innovation can contribute to a Smart City – Köln?

The OI application in the city brought essential changes to move towards the construction of a smart city, prioritising the union of economy, people, mobility, environment and living, enabling a more cohesive evolution of the six dimensions.

The data reveals that Köln has taken actions to improve the various city branches, using open innovation both nationally and internationally, encouraging the exchange of knowledge and funding. The importance of the people who inhabit the city is highlighted, since it is by them that improvements are made. In that regard, their opinions have been increasingly taken into account and the ongoing research to find out more about what people want the city to do has grown. This means that efforts are focused on the end result – meeting citizens' needs – such as creating strategies to gather the citizens' opinions.

Although the changes made by the city are recognised, the knowledge that communication can be done from the bottom up is still poorly disseminated and, therefore, the process from root idea to the final result is relatively time-consuming.

The results demonstrate that the city has some barriers when establishing new strategies, as governmental and legislative entities have power over specific issues that cannot be avoided because the citizens' data and their protection, for example.

10.2 Theoretical and Practical Implications

The implications at the theoretical and practical levels are evident in this study.

There are studies concerning OI and other study domains. However, the same is not found in the relation of open innovation with smart city, where a lack of studies devoted to analyse the role of open innovation in the development of smart cities can be found. This research thus fills gaps in the literature in this field.

This study adds value to open innovation's contribution, filling the knowledge gap on the strategies that the cities can adopt to become a SC.

This study and its results are crucial for practical recommendations and understanding the actions of the Stadt Köln, SmartCity Cologne and citizens. It provides a forward-looking perspective on how to define strategies, and support networks in knowledge and finance, captivating other countries to take a step towards change. From citizens to entrepreneurs and city representatives, this study provides know-how on the added value that these initiatives implemented in cities brought in the long term to build a smart city in the six areas Giffinger et al. (2007) state. This helps to provide and understand that smart cities can be used as a tool not only to improve the citizens' life quality, but also to improve the environment's quality and to slow down or even suppress the damage that the human actions have been causing on the environment.

10.3 Research Limitations

At the final moment of this research, it is intended to outline some limitations encountered throughout the study.

One of the initial limitations is the small number of key persons interviewed. Challenge of the German language and the distance from the necessary networks for the study have limited the dynamics of the research.

Another limitation was that the results of this study were confined to the studied organisation and, therefore, cannot be generalised to the whole range of German municipalities. The characteristics and challenges of the Stadt Köln will not be the same as in another city. It follows that the theoretical generalisation of the results cannot be transferred. Therefore, adaptation should be taken into account for the realities and needs of each location concerned.

10.4 Future Research Lines

As well as the limitations mentioned, here are some recommendations and suggestions for future research.

On that account, it would be interesting to see multiple case studies carried out in German municipalities. This would allow observing the problems and strategies that each one has, aiming to achieve a positive final result.

It would be highly suitable to extend the case study to other participants, using other methods to collect the intended data, such as applying questionnaires to several municipalities.

As for recommendations for future research on the same topic, it would be interesting to carry out cross-culture studies. This sort of study would make it possible to observe across borders what two or more cities from countries with different characteristics can do to build a SC.

Another suggestion for future research, but not less relevant, would be to add to the research model-new constructs, such as the role of startups, the contribution of creative industries, the application of technologies in the processes, and the analysis of how these concepts add value and impact in SC.

Finally, for future research, it would be interesting to observe the performance of AWB, which offers its waste disposal services, for the best disposal solutions for Köln and its citizens.

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Appendix – Interview Script

Name:

Place:

Date:

Interviewee's name:

Position in the organization and years of service:

Socio Demographic Characterisation

Q1. When was SmartCity Cologne established?

Q2. What is the legal form of the organisation? And the main founders?

Smart Economy

Q3: In what way do climate protection and energy transition contribute to a Smart Economy?

Q4. Concerning Smart Economy, is there a chance that a strategy applied in another city, could be redesigned for Köln?

Q5. Does SmartCity Cologne have international partners? If so, what economic competitive advantage do these partnerships bring to the Köln?

Q6. Are the partnerships established more of a financial or knowledge character?

Smart People

Q7. How can climate protection and energy transition impact on Human Resources qualifications?

Q8. The referred international partnerships, can enhance Smart People? Through which projects/activities?

Q9: Are knowledge partnerships important for Smart People? In what levels?

Q10. How are the citizens involved in the projects?

Q11. As the stakeholders/participants can be diverse – people, civil society, business organisations and business initiatives –, how does the first approach come out? Top-down or bottom-up approach?

Smart Governance

Q12. Has the technology applied in the local services contributed to a more sophisticated organisation and a more efficient service for citizens?

Q13. What are the barriers or challenges to using technology for the initiatives associated to the Governance? How are those challenges overcome?

Smart Mobility

Q14. What are the elements that constitute the mobility network? Does the Köln's mobility network provide high standards of life quality?

Smart Environment and Living

Q15. In what way did the initiatives carried out for the climate protection and energy transition contribute to an improvement in the population's life quality?

Q16. As you work with educational partnerships, is there any contribution from you to these institutions? If yes, which one?

Smart Cities Dimensions

Q17. From the six Smart City Dimensions – Economy, People, Governance, Mobility, Environment and Living – which one(s) do you consider to represent the biggest weakness? What are the (new) projects that you intend to develop to improve that situation?