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The smart city service ecosystem:
Co-creation of value through alliancing-enabled resource integration

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Submitted for the award of **Doctor of Philosophy** in **Management in Construction**

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Abstract

The detrimental effects of rapid urbanization have led to the urgent need to reconstruct how cities operate and utilize resources. Smart cities have emerged as a possible solution towards more efficient urban environments. They are considered imperative for a sustainable future and have consequently evolved into a multibillion industry. While there is a plethora of research focusing on the technological and urban aspects of smart cities, there is a dearth of literature on the organisational and managerial issues arising by this rapidly emerging concept. Particularly, there is an identified gap in how and why smart city stakeholders collaborate between each other, leading to a restricted understanding of the mechanisms of value co-creation in smart cities. Via the lens of the service dominant logic, with a focus on resources, this research studies how diverse actor groups collaborate and integrate resources in order to deliver smart city projects -typically publicly funded multi-actor consortiums and alliances-. More specifically the research questions of this thesis is: how do actors within project alliances exchange and integrate resources to co-create value and what factors influence their interactions in the process of resource integration?

This thesis is based on empirical evidence collected through qualitative interviews with 60 senior staff from representative organisations from all actor groups across 80 smart city projects. These were used to map the dyadic and triadic interactions that occur between organisations within the smart city ecosystem, that serves as a stepping stone towards responding to the research question.

Findings of the study demonstrate the main resources exchanged within the smart city ecosystem, as well as the institutional arrangements that govern these exchanges and the strategic goals and intentions that underpin them. As value in smart cities is most commonly co-created in alliances, this study further focuses on the intricate dynamics between actors and their resource integration mechanisms. The theoretical contributions of these findings appertain to proposing the notion of quality of interactions as a determining factor of smart

city ecosystem wellbeing, identifying critical resources and their contribution in creating opportunities of future value -future value propositions- and examining their accessibility, and introducing the service sub-ecosystem as level of analysis for the alliances. The practical contributions provide evidence-based guidance for the effective management of smart city organisations and consequently lead to managerial and organisational urban innovation, eventually leading to the improvement in citizen well-being and quality of life.

Impact Statement

This thesis parted from the premise of understanding the value co-creation mechanisms in the smart city service ecosystem and was guided by the foundational premises of the Service Dominant Logic (SDL). The smart city sector is a multi-billion dollar industry at its infancy. The European Commission alone has assigned a budget of nearly one billion euros on smart city projects, for the period 2014-2020 (European Commission, 2013), while the wider smart city market is expected to exceed 2.5 trillion by 2025 (PWC, 2019). The goal of these smart city projects is to provide innovative solutions to long-existing urban problems that have been negatively affecting the quality of life of citizens, such as transportation and traffic, waste management, parking and citizen safety. In order to comprehend these value co-creation mechanisms, I studied how smart city actors interacted between each other in the form of alliances and how they exchanged resources between each other, through qualitative interviews with senior staff from representative organisations. Studying the way in which the resources are exchanged is crucial in order to understand the intricate mechanisms of value co-creation, which are enabled by convoluted interactions founded on individual benefit creation. Simply put the description of how and why the interactions occur for each resource allows for observing the motives of the actors behind the exchanges, what resources they offered to the project in return and the barriers and enablers in their process of exchange.

The theoretical contributions of the findings of this research appertain to proposing the notion of quality of interactions as a determining factor of ecosystem wellbeing, identifying critical resources and their contribution in future value propositions and examining their accessibility, and introducing the service sub-ecosystem as level of analysis for the alliances. As the service dominant logic is a rapidly evolving theory with increasing popularity amongst both academics and practitioners these findings will provide much needed conceptual clarity in the under-researched field of alliancing. The practical findings of this study provide evidence-based guidance that will contribute to a better understanding of how smart city managers can maximize the public value created via smart city projects and allocate resources more efficiently to respond to the challenges that arise in the process of urban innovation. These findings can lead to significant reduction of public spending, improvement of public urban services and improvement of the quality of life of citizens.

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1 Introduction

The world is facing unprecedented levels of urbanization (Dirks and Keeling, 2009). While currently 57% of earth's inhabitants live in urban areas (Statista, 2024), this is expected to rise to 68,45% by 2050, meaning that approximately seven out of ten people will be residing in cities (UN, 2018). Even though cities occupy just 3% of the Earth's land, they account for 60 to 80% of energy consumption and 75% of carbon emissions (UN, 2020). Cities are already facing numerous issues that are bound to increase due to rapid urbanization.

As a result of this rapid urbanization, cities are expected to experience challenges related to growth, performance, competitiveness and residents' livelihood (McKinsey & Company, 2013). Deterioration of citizen well-being related to challenging waste management, scarce resources, air pollution and traffic congestion, cause human health concerns. These, in addition to aging public infrastructure, are some of the main problems generated by rapid urbanization (Washburn et al., 2009). Other issues are of social and organisational nature, such as multiple stakeholders, increased interdependence levels, competing values and social and political complexity (Yovanof and Hazapis, 2009). Nam and Pardo (2011) identify these problems as wicked and tangled. The concept of smart cities has been identified as a solution to address issues related to sustainability, resource management and urbanisation challenges (Bibri et al., 2024). As wicked and tangled problems are social, political and organisational, smart city innovation strategies must focus on management, policy and technology (Nam and Pardo, 2011). In this thesis, I focus on issues of management of smart city projects.

1.1 Background and motivation

Few studies address the organisational and managerial issues of smart city (Chourabi et al., 2012), as literature most frequently focuses on the use of technology to enhance urban dimensions (Allam et al., 2022). Following 25 years of systematic research on smart cities, at this stage the current fundamental requirements for establishing future smart cities have been identified as interoperability, scalability, fast deployment, robustness, ecological friendly and efficiency and multimodal access (Javed et al., 2022). Specifically, interoperability, scalability as well as efficiency in resource management, are essential to support the integration of advanced technologies and data driven systems in the city's infrastructure (Bibri et al., 2024). All of these issues are of organisational nature and are less relevant with technology (a well-researched element of smart cities) and more related to how these technological advancements are being managed. There is an evident gap in the literature in the management of public value in smart cities (Timeus et al., 2020). In the context of smart cities public value may be described as efficiency-related value (cost reduction related), effectiveness-related value (improving services related) and societal challenges-related value (Barrutia et al., 2022). In smart cities, public value is being created through collaboration amongst different stakeholders (Neumann et al., 2019). Nonetheless, despite collaboration between the foundational enabler of smart city projects -and public value creation- since their inception and early adoption, there is still a lack of literature on the factors that affect collaboration amongst smart city stakeholders and on the characteristics of the smart city collaboration ecosystem (Clement et al., 2022), as well as a lack of literature in comprehending the perspectives of diverse stakeholder groups (Marrone and Hammerle, 2018). In other words, there is a gap in how and why smart city stakeholders collaborate between each other, leading to a restricted understanding of the mechanisms of value co-creation in smart cities. A particularly useful approach to study and deeply understand these, is the service dominant logic (SDL).

1.2 Aims and objectives of this thesis

In order to comprehend the mechanisms of value co-creation by collaborating stakeholders in smart cities, it is necessary to study in depth the nature of service, as a notion that brings processes or systems together (Chandler and Lusch, 2015). This thesis studies these mechanisms of value creation guided by the foundational premises of the Service Dominant Logic (SDL), a service centric theory that provides an advanced market understanding. It demonstrates how complex (often socially constructed) resources are integrated in a specific market space, to create value via collaborative practises. In SDL terminology, stakeholders are viewed as actors, while value is not created by a stakeholder and clearly measured but rather co-created collaboratively, but perceived individually by the actor that is on the receiving end (beneficiary). Consequently, having identified the research gap in the literature related to the management of smart cities and principally the lack of studies on mechanisms for the realisation of value in smart city projects, this research studies how actors interact and integrate resources between each other via the lens of the Service Dominant Logic (SDL). This novel approach will allow researchers to identify how the smart city ecosystem co-creates value through actor interaction and resource integration, thus contributing to the optimisation and efficient management of cities and their resources.

The empirical findings of this research aid in providing a better understanding of the under-researched role of value propositions in the service ecosystem (Frow et al., 2014) and how these are enabled through strategic resource integration processes between actors. They provide a novel perspective on the outdated innovation literature largely rooted to technological product inventions, which is based on a goods-dominant logic paradigm (Michel et al., 2008). This is because viewing innovation through SDL allows for the emphasis to shift from the created goods or services themselves, to the actual processes of developing service (Edvardsson and Tronvoll, 2013). The practical findings of this study can eventually contribute to a better understanding of how smart city managers can maximize the public value created via smart city projects and allocate resources more efficiently to respond to the challenges that arise in the process of urban innovation. This can eventually lead to a potential mitigation of managerial and policy related aspects of future arising challenges related to urbanization.

1.3 Structure of the thesis

In order to present a comprehensive, detailed and critical review of the literature, the literature review is comprised of three chapters. This thesis starts from setting the context of smart cities by investigating what the term entails. The next chapter is an introduction to the service dominant logic, followed by a chapter on how smart cities can be studied through its lens. Following the conclusion of the literature review, I present the research question of this thesis which is built by the gaps and shortcoming identified in the literature review. Then the research methods that underpin this thesis are presented, followed by the findings and the discussion. The discussion is divided in two parts, one regarding the findings on resource exchanges and one that builds on the most significant resources in smart cities technology, intellectual property and data. Subsequently, I present two separate chapters on theoretical and practical implications, corresponding to the two parts of the discussion. Finally, I present my concluding remarks in chapter 11.

Parts of this thesis have been published in two peer reviewed journal articles. The first journal article regards the role of sustainability in smart city definitions at the Journal Frontiers in Built Environment (Toli, A.M. and Murtagh, N., 2020. The concept of sustainability in smart city definitions. Frontiers in Built Environment, 6, p.77.), while the second one is on co-owned resources and intellectual property and data in smart cities, published in the Journal of Service Theory and Practise (Toli, A.M., Murtagh, N. and Smyth, H., 2022. Co-owned resources: IP and data in smart cities. Journal of Service Theory and Practice, 32(2), pp.156-178.). In addition to these journal articles I have contributed to the following peer reviewed articles:

- Walletzký, L., Carrubbo, L., Badr, N.G., Dragoicea, M., Toli, A.M. and Badawi, S., 2023. Reconfiguring the service system for resilience: Lessons learned in the Higher Education context. Journal of Business & Industrial Marketing.
- Drăgoicea, M., Walletzký, L., Carrubbo, L., Badr, N.G., Toli, A.M., Romanovská, F. and Ge, M., 2020. Service design for resilience: A multi-contextual modelling perspective. IEEE Access, 8, pp.185526-185543.

2 Smart Cities

Today more than 50% of the world's population resides in cities, while by 2050 it is estimated that this percentage will rise to 70% (World Bank, 2022). This implies that 2.4 billion people will be potentially added to the global urban population. Consequently, this will inevitably result in a significant expansion of existing urban environments and lead to the need to create new ones. The United Nations Environment Programme (UNEP, 2018) estimates that the material consumption related to cities will augment to approximately 90 billion tonnes by 2050 compared to 4 billion tonnes in 2010, creating significant challenges.

The concept of smart cities appears to address these issues related to sustainability, resource management and urbanisation challenges (Bibri et al., 2024). It gained popularity in the early 2010s as a solution to managing urban resources more efficiently and addressing sustainability issues related to growth and since then has triggered policy-making processes particularly in the smart transport and smart energy aspects (Angelidou et al., 2022). While sustainability has been the original goal of smart cities, through examining smart city definitions it is evident that the concept has gradually evolved to encompass an umbrella of goals. There is an abundance of definitions of smart city in the literature, many of which are diverse in nature. Their diversity ranges from what elements a city needs to encompass to be deemed as smart, to what resources it needs to employ, what characteristics it needs to present and what are the smart city's goals, purpose and scope. This diversity and lack of clear understanding of what a smart city is and how it can be defined, makes the assessment of the effectiveness and impact of the smart city focused activities, challenging (Marchesani, 2023) and thus undermining the potential of value creation through such activities.

While the term is increasingly being used in a variety of sectors, this plethora of smart city definitions has led to confusion amongst urban policymakers, working on establishing public policies to enable the transition to smarter cities (Albino et al., 2015). This transition is considered as essential by policymakers and is reflected in the establishment of the 11th UN Sustainable Development Goal (SDG) “Sustainable Cities and Communities”, aiming on making cities inclusive, safe, resilient and sustainable (UN, 2018). Despite these types of policies being conceived in global leadership summits, the local governments are the ones that bear the responsibility for their implementation (Allam et al., 2022). In general, local governments are considered more equipped to respond to the SDGs as they have higher potential for sharing information, learnings and knowledge and formulating custom policies that targeting local challenges (Leavesley et al., 2022). The European Commission alone had assigned a budget of nearly one billion euros on smart city projects, for the period 2014-2020 (European Commission, 2013). As part of European Commission’s ongoing funding streams, Horizon 2021-27, climate-neutral and smart cities are one of the key five mission areas (European Commission, 2021). As smart cities are continually becoming more prominent, the confusion in their scope is becoming increasingly alarming and will have effects on the creation of public benefit and value. Moreover, as increased efforts for a diffused adoption of smart city initiatives are evident in the UN SDGs, issues arise related to the way in which the smart city concept, which is developed in the Global North, is been imported to the Global South (Pratama et al., 2023).

This chapter aims to provide an in-depth understanding of how smart cities are defined as well as the goals they strive to achieve. These goals subsequently become the objectives of funding streams of smart city programmes and projects. The chapter starts from a summary of the smart city actors and their goals, a review of how smart city literature has changed in the past years and an example of a smart city project. The following sections include a comprehensive literature review of smart cities that includes studies from 2010 to 2019, with a particular focus on identifying their connection to the parting goal of smart cities, which to become more sustainable. Understanding which are the goals of a smart city is a stepping stone towards comprehending the goals, and needs -such as resources and skills- to achieve such goals, of smart city projects and the actors that deliver them. Furthermore, these goals act as a motivating aspect of smart city actor groups thus influencing their actions and consequently the value co-creation process. Subsequently, the analysis below presents the findings in respect to each actor group (academia, industry government).

2.1 Smart city actors and how they affect smart city goals

In order to comprehend how smart cities are defined and their strategic goals, it is essential to comprehend which are the actor groups that operate in smart cities. Numerous authors identify three main organisational and institutional actors in the smart city: universities, industries and governments (Cocchia and Dameri, 2016). This has inspired the triple helix model (Etzkowitz and Leydesdorff, 1995; Etzkowitz and Zhou, 2006; Leydesdorff and Deakin, 2013) of smart city actors, which evolved into a quadruple helix by building Parsons' theory by acknowledging civil society is one of the key actors (Parsons, 1963). Nguyen et al. (2022) further conceptualises this quadruple helix as a smart city collaborative ecosystem defined by a set of arrangements between actors with different sources of power. This advanced model considers the helix with its four strands to operate in a complex urban environment, where the interrelations between universities, industries and the government are formed by civic society and social capital (Lombardi et al., 2012). Universities analyse and define the fundamental aspects of the smart city concept and develop intellectual capital (Leydesdorff and Deakin, 2013). Industry translates the academic outcomes into products and services. The fundamental target of the industry is to create knowledge value, while in the meantime it also produces public wealth for citizens. There is a continually increasing number of industrial actors developing smart city technologies (OECD, 2020). Numerous industrial actors in this sector are hybrid organisations, which undertake commercial activities with a socially oriented approach and social focused goal (Battilana & Lee, 2014). Finally, governments, both at a national and a local scale, are both players and coordinators of the initiatives. As governments are the owners of the urban infrastructure, the long-term transformation to a smart city requires extensive governmental support in order to upgrade this infrastructure (Silva et al., 2018). They need to play a fundamental role in defining standards and issuing rules. The coordination between the different scales of government (national, regional, city level etc.) is considered essential for a city to function in an innovative way (Nam and Pardo, 2011b). However, city level government is considered more nimble and innovative and thus are more likely to adopt transformative actions, especially regarding sustainability related issues (Masuda et al., 2022). At the same time, the government also monitors and evaluates the value and benefits created by the organisations. There are contradictory opinions regarding whether intelligent technologies can indeed improve public sector efficiency, as while some appear to be optimistic, others highlight a need for complete restructure of public services (Angelidou et al., 2022).

Civic society is considered the fourth helix. Apart from the users of the urban environment, citizens are also the main generators of data through their daily activities (Nesti and Graziano, 2020). The engagement of civic society in smart city initiatives is considered essential (Batty et al., 2012). However, ICT enabled government-citizen collaboration for urban sustainability is considered rare and is typically a one-way interaction (Allam et al., 2022). The involvement of civic society along with social and capital endowments, in theory frames the relationship between university, industry and government (Lombardi et al., 2012). Although the quadruple helix model is quite popularised in smart city literature Borghys et al. (2020) notes that in practise, cities prefer working in the triple structure (government, industry, academia), as it is more comfortable and less risky, systematically excluding the citizens from the collaboration process (Nguyen et al., 2022). Cocchia and Dameri’s (2016) research on each actor’s vision of the smart city reveals that on the surface the actors appear to share the same vision of a new way to understand future cities (Lombardi et al., 2012). This is the vision of a city economically and environmentally sustainable and socially inclusive (Zygiaris, 2013), while at the same time improving the quality of life of its inhabitants (Chourabi et al., 2012). Nevertheless, in depth analysis shows that each actor has diverse targets that directly influence their vision, and that smart city initiatives are not always as citizen focused as they appear to be (Cocchia and Dameri, 2016).

2.2 Changes in the literature throughout the years

Systematic research on smart cities started in the early 2000s, (Allam et al., 2022; Kim, 2022; Park and Yoo, 2023) and throughout the years, it has gradually evolved. Until 2015, the literature focused extensively on how IoT (Internet of Things) and Big Data technologies can be used to improve environmental sustainability, with a focus on transport, mobility, energy, waste, pollution control, air quality, and planning (Bibri et al., 2024), in conjunction to economic growth (Park and Yoo, 2023). The concept had started gaining momentum as ground-breaking documents, starting with the Paris Agreement, The Sustainable Development Goals, and the New Urban Agenda, were published and many cities had started to embrace different aspects of the concept (Allam et al., 2022). Between mid 2010s and 2022 there was an increase in accelerated digitalisation and decarbonisation agendas and a rapid advancement of data driven technologies (Bibri et al., 2024). In the first five years, smart city publications increased exponentially due to a more diffused acceptance of the concept and the increased interest of Internet of Things (IoT), Big Data, Artificial Intelligence and Blockchain technologies in smart city research (Allam et al., 2022). Smart city services were under development but were still neither fully operational, nor could be described as profitable (Kim, 2022). Post 2020, there was a shift in smart city literature, prompted by COVID-19 (Dwivedi et al., 2022). The COVID-19 pandemic has triggered an increase in the development and launch of hardware and software related to safety and IoT infrastructure (Gade and Aithal, 2021). It additionally allowed for smart city technologies related to social wellbeing and crises management to gain recognition, due to the obligatory shift of citizen activities to digital platforms (Megahed and Abdel-Kader, 2022). More importantly, the pandemic led to a renewed attention to resilience and urban recovery planning (Strielkowski et al., 2022).

The change in the priorities of implementation of smart city projects are related to a demand for faster implementation of smart technologies in work related processes and deployment of smart city related initiatives to combat the pandemic (Kuzior et al., 2022). Published research post-COVID prompted aspects such as sustainability, economic growth, mobility, and resilience of communities, to gain popularity (Allam et al., 2022). Multiple studies focused on exploring the correlation between COVID pandemic response efficiency and smart cities (Ciasullo et al., 2020; Pratama et al., 2023; Troisi and Grimaldi, 2021) with conflicting results. While urban life has returned close to its previous state, the aftermath of the pandemic in the urban environment is expected to have longer lasting effects (UIA, 2023). Currently, according to Angelidou (2022) future trends for smart cities are expected to be shaped as follows: citizens are recognised slowly as the drivers and actors in smart city initiatives and not just the recipients; there is an expected growth and concentrating of the smart city market with industrial partners seeking to monopolize their technologies; a change in the mindset of policymakers may be required to plan smart city initiatives according to a business-model logic to ensure financial and social viability.

However, despite the extensive existing literature, empirical research on one of the most renowned smart cities, Amsterdam, still reveals a fragmented emerging landscape (Voorwinden, 2022). Several of the drawbacks in the implementation of smart city initiatives have been identified to be related to high implementation costs, increased privacy and security concerns, lack of standardization, difficulty in integrating in existing infrastructure and unequal distribution of benefits (Gracias et al., 2023). Additionally, the documented low effectiveness of current smart city solutions, which is translated in low or marginal increases in city performance, creates mistrust (Komninos et al., 2022). This is further perpetuated by the fact that many smart city projects are terminated at the pilot stage along with their lessons learned and there is no scaling up to inform further projects (Van Winden and Van den Buuse, 2017). Apart from not scaling up, the vast majority of the projects face issues with lack of replicability in other contexts, due to compartmentation; leading to hampering synergies and attenuating the scale ups and creation of economies of scale via diffusion with urban ecosystems (Komninos et al., 2022).

Having so many separate smart city initiatives addressing the same challenges repeatedly, without particularly building on previous efforts, is highly inefficient (José and Rodrigues, 2024). At the same time, smart city literature is characterised as rich, disparate and interdisciplinary (Zhao et al., 2021). It is evident that there is a disparity between the number of studies in smart cities and the actual applicability and implementation of the initiatives. Smart city research is populated by numerous small-sample analyses, particularly single case studies (Mora et al., 2023). These studies that take a case study approach, often focus on a specific service and are highly context driven (Zhao et al., 2021), thus offering limited generalisability (Mora et al., 2023). The lack of significant comparative studies makes it challenging to quantify the significance of reoccurring relationships (Israilidis et al., 2021) especially across various smart city projects. The focus on case studies and limited number of cross-project empirical studies, along with the misunderstanding and vagueness stemming from a lack of concrete empirical findings on how the numerous technologies discussed in smart city literature consolidate into new sources of value for the cities (José and Rodrigues, 2024)**,** leads to additional considerations regarding feasibility and value creation. More specifically, there is an evident gap related to cross-project key factors contributing to project failure and especially in relation to institutional factors that prompt business failure or disengagement of industrial actors in smart cities (Zhao et al., 2021). Finally, few of the studies on smart cities utilise a distinctive theoretical framework (Zhao et al., 2021) and authors highlight the need for empirical studies that offer a more holistic perspective of the multi-stakeholder processes that take place in this context (Israilidis et al., 2021). This research draws on empirical cross-project evidence, focusing on value co-creation through utilising an appropriate theoretical framework to study innovation driven environments, such as smart cities. SDL is considered applicable due to its broad nomology and overarching perspective, guided by its foundational premises, which complement other theoretical approaches to innovation (Ordanini and Parasuraman, 2011). It provides a novel perspective on the outdated innovation literature largely rooted to technological product inventions, which is based on a goods-dominant logic paradigm (Michel et al., 2008). In order foster a more comprehensive understanding of how a real smart city project works, I present below an example of the REPLICATE project, located at Bristol, which a pionnering project in this field.

2.3 Example of a smart city project: The REPLICATE project at Bristol

Bristol is one the cities part of the “100 climate-neutral and smart cities” EU mission (European Union, 2024) and is considered as a city that displays a concentration of experiments and policy-led initiatives towards low-carbon transition. In the UK Smart cities index 2017, Bristol was deemed as Britain’s smartest city, due to its initiatives on the City Operations Centre, Bristol is Open and The Bristol Approach to Citizen Sensing (Woods, 2017). One of the most significant smart city projects in Bristol, is the REPLICATE project. A summary of the project is presented below.

The following information is a compilation of information of the official page of the project, hosted at the (CORDIS EC, 2024) website. The RE.PL.I.Ca.TE (REnaissance of Places with Innovative Citizenship and TEchnolgy) project started in February 2016 and ended in January 2021. It was funded by the EU under the mission “SOCIETAL CHALLENGES - Secure, clean and efficient energy”, as a response to the EU call for proposal part of Horizon 2020 (H2020-SCC-2014-2015) and had a total budget of approximately 29 million €. It was coordinated by the San Sebastian (Spanish city) City Council.

The objective of the project was to demonstrate how smart city technologies in energy, transport and ICT sectors could be implemented in three lighthouse cities: San Sebastian, Florence and Bristol and subsequently replicated in the follower cities Essen, Nilufer and Lausanne. The two fundamental points of the programme were (1) the cities are the customer and local specificities needed to be considered, and (2) the solutions needed to be replicable, interoperable and scalable. The greater aim of the project, and the reason for receiving the EU funding was to lead to an increase to the quality of life for citizens across Europe through showcasing the impact of innovative technologies used to co-create smart city services along with citizens, as well as optimise the process for replicating successful solutions across cities. REPLICATE is considered a large-scale project with the goal to deploy smart services that aim in optimizing energy consumption, improving mobility, improving ICT connectivity, and developing smart city business models (Timeus et al., 2020).

The partners specific to the part of the project taking place in Bristol, were the Bristol City Council acting as the main enabler and coordinator, the University of Bristol and The Chancellor, Masters and Scholars of the University of Oxford, University of the West of England-Bristol and University of Exeter as academic partners, Bristol is Open Limited (JV between Bristol City Council and the University of Bristol) as a hybrid organisation acting as a coordinating partner, Knowle West Media Centre LBG – KWMC a charity as the point of contact with citizens, Toshiba Research Europe Limited, Nec Europe LTD as multinational industrial partners and Route Monkey LTD, Esoterix System LTD and Co-Wheels Car Club Community Interest Company as SME partners (REPLICATE PROJECT, 2021a). Each of the different partners had their own assigned responsibilities, for example University of the West of England would collect and evaluate the centrally recorded information from the rest of the project partners in order to monitor the project and support the scale-up and replications (REPLICATE PROJECT, 2021b). University of Bristol was predominantly in charge of the integration of the demonstration ICT systems with the ICT Smart City Platform (REPLICATE project EU, 2016). Knowle West Media Centre supported the project in collaborating with local organisations, volunteers and residents of an area in Bristol by coordinating the activities of the 'Created By Us' theme, where organisations, groups and the wider community worked together to identify issues in the specific area and the appropriate digital technologies to tackle them (KWMC, 2021). The Co-Wheels car club, an industrial collaborator, was responsible for deploying e-bikes and EV cars. Along with Route Monkey, another industrial actor responsible for the charging points, they collaborated in the EV initiative, while Esoterix was responsible for the deployment of the electric taxi-buses (REPLICATE project EU, 2016). Each of the partners had their own sector of expertise, which they brought into the project.

The solutions demonstrated in Bristol were (Smart Cities Marketplace, 2024):

- **Energy efficiency in buildings**
    - Retrofitting the building envelope: 240 households, including 150 smart homes (20 400 m²).
- **Energy systems integration**

    - District heating and cooling
    - Biomass boilers
    - Smart street lighting
    - Photovoltaics: PV will be installed both on residential and community scale
- **Mobility & Transport**
    - Clean fuels and fuelling infrastructure
    - Electric, hybrid and clean vehicles: E-bikes, electric car club vehicles, an on-demand electric mini-bus service and electric vehicle charging points in the district
- **ICT**
    - Neighbourhood energy management system: The energy management system will work at city level.
    - Smart electricity grid
    - Urban data platform
    - Travel demand management
    - Strategic urban planning
    - Mobile applications for citizens: Travel planning and parking apps

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2.4 The strategic goal of smart cities

Following an overview of the concept of smart cities and its evolution throughout the years, the following sections discuss the variance in the strategic goals of smart cities, as these have been identified through studying smart city definitions, with a particular focus on sustainability, as discussed at the start of this chapter. This is because the initial and primary purpose of smart cities was to respond to challenges related to urban growth and efficiency in resource management (Angelidou et al., 2022), as well as the deterioration of citizen well-being related to challenging waste management, scarce resources, air pollution and traffic congestion and aging public infrastructure, stemming from rapid urbanization (Washburn et al., 2009). Urban sustainability indeed appears to be one of the prevailing themes in smart city literature, but to what extent is the concept embedded in the understanding of smart cities and how comprehensively is it addressed? There is currently no single best-established definition of urban sustainability, nevertheless there is a commonly-used set of characteristics of urban sustainability. These include intergenerational equity, intra-generational equity (social, geographical and governance equity), conservation of the natural environment, significant reduction of the use of non-renewable resources, economic vitality and diversity, autonomy in communities, citizen well-being, and gratification of fundamental human needs (Maclaren, 1996).

These characteristics incorporate the three dimensions of sustainability: the environmental, the economic and the social dimension (Lehtonen, 2004), where the environmental regards the ecological aspect and includes the conservation of the natural environment (flora and fauna) and natural resources and an energy production-based economy. The social dimension includes equity, community autonomy, citizen well-being and gratification of fundamental human needs, while the economic one consists of the economic vitality and diversity of urban areas .

2.5 The range within smart city definitions

Smart city definitions are heterogeneous in nature (Ponting, 2013), as there appears to be neither a predetermined template, nor a one-size fits-all definition of what the term smart city encompasses (O'Grady and O'Hare, 2012). As such, definitions tackle different perspectives of smart city development ranging from the adoption of Information and Communication Technology (ICT), user communication, e-governance and equitable development to education and sustainability. In addition to variations in content, sustainability-oriented definitions present a discrepancy in the prioritization of sustainability as a smart city goal. A summary of the definitions retrieved and analysed can be found in Table 1. The definitions used in this comprehensive literature review have been retrieved from academic papers on the conceptualization of smart cities, from organizational and governmental reports, as well as from documents and reports produced by industrial actors.

The following sections discuss whether sustainability (environmental, economical or quality of life focused) remains the primary goal of smart cities according to the definitions in the literature, or whether other focal goals have emerged, as well as how this affects the smart cities themselves. In order to unveil this the sections below will discuss if sustainability is still a goal or not, which dimensions -environmental, social or economic- are taken into account and how sustainability goals are prioritized. Prioritization was assessed according to whether sustainability appeared as a primary, secondary or tertiary goal, where primary was indicated as of fundamental importance, secondary as important but not fundamental goal and tertiary a goal of less importance compared to the other two categories. The analysis of the goals of smart cities is presented per actor group in order to aid in forming a comprehension of the motives that drive each of these actors, namely the academia, the industry and the government.

Table 1 The definitions retrieved by the literature and catalogued according to whether they are sustainability oriented and if yes, which dimension (environmental, economic or social) is present in the definition and how high of a priority it appears to be. The dot (•) means that the definition includes that dimension.

Author	Keywords	Environmental	Economic	Social	Priority
Sustainability Oriented Definitions					
Academic Definitions					
Bakıcı *et al*. (2012)	High-tech, connections, ICT, sustainable, greener city, competitive, innovative	•	•	•	Primary
Barrionuevo *et al.* (2012)	Technology, resources, integrated, habitable, sustainable			•	Secondary
Caragliu *et al*. (2011)	Human and social capital, ICT, Infrastructure, sustainable economic growth, quality of life, participatory governance	•	•	•	Primary
Lazaroiu and Roscia (2012)	Technology, interconnected, sustainable, comfortable, attractive and secure			•	Secondary
Giffinger *et al*., (2007)	Economy, mobility, environment, people, living, governance	•	•	•	Primary
Kourtit and Nijkamp (2012)	Knowledge-intensive creative strategies, socio-economic, ecological, logistic competitive, human capital infrastructural, social and entrepreneurial capital	•	•	•	Primary
Kourtit *et al.* (2012)	Productivity, education, knowledge intensive jobs, creative, sustainability oriented			•	Tertiary
Nam and Pardo (2011)	Information, infrastructure, efficiency, mobility, decision making	•		•	Primary
Schaffers *et al*. (2012)	ICT, social and environmental capital, competitiveness	•		•	Secondary
Thuzar (2011)	Sustainable urban development policies, equity, sustainable economic development, human social capital, natural resources	•	•	•	Secondary
Toppeta, D. (2010)	ICT, governance, sustainability, liveability			•	Primary
Zygiaris (2013)	Innovative socio-technical and socio-economic growth, green, interconnected, intelligent, knowledgeable, innovating, interactive	•	•	•	Secondary
Industrial Definitions					
Alcatel Lucent (2011)	ICTs, competitiveness, environmental sustainability, liveability.	•	•	•	Secondary
Bosch (2019)	Technology, quality of life, traffic, intelligent homes and energy efficient buildings	•		•	Tertiary
HITACHI (2012)	Environment, safe, quality of life	•		•	Primary
McKinsey (2018)	Digital intelligence, information, tools, services, businesses	•		•	Secondary
Microsoft (2018)	ICT, services, public utilities, safer and healthier city	•		•	Secondary
Schneider-Electric (2013)	Efficient, liveable, sustainable	•		•	Primary
Siemens (2017)	Resilience, social and human aspect, technology, services	•	•	•	Primary
Telefonica (2016)	Improving public services, quality of life, governance, sustainability			•	Tertiary
Institutional Definitions					
BIS (2013)	Liveable, resilient, engaging, hard infrastructure, social capital		•	•	Tertiary
BSI (2014)	Integrative, physical, digital and human systems, sustainable, inclusive			•	Secondary
EIP-SCC (2013)	Energy, materials, services and capital, sustainable economic development, resilience, quality of life	•	•	•	Primary
EIP-SCC (2013)	Technologies, environmental impact, better lives, governance	•		•	Primary
European Commission (2019)	Networks, services, ICT, resource use, emissions	•		•	Primary
Evergreen (2018)	Resilience, inclusivity, collaboration, data, quality of life			•	Primary

ICLEI (2017)	Operations, sustainable, resilient, physical and social capital	•	•	•	Primary
IDA (2012)	ICT, real-time analysis, sustainable economic development.		•		Primary
ITU (2016)	ICT, quality of life, city services, competitiveness	•	•	•	Primary
ISO 37122 (2019)	Collaboration, data, technology, quality of life, natural environment	•	•	•	Primary
NRDC (2014)	Efficient, sustainable, equitable, liveable	•		•	Primary
Non-Sustainability Oriented Definitions					
Academic Definitions					
Batty *et al*. (2012)	ICT, infrastructures, coordinated, equitable, engaging				
Bélissent (2010)	ICT, infrastructure, interactivity, efficiency				
Chen (2010)	Communications and sensor capabilities, infrastructures, optimization, quality of life				
McFarlane and Söderström (2017)	Data, technology, locality				
Industrial Definitions					
ARUP (2011)	Engaged citizens, efficient, interactive, engaging, adaptive and flexible city				
CISCO (2012)	ICT, increase efficiencies, reduce costs, quality of life				
Deloitte (2018)	Technology, city operations, data, networks, decision-making				
Fiberhome Technologies, (2017)	Data integration, policy, technology, process, capital				
IBM (2018)	Interconnected information, operations, optimization of resources				
Institutional Definitions					
Azkuna (2012)	ICT, infrastructure, efficient, citizen awareness				
Future Cities Catapult (2017)	Marketing, global tech industry, digital transformation				
London Assembly (2013)	Systems, collaboration, technology				

This cumulative table categorizes the definitions in sustainability oriented and non-sustainability oriented, in addition to type of author (academic, institutional, industrial). In many of the definitions presented, sustainability is regarded as one of the primary goals of smart city, along with liveability. Respectively, approximately one third of the definitions found, feature sustainability as one of the secondary goals in smart cities along with liveability, efficient use of resources and governance. A small number of definitions present sustainability as a tertiary goal, diminishing its importance in the smart city agenda. The primary goal in tertiary definitions is the quality of life and governance. Whether sustainability is considered a primary, secondary or tertiary goal is determined by examining how prominent its role is within a definition i.e. if it is the main goal or if it is expressed as one of the many other goals or as a minor goal.

Starting this analysis from definitions that have diverged from treating sustainability as one of the smart city strategic goals, the goals appear to be more technology and infrastructure oriented. In such definitions smart cities are viewed as cities that utilize ICT to create more interactive and efficient components and functions of critical infrastructure (Azkuna, 2012). These components are suggested to be administration, education, healthcare, public safety, real estate, transportation and utilities (Bélissent, 2010). When describing the vision for Smart London, the London Assembly (2013) regards such components as systems integrated through different technologies. It focuses on the linkage between local labour markets to financial markets and from the local government to education, healthcare, transportation and utilities. Smart cities will use communications and sensor capabilities embroidered into the infrastructure of the city in order to optimize electrical, transportation-related and other logistical everyday operations, with the goal of improving quality of life (Chen, 2010). Such technologies provide an interaction space between citizens, authorities, businesses and other actors, to become actively engaged in the design and planning processes (Batty et al., 2012).

While the definitions above derive from academic literature and governmental papers, similar themes can be observed in definitions deriving from industrial actors. Smart cities adopt scalable solutions that utilize ICT to boost efficiency, decrease costs and improve quality of life (CISCO, 2012). IBM (2009) in the early stages of the development of the concept considered that a city can become smart by optimally using all the available interconnected information to comprehend and regulate its operations and optimize the utilization of available resources. Accordingly, others support that a smart city can be built by integrating platforms and data, through policy, technology and capital, in an efficient way (Fiberhome Technologies Group, 2018). Technology is used as a means to better all aspects of city operations and improve the services offered to citizens. Data are collected and used to inform decision-making and at the same time create networks of partnerships between governments, businesses, non-profits, community groups, universities, and hospitals (Deloitte, 2019). From a different point of view, ARUP (2011), views the smart city as a city with clear and transparent structure of its urban systems, which are simple, responsive and adaptable with the use of technology and design methods. In this city, citizens are encouraged to interconnect with their wider ecosystem and collectively engage with it (ibid).

Some non-sustainability oriented definitions described smart cities more critically, exploring their origin and promises. More particularly, smart urbanism, which gave birth to smart cities, has been described as “a loosely connected set of confluences between data, digital technologies, and urban sites and processes”, while the “promise continually sold is of the digitally enabled data-driven, continually sensed, responsive and integrated urban environment” (McFarlane and Söderström, 2017, p. 314). Smart city itself has also been described as a concept that became popular in early 2010 on how recent technological advancements and data can enable more efficient city management but was established in “public consciousness as a marketing concept from global technology companies that saw an opportunity to sell digital transformation and new technology into big city systems” (Future Cities Catapult, 2017, p. 4).

On the other hand, sustainability focused definitions describe smart cities as “vehicles” towards achieving a more environmentally friendly and liveable urban environment. In these definitions smart cities are described as resilient and inclusive cities built collaboratively, that use different types of technology and data in order to achieve a better quality of life for all their residents (Evergreen, 2018). They can be viewed as cities performing well on six characteristics: environment, economy, mobility, people, living and governance (Giffinger and Pichler-Milanović, 2007). They derive from knowledge-intensive creative strategies that have as a goal the improvement of the socio-economic, ecological, logistic and competitive performance of cities and rely on a mixture of human, infrastructural, social and entrepreneurial capital (Kourtit and Nijkamp, 2012). These investments in human, infrastructural (transport and ICT) and social capital promote sustainable economic growth and a good quality of life, via participatory governance and by intelligently managing natural resources (Caragliu et al., 2011). In summary, while sustainability-oriented definitions appear to focus on the performance of the environment, economy, mobility, people, quality of life and governance, non-sustainability-oriented definitions are particularly interested in the efficiency of transportation, education and administration. These definitions appear to focus more on how technology can make a city smarter and less on the human component and appear to equate quality of life with urban systems efficiency.

Despite the common characteristics, sustainability-related smart city definitions present, they also demonstrate a number of variations. Different smart city definitions may include different dimensions of sustainability as their goal. Furthermore, the prioritization of sustainability as a strategic smart city aim appears to vary between definitions.

2.6 Sustainability oriented smart city definitions

The sustainability oriented smart city definitions have also been analysed according to the dimensions of sustainability they encompass, namely the environmental, the social and the economic dimension. This categorization allows for thematic patterns to be identified. Firstly, definitions that consider all three dimensions are presented. For these, the term ‘holistic approaches’ is used here. They view the “smartness” of a city as a “certain intellectual ability that addresses several innovative socio-technical and socio-economic aspects of growth” (Zygiaris, 2013, p. 218). Such perspective demonstrates the perception of a smart city as green, interconnected, intelligent, innovating and knowledgeable; terms which themselves have been the subject of a number of literature reviews. This “smartness” is embedded into the city operations and is based on the analysis, monitoring and optimization of urban, physical (energy, water, waste, transportation and others) and social (equity, governance, citizen participation) systems, through transparent and inclusive communication structures (ICLEI, 2017). Accordingly, Siemens (2017) considers that the term “smart” does not only affect the technological aspect of the operations, but has a social and human aspect as well.

The addition of sensors and updating existing urban infrastructure will positively affect the efficiency and capacity of the delivery of services, economic opportunity and quality of life for citizens. Similarly, smart cities can be regarded as systems of humans, utilizing flows of energy, materials, services and capital to achieve sustainable economic development, resilience and high life quality (EIP-SCC, 2013). The challenges smart cities respond to are related to climate change, rapid population growth and political and economic instability. They do so through collaborative leadership and cross-disciplinary, city-wide collaboration and the use of data and technology, with the goal of providing better services for their citizens, but without causing unfair disadvantage to other citizens or further degrading the natural environment (ISO 37122, 2019). While the end goal is to improve the quality of life, efficiency of city operations and competitiveness, smart cities need to ensure that they meet the needs of present and future generations from all aspects: economic, social, environmental and cultural (International Telecomminication Union (ITU), 2016). In order for smart cities to achieve these goals, equitable, participatory, sustainable urban development policies will need to be developed (Thuzar, 2011).

Predominantly, environmentally oriented definitions, focus on the impact that digital technologies will have on the delivery of particular urban services. Such technologies can be used to improve the use of resources and decrease emissions. This can lead to not only smarter transport infrastructure, improved water supply and waste disposal systems and more efficient building thermal control, but also improved city administration services, safer public spaces and better response to the needs of ageing population (European Commission, 2019). Numerous industrial actors, with operations predominantly in the IT sector, provided definitions similar to the one from the European Commission. Microsoft (2018) considered smart city as one that uses ICT to improve the provision of citizen services like energy, water, public safety and transportation increasing the health, sustainability, resilience and safety of cities. Bosch (2019) provided an analogous definition supporting the idea that the use of various technologies can improve the citizen's general quality of life, through saving time, using new mobility methods and breathing cleaner air and lead to decreased traffic, intelligent homes and energy-efficient use of buildings. Nevertheless, citizens' quality of life and a more comfortable, safe and convenient lifestyle, should be in harmony with the environment, and smart cities should aim in enabling a well-balanced relationship between people and the Earth (Hitachi, 2012), as the efficient, liveable, and sustainable elements should go hand-in-hand (Schneider-Electric, 2013).

Interestingly, all sustainability oriented smart city definitions identified include a strong presence of the social dimension as well. When the concept of smart city was introduced, it was regarded as a strategic tool to underline the increasing importance of ICT and social and environmental capital in sculpting the competitiveness of modern cities (Schaffers et al., 2012). Consequently, smart city definitions that encompass the environmental dimension of sustainability frequently include the social dimension. Schaffers et al. (2012) argued that this is due to the distinctive attributes that social and environmental capital can offer to smart cities compared to the "more technology-laden counterparts", frequently mentioned in the literature as digital or intelligent cities. Thus, the distinction between digital or intelligent cities and smart cities appears to be the prevalence of the human element in the latter.

Indeed, numerous sources in the literature, view sustainability in smart city as a predominantly social scope. The British Standards Institute (BSI), the national standards body of the United Kingdom, support that a smart city includes the efficient integration of physical, digital and human systems in the built infrastructure in order to create a sustainable, prosperous and inclusive future for its inhabitants (BSI, 2014). This emphasis on the habitability and inclusivity of the urban environments particularly underlines the social nature of smart cities. Via the use of digital intelligence, tools can be designed that save lives, prevent crime, and reduce the disease burden. These can save time, reduce waste, and even help boost social connectedness (McKinsey & Company, 2018). In other words, smart cities strive to improve city services and urban management for the citizens, by creating a socially advanced environment. The ultimate goal of these processes is to improve the sustainability and liveability of the city (Toppeta, 2010). Through these definitions, it can be observed that the combination of human capital with technology can have an effect on urban services, city services, local actor interaction and quality of life, thus improving the social aspect of urban environments.

The identified literature includes few definitions that focus solely on the economic aspect of sustainable smart cities. Similarly, to the environmentally oriented definitions, the economic oriented ones consider smart cities as cities that combine hard infrastructure with social capital, community institutions and technologies, but with an alternative purpose: that of boosting sustainable economic development and creating an attractive business environment (BIS, 2013). According to this approach, economic competitiveness along with environmental sustainability and general liveability become increasingly driven by ICT (Alcatel-Lucent, 2011). In the case of Singapore, the smart city has been defined as a local entity that holistically employs ICT and real-time analysis to promote sustainable economic development (IDA, 2006). Barcelona consider smart city as a sustainable, greener, highly technological city with competitive and innovative commerce, and an enhanced quality of life that creates connections between people, information and urban elements, through the use of new technologies (Bakici et al., 2012). This approach is a less theoretical and more practical one, where the need for sustainable development is recognized along with the need of the city to grow and flourish economically, through the combination of both hard and soft elements. However, these resources do not make clear if economic growth and enhanced quality of life are causally related, with economic improvement leading to better quality of life, or if these two goals should be independently pursued.

2.7 Critical discussion of the identified themes

In the sections above I present an overview of the goals of smart cities, found in the definitions in the literature. Fostering a well-rounded understanding of the goals of smart city is the basis towards comprehending the goals of smart city projects and furthermore, identifying and studying the goals and motivations of the actors of these projects. Through studying these some consistently appearing themes can be identified. These are: the relatively anthropocentric focus of sustainability-oriented approaches, the prevalence of result-focused definitions and the role of technology as a facilitator. Further investigating these themes allows for a deeper understanding in the positive expectations as well as the shortcomings that may result from the way in which smart cities are perceived, by industrial, institutional and governmental entities.

Sustainability oriented approaches are related to the use of soft and hard capital, where soft capital is considered as human capital and societal structures and hard capital as the city infrastructure and material resources, combined through diverse technologies, with the purpose of enhancing environmental aspects of the city, boosting the economy and ensuring a high quality of life. In contrast, non-sustainability related definitions particularly highlight the importance of ICT in order to optimize the performance of the city and the use of resources, while the ultimate purpose of enhancing the quality of life remains still a high priority. This focus on ICT consequently, underpins the importance of hard elements. This can be specifically observed in definitions provided by technologically related industrial actors (CISCO (2012), IBM (2009), Fiberhome Technologies Group (2018) and Siemens (2017)). In contrasting, other actors in the ICT industry, such as Hitachi (2012), Microsoft (2018) and Schneider Electric (2014), provide more sustainability oriented, holistic definitions. This may be due to the fact that these firms are not solely ICT based but have a diversified portfolio that ranges from power and automotive systems to social infrastructure. In a similar alignment of sector and definition, ARUP, a company related to the built environment, defines smart city as an urban system with structures focused on citizens and their neighbourhoods, thus underlining the urban aspect.

Additionally, it can be observed that sustainability oriented definitions appear more results based, while non-sustainability oriented definitions more process based. Most sustainability oriented definitions highlight the results that smart cities aim to achieve answering to “why a city should be smart”, while the non-sustainability-oriented definitions appear to answer to “how these results can be achieved”, through expanding on the integration of different kinds of resources, such as human and infrastructure capital, in order to achieve the smart city goals. This is furthermore noticeable in the role of technology, which in the first approach came across as a facilitator to an end-result, while in the non-sustainability-oriented approach technology takes a more prominent role.
Holistic approaches take into consideration all sustainability dimensions, the environmental, the social and the economic, and present a rather balanced point of view on what a smart city should be. Environmentally oriented definitions, which include the social dimension as well, support the cause of

reduction of the environmental impact of urbanism, the enhancement of life quality and the efficient use of resources as the smart city goals. These may be achieved through the use of technology in almost all definitions. This approach emphasizes mitigating the impact of cities on the environment and rarely takes into account the economic growth or development of the city. In doing so, such definitions sidestep the growing argument on the incompatibility between continuous economic growth and environmental sustainability, and the need for a paradigm shift to de-growth.

Similarly, social sustainability-oriented definitions demonstrate how smart cities integrate technology with governance to improve the sustainability and liveability of the city. In contrast to socially oriented definitions, those focused on the economic dimension of sustainability proposed the combination of hard infrastructure and soft capital with the purpose of creating competitive cities and boosting sustainable economic development.

A prevalence of socially related elements may be observed in smart city sustainability-oriented definitions. This is contrary to the urban sustainability literature where frequently the societal factor is overlooked or shadowed by the ecological aspect (Lehtonen, 2004). This phenomenon is also extended to the urban sustainability assessment literature (Berardi, 2013). Nevertheless, the human nature of urbanization and the social issues that rapid urban growth has caused, such as social inequality (Kim and Han, 2012), social deprivation, community disruption, public safety and health decrease (Bibri and Krogstie, 2017), have underlined the importance of the social aspect of smart cities and appear to have had a significant impact on the way in which scholars, organisations and industries define the term.

Even though the definitions underpin the importance of the social aspect, the current implementation of the smart city model paints a different story, where technology comes first and resolution to social problems comes second (Hollands, 2015; McFarlane and Söderström, 2017). While industrial actors are developing ICT solutions that cater to a variety of clients, such as governmental agencies, other enterprises and civic society, it is currently unclear whether these technologies facilitate the scope of improvement of the “general” quality of life of all citizens, or whether they benefit a specific “elitist” part of society that is digitally skilled and can financially afford these solutions, while excluding another one. This part of society can be a local council of a low-income borough, a state school with limited resources, an immigrant camp, an elder or a low-income young citizen. These smart city solutions may improve the quality of life of some citizens, while at the same time may marginalize and create a deeper gap between those who have access to 'smart' and those who have not (Datta, 2014). This may lead to the misrepresentation of specific communities that have limited or no digital footprint, as happened with Hurricane Sandy, which through social media falsely appeared to be centred on Manhattan, due to higher access and engagement to social media from that location and consequently led to false assumptions and adverse actions from leadership (Crawford, 2013).

Social exclusion issues go beyond representation and access to technology, to distortion of the 'reality of a city' and the particular characteristics of a locality such as the history, concerns, knowledge and trajectories of the existing urban community (McFarlane and Söderström, 2017). In other words, while existing smart city definitions appeared to highlight the importance of the social aspect and quality of life, many of them did so by excluding a part of the population with limited access to technology and by stripping off the particularities of the existing urban fabric, in a way that may be considered as parallel to a process of gentrification.

In contrast with the social dimension, a low number of definitions that took economic sustainability into account can be observed. This is contrary to the common connection between social and economic sustainability, frequently referred to as "socio-economic", indicating the strong connection between these two elements in the wider literature. This tendency of the definitions to disassociate from the economic aspect can additionally be observed in the way in which particularly industrial definitions downplay the importance of economic sustainability in the implementation of the smart city vision. This is opposite to the reality. The smart city model is being promoted and supported with significant investment of resources by numerous industrial actors (Söderström et al., 2020). It is a highly competitive market, where there is an evident risk of prevalence of stand-alone profit-making agendas (Sadowski, 2016), that may undermine economic development through their isolated ICT branding exercises (Allam and Newman, 2018). This risk becomes more and more imminent when examining the financial growth of the smart city market. Thus, it is evident why technology companies view smart cities as an opportunity to promote digital transformation.

It is apparent that the diverse sustainability oriented definitions of smart city do not view the goal of sustainability equally. Most definitions that take a holistic approach appear to view sustainability as one of the primary smart city goals. Interestingly, this is not the case for socially oriented definitions which focused more on quality of life and development or efficient use of the human capital, thus view sustainability as a desirable attribute, but has secondary or tertiary priority. This raises questions as to what trade-offs predominantly socially oriented smart cities are willing to make in order to achieve quality of life over the preservation of the environment, as well as what the cost of this trade off will be. Additional concerns are raised by the fact that no definition provides an explanation of what is meant by quality of life and what it incorporates. Undoubtedly, quality of life has different meanings for different parts of the world, as access to food, clean water and medicine as well as equity and equal opportunities are still an on-going problem in numerous parts of the globe.

Regardless of the number of sustainability-driven smart city definitions and its apparent high priority as a goal, some authors pose questions regarding to the true impacts of smart city on ecological sustainability. One of the arising issues is the potential psychological disconnection of citizens from the environment and disruption of their relationship with nature due to overexposure to technology (De Jong et al., 2015). Additionally, some authors disputed the net contribution of smart cities to sustainability (Salvati et al., 2013; Viitanen and Kingston, 2014). These are supported by the findings of De Jong et al.'s (2015) network analysis of smart city concepts, which indicates a distance between the sustainable and the smart city. Whether these concerns are valid or not, largely depends on the way in which the smart city model is or will be embedded in the urban system, and the strategies and main goals that the authorities will set for each city, as well as the resources that will be used in order to achieve it.

After analysing the existing smart city definitions, it is evident that most of the definitions, as currently present in the literature, describe a utopian urban environment that frequently disregards issues of the societal and environmental urban reality. This indicates the need for a re-adjusted definition that takes into consideration the issues raised above and most specifically: excluding groups of citizens, stripping off the particularities of the existing urban fabric by equalizing all localities, creating confusion between the environmental trade-offs needed to achieve an undefined quality of life and regarding technology as the central solution and not as a facilitator.

Taking into account these points, as well as drawing on wider literature the following definition is proposed: *Smart city is a concept of urban transformation that should aim to achieve a more environmentally sustainable city with a higher quality of life, that offers opportunities for economic growth for all of its citizens, but with respect to the particularities of each locality and its existing inhabitants.* This transformation is currently enabled by various types of technologies, typically provided by global industrial partners that are embedded into the city's infrastructure system, transforming the existing provision of services by adding layers of interconnectedness.

3 Service Dominant Logic

Following the enquiry into what a smart city is and how it is defined, presented in chapter 2, this chapter provides a brief overview of the foundational elements of the theory that underpins this thesis, the Service Dominant Logic (SDL). SDL is considered particularly valuable in studying environments guided by innovation and through its lens I will be studying the mechanisms of co-creation of value in the context of smart cities. Starting from the Axioms and Foundational Premises of SDL, this chapter explores the notions of value in use and value in exchange, the service ecosystem framework and the levels of interaction as well as describes how interactions occur within these levels via resource exchange. Finally, the institutions and institutional arrangements that govern these interactions as well as the limitations of the theory are presented.

3.1 The main theory – Axioms and Foundational Premises (FPs)

The Service-Dominant Logic (SDL) is a theory developed by Vargo and Lusch and first published in 2004 as part of service marketing, an area of marketing studies that emerged in the 1980s (Vargo and Lusch, 2017). The article via which SDL was introduced in 2004 is considered to have prompted a paradigmatic shift in the discipline of marketing as a whole (Brodie et al., 2019). The theory argues a novel logic for marketing studies that challenges the existing economic models based on the exchange of manufactured goods (Hietanen et al., 2018) and has undertaken continues reiterations through the past years, but its core belief remains unaltered (Vargo et al., 2023b). SDL suggests that all economic activity is best perceived in terms of service-for-service exchange instead of the traditional goods-for-goods or goods-for-money exchange (Vargo and Lusch, 2017). It proposes an underlying theoretical framework for analysing markets and studying marketing, by shifting the focus of studying exchange in terms of units of output, to the way and mechanisms by which value is created through interaction between various stakeholders (Akaka et al., 2013a). SDL is considered one of the few theoretical frameworks that have the potential of being developed into a more general and overarching theory (Hunt et al., 2022) and its contributions may be leading toward being viewed as a general theory of markets (Vargo et al., 2023b).

At its conception SDL was based on foundational premises (Table 2), which through continuous reiterations were reduced to five axioms through which the remaining six foundational premises could be derived (Vargo and Lusch, 2016). These function as the core of the logic. The first axiom posits that service is the fundamental basis of exchange. It is the utilization of resources to benefit another actor. Actors are considered entities (organisations or individuals) that may integrate resources and engage in service-for-service exchange, while service is the operation of an actor using their resources to create benefit for another actor (Vargo et al., 2023a). The second axiom suggests that the consumer or user is always a co-creator of value. Value is co-created through individual and/or organisational interaction. According to the third axiom, all social and economic actors are resource integrators. Value is co-created by economic and social actors through resource integration in an almost infinite number of possible combinations. The fourth axiom supports that value is always uniquely and phenomenologically determined by the beneficiary. Each entity experiences and determines value in a unique way. Finally, according to the fifth axiom, recently added in 2016, the co-creation of value is accommodated through actor generated institutions and institutional arrangements.

According to Vargo and Lusch (2016) the remaining six foundational premises (FP hereafter) state that indirect exchange masks the fundamental basis of exchange (FP2), goods are distribution mechanisms for service provision (FP3), operant resources (defined below) are the fundamental sources of strategic benefit (FP4) and all economies are service economies (FP5). Furthermore, actors per se do not have the ability to deliver value but can be part of the creation and offering of value propositions (FP7) and the service-centred view is inherently beneficiary oriented and relational (FP8).

Table 2 Foundational Premises and Axioms of SDL. Adapted from Vargo and Lusch, 2016

Code	Foundational Premises	Axiom
FP1	Service is the fundamental basis of exchange	Axiom Status
FP2	Indirect exchange masks the fundamental basis of exchange	
FP3	Goods are distribution mechanisms for service provision	
FP4	Operant resources are the fundamental source of strategic benefit	
FP5	All economies are service economies	
FP6	Value is co-created by multiple actors, always including the beneficiary	Axiom Status
FP7	Actors cannot deliver value but can participate in the creation and offering of value propositions	
FP8	A service-centred view is inherently beneficiary oriented and relational	
FP9	All social and economic actors are resource integrators	Axiom Status
FP10	Value is always uniquely and phenomenologically determined by the beneficiary	Axiom Status
FP11	Value co-creation is coordinated through actor-generated institutions and institutional arrangements	Axiom Status

3.2 Value in exchange, value in use and value propositions

It is obvious that the notion of value co-creation is continually emerging through the axioms and FPs of SDL. But what is value co-creation? Value and value creation are considered to be “at the heart of service” (Vargo et al., 2008, p. 146) and are fundamental to comprehending the dynamics of service systems and to the development of service science. Value can be described as “a change, positive or negative, in the viability of the well-being of a system” (Vargo et al., 2023a, p. 7). Through years of philosophical discussions on the elusive term “value”, two general meanings have emerged, “value in exchange” and “value in use”. These demonstrate different ways of thinking about how value is created (Vargo et al., 2008). The traditional view is based on value in exchange and describes how value is created in goods-dominant logic (Vargo et al., 2006). In this logic, value is “manufactured” by firms and distributed in the market, facilitated usually through the exchange of goods or money. Value in exchange is considered the negotiated evaluation between producer and consumers (Kowalkowski, 2011), thus producers and consumers have distinct roles and value creation occurs through a sequence of activities performed by the firm.

Alternatively, the service-dominant logic adopts the value-in-use meaning of value (Vargo and Lusch, 2008), suggesting that “there is no value until an offering is used” and that “experience and perception are essential to value determination” (Lusch and Vargo, 2006, p. 44). Via service-for-service exchange and the integration of resources, value in use is co-created instead of being created by one actor and delivered to another (Vargo, 2020). In SDL the producer and consumer do not assume distinct roles, indicating that value is always co-created in a joint and reciprocal way through interactions between providers and beneficiaries. This interaction occurs through the integration of resources between these two actors, and application of competences (Vargo and Lusch, 2008). Actors, per se, cannot deliver value, they can only propose value (Vargo, 2020), participating in the creation and offerings of value propositions (Vargo and Lusch, 2016).

One of the first pieces of literature that started the discussion on value propositions, was an internal staff paper of McKinsey in 1988 discussing IBM’s capabilities of creating services that offer a “superior value (benefits minus price) as perceived by the customer” (Lanning and Michaels, 1988, p. 2). The authors visualise value proposition as a promise of value to customers, where value is described as a combination of benefit and price. The concept of value proposition underwent multiple reiterations in the following years some of them leaning heavily on the customer point of view for example (Anderson et al., 2006; Kambil et al., 1996; Lanning, 1998), while others on the organisational side, by viewing value propositions as a differentiating factor between competitors. Further development of these two approaches led to the conceptualisation of value propositions as “reciprocal promises of value, operating to and from suppliers and customers seeking an equitable exchange” (Ballantyne and Varey, 2006, p. 334,335) and as a key component of the service dominant logic (Lusch and Vargo, 2006). They appear to be a configuration of resources that promise future value to users (Skålén et al., 2015) and can be defined as a dynamic and adapting mechanism for determining how resources are shared within a service ecosystem (Frow et al., 2014). In essence, a value proposition is a suggested value that has not been realized yet (Gummesson, 2007a).

The definition of value proposition, through the lens of service dominant logic, along with other key concepts, has evolved through-out the years, following the advancements in the theory (Vargo, 2020). The term was firstly introduced in the first paper on service dominant logic, as part of the 7th foundational premise stating that 'the enterprise can only make value propositions' (Vargo and Lusch, 2004). This premise evolved into 'the enterprise cannot deliver value, but only offer value propositions' (Vargo and Lusch, 2008) which was later further developed to "actors cannot deliver value but can participate in the creation and offering of value proposition" (Vargo and Lusch, 2016, p. 8). The advancements in the use of the term demonstrate the progressive realisation of the elusiveness of value and its dependency on how it is perceived by each actor, through value propositions. This is further illustrated in the most recent, revised definition of value propositions, where value propositions are viewed as multi-actor, intersubjective, institutional co-creations as phenomenologically interpreted by an actor, in a given context (Vargo, 2020). This updated definition, which is the one adopted in this research, additionally, takes into consideration the significance of context under which both value proposition and value, as terms can be determined and perceived.

Value propositions are continually reshaped as the markets are dynamic and constantly changing, leading actors to continually integrate new resources (Bettencourt et al., 2014). Actors draw upon their relationships with other actors and establish processes and capabilities that aid them in not only reshaping value propositions, but developing new ones (Greer et al., 2016). The basis of value propositions is co-produced knowledge (Tregua et al., 2022). Knowledge of an actor combined with the knowledge of other actors of the service chain and along with other operant resources are the foundations of the creation of value propositions (Vargo et al., 2008). Albeit the fact that the notion of value propositions is continually evolving in the service dominant logic literature, there is still a considerable literature gap in defining what a value proposition truly encompasses (Payne et al., 2020) and in understanding how actors within the service ecosystem can create value propositions (Verleye and Reber, 2022). Particularly, there is a gap in empirical research on the processes and practices of creating value propositions (Lee and Park, 2023).

3.3 The narrative of the SDL

Through the development of the SDL over the years, the narrative of value co-creation has gradually evolved. The most recent narrative of this framework suggests that value is co-created through "resource-integrating, reciprocal-

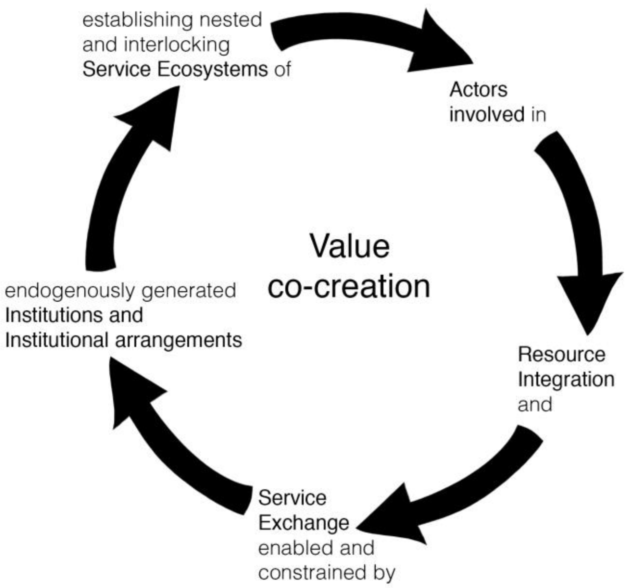

Figure 1 Representation of the narrative and process of S-D logic. Adapted from Vargo and Lusch (2016, p. 7).

service providing actors" (Vargo and Lusch, 2016, p. 7), that co-create value via aggregated meaningful experiences in nested service ecosystems, governed through institutions and institutional arrangements, which have been endogenously -deriving from the inside of the ecosystem- generated. These endogenously generated institutions and institutional arrangements, which are additionally characterised as emergent, provide the context for additional, emergent iterations of value co-creation (Vargo et al., 2023a). The main components of these processes are presented in Figure 1.

The following sections will study the elements the process of value co-creation starting from the service ecosystem, continuing to the levels it comprises of, resource integration and types of resources, and concluding with the institutions and institutional arrangements that govern the exchange.

3.4 Service ecosystems framework

Interactions between actors do not occur in isolation but rather within a network of actors. This network serves a purpose, but not purpose in the sense of collective intent but as an individual survival/wellbeing scope that is a partial function of collective wellbeing (Vargo and Lusch, 2017). These networks can be observed in different levels of aggregation. Since these networks are composed by actors, and axiomatically all social and economic actors are resource integrators (axiom three), then the realization of value in the network does not occur in isolation, but through the integration of actor resources. These networks are called service ecosystems (Vargo and Lusch, 2016). Lusch and Vargo (2014, p. 24) define a service ecosystem as “a relatively self-contained, self-adjusting system of resource-integrating entities that are connected by shared institutional logics and mutual value creation through service exchange”. The term in itself describes the nature of the service ecosystem concept. Service is the use of competences, such as knowledge and skills, by one agency for the benefit of another (Vargo and Lusch, 2004), while the term ”ecosystem” stems from natural sciences. Tansley (1935) described ecosystems as the “basic unit of nature”, while in SDL it is viewed as the unit of analysis for value co-creation (Vargo and Lusch, 2011). The nature of service ecosystems is interdependent, nested and overlapping, as the nature of the universe is intrinsically nested and entangled (Vargo et al., 2023a). Similar to natural ecosystems, service ecosystems cannot be fully controlled by a single actor due to their emergent properties (Chandler et al., 2019). These emergent properties stem from the continual reiterations of interactions between actors with different resources and different intentions (Lusch and Nambisan, 2015). However, differently from natural ecosystems, service ecosystems incorporate actors who posses the reflective capacity to comprehend how they affect the ecosystem (Polese et al., 2021) and comprehend why they participate in it (Castañer and Oliveira, 2020). Studying interactions through a service ecosystem perspective allows for a systematic and holistic comprehension of the process of value co-creation and of the way in which actors within the service ecosystem can influence this process (Vink et al., 2021).

Service ecosystems are composed by three levels of aggregation the micro, the meso and the macro level. These levels of aggregation correspond to the levels of context or else levels of interaction between the actors of the service ecosystem (Chandler and Vargo, 2011). These levels of interaction provide differentiating but interrelated perspectives via oscillating foci – zooming in and out of focal phenomena (Archpru-Akaka et al., 2023; Chandler and Vargo, 2011). Simply put, interactions in service ecosystems unlike natural ones, are the result of reflective capacity.

3.5 Service ecosystem levels of interaction

Service ecosystems operate at the micro (individual), the meso (intermediary) and the macro (institutionalized) level, which concur with essential value co-creation processes (Chandler and Vargo, 2011). These levels are nested within each other (Mars et al., 2012) and cannot exist -or studied- independently (Archpru-Akaka et al., 2023). Additionally, a specific ecosystem may be a part of an extended ecosystem at the meta level (Chandler and Vargo, 2011). In the micro-level, actors articulate the interactions needed to facilitate their interdependence (Akaka et al., 2015). They combine resources and penetrate into the wider service ecosystem (Gummesson and Mele, 2010). Through integrating miscellaneous resources, actors in this level establish the foundation for the co-creation of value (Haack et al., 2019). Service exchange in the micro level is direct between actors (Chandler and Vargo, 2011) through micro-actions (Archpru-Akaka et al., 2023). The meso-level accommodates all the ordinary structures and activities between firms, customers and institutions. This is where the indirect service-for-service exchange occurs (Chandler and Vargo, 2011), relationships are reinforced and value is created through resource-integrating and service exchange processes, along with the establishment of institutional arrangements, such as rules and norms (Akaka et al., 2015). The macro-level is the domain of wider societal structures and activities, where enduring institutions and rules on community formulation at micro and meso level are assembled (Lusch and Vargo, 2014). The process of exchange in this level is characterized by synergies of direct and indirect service-for-service exchanges, occurring concurrently (Chandler and Vargo, 2011). Utilizing the lens of service ecosystems, micro and macro views can be reconciled through moving away from distinctly defined levels to recognising the significance of the meso view, which demonstrates both higher and lower sets of interactions (Archpru-Akaka et al., 2023).

3.6 Resource integration – Operant and operand resources

While observing the terminology present in the SDL literature, the reoccurring presence of ‘resources’ and ‘resource integration’ emerges. Resources can be defined as tangible or intangible entities, at the disposal of an organisation, that enables it to create efficiently and/or effectively a market offering that possesses value for particular market segments (Hunt, 2000). For enterprises, resources have been recognized as a key element to achieve growth (Penrose, 1959) and competitive advantage (Hunt, 2002). Zimmerman (1933, p. 15) highlights that “Resources are not they become; they are not static but expand and contract in response to human wants and human actions.” However, this process entails some fundamental preconditions to be met. These are related to the actors’ ability and allowance to use or integrate a resource (Haase and Kleinaltenkamp, 2011). Nevertheless, resource integration requires the implementation of processes and forms of collaboration (Kleinaltenkamp et al., 2012). These processes and collaboration are possible through interaction. ‘Interaction is mutual or reciprocal action where two or more parties have an effect upon one another (Grönroos, 2011, p. 289). These parties are in some type of contact between each other. The interacting parties have the opportunity to provoke reciprocal influence, through involvement in each other's practices. In service contexts these interactions takes place through service encounters. The subject of operand and operant resources is discussed extensively in chapter 4.

3.7 Institutions and institutional arrangements

The process of value co-creation of SDL in section 3.3 explains how endogenously generated institutions and institutional arrangements govern the resource exchange and value co-creation within the service ecosystem. They are considered the key to comprehending human systems and social interactions in general (Vargo and Lusch, 2016). Institutions are defined as humanly conceived rules, norms and beliefs that permit or constrict action and provide meaning and expectation to social life that have durable social structures and include both symbolic and material elements (Scott, 2014), or alternatively a consistent system of beliefs, rules, goals, narratives, norms, and organisations that develop a collective pattern of behaviour (Greif, 2006). They encompass laws, norms, values and moral codes that delineate appropriate behaviour between actors in addition to cultural beliefs and cognitive models that outline the presupposed assumptions and beliefs that are imperative to govern social interactions (Scott, 2014; Thornton et al., 2012). Institutions can be perceived as resources that may be integrated in the value co-creation process (Archpru-Akaka et al., 2023; Koskela-Huotari and Vargo, 2016). They typically exist as components of more comprehensive, interrelated institutional arrangements (Vargo and Lusch, 2016) Institutional arrangements are high-order congregations of interdependent institutions, commonly referred to as institutional logics (Vargo and Lusch, 2017). North (1990) argues that they are a set of interrelated institutions and devise 'the rules of the game'. Institutional arrangements are constructed, maintained and deconstructed, through interspersing institutions, via interactions and social evolution (Archpru-Akaka et al., 2023). They appear to be coordinating mechanisms that act as enablers or barriers to value co-creating actions (Vargo et al., 2023a).

Both institutions and institutional arrangements have the role of acting as a mechanism of facilitation of resource integration and service exchange procedures. They enable actors to achieve augmented levels of service exchange and value co-creation under cognitive constraints. This is largely due to the network effect created by the actors' interconnectedness. The more actors share an institution the greater the potential benefit for all members (Vargo and Lusch, 2016).

Simultaneously, the same actors that share the institutions and institutional arrangements continually form and reform them, due to the recursive relationships between individual actions and the propagation of relationships and shared meanings (Akaka et al., 2013). More specifically, the reconfiguration of institutions is dynamically sustaining or altering the institutional arrangements that enable value co-creation (Archpru-Akaka et al., 2023). This is due to the proposition that these shared institutions are at the same time composed of the human actions and interactions of their actors (Giddens, 1984). Consequently, these institutions are dynamic in nature and they are not exogenous or static (Vargo and Akaka, 2012). In other words, the institutions and institutional arrangements that govern the service ecosystem are generated from within it, through actor interaction, and constantly change through every new interaction that the actors have among them, thus they are endogenously generated. In order for actors to interact within the service ecosystem, they need to develop the quality of reflexivity, which allows them to comprehend how norms, values, beliefs and expectations of their social environment, constrain or enable their interactions (Suddaby et al., 2016). However, not only the interaction in itself but the nature of interaction may additionally affect the evolution of an ecosystem's institutions, more particularly whether the interactions are loose (voluntary) or tightly (prescribed by contracts) coupled, a perspective which has been largely overlooked in the existing literature (Mustak and Plé, 2020).

3.8 Collaboration and alliancing

Throughout the years societies have become more interdependent, multi-nodal, multi-level, multi-logic and spreading across multiple sectors, involving a plethora of actors and practices (Bryson et al., 2017). In order to engage in processes of value co-creation across geographical boundaries, between different groups of people and inside and outside of organisations, collaboration becomes increasingly important (Akaka et al., 2024). Collaborations emerge as actors work together around shared problems that are a source of potential opportunity or threat (Baker and Nenonen, 2020). Thus, collaboration towards achieving a common goal and mutual benefits is the foundation of partnership (Le Pennec and Raufflet, 2018). Partnerships provide quicker access to assets and capabilities, with less resources spent and less risk acquired, especially in markets that the organisations have not developed core competences in (Deloitte, 2019). Within the partnerships, organisations share resources such as knowledge, human and financial capital, skills and expertise (Rathi et al., 2014). This access to novel resources and capabilities, serves both the individual and the collective interests of the partnerships (Iheanachor and Umukoro, 2022). More specifically, partnerships serve as a mean to mobilize resources that have been traditionally deemed as immobile (Lavie, 2006), allowing partnering organisations to gain rapid knowledge about a new capability or market without devoting an outsized investment of time or capital (Deloitte, 2019).

The definition of a partnership or a collaboration, is multifaceted and contextual. Collective action may be as intricate as a plethora of actors formally collaborating or as simple as two individuals mutually agreeing to work together (Baker and Nenonen, 2020). Actors form soft and hard contracts to collaborate within and outside organisations (Vargo and Lusch, 2010, p. 176). Hard law based contracts delineate legal obligations which are binding on the parties involved, while the term soft contracts denotes agreements, principles and declarations that are non-legally binding (European Center for Constitutional and Human Rights, 2024). Collaborations and partnerships can be joint ventures, franchising, long-term licensing contracts, reciprocal trade agreements, R&D partnerships or affiliations in consortia, among others (Lavie, 2006). Overarchingly and in the context of this research, I use the term alliance to include both hard and soft contract partnerships. Interorganisational alliancing agreements require coordination provisions that enable information sharing and joint planning between partnering actors, in order to ensure suitable timing and sequencing of actors, efficient combination of resources and capabilities, and rapid response to market changes (Gulati et al., 2012). As partnerships, alliances operate as collaboration ecosystems, which are gradually gaining increased importance as structures for value co-creation (Elo et al., 2024). Collaboration ecosystems can be defined as sociotechnical structures and networks of relationships that support interactions among interdependent participants within, across and outside of organizations (Akaka et al., 2024), where actors make conscious and intentional efforts to co-create value, coordinated by shared institutional arrangements, in order to gain mutual benefits (Elo et al., 2024). They are dynamic and constantly evolve (Baker et al., 2019).

3.9 Collaboration ecosystems

In collaboration ecosystems, actors while influenced with their personal qualities and intentions, initiate collaboration via interaction, and start operating as an ephemeral collective while morphing into a stable collective (Baker and Nenonen, 2020). They develop mutual agreement on who will take part in the collaboration ecosystem, which resources they are willing to contribute and how their personal goals and intentions will be aligned and governed (Randhawa et al., 2022). These actors, coming from diverse backgrounds continually process the complexities of constituting and maintaining a shared understanding while at the same time properly managing their collective efforts (Elo et al., 2024). These processes are influenced by the learning cultures of the collaborating actors, that reinforce the positive corelation between interorganisational collaboration and performance (Lindsey Hall et al., 2022). These processes of collaborating action occur in three phases: (1) coalescing, which involves determining the shared problem and end goal and selecting other collaborators,

(2) legitimizing, where actors negotiate and establish rules and common objectives, and finally the legitimised collective (3) manipulating the market via promoting the preferred arrangements (Baker and Nenonen, 2020). The collaboration ecosystem is continuously reconfigured by the partners, through restructuring the actors, resources and institutional arrangements in order to enhance the mutual value propositions (Randhawa et al., 2022). These value propositions, as well as the cocreated value created in the collaboration ecosystem, can solely be determined across the multiple levels by diverse organisational actors and may not align, as not all resources are valuable to all actors (Sebesta and Archpru Akaka, 2024).

Value co-creation within collaboration ecosystems, facilitated via collaboration engagement is guided by institutional arrangements that reflect the notion of interdependence and facilitated by collaboration technologies (Akaka et al., 2024). Collaborative engagement is mediated through normative elements such as shared values and norms (Elo et al., 2024). These institutions and institutional arrangements based on social and cooperative norms, that underpin the collaboration between partners, form the basis of the relational governance (Bicen et al., 2021) of the collaboration ecosystem and dictate how the differing goals between actors need to be aligned and governed (Randhawa et al., 2022). The latter is crucial, not only because collaboration is more efficient when actors share a common goal and make sincere collaborating efforts (Richey et al., 2012) but because misalignment or divergence of interests and incentives to join a partnership is the root of cooperation failures (Gulati et al., 2012). Institutional arrangements may be intentionally shaped, by collectives of actors through reflexivity and reformation, in order to aid the process of emergence of favourable co-creation forms (Vink et al., 2021). Institutional change materialises through collective agency and not through individual action (Baker and Nenonen, 2020).

3.10 Collective and individual agency

Intentional action conceived in collective agency is considered a fundamental form of social reality (Bertalanffy, 1968). Drawing from philosophy, (Bratman, 1992, p. 11) describes shared (collective) intentions as “state of affairs consisting primarily of appropriate attitudes (none of which are themselves the shared intention) of each individual participant and their interrelations”, while (Gold and Sugden, 2007) describes them as the product of a particular way of practical reasoning, team reasoning, where agency is attributed to groups rather than individuals. Collective action is significant due to (1) the multiplying effect that increases exponentially the power to get things done compared to individual agency, and (2) the access to the possibility of pursuing forms of actions, by their nature unavailable to individual agency (Bertalanffy, 1968)**.** Accordingly in service literature, more participants -interacting for their mutual benefit- are attracted within the value co-creation process leading to inter and intra organisational complexity that may create greater value (Akaka et al., 2024)**.** Collective agency is inherently moulded by individual agency, each individual acts on their own preferences and beliefs (Gold and Sugden, 2007)**.** Individual intentions involve a kind of reflexivity and constraint future actions to ensure the fulfilment of the individual intention in line with the individual’s beliefs (Bratman, 1992). Thus, individual intentions are not solely enablers of collective agency but additionally a source of challenges and constrains to the collaboration process. Additional issues related to individual intentions may stem from power and status imbalance (McGuire, 2006). In order to metamorphose individual to collective agency coordination is essential.

3.11 Coordination, communication, and alliancing capability

Coordination, the deliberate and orderly alignment or rearrangement of the actions of partnering actors to accomplish mutually agreed goals, is integral to the collaborative efforts of an alliance (Gulati et al., 2012). In order to establish a project alliance, one of the most important capabilities required by the partners is cooperation (Zhu et al., 2020), achieved via collaborative communication, the formal and informal integration of purposeful and timely information amongst actors (Anderson and Narus, 1990)**.** Communication encounters between partners transform information reciprocity and collaboration into value co-creation (Peltier et al., 2020). Partnering actors that share intense communication processes, orchestrate effectively their innovation procedures (Bicen et al., 2021). However, when miscommunication occurs significant issues arise within the collaboration (Dudau et al., 2016). Communication problems between actors -part of a service ecosystem, may lead to a decline in the collaboration ecosystem wellbeing and thus to value co-destruction (Plé and Chumpitaz Cáceres, 2010) and (Prior and Marcos-Cuevas, 2016.

As all service ecosystems, collaboration ecosystems are dynamic structures (Baker et al., 2019) that continually reconfigure. Dynamic capabilities are considered crucial in responding to changes in dynamic environments (Teece et al., 1997). Thus, in order to respond to the dynamic nature of collaboration, partnering organisations need to develop alliancing dynamic capabilities. Alliancing capabilities allow organisations to learn how to better manage alliances and how to perfect and re-apply inferences from one alliance to the next one (Porrini, 2004). They enable organisations to establish, structure and manage alliances (Draulans et al., 2003), by formulating a clear vision, identifying and establishing growth pathways and establish partnerships with rigorous diligence and effective negotiation (Deloitte, 2019). They are essential in order to avoid a decline in the ecosystem wellbeing, that maybe caused by cultural differences, existing organisational structures, knowledge and cognitive limitations of the partnering actors (Puranam et al., 2012). Alliancing capabilities, as all capabilities, are path dependent and lengthy to develop (Cardeal and Antonio, 2012). They become acquired characteristics embedded in organisational routines and thus can become an enabler of repeatable behavior (Schreyögg and Kliesch-Eberl, 2007).

Despite the increased need for alliancing due to the rapidly changing environment and increased demand for accelerating innovation rates (Deloitte, 2019), there is still limited understanding of how alliancing ecosystems work. There is limited research on the processes of value co-creation in alliances between digitally focused organisations, as well as the key factors of success and viability of such alliances (Elo et al., 2023) Additionally, there has been limited research on the way in which organisations engage in collaboration and how this impacts the broader ecosystem (Sebesta and Archpru Akaka, 2024).

While a research gap in alliancing capabilities literature has been long identified (Comi and Eppler, 2009)**,** there is still limited research on them, especially as key capabilities in collaboration ecosystems. Moreover, there is a significant gap in understanding how power dependencies between actors affect the interactions between partners within -and outside of- the collaboration ecosystem (Mustak and Plé, 2020). Particularly, by reviewing the literature there is an evident gap in the literature on empirical work, on collaboration ecosystems, especially context specific research, as effectiveness of collaboration capabilities may vary across industries or stakeholder ecosystems and collaborative efforts that may have positive outcomes in one context may not translate to another, due to contextual factors **Shahriar**. The ground work on understanding how actors engage in alliances from a managerial perspective has been largely set on (Gulati et al., 2012) and Cummings (1991) work, while (Madhavaram et al., 2024)**,** one of the seminal researchers on resource advantage theory, has recently started exploring collaboration capital as an aspect of supplier capabilities; and along with (Bicen et al., 2021; Hunt, 2020), the notion of innovation alliance performance. In service dominant logic literature, (Akaka et al., 2024) recently issued a call for conference paper on collaborative ecosystems. Elo et al.(2023) (2024)**,** along with (Sebesta and Archpru Akaka, 2024) and (Randhawa et al., 2022) are some of the few pieces of literature that discuss this. It is evident that research in alliancing service ecosystems has started gaining traction in the past years.

3.12 Limitations of SDL and gaps in the literature

From its initial conception in 2004, service dominant logic has been through a process of continuous refinement to arrive to its current form (Vargo and Lusch, 2016) and it continues to evolve (Vargo et al., 2023b). Nevertheless, its core has always remained the same, value is co-created via actor interaction that guides resource exchange, in service ecosystems (Akaka et al., 2013a). There are numerous studies that criticize SDL, in philosophical, epistemological, political and practice level. However, from the rapidly growing literature that uses the concept of SDL, it is evident that the interest in this theory is rising and diffusing across disciplines (Bhanja and Saxena, 2022). From a philosophical point of view SDL is cited to be insufficiently considering the cultural, societal and political aspects of consumers and consumption (Arnould, 2006; Flint, 2006; Schembri, 2006) through minimizing the importance of the political dimensions of markets (Hietanen et al., 2018) and downplaying the impact of cultural influence (Peñaloza and Venkatesh, 2006) Epistemologically, it is considered to present a unitary grand theory leading to overgeneralizations (Brown and Patterson, 2009; Grönroos, 2011) and demonstrates a lack of clarity in its nature, on whether it is positivist or interpretivist (O'Shaughnessy and Jackson O'Shaughnessy, 2009). Politically, SDL has been accused of catering to overt individualism and objectifying customers by using general assumptions to interpret individual behaviours (Brown, 2007; Schembri, 2006). Additionally, it has been accused of promoting the use of the subjugation of the consumer into free labour (Cova et al., 2011; Zwick et al., 2008) and of omitting the centrality of the materiality deriving from service provision (Campbell et al., 2013). Many of these critiques have been addressed in a smaller or larger scale through-out the years, however along with the gaps and limitations identified in sections 3.2, 3.7 and 3.11, there are two additional points that still pose limitations to SDL, overpositivity and applicability.

Service dominant logic terminology appears to be primarily positive (Hansen, 2019); Plé and Chumpitaz Cáceres (2010), with a lexicon that consists of terms with a positive connotation such as "strategic benefit", "value co-creation" and "beneficiary oriented". This is especially evident in how actors are not "being viewed as rather passive destroyers of value at the end of firm-created linear value chains" but rather as "participants who actively contribute to ongoing value cocreation processes" (Vargo et al., 2023b, p. 3)**.** *Disregarding the negative effects of value co-creation (negative value co-creation or value co-destruction) (Plé and Chumpitaz Cáceres, 2010), or the negative effects of the decline of an ecosystem's wellbeing may lead to false expectations and even affect negatively the process of value-cocreation.* On the other hand, there have been limited efforts to address this by re-defining value as a positive or negative change in the viability of ecosystem wellbeing (Vargo et al., 2023a). However, this dichotomy demonstrates the existence of solely two extreme outcomes, while there needs to exist a spectrum of value outcomes (Wang et al., 2019). Furthermore, Mustak and Plé (2020) identifies three aspects of positive bias in SDL: first, mutual value creation constitutes ex-ante a positive resolution of both the process and the outcome; secondly, the axiom that service ecosystem actors operate under the same institutional arrangements implies that institutions always facilitate or optimise actor's interactions and lead to positive value outcomes and thirdly that actors have both the ability and willingness to integrate their and other's resources.

On a practical level, SDL has been cited to lack managerial reflexivity and applicability to the managerial practice (Brodie et al., 2006; Brown and Patterson, 2009), failing to account for practice based aspects and long-term results (Arnould, 2014). Additionally, despite the increased research in SDL in the past years, that has led to the continuous advancement of the theory (Vargo et al., 2023a)**,** understanding of the way in which an organisation can embed SDL in their thinking, is limited (Chou et al., 2023) and appears under researched. The limitations related to the applicability of the theory may be related to the limited number of studies that are based on empirical evidence, especially in proportion to theory focused research. There is a need for empirical studies applying and challenging theoretical frameworks in order to avoid perpetuating terminologies that may not be suitable for analysis of evidence based research (Hansen, 2019)**,** particularly related to value in diverse possibilities of collaborative conditions (Wang et al., 2019). This thesis addresses these limitations by studying cross-actor collaboration in diverse projects, through empirical data.

3.13 Other theories explored: Service logic, Network theory, Consumer culture theory

As seen above, as a novel theoretical framework that is still evolving, the service-dominant logic presents some limitations. A number of other theories were studied before selecting SDL, three of which are presented in this section. These are the service logic, network theory and consumer culture theory.

Naturally, since smart cities as a sector are largely dependent from service provision, both as providers and as users, the first theory explored was the service logic. Service logic is the "study of service systems, which are dynamic value co-creation configurations of resources (people, technology, organisations and shared information)" (Maglio and Spohrer, 2008, p. 18). Service science is advocating a more rigorous, interdisciplinary science and systems approach to the complexity of service, with a focus on business-to-business service exchange, and for the pursuit of innovation, while at the same time it is putting a strong emphasis on technical sophistication (Bowen, 2016). The service logic supports that different type of actors, co-create value in different ways. Customers create value both interdependently and independently, while service providers facilitate customer value creation and further interact with customers to co-create value (Grönroos and Voima, 2013). Consequently, according to the service logic, it is important to capture the complexity of many different relations and roles occurring before, during and after the service encounter, while at the same time recognizing that all actors involved are simultaneously independent and interdependent acting entities in the process (Grönroos, 2011).

While SDL has its root in the service logic, they demonstrate two fundamental differences. The two logics different in the nature of value creation, as in SDL value is always co-created (Vargo and Lusch, 2016) while service logic distinguishes between value facilitation, value creation and value co-creation (Grönroos and Voima, 2013), where the customer is the value creator (Grönroos, 2011). The second fundamental difference, between the two logics, lies in their approach to analysing processes (Holmqvist and Diaz Ruiz, 2017), as SDL highlights the fundamental connection between the levels of analysis (micro, meso, macro), meaning that analysis on the macro-level is axiomatically imperative to understand the ecosystem, as its characteristics – such as institutions- cannot be holistically studied in the micro-level. On the other hand, service logic argues that micro-level analysis allows for more in-depth interpretation to be carried out (Grönroos and Gummerus, 2014). While this research had as a starting point studying interactions at the micro-level, its aim is to draw conclusions that extend to the macro-level as well. In order to be able to achieve this, the institutions that govern service exchange need to be studied as well. Consequently, service-dominant logic appears to be more suitable for this study, than service logic.

Since the goal of this research is to study value co-creation within the smart city sector, an interdisciplinary and highly connected network, Network Theory was one of the first theories studied. Network theory includes mechanisms and processes that interact with network structures to produce certain outcomes for individuals and groups (Borgatti and Halgin, 2011). It regards the consequences of network variables, such as the ties and central location of the firm (Brass, 2002). The key elements of all networks are the nodes, the hubs, links and interaction. The nodes are the representation of anything of significance to describe and explain a phenomenon, while the hubs are highly interconnected nodes (Gummesson, 2007b).

Part of network theory, are business networks. Business networks are formed by nodes, connected to each other by ties (Håkansson and Ford, 2002). Nodes represent actors in the market, for example firms, while ties represent the business relationship between these nodes. Firms exercise influence in the network by managing the respective importance of other nodes through business relationships (Ford and Håkansson, 2006). They manage the network through influencing the facilitation of entry of new actors, removal of existing actors and managing where the actors are positioned within the network (Cantù et al., 2012). Close collaboration between the firms of a business network will facilitate the development of new resources, unavailable to actors external to the business network (Cohen and Levinthal, 2000). These resources will also be unavailable to each of the participating firms separately from the network (Gulati and Nickerson, 2008). Resources include: assets, capabilities, bargaining power and knowledge that can improve efficiency and effectiveness (Cohen and Levinthal, 2000).

There are two main generic outcomes of network theory. The first one can be broadly referred to as choice, meaning behaviours, attitudes, beliefs or internal structural characteristics regarding organisations. The second is success, such as performance and rewards, on node or holistic network level (Borgatti and Halgin, 2011). The way in which network theory studies resources and behaviours, is particularly fitting with the purposes of this study and as such it could be used to study smart city networks. The SDL was favoured over network theory for two main reasons. Firstly, smart cities are still a developing sector and the business networks have not been clearly set, thus the boundaries of the network are blurred and can be determined difficultly. This means that the behaviours and attitudes within the network can be also studied with much more difficulty. SDL offers more loose structures that have the ability to study the recursive properties of the network/ecosystem, in a more dynamic way (Vargo and Lusch, 2017). As relationships in smart city networks are still being developed, there is no reason, at this moment, to distinct between nodes and hubs, as this can rapidly change, so the loose way in which actors are represented in service ecosystems fit the purposes of a highly dynamic research, more.

Another framework explored, was the consumer culture theory (CCT). CCT is a theory based on the study of the cultural aspects of consumption (Arnould and Thompson, 2005). This theory largely draws from midrange theories stemming from anthropology, sociology and other theories such as culture theory, identity, symbolism, social class, ethnicity, ritualism, critical and media theory, environmental influence, and semiotic and literary critical theories (Vargo et al., 2023b). This area of research studies market-related experiences beyond specific encounters between firms and customers through extending the temporal and social scope of experience and studying it through a cultural frame (Akaka et al., 2015). In CCT cultures are not pre-developed or static but rather composed by heterogeneous meanings and multiple viewpoints, and are largely overlapping and constantly evolving (Arnould and Thompson, 2005). For the study of value co-creation, CCT and SDL have been viewed as “natural allies”, by Arnould (2007) due to their complementary views on resources and value. The focus of CCT on the consumer does not explicitly reflect how a smart city works, as smart city actors often create value through the provision of non-consumerism based services. On the other hand, the broad nomology and non-consumer based terminology of service dominant logic, better suit the purposes of this research. Nevertheless, useful insights of CCT can be used in this study to understand the consumer ideology of the civic society in relation to services/products offered by the industry in a micro level of interactions.

4 Resources

From the chapters above, it is evident that the integration of resources by the actors of a service ecosystem, is the basis of the process of value co-creation (axiom three of SDL). Studying the resources exchanged and integrated between smart city actors is a crucial step in identifying how value is co-created in innovation centric service ecosystems, such as smart city ecosystems. While the subject of resources has been discussed in section 3.6 and alliancing capabilities in section 3.11, this chapter explores the foundation of the theoretical perceptions around resources how these delineate, affect and dictate innovation-driven service ecosystems.

4.1 Resource theory

Resources have been the subject of extensive research in multiple fields in academia, for the past 70 years. In management they are "the things an organisation depends upon and that are means to attaining its objectives" (Constantin and Lusch, 1994). They are the assets, capabilities, organisational processes, firm attributes, information, knowledge and others controlled by an organisation, that allow the firm to create and implement strategies that may impact its efficiency and effectiveness (Daft, 2007). They can be categorized as financial, physical, legal, human, organisational, informational and relational (Hunt and Madhavaram, 2020).

In management science, as well as in marketing, all conceptualizations of resources have configurated between the notions of material, ''raw'' resources and immaterial, dynamic resources (Campbell et al., 2013), commonly referred to as tangible and intangible resources, accordingly. In essence, in enterprise management tangible resources appear on the balance sheet as assets in the form of money, inventory buildings and other "hard infrastructure" (Constantin and Lusch, 1994). They can be financial, organisational, physical and technological (Hitt et al., 2010). They are inert entities with the potential to be exploited to advantage (Campbell et al., 2013). On the other hand, intangible resources are typically not found on the balance sheets and include a multiplicity of concepts such as design, financial management and accounting, human resources and personal and organisational skills, as well as institutions, branding and access to markets (Constantin and Lusch, 1994). They are categorised as human -which includes knowledge, skills and organisational routines; innovational -including ideas and innovation capacity; and reputational, such as brand reputation and perceived quality (Hitt et al., 2010). These tangible and intangible actualities, which in a managerial context are available to the organisation, enable the organisation to effectively develop a market offering that can become a value proposition (Hunt, 2000). In order to comprehend how this is possible, the foundational premises of resource theory need to be explored.

There are certain types of resources whose nature makes them challenging to categorize in operant or operand, such as social roles and technology. Social roles may be considered as resources because they generate expectations for the service exchange (Solomon et al., 1985) and produce unique social positions (Baker and Faulkner, 1991). Social roles can be viewed as operant resources when they are regarded as capable of influencing other resources, while they can be conceptualized as operand when they are enacted upon from other resources to achieve predetermined expectations (Archpru Akaka and Chandler, 2011). Drawing from the seminal study of Akaka and Chandler (2011), Sebesta and Akaka (2024) further conceptualises roles as sets of practices that may affect the stability and change in service ecosystems and highlights their dependant from the resources, actors have access to. Studying roles allows for a deeper understanding in how relationships between actors are formed and consequently how ecosystems emerge (Randhawa et al., 2022). Ambiguity of roles may hinder the process of value co-creation (Mele et al., 2018). In the context of this research, roles are considered as resources which are dynamic, fluid and critical in the process of forming lasting institutions (Archpru-Akaka et al., 2023).

Likewise, technology is becoming increasingly challenging to categorise. This is due to the way in which it is blurring the lines between services and products (Bhanja and Saxena, 2022). However, the operant or operand debate on technology is more of philosophical in nature and regards the advancement of machine learning and artificial intelligence, as in certain circumstances technology may take the form of an operant resource. In such cases literature debates whether operant resources presume the existence of human agency (Kleinaltenkamp et al., 2012).

4.1.1 Operand and operant resources

Firms as all organisations can be described as a collection of physical and human resources, heterogeneously distributed across them (Penrose, 1959). At the foundations of resource management, Zimmerman (1933) conceptualises resources as natural, human, and cultural and studied the interactions between them, that led to them being transformed into sources of support and means to satisfy wants and needs of humans. Resources also derive from the interaction between humans and their environment, as humans have the capacity to make use of presented opportunities (Zimmermann et al., 1972). Zimmerman (1933) observed that there was an inclination towards characterizing resources as mostly tangible, to the disfavour of intangible ones, which led to the exclusion of cultural and human resources and additionally led to resources being perceived as single assets instead of an interactive system. Possibly Zimmerman's most popular quote is that "resources are not, they become", opening the discussion on the nature of tangible and intangible and whether this distinction is adequate in effectively distinguishing and evaluating resources. On the basis of this, along with the notion that the division of resources into tangible and intangible may "allow some hybrid resources to fall in the cracks" (Constantin and Lusch, 1994), resources are conceptualised as operand and operant, meaning:

- operand resources were perceived as resources upon which an operation is performed in order to produce an effect, while
- operant resources operate on another resource to produce an effect.

The transition between tangible/intangible and operand/operant is not solely a change in the terms but a change in the way of distinction. Operand resources do not only include the tangible elements -“hard” infrastructure etc-, but also many of elements traditionally described as intangible, such as design, branding, data, intellectual property and virtual digital infrastructure. Operant resources on the other hand, include many intangible elements in addition to capabilities (such as skills, knowledge, gaining market insight etc).

The distinction between operand and operant resources is essential as they fundamentally differ in the type of underlying assumptions and consequently in the way in which they can be analysed in order to influence the decision-making process, the policies and other pivotal choices related to the strategic management of an organisation (Constantin and Lusch, 1994). Their differences are summarized in Table 3. Operand resources are typically physical (materials, natural resources) (Hunt, 2004), basic and “hard” and have been characterised as static and finite (Lusch and Vargo, 2006). On the other hand, operant resources are typically human (skills and knowledge), organisational (routines, cultures, competences), informational (knowledge) and relational (relationship with other actors of the ecosystem) (Hunt, 2004), “soft”, dynamic and infinite (Vargo and Lusch, 2004). They can be described as competences or processes (Lusch and Vargo, 2006) and capabilities and dynamic capabilities (Constantin and Lusch, 1994). By definition they generate effects and enable value-creation through the transformation of inert operand resources and other operant resources (Lusch et al., 2008). Thus, operant resources are able to provide strategic benefit to organisations (Fuentes and Smyth, 2016) and appear to not only be pivotal in the process of ongoing value co-creation, but also the key to the advancement of new avenues of creating value (Akaka and Vargo, 2014).

Table 3 Differences between operant and operand resources

	Operand resources	**Operant resources**
(Constantin and Lusch, 1994)	Something an operation is performed on to produce an effect	The resource that operates upon another resource to produce an effect
	Basic, hard	Soft

	People (human operational capital), money, machines and materials, or institutions such as wholesalers who distribute products	Knowledge, skills, technology or concepts for the use of people, money, machines and materials; or the skills and concepts related to an institution such as a wholesaler; and information
Zimmerman (1933)	Non-renewable resource	Renewable resource
	Neutral till operand applied on them	Applied on operand
Hunt (2004)	Financial (money-related resources and access to financial markets), physical (infrastructure and equipment), legal (trademarks and licenses)	Human (skills and individual knowledge), organisational (culture, competencies and policies), informational (consumer knowledge, competitive intelligence), and relational (relationship with other players)
Vargo and Lusch (2006)	Static and finite	Dynamic and infinite
Maglio and Spohrer (2008)	Resources as property (technology and shared information) Physical entities (people and technology)	Resources with rights (people and organisations) Socially constructed resources (organisations and shared information)
Barney (1991)	Physical	Human and organisational capital

4.1.2 Capabilities as resources

As described above, the process of value co-creation is facilitated by operant resources which include competences or processes and capabilities and dynamic capabilities. In SDL capabilities and competences are types of higher order resources, which are essentially configurations and bundles of basic resources (Hunt, 2000). However, Day (1994) conceptualises these as something that exceeds resources, rather as complex bundles of skills and collective learning, applied through processes that enable organisations to coordinate -or secure the superior coordination- of endeavours, and utilise their assets. They have been explained as the ability of a firm to utilise its operant resources in an effective way in order to achieve a goal (Nenonen and Storbacka, 2010). The terms capabilities and competences have been used interchangeably (Hunt and Madhavaram, 2023), however Hunt (2020) and the Resource-Advantage theory conceptualise competences as higher order of resources that will be described below as Interconnected, operant resources. Accordingly, capabilities have been described as operant resource-based capabilities, where they have been theorized, through a combination of the resource based view and SDL, as resources that are not operant per se, but in possession of characteristics of operant resources, as they act upon other operand and operant resources to generate effects (Ngo and O'Cass, 2009). In other cases capabilities are presented as something that needs to be combined with resources, in order for the value potential of the latter, to emerge (Sirmon et al., 2007). Subsequently, in order to provide theoretical clarity between dynamic capabilities and 'ordinary' or operational capabilities (that is, those presented in the resource-based view), a distinction between the terms needs to be established (Ambrosini and Bowman, 2009).

Dynamic capabilities can be defined as the specific processes through which organisations reconfigure their resources and operational routines (Zahra et al., 2006). In themselves, they have been the focus of many theorisations and discussions (Barreto, 2010) both in the field of strategic management and in resource management. Operational capabilities are routines -or a set of routines- that focus on the operational functioning of the firm and include both human capital and operational activities (Winter, 2003). Dynamic capabilities appear to be developed by organisations, to create, process and attain resources in the long term (Ambrosini and Bowman, 2009), while operational ones appear to be capabilities related to how an organisation currently operates (Cepeda and Vera, 2007). This is because dynamic capabilities appear to be primarily related with change (Winter, 2003) and rate of change of ordinary capabilities Collies (1994). These changes in organisational processes occur through the dynamic capabilities modifying operational capabilities (Cepeda and Vera, 2007).

Thus here, a parallelism can be drawn between how operant resources (dynamic) act upon operand resources (static) to produce value, and how dynamic capabilities (forward looking) modify operational capabilities (current) to drive change in organisational processes.

4.2 Hierarchy of resources and competitive advantage

One of the foundational premises of SDL dictate that operant resources are the fundamental source of strategic benefit (Foundational Premise 4) (Vargo and Lusch, 2016) and a source of competitive advantage (Madhavaram and Hunt 2008). An organisation has a competitive advantage when operationalising a strategy that creates value and is not simultaneously being implemented by other actors in the market, while this becomes a sustained competitive advantage when in addition to this, the other actors in the market are unable to imitate the benefits of this strategy (Barney, 1991). Competitive advantage is achieved solely through the ability of an organisation to develop capabilities that facilitate the proper coordination of the rest of the resources effectively (Eisenhardt and Martin, 2000)**.** This strategic capability is deemed as a superior operant resource, that is significant in actualising value-in-context with the rest of the actors of the ecosystem (Karpen et al., 2012).

There are two capabilities that are deemed particularly important in achieving the creation of competitive advantage, in organisations influenced by contextual externalities, according to (Day, 1994):

- The organisation's market sensing ability, which is related with the ability of an organisation to sense shifts in the market, prepare accordingly, and anticipate the responses of the other actors of the ecosystem;
- The customer-linking capability, which includes the skills, abilities and processes to nurture relationships and collaborations with the customers in order to rapidly identify their needs.

Barney (1991), identifies four main attributes that deem resources a source of competitive advantage:

- Value - resources should be valuable,
- Rareness - they must be rare in comparison with the current and future competition
- Inimitability - they must be imperfectly imitable
- Non substitutability - there cannot be other resources that may substitute this resource that are valuable but are not rare and imperfectly imitable.

Value is a rather elusive concept, that has been the subject of extensive studies and diverse theorizations. In a rather dated approach, a valuable resource can be described as one that enables an organisation to perform actions that will lead to the generation of economic value (Fiol, 1991). According to Barney (1991) resource generates value if it drives the exploitation of opportunities and the neutralization of potential threats. On the other hand, from a service theory perspective, SDL prescribes that value is uniquely and phenomenologically determined by the beneficiary of a service (Vargo and Lusch, 2016). By extension, the value of a resource can, also, uniquely be determined by the beneficiary of the resource. Consequently, a resource that may be of value to one organisation, may be of no value to another organisation (except its value-in-exchange). However, regardless of how valuable a resource might be perceived as, if other competitor organisations own it, they might implement similar value creating strategies, leading to the loss of competitive advantage (Cardeal and Antonio, 2012).

In addition to rare, a resource must also be inimitable. Inimitability may be the result of the social complexity of the resource, of its connection to unique historical conditions or it may result from the casually ambiguous connection between the resource and the competitive advantage (Gibson et al., 2021). Finally, if a resource possesses all these attributes, but there is another similar resource that can substitute it, which is accessible and easy to imitate, then that resource is no longer a source of competitive advantage (Wright et al., 1994). The attributes of value, rareness, inimitability, and non-substitutability are not universal constraints but characteristics vulnerable to unpredictable changes in the environment (Newbert et al., 2008). Consequently, the process of creating and maintaining a competitive advantage is a dynamic and continuous activity (Hung et al., 2010).

There are six types of resources that appear to be significant sources of competitive advantage in the international market, all of which are operant. These are: reputational, human, cultural, relational, informational and access to financial resources (Morgan et al., 2006). While on a first glance the latter might appear operand, it refers to the capability of an organisation to have access to financial resources and not to the financial resources themselves.

To avoid confusion, it is imperative to highlight, that no single resource can lead to the creation of a competitive advantage (Enz, 2008). Multiple resources which are heterogeneously distributed need to be properly bundled in order to be a potential source of competitive advantage (Hunt and Morgan, 1995).

4.2.1 Hierarchy of resources

From the literature above, it is evident that operant resources appear to have a hierarchical superiority to operand resources (Campbell et al., 2013). Numerous authors argue that resources can be arranged in hierarchical order (Collis, 1994; Danneels, 2002; Hunt, 2000; Winter, 2003). Madhavaram and Hunt (2008) have created a hierarchy of operant resources in the context of the SDL. These are:

- Basic, operant resources;
- Composite operant resources; and
- Interconnected, operant resources.

All operant resources appear to be combinations of basic and operant ones, nevertheless the higher the hierarchy, the more interconnected the resources are, and the more difficult it is for competitors to obtain or develop (Figure 2) (Hunt and Madhavaram, 2023). Vargo and Lusch (2004) from an SDL perspective, support that operant resources have a primacy over operand due to their capability to generate strategic benefit (Foundational Premise 4) and sustained competitive advantage through attributes such as value, rareness, imitability, and substitutability (Arnould, 2008). As resources move towards the top of the hierarchy in Figure 2, the more competitive advantage they generate via rareness and imitability and they increase in terms of their cost and time of acquisition and development, and commitment of the organisation to resource development (Madhavaram and Hunt, 2008). How valuable a resource is can be evaluated based on shared institutions or social structures that influence the interpretation of experience and actions among actors (Vargo and Lusch, 2011). Nevertheless, they underline that value creation is mediated by operand resources (Akaka et al., 2015) and that the importance of natural or national resources, or the need for import and export of tangible goods is not decreased (Lusch and Vargo, 2006). On the contrary, through an extensive literature review (Campbell et al., 2013) has identified that due to the excessive amount of studies that focus on the conception of operant resources as dynamic and infinite, there is an observable neglect to consider that for each immaterial competence, skill and dynamic operant resource that is developed, there is a significant composition of material formations already in place. Consequently, the significance of operand resources should not be neglected or undermined, because they operate as the foundation of the process of resource integration.

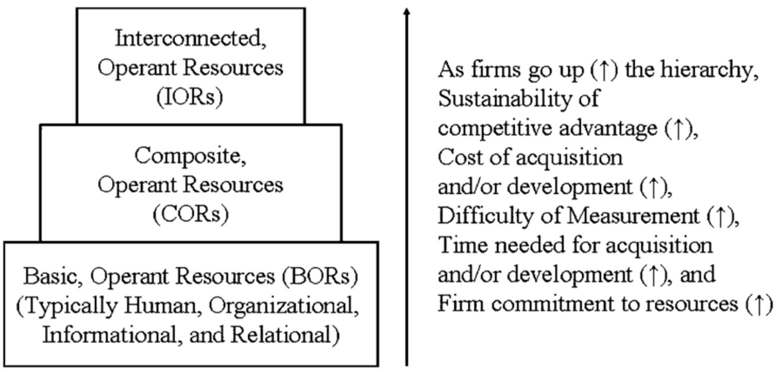

Figure 2 A hierarchy of operant resources. Source: Madhavaram and Hunt (2008) pg 70

4.2.2 How do we identify the hierarchy of a resource?

Summarising the review of the literature above, the following points can be observed:

- Resources can be classified as: Basic, operand resources; basic, operant resources – lower level resources, building blocks of higher level; composite operant resources, combination of two or more basic resources with low level of interactivity; and interconnected, operant resources, combination of two or more basic resources with significant levels of interactivity.
- Operant resources are deemed superior to operand
- The superiority of a resource depends on their ability to create a competitive advantage
- The source of competitive advantage is the attributed value, rareness, inimitability and non- substitutability
- The value of a resource is determined by the shared institutions of the service ecosystem

4.2.3 Value co-creation through resourcing

Resources may solely be a source of competitive advantage or sustained competitive advantage when they are valuable (Barney, 1991) to an organisation. A resource can be valuable in a particular place and time; which is heavily influenced by the shared institutions that govern the service ecosystem of the organisation (Vargo and Akaka, 2012). These shared institutions also delineate the way in which resources may be accessed, adapted and integrated in a specific context. This is because the process of value co-creation (Figure 1) dictates that, organisations co-create value through integrating resources and exchanging services via interactions between each other and such interactions are enabled and constrained by institutions and institutional arrangements (Vargo and Lusch, 2016). Thus, interaction is established as the element that defines the process of resource integration

(Coimbatore K Prahalad and Ramaswamy, 2004). There appear to be six capabilities that facilitate the process of value co-creation via interaction (Karpen et al., 2012). Those interaction capabilities are:

- individuated interaction capability – comprehending the individual service processes, contexts, and goals of the beneficiary (attributed customer)
- relational – enhancing the social and emotional connection in the service processes
- ethical – engage in non-opportunity service encounters
- empowered – enable customers to participate actively in the co-creation process
- developmental – support the development of knowledge and competences of the customers
- concerted – enable the provision of coordinated and integrated service processes that involve customers

According to the process of value co-creation described above, value occurs when a potential resource is transformed into a particular benefit, an activity defined as resourcing by (Lusch et al., 2008) and presented below. There are three aspects to resourcing:

- **Resource creation**: operand and operant resources, unequivocally are bound by human knowledge and dexterity. This is in line with the axiom of SDL that dictates that value is determined solely by the beneficiary (Vargo and Lusch, 2016) and consequently their skills and abilities;
- **Resource integration:** value co-creation stems from the integration of resources by the economic and social actors of the service ecosystem (axiom three) (Vargo and Lusch, 2016);
- **Resistance removal**: actors having the ability to remove the resistance of potential resources in order to render them useful. The actors often need to remove the resistances of other actor groups (users, consumers, beneficiaries etc,). The neutrality of resources, thus resources not being used, may become such a resistance.

Resource creation and resistant removal act as enablers to resource integration. Resource integration which is enabled through interaction, is considered as the process that enables value co-creation between actors in service ecosystems (Vargo and Lusch, 2004).

4.2.4 Resource integration via meaningful interaction

This process is regulated by institutions that influence value co-creation by delineating what might be perceived as a valuable resource in a particular place and time, as well as the way in which these resources may be integrated according to a specific environment (Akaka et al., 2012). These shared institutions emerge from the ecosystem and are influenced by each and every interaction taking place in it (Vargo et al., 2023a). These service ecosystems are influenced by the complexity of the social context in which they operate (Chandler and Vargo, 2011). More specifically they are influenced by three factors, the diversity of resources, the multiplicity of institutions and the numerous practise existing within a given context (Akaka et al., 2013b). However not all interactions result in positive value outcomes, as the interactions might lead to value co-destruction (Järvi et al., 2018). Value co-destruction occurs when the interaction between actors of the same ecosystem results in the decline of the well-being of at least one of the actors (Plé and Chumpitaz Cáceres, 2010). This decline in well-being, which is a precursor to managerial project failure, may be determined by the way in which the cultural resources of knowledge, concepts and information are managed (Constantin and Lusch, 1994). In general it is suggested that socially constructed resources have been proven exponentially significant as a mechanism of value co-creation (Spohrer and Maglio, 2010). Thus, interaction needs to be meaningful in order for positive value co-creation to occur. Meaningful interaction requires: focusing on value-in-context, viewing other actors as social relationship partners, being interested in ethical values that will have long term effects, focusing on co-production, understanding that the other actor's accessible resource can act as the basis of value realization and comprehend the interlink between the processes of resources integration that are actors are part of (Karpen et al., 2012).

4.2.5 Synopsis of the theoretical framework

As the theoretical framework delineating this research, is the Service Dominant Logic, this chapter views resources as operand and operant and considers capabilities as a type of operant resource that is a configuration -or bundle- of resources (Figure 3). These capabilities are either operational -related to how an organisation currently operates-, or dynamic -related to how an organisation will respond to future changes. While there have been multiple studies on how dynamic capabilities transform an organisation, there is limited research on the effect of dynamic capabilities on the wider ecosystem (Nenonen et al., 2019). Understanding, how capabilities, as a type of resource, affect the service ecosystem, thus appears to be crucial in identifying how value is co-created within it.

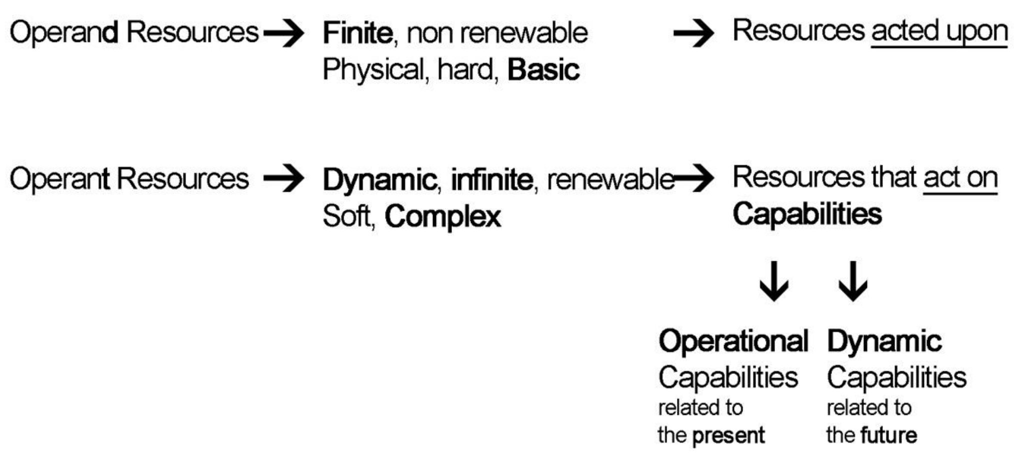

Figure 3 Conceptualisation of key constructs used in analysis

5 How SDL can be used to study smart city organisations

5.1 Smart city development according to the SDL axioms

As described in the previous chapters, the Service Dominant Logic goes beyond a theoretical framework, as it provides a novel perspective in how economic activity is perceived as a whole (Vargo and Lusch, 2017). Any exchange is considered a service exchange. However, it appears particularly fitting to act as a lens for studying value co-creation in smart cities. Cities worldwide are rapidly transforming into artificial ecosystems of interconnected, interdependent organisms that can act in an intelligently coordinated manner (Yovanof and Hazapis, 2009). Public and private sector societal actors work together to achieve a common goal. In other words, they operate as an ecosystem in order to accomplish their objectives through value co-creation (Letaifa, 2015), just like a service ecosystem where value is co-created through individual and organisational interaction (axiom two of SDL) (Greer et al., 2016). Smart cities are considered territories of high innovation and learning capacity. Innovation is one of the key dimensions of the smart city and can be technological, organisational or policy based (Nam and Pardo, 2011a). They are a fertile environment to foster technological, managerial and organisational innovation, while working towards environmental and social wellbeing (Polese et al., 2021). In order to transform urban environments into smart cities, innovation in planning, management and operations is essential (Naphade et al., 2011). SDL argues that all types of innovation involve some kind of service exchange and that the combination and integration of resources determine the boundaries of innovation. This is because innovation stems from integrating resources in unique and novel ways (Greer et al., 2016). By utilizing technology in an intelligent and coordinated manner (Barrionuevo et al., 2012), the smart city ecosystem can provide these innovative solutions in the form of advanced, user dominant and user co-created services to its citizens (Yovanof and

Hazapis, 2009). The user centricity and adaption of smart cities (Marsa-Maestre et al., 2008) is coherent with the first axiom of the service dominant logic where resources are utilized for the benefit of another entity (beneficiary).

Having described the fundamental principles of SDL The following sections will argue how SDL illuminates the process of value co-creation in smart city ecosystems through exploring the way in which resources are integrated by smart city actors, the institutions and institutional arrangements that coordinate these integrations, and finally the levels of interactions between the actors.

5.2 Smart city service ecosystems

5.2.1 Resource integration

Value co-creation stems from the integration of resources by economic and social actors (axiom three). Smart cities utilize a synthesis of resources from their societal actors in order to innovate in the knowledge economy and society (Dameri, 2017). Numerous resources can be identified in the smart city literature as can be seen in Table 4. These can be tangible or intangible. Tangible resources include technologies (Barrionuevo et al., 2012), such as information and communication technologies (ICT) (EIP-SCC, 2013) as well as sensors and automated systems; a city’s hard infrastructure (Caragliu et al., 2011) including roads, bridges, railroads and others; and data and information which are typically infused in the city’s infrastructure (Nam and Pardo, 2011a) in order to facilitate the provision of services. Additionally, they include financial and environmental capital (EIP-SCC, 2013) such as energy and raw materials. Intangible resources include human capital (Caragliu et al., 2011) such as a skilled labour force (Kourtit and Nijkamp, 2012), social capital (Caragliu et al., 2011) such as culture and societal values and entrepreneurial capital force (Kourtit and Nijkamp, 2012), which comprises of leadership, knowledge and education among others. In the service dominant logic, resources such as knowledge, skills and competencies are characterized as operant, because they have the ability to act on other resources to create value, while resources such as raw materials, infrastructure, goods and money -thus resources of a tangible nature- are characterized as operand because they can be acted upon in order to create value (Akaka et al., 2015). Operant resources are regarded as the fundamental resources of economic and social exchange (Chandler and Vargo, 2011). The value and importance of each of these resources is determined by the social structures that dictate the actions and interplay between actors (Chandler and Vargo, 2011).

Table 4 Tangible and intangible smart cities resources as resulting from the literature review.

Resource	What it includes
Tangible Resources	
Information	Data Intellectual capital
Technologies	Information and Communications Technology (ICT) Web 2.0 Technology Sensors Automated systems
City infrastructure	Physical infrastructure Services
Financial Capital	
Environmental Capital	Energy Raw materials
Intangible Resources	
Human capital	Skilled labour force
Social Capital	Culture Societal Values
Entrepreneurial Capital	Leadership Knowledge Education

5.2.2 Interaction between smart city actors

The current, albeit limited, literature suggests that operant and operand resources are combined by the smart city societal actors in order to achieve a common result, a smarter city. Operant resources are likely to be dynamic and infinite while operand ones are frequently static and finite (Vargo and Lusch, 2004).From an SDL perspective, operant resources appear to have a primacy over operand due to their capability to generate strategic benefit (Vargo and Lusch, 2004) and sustained competitive advantage through attributes such as value, rareness, imitateability, and substitutability (Arnould, 2008). Nevertheless, value creation is mediated by operand resources (Akaka et al., 2015) and the importance of natural or national resources, or the need for tangible goods is not decreased (Lusch and Vargo, 2006). How valuable a resource is can be evaluated based on shared institutions or social structures that influence the interpretation of experience and actions among actors (Vargo and Lusch, 2011).

In smart cities, operant and operand resources are being used in an intelligent and coordinated manner to develop integrated, habitable and sustainable urban centres (Barrionuevo et al., 2012). These are integrated by actors in the smart city ecosystem in diverse configurations. Configuration of resources can be defined as a set of resources available for an intended actor (Edvardsson and Tronvoll, 2013). The complexity that characterises urban systems in combination to the multiplicity related to the amount of diverse stakeholders who have formed dependencies and interdependencies that deeply affect the urban environment (CISCO, 2012), leads to a very high amount of various configurations of resources. To better understand these, they can be presented in a simplified manner per actor group.

The three main organisational and institutional actors in smart cities are universities, industries and governments (Cocchia and Dameri, 2016). Universities and research centres, as entities, were the first actors to study and experiment with pilots and models of smart city. They use urban data sourced from citizens as well as planning authorities, in order to analyse and develop models and theories (Cocchia and Dameri, 2016).

Industry actors make value propositions through the transformation of user-data-driven research and academic output into products and services (Cocchia and Dameri, 2016) as they create exploratory alliances in order to benefit from sharing resources (Möller et al., 2005). Firms frequently enter in such alliances with various public actors such as universities and research centres, as well as with different city-scaled governmental players, with the aim of augmenting the probabilities of developing new technologies and services (Sandulli et al., 2017).

The government is both a regulator of the industry and an active player (Cocchia and Dameri, 2016). Government at the city level has the role of planning and implementing the smart city vision. They coordinate, organize and regulate the other actors part of their ecosystem (European Parliament, 2014). The final actor is the smart city user who, frequently, through personal devices and other equipment (Harrison et al., 2010) provides invaluable data that co-create value through information use and re use (Komninos, 2008). Citizen data are usually collected by using sensors, kiosks, meters, smart phones and smart appliances w and are analysed with various software (Harrison et al., 2010). Without such resources the smart city ecosystem cannot function. The participation of citizens in the ecosystem goes far beyond providing data, as they are the human engine of a city and have a behavioural influence on its historical as well as cultural heritage (Zygiaris, 2013), thus additionally influencing the norms under which co-creation of value occurs. Citizen engagement in smart city initiatives is essential in the design and planning process (Batty et al., 2012) and in the co-production of goods and services (Paskaleva, 2011).

5.2.3 Technology, service innovation and the need for alliancing

As described in section 4.1 smart cities are territories of high innovation (Nam and Pardo, 2011a). The current pace of technological innovation has been unprecedented (PWC, 2024). SDL is considered particularly valuable in studying service innovations due to its broad nomology and overarching perspective, guided by its foundational premises, which complement other theoretical approaches to innovation (Ordanini and Parasuraman, 2011). Additionally, it has been established in the second chapter that technology plays a major role in smart cities. Technology in service innovation has a dual role, as both an operant resource, acting upon other resources to enabling value creation and as an operand resource, having the role of a facilitator (Lusch and Nambisan, 2015).

Studying innovation from an SDL perspective, the focus of its definition shifts from "production of innovative products to resource integration and enhanced value propositions" (Michel et al., 2008, p. 65). Service innovation occurs through advancing existing or creating new processes and/or resources, that result in new or further developed value propositions (Skålén et al., 2014).

SDL argues that all types of innovation involve some kind of service exchange and that the combination and integration of resources determine the boundaries of innovation. This is because innovation stems from integrating resources in unique and novel ways (Greer et al., 2016). Service innovation is frequently connected to new ways driven by actors to integrate resources and capture value within service systems (Edvardsson et al., 2011). In other words, SDL conceptualises that value co-creation is formed through innovative resource integrations (Vargo and Lusch, 2008).

5.2.4 Alliances in smart cities

Nam and Lee (2010) identify two dimensions of creating value: the degree of co-creation and the degree of networked collaboration. Drawing from Payne et al. (2008), they suggest that the process of value co-creation will likely form the innovation in service and consequently the process of interaction is particularly significant. The second dimension suggests that service innovation is provoked by collaboration between multiple actors and resources in order to co-create value. Essentially, these actors integrate their resources to co-create value (Vargo and Lusch, 2017) that will lead to service innovation.

But why are these collaborations essential? In the past years there has been a change in the market towards cooperation systems, where urban operation companies work towards building cooperative partnerships to diversify smart city services and expand their markets (Kim, 2022). Managers are aware that no single firm obtains sufficient knowledge and human resources to create innovations that can compete in the global market (Lusch et al., 2010). Consequently, they form alliances or collaborations. Early literature on the attempt to create technological innovation describes how firms created alliances in order to deliver breakthrough technological developments, with varying -mostly negative- degrees of success (Cummings, 1991). Cummings (1991) argues that in order for such alliances to be fruitful, the partnering actors must commit to the transfer of skills, knowledge and tools, in order to receive long-term economic gains from this interaction. In recent years, firms still suffer from insufficient internal technological resources and capabilities, which render them incapable to develop complex technological projects (Cesaroni and Duque, 2013). Specifically, in smart cities, where the public budgets are curtailed, numerous projects need to rely on international consortia that leverage opportunities for external funding (from EU funding streams or others (Voorwinden, 2022).

For this reason, recently multinational firms that develop technologies related to urban innovation, such as IBM, CISCO and Siemens have entered into alliances and collaboration networks with other actors (SMEs, governments and universities), in order to obtain capabilities to develop such technological projects. Accordingly, start-ups benefit from participating in alliances by gaining access to external funding from investors that will aid their financial performance (Parker et al., 2010) and potentially gain access social, technical, and commercial resources that typically require yearlong experience to develop (Baum et al., 2000). Moreover, public organisations that face increasingly complex and ambiguous challenges, enter in collaboration as it is essential to deliver their personal goals or common goals (Eriksson et al., 2020). On the other hand, social enterprises enter in alliances with both not for profit and for profit organisations in order to advance social innovation strategies (Felício et al., 2013)**.** These collaborations between multiple organisations have been recognised as crucial for knowledge transfer (Xu et al., 2019). Nevertheless, in these types of alliances, ambiguities on intellectual property ownership frequently make managers reconsider about taking part in R&D collaborations and if not clarified, may be the source of intense debates (Cummings, 1991) as intellectual property is critical to the long-term interests of the organisations.

As discussed above, collaboration is critical to the delivery of smart city projects (Cocchia and Dameri, 2016), particularly in exploratory work involving innovation (Ferraris et al., 2017). Through the process of innovation new enhanced value propositions occur (Michel et al., 2008). The value-in-use of these value propositions though, can be threatened by ambiguities on intellectual property and data ownership (Cummings, 1991). Consequently, this study additionally addresses the gap in the existing literature related to the ownership of intellectual property and data co-created through formal actor collaborations in smart city projects, through the lens of the service dominant logic.

By studying the way in which the smart city actors operate interdependently by co-creating value through reciprocally exchanging tangible (operand) and intangible (operant) resources, the emergence of a service ecosystem can be observed. The smart city actors appear to be linked through common dynamic processes, referred to as service provision (Vargo and Lusch, 2017), which define them along with the resource integration activities possible through service exchange, such as the exchange of data, innovation and the common use of a technology or expertise. Through these activities, partner collaboration ecosystems emerge (Vargo et al., 2023a) as discussed in section 3.8. Establishing these ecosystems may possibly require partnering actors to perform minor adjustments to their institutional structures, in order to align with the shared institutional framework (Elo et al., 2024).

5.2.5 Levels of interactions

The use of the service dominant logic allows researchers to study how smart city actors operate between each other and as a whole. By studying the interactions between smart city actors in the micro, meso and macro level, the value co-creation mechanism of the smart city ecosystem, can be studied. In order to aid in understanding the reciprocal exchanges between actors in the three levels of interaction, a visual representation of the interactions is adopted. This representation is inspired by Chandler and Vargo (2011) and has been further developed in the context of this thesis, in order to plainly and instantly show what resources are exchanged between actors.

At the micro level service exchange occurs between two individual actors, thus the interaction is framed in dyads (Chandler and Vargo, 2011). Each of the smart city actors (i) is distinctively and uniquely connected to another actor (ii) via a service-for-service exchange(s). For example, civic society provides university with data while the university provides technology in return (dyad A), thus both civic society and the university are active participants in this exchange. In another example the university provides innovative models to industry while the industry provides technological solutions, funds or other kind of resources to the university (dyad B). The dyadic interactions, explained in section 4.2.2, are presented in figure 4. In this level every actor engaging in exchange is coordinated by a set of institutions (Williamson, 2000). How successful the dyad interaction will be often depends on the accordance between the institutions of actor (a) and (b), as similar actor institutions suggests that the interaction is likely to be more successful (Akaka et al., 2013a). The micro level interactions are nested in a broader meso level context (Chandler and Vargo, 2011).

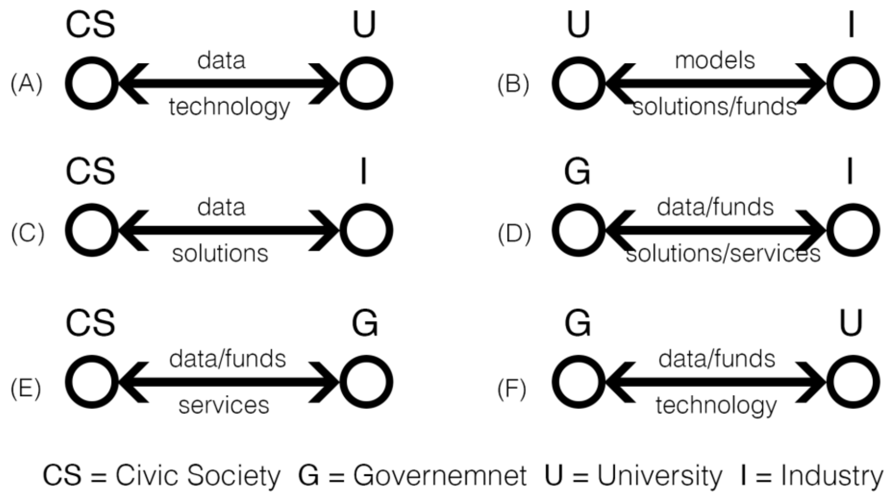

Figure 4 Dyadic interactions between smart city actors. Created by the author, based on Chandler and Vargo (2011).

At the meso level (Figure 5) there is an indirect service-for-service exchange, as one actor (a) serves another (c) through a third actor (b). In this level the interaction is studied in triads. For example, civic society indirectly serves the industry through directly providing data to the university and the industry indirectly serves the civic society by providing technological solutions or funds to the university (triad AB) as seen in Figure 3. Here the two actors, civic society and industry directly serve one another by serving the same actor (the university). In relation to the micro level, this level includes additional actors and operates under a unique set of institutions (Akaka et al., 2013). More specifically, the partnering actors already operate within a collaboration ecosystem, established and maintained by macro-level institutions (Elo et al., 2024). The meso-level is where collaboration shapes collective market actions (Baker and Nenonen, 2020).

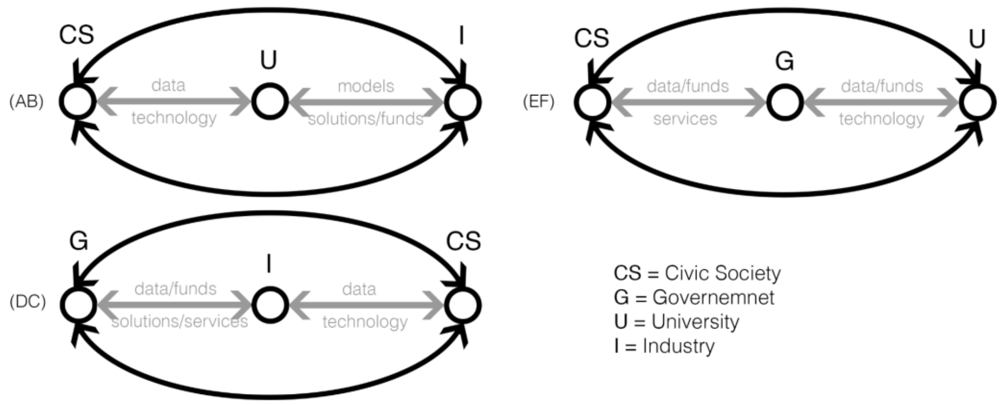

Figure 5 Triadic interactions between smart city actors. Created by the author, based on Chandler and Vargo (2011).

At the macro level (Figure 6) the exchange of services creates a complex network, as actor synergies are comprised by both direct and indirect service-for-service exchanges. The various triads apply their resources for the beneficiary of a specific context (Chandler and Vargo, 2011). In this case, considering the university as the beneficiary, the civic society provides information to the government, which provides them in the form of data to the university in a triadic indirect interaction, while the industry provides funds directly to the university in a dyadic interaction. This is merely a sample of the number of interactions this ecosystem contains.

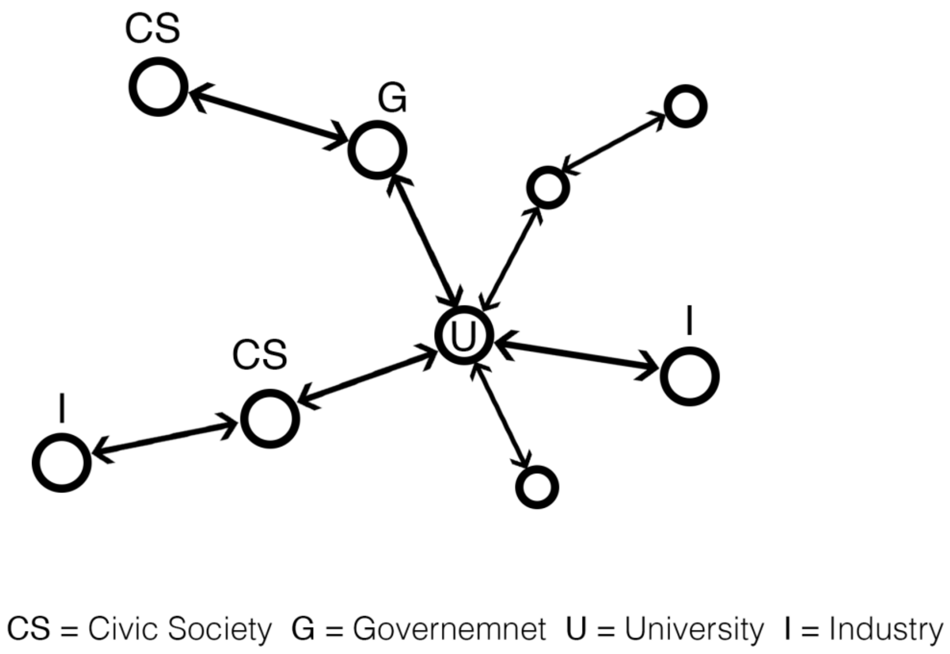

Figure 6 Smart city actor interactions on the macro level, with university as the beneficiary. Created by the author, based on Chandler and Vargo (2011).

As actors navigate through interactions and become influenced by various institutions and service exchanges, they may assume different roles in the ecosystem thus their micro, meso and macro level context is bound to continuously change (Edvardsson et al., 2011).

5.3 Considerations on smart cities, through the lens of SDL

The use of the SDL to study smart cities as service ecosystems provides an appropriate framework for studying how actors exchange and integrate resources and how these processes affect the value co-creation mechanisms within this sector. Certain considerations arise that stem from the global aspect of smart cities, the multidisciplinarity of sectors involved and the increasing popularity of “big data”, IoT and AI. These considerations will be explored in this section.

The first consideration regards the global aspect of smart city ecosystems, as the industrial and university actors involved in such ecosystems often cross the urban scale boundaries that constrain both the government and citizens. Industrial actors predominantly, but not always, create global solutions that can be applied to more than one smart city around the globe. Some of the best known players are IBM, Cisco, Telefonica, Siemens, Bosch and others. Smart cities have indeed been accused of not taking into consideration local realities (Glasmeier and Nebiolo, 2016). China and India expressed their interest in participating in the trend in mid 2010s with India announcing building 100 smart cities in 2015 (Park and Yoo, 2023). As discussed above this is particularly relevant, on a larger scale, to smart city solutions imported from the Global North to the Global South (Pratama et al., 2023). Furthermore, a part of smart city research and literature produced from universities is non-context specific and can be adapted locally to a specific context after certain considerations are made. The internationality of these actors increases the complexity of the ecosystem, as global contexts appear to be more complex than domestic ones due to the increased embeddedness of microlevel interactions within meso and macro institutions that cross geographical boundaries (Akaka et al., 2013).

Other considerations arise from the multidisciplinarity of sectors involved in smart city organisations, as different sectors might operate under different institutions and institutional arrangements. The smart city industry involves players from a variety of sectors such as IT, construction, healthcare, energy, environmental studies and others. Smart city technologies are heavily dependent on the use of data. The management process of this data involve a range of actors -policymakers, governmental bodies, providers, users and other (Ooms et al., 2020). Akaka et al. (2013) support that the likelihood of a successful interaction between two actors that abide by a different set of institutions, may be reduced and may lead to conflicts. Conflict between service ecosystem actors may frequently occur due to the multiplicity of networks in which different actors belong, and the different value creating function they assume in each network (Akaka and Chandler, 2011).

Moreover, the increasing popularity of “big data” and IoT and AI, particularly relevant to smart cities, poses questions related to the change of actor dynamics. “Big data” is a term commonly used by media to characterize large or complex data sets and is predominantly associated with the data storage and data analytics (Ward and Chapman, 2003). Big data are stored but not analysed (Batko and Ślęzak, 2022) and their analysis is possible through actions defined as big data analytics, which allows for insights and patterns in the data to emerge (Naeem et al., 2022). Large-scale data and IoT are rapidly gaining momentum due to their analytical advantages (Mehmood et al., 2017). Vargo and Lusch (2017) argue that the new era of “big data” appears to be well aligned with the SDL, as data analytics enable a new typology of organisations that adapt to the dynamics of the system (Zeng and Lusch, 2013). The capacity for analysis of large-scale data will allow sensors and devices usefully to capture and record smart citizens’ behaviours (Mehmood et al., 2017). AI is considered as key in the future development of smart cities in order to process this large scale data, aid in the synergy of system operations and bring timely execution of the functions in various aspects of urban living (Javed et al., 2022). This will affect the position of the actors in the ecosystem as the dynamics of citizen data input methods will change. Additionally, it provokes questions related to the further loss of direct interaction between the other actors and the civic society. Since the collection and analysis of large-scale data may eliminate the element of direct interaction between the actors, there is a loss of opportunity for customer engagement and the opportunity to influence the customer’s flows and outcomes (Grönroos, 2011). In addition to loss of opportunity the way in which data about past behaviour, may be analysed to predict future behaviour, hence types of future interaction, may lead to value co-destruction, meaning to the decline of the wellbeing of at least one of the systems, through direct or indirect interaction (Plé and Chumpitaz Cáceres, 2010), due to the inaccurate predictions that may occur through the use of historic data. Value co-destruction may, additionally, indirectly take place through the diffused use of large scale technology and use of data, due to provoking social exclusion, privacy, confidentiality or misinformation (Megahed and Abdel-Kader, 2022). Consequently, it is not the data per se that may co-create or co-destruct value, but the way in which data are analysed. Different ways of analysis may result in the prioritization of different types of interactions, which will have intended and unintended consequences for the ecosystem.

Finally, the diffusion of large-scale data analysis and IoT lead to a global issue that is becoming more relevant day by day, the issue of cyber security. Integrating data analytics, along with digital capabilities arises concerns around data privacy and security (Shahriar and Ko, 2024). In addition to this, the adoption of smart city applications also poses important privacy, security, safety as well as ethical concerns (Angelidou et al., 2022). How can citizens and other smart city actors ensure that they do not, involuntarily, become direct or indirect resource providers in fraudulent or malign activities? Device level vulnerabilities appear to be a paramount issue in smart cities (Haque et al., 2022). According to Hewlett Packard (2014) 70% of the most popular devices that utilize IoT technologies, faced vulnerabilities in terms of password security, encryption and general lack of granular user access permissions. The number of devices at risk is expected to augment significantly, with the estimated future increases (Middleton et al., 2013). Such a potential breach of security means the involvement of actors in value co-creation to which they have not consented to participate. Moreover, there is a rising ethical dilemma related to the extensive use of personal data that may pose a threat to the citizen's right to data protection (Autoriteit Persoonsgegevens, 2021). The participation of citizens in involuntary value co-creation is yet another source of potential value co-destruction.

In the previous sections I have extensively presented the foundations of the service dominant logic and I have shown how it serves as a lens in studying value co-creation through resource integration in smart cities. After having established how resources are viewed in this research in the previous chapter, the following section provides a more in-depth view of two resources, technology and data, that appear particularly prevalent in the smart city literature, alongside with a third resource, intellectual property. Technology and data are arguably two of the central resources around which smart city definitions concentrate (Toli and Murtagh, 2020). Intellectual property, while frequently overlooked in the literature, is considered as the powerhouse of the economy (International Chamber of Commerce, 2011) and a key component of smart cities (Szewc and Rubisz, 2022).

5.4 Technology, data and intellectual property

5.4.1 Technology and data as a resource in smart cities

Technology is considered an enabler of smart cities (Paquet, 2001) from its early conception and its necessity to deploy smart city projects can be observed by the vast amount of literature on the development of technological solutions. This is particularly evident from its central role in smart city definitions (Toli and Murtagh, 2020). The COVID-19 pandemic has additionally triggered an increase in the development and launch of hardware and software related to safety and IoT infrastructure (Gade and Aithal, 2021). Moreover, Data and data-driven innovation are considered key to respond to the most significant urban challenges, but they are largely underexploited (HM Treasury, 2018).

Hardware and software based technological solutions, related to the smart city agenda, have been developed by numerous practitioners and academics over the years and cover a wide range of applications such as air pollution (Castelli et al., 2017; Vakali et al., 2014), transport (Adart et al., 2017; Barba et al., 2012; Chen et al., 2015), waste management (Anagnostopoulos et al., 2015; Perera et al., 2014), healthcare (Hussain et al., 2015), citizen engagement (Gagliardi et al., 2017) and e-governance (García-Magariño et al., 2018). Four types of enabling technologies have been described in smart cities: IoT technologies, “Big Data”, cloud computing and cyber-physical systems (Santana et al., 2017) and recently Blockchain, AI (Artificial Intelligence) as well as the integration of AI with IoT (AIoT) have gained significant traction in the literature as enabling technologies in smart city research (Bibri et al., 2024). IoT can be defined as a paradigm where everyday objects are equipped with sensors and appropriate protocol stacks that allow them to communicate between each other and with their user and become an integral part of the internet (Whitmore et al., 2015). A wide variety of these devices such as sensors, home appliances, cameras, displays and vehicles can potentially generate large amounts of data used to create new citizen services (Zanella et al., 2014). “Big data” is a term commonly used by media to characterize large or complex data sets and is predominantly associated with data analytics and data storage (Ward and Barker, 2013). It may be used to forecast future behaviors, through studying people's purchasing and search patterns, borrowing activity and social network presence (Porat and Jacob Strahilevitz, 2014). In recent studies big data research has been linked with AI research too address environmental sustainability issues (Bibri et al., 2023). Cloud computing is an infrastructure that provides large and elastic data storage and processing capabilities to its users (Santana et al., 2017). The integration of cloud computing and IoT is frequently discussed in the literature and appears to be mutually beneficial for both technological domains, as one addresses some of the gaps of the other (Stergiou et al., 2018). Finally, cyber-physical systems enable system interactions within the environment (White et al., 2010). Specifically, large scale data and IoT appear to be currently rapidly gaining momentum due to their analytical advantages, as the capacity for analysis of large-scale data appears to allow sensors and devices to capture and record smart citizens' behaviours (Mehmood et al., 2017).

The creation and development of this vast array of technological solutions available in the smart city market, requires continuous innovation processes which involve a significant number of various stakeholders (European Commission, 2016). But are all these solutions really needed? Angelidou (2015) describes the existing situation of the smart city market as being formed by two forces: the technology-push and the demand-pull. In a global market that is expected to exceed 150 billion US dollars by 2027 (Statista, 2023)**,** tech driven companies view smart cities as an opportunity to promote digital transformation (Future Cities Catapult, 2017). Thus, firms rush to quickly advance technological solutions "driven by supply, regardless of the expressed needs of society" (Angelidou, 2015). In this competitive market, there is an apparent risk that stand-alone profit-making agendas mind prevail over societal needs (Sadowski, 2016)**,** consequently potentially undermining economic development through industrial isolated ICT branding exercises (Allam and Newman, 2018)**.** This may additionally fuel the risk of companies creating monopolies of smart city technologies, consequently gaining control of the market (Onufrey and Bergek, 2021).

On the other side, the demand-pull force enables solutions that respond to the demands of society, to be developed. For smart city projects, governments are the main actor in the demand side (Wolfram, 2012). Recognizing that need, a few local governments offer their city as a living lab for technologies to be tested. In order for living labs to succeed they need technology platforms that enable the process of co-creation and the assessment and evaluation of new alternatives to sectors such as energy management, smart mobility, environment monitoring and homecare services (Schaffers et al., 2011). However, this may bear the risk of citizens being treated as customers or consumers, leading to potentially threatening the social and environmental aspect of smart cities (Timeus et al., 2020). Public administration can use public procurement as a tool to foster urban innovation and stipulate demand for such solutions, especially in sectors like transport and energy (European Commission, 2016). While, new investments are imperative for the creation and adoption of the majority of smart city solutions (Future Cities Catapult, 2017), the recent budget cuts in some countries, such as the UK, are driving cities to focus on providing statutory services instead of employing smart initiatives, despite their potential financial benefit (Centre for Cities, 2014).

Technological solutions can be either already developed and tested before being applied to the smart city programme/project or can be newly formed solutions that utilize the project as a testbed, thus transforming it into a pilot. Such projects frequently involve the collection of data through IoT platforms by governmental and industrial actors as well as citizens, that are sometimes made open (Ahlgren et al., 2016). Open data are data practically and legally available for utilization and republication by any party (Lindman et al., 2013). As a result, at the end of the pilot, new intellectual property as well as new data are created. The particular focus of the majority of smart city projects on the development of new technology, in combination with the supply and demand aspect and the need for close collaboration between a variety of public and private actors, create complexities related to both intellectual property (IP) and data.

5.4.2 Intellectual Property

Intellectual Property (IP) is defined by the World Intellectual Property Organisation (2019) as “creations of the mind: inventions, literary and artistic works, and symbols, names, images and designs used in commerce” and can be divided in two parts: industrial property and copyright. Industrial property includes patents, utility models, trademarks, industrial designs and geographical indications of source, while copyright includes amongst others literary and artistic works and architectural designs. Essentially, IP is a unique property physically created (Intellectual Property Office, 2014) and encompasses different types of protection which depend on the nature of the property. While some types of protection are attributed automatically, for others formal filling procedures need to be followed. In smart cities most patents are related to the implementation of digital solutions (European Commission IPR SME Helpdesk, 2020).

While there is some literature on intellectual capital, there is very limited research on intellectual property in smart cities. Thus, the few studies on the subject, focus on using patents as an indicator to study the level of activity of countries and companies in specific fields within smart city projects (Pellicer et al., 2013), the impact of smart city policies on innovation (Caragliu and Del Bo, 2019)**,** investigate the economic factors of sustainability in smart cities within the EU (Voda and Radu, 2018) and the potential in the use of IoT (Intellectual Property Office, 2014). These studies are based on the premises that the number of patent applications filled in a city can serve as part of the measurement to asses innovation in smart cities (Komninos and Sefertzi, 2009). Patents have additionally been used as an indicator by various agencies, such as the UK Intellectual Property Office Informatics Team, to produce reports on specific areas of technology. Along with GDP (public and private), R&D investments and employed ITCs specialists, patent applications appear to be key elements in the creation of smarter cities (Voda and Radu, 2018).

According to (Pellicer et al., 2013) the main activities that patents in the field of smart cities are filled for are: traffic control systems related to smart mobility, water treatment, wastewater and sewage systems, energy efficiency improvement in electric heating and lighting, related to smart homes, methods for separating solids for recycling of municipal waste, and smart environment applications related to intelligent building systems and data processing systems or tools of administrative, commercial, financial and managerial value related to smart governance and smart living.

There appear to be a number of benefits for using a firm's IP in smart city projects, such as attracting potential investors, increasing the competitiveness of the firm, boost future profitability and enhance the firm's image (The Latin America IPR, 2019). Nevertheless, the European Commission highlights existing significant concerns in the EU R&D market, related to the potential replication of solutions by foreign companies and emphasises the need to create a suited smart city regulatory environment that will protect the European companies and especially start-ups and SMEs. Such environment should be flexible enough to accommodate the risk-taking and trial-error nature of such endeavours (European Commission, 2016). Apart from the analysis of documents related to specific projects and anecdotal evidence scattered around the literature, there is little to no evidence on how IP really works in smart city projects.

Finally, while there is some literature on intellectual capital (Dameri and Ricciardi, 2015) there is very limited research on intellectual property in smart cities. This appears to be related to the difficulty of identifying ways to accurately measure intellectual property.

5.5 Scope of this research and research question

Drawing from the definition of smart cities proposed in Chapter 2, and the literature review presented in Chapters three, four and five on smart cities, service dominant logic, resources and how SDL can be used to study smart city organisations, this research starts from the premise that the smart city ecosystem is a collaboration based ecosystem (Nguyen et al., 2022) with its wider meaning, based on both loose and tight relationships between the actors part of the quadruple helix (government, industry, academia, civic society) and may be studied through the lens of service dominant logic. This allows for certain assumptions to be made. Firstly, value is co-created by multiple smart city actors, including the beneficiary of a service, through the integration of resources. In other words, smart city actors co-create value through the exchange of resources. In order for resource exchange to take place, actors need to have some type of interaction between each other. They additionally need to be capable to act upon these resources. Within smart city projects these interactions occur within project alliances. Alliancing ecosystems are part of the city ecosystems, where the latter are defined by activities, areas and infrastructure networks (Komninos et al., 2022).
Influenced by these premises the research questions of this thesis are:

- how do actors within project alliances exchange and integrate resources to co-create value and
- what factors influence their interactions in the process of resource integration?

The complex nature of interactions in smart cities, a multibillion multidisciplinary sector in its infancy, as well as the type of 'advanced' and/or controversial resources that are exchanged, require in depth analysis of actor interactions. Furthermore, in depth research is crucial in order to determine the type and nature of operant resources that smart city actors use, as these tend to be deeply embedded in everyday operations, thus may be used subconsciously and as part of an 'invisible infrastructure'. These are the types of resources that create strategic competitive advantage for the actors that possess them and know how to utilize them. This study aimed to address limitations and gaps in the literature identified in both the smart cities and the service dominant logic research,

In summary,:

- The study recognises the fragmentation in smart city literature stemming from the prevalence of a case-study based approach, exacerbated by (and possibly founded in) the fragmentation within the smart city projects themselves and their scope. By adopting a cross-project methodology instead of a single project one, this thesis addresses the gaps in the literature regarding the identification of reoccurring relationships between actor groups, how these groups interact, their success or failure factors and the bases of cross actor resource exchange.
- Since these relationships occur with collaboration ecosystems, I respond to the gap in the literature identified on how alliancing actors interact, integrate resources and co-create value in alliances, the key factors of success or demise of these interactions and how the alliancing (or collaboration) ecosystem is affected by the outcome.
- With respect to addressing limitations within SDL, I choose to study solely tightly coupled interactions in the form of alliances and utilise terminology that acknowledges and evades the positivity bias of the theoretical framework and the underlying assumptions that stem from it. These assumptions are related to the willingness of actors to integrate theirs and other actors' resources and what influences this willingness, the duality of the nature of value and the wellbeing of the ecosystem.
- Additionally, I attempt to contribute to the literature on value propositions by responding to the need for empirical data on how they are created and what they encompass.

The following chapter will focus on the methodology of this thesis. This chapter will firstly present the philosophical stance of this research, followed by the methodology, data collection and data analysing methods.

6 Methodology

This section presents the research methods that govern this research. The methodology has been crafted to respond to the research question on how actors within project alliances co-create value through exchanging and integrating resources via intra-actor interactions and what factors influence these interactions and the process of resource integration. Firstly, the philosophical stance of this study is presented, followed by an overview of the methodology and of the data collection methods including a description of the questionnaire design, the recruitment of participants process, a breakdown of the participants and ethical considerations. Finally, the methods of data analysis are presented along with an acknowledgment of the effect of reflexivity on this study.

6.1 Philosophical stance

In everyday life, there is frequently more than one way to explain things. The same applies to research as well. Underlying the available different explanations, there are paradigms – fundamental models or frameworks of reference utilized to systematize the researcher's observations and reasoning (Babbie, 2016). They can be defined as a concurrent pattern describing the way researchers understand, and inquire into the world (Easterby-Smith et al., 2008). Social sciences are characterized by simultaneous, competing research paradigms. The characteristics defining these paradigms are the assumptions made about the nature of social reality - referred to as ontology (Blaikie and Priest, 2017). Ontology may be defined as the 'science or study of being' (Blaikie, 2007, p. 6). Nevertheless, ontological assumptions cannot, by themselves, demonstrate how social research captures knowledge about social reality, thus another set of assumptions is needed, to guide how knowledge of the assumed social reality, can be obtained. These are the epistemological assumptions (Blaikie and Priest, 2017). Epistemology is the science of knowing (Babbie, 2016). It is a general set of assumptions about the most appropriate means of inquiry of the nature of the world (Easterby-Smith et al., 2008). Blaikie

(2007) has reviewed four classical paradigms -positivism, critical rationalism, classical hermeneutics and interpretivism- and six contemporary paradigms – critical theory, ethnomethodology, critical realism, contemporary hermeneutics, structuration theory and feminism.

The classical paradigms are delineated by positivism and interpretivism, two epistemologies frequently seen as fundamentally different. Positivism is considered as a 'scientific' or 'naturalist' approach and assumes the ontological view that humans are part of nature and can be studied as the other objects in the physical world (King and Horrocks, 2010). On the other hand, in interpretivism social reality is considered as dependent from social actors and researchers (Blaikie and Priest, 2017). There can be multiple realities and different interpretations of the same event, depending on the person who interprets it. In the middle of the philosophical spectrum created by positivism and interpretivism, there are numerous other paradigms that adopt a less deterministic view of the world. One of these paradigms is critical realism. Critical realism is a paradigm that suggests that observed regularities can eventually be comprehended through underlying 'real' casual structures and/or mechanisms (Blaikie and Priest, 2017). This study will be conducted through the lens of critical realism, because it considers social structures when attempting to understand the social reality, while at the same time, recognizes the 'real' potentiality of mechanisms and structures, without proposing hard determinism (King and Horrocks, 2010). This view is especially valuable for this research, where smart city organisations are seen as operating in a service ecosystem bound by mechanisms and structures that define how it operates. These mechanisms and structures are created through the axioms and foundational premises set by the service-dominant logic.

A critical realist ontology maintains things are real inasmuch as they produce effects (Babbie, 2016), referred to us regularities. While regularities can be observed in the world around us, the direct observation of the fundamental elements, casual structures and mechanisms may not be possible (Blaikie and Priest, 2017). Drawing ontological and epistemological assumptions from critical realism is challenging due to the ontological disagreement of its two major founders, Bhaskar and Harré (Blaikie and Priest, 2017). Bhaskar adopts a more structuralist approach, while Harré a social constructionist approach.

Bhaskar describes the social world as being consisted by three levels of ontological depth: the empirical, the actual and the real existence. The empirical domain is composed of observations and experiences of change that materialize in the actual domain. In other words the empirical domain is what the researcher can observe, measure and collect data on. In the actual domain events emerge from the action of generative mechanisms in the real domain, but in contrast with the empirical domain, they don't need to be observed. The events occur independently of the observer's ability to capture them. Finally, the real domain encompasses objects that have structures and/or generative mechanisms that potentially may trigger change in events. The elements of these objects may not be readily accessible or directly observable in the real domain (Blaikie and Priest, 2017). Fletcher (2017) describes the domains of critical realism as an iceberg metaphor (Figure 7). In critical realism there are transitive and intransitive objects of science (Outhwaite, 1987). The transitive objects are the concepts, theories and models created and developed by scientists in order to comprehend and provide explanation on certain aspects of reality. Intransitive objects are the real entities and the relations between them that constitute the natural and social worlds. In Bhaskar's theory, it is imperative to acknowledge the position of the researcher as the observer. The social, cultural, demographic and intellectual background, and the location and time of the observer will inevitably affect the way in which he/she observes and decodes the social world (Blaikie and Priest, 2017). However, changes in the way in which the observer interprets the social world may not cause changes in this world, thus the actual and real world operate independently from the existence of the researcher.

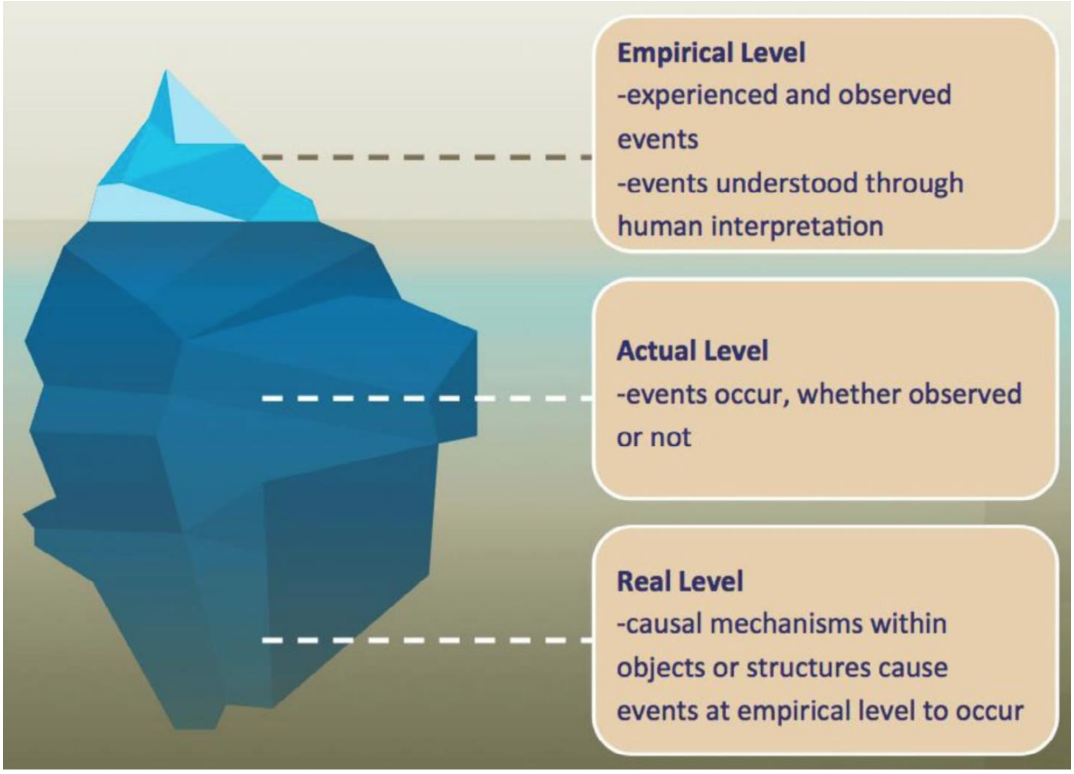

Figure 7 The domains of critical realism depicted using an iceberg metaphor (Fletcher, 2017, p. 183).

6.1.1 Ontological and Epistemological assumptions

The present study is adopting Bhaskar's ontology of the three domains and will be studying the smart city service ecosystems bound by the ontological and epistemological assumptions of this paradigm of critical realism. Ontologically, the events identified and measured in the empirical domain, occur in the actual world. Thus, the researchers understand that the data collected in the empirical domain are transitive and may describe events existing in the actual domain, which are triggered by intransitive objects such as generative mechanisms and structures in the real domain. This empirical domain would not have existed if the researchers as observers were not studying it, while both the actual and the real world exist independently of the researchers. More precisely, epistemologically we seek to understand the causes of observed regularities, which are assumed to derive from the structures and generative mechanisms that produce them. This study aims to identify the generative mechanisms/structures of resource exchange in the real, which result in the regularities in the actual. The identification and study of such structures and mechanisms may necessitate deeper research beyond the surface. The unit of analysis is the resource exchange -as an event/concept in the actual-, which is enabled and constrained by specific institutions and institutional arrangements in the real.

6.2 Methods

This study is of qualitative nature due to its scope. Qualitative analysis uses qualitative data such as interviews or observations to examine and interpret them with the purpose of discovering underlying meanings and patterns of relationships (Easterby-Smith et al., 2008). In-depth, qualitative interviews were used in order to deeply uncover new elements, open up new dimensions of the issue in question and obtain vivid, accurate inclusive accounts based on personal experiences (Burgess, 2003). The main target of using qualitative interviewing was to attempt to gain understanding from the respondent's point of view, thus their perspective and the reason why they have that perspective (King, 2004). Additionally, they aided in the collection of information that captures the meaning and interpretation of phenomena for the interviewee (Kvale, 1996). Anonymous data collection was selected. This is due to the nature of smart city projects. This type of projects involves a large number of different kind of actors coming from all actor groups, that do not only have similar but additionally competing interests. This is particularly applicable to projects where there are multiple commercial actors that offer similar services. Additionally, the majority of the projects involve commercially sensitive information related to technology, knowledge and data. In order to be able to collect this type of meaningful information the level of structure within the interview needs to be determined.

Semi-structured interviews were used to permit for a higher degree of flexibility, personal interaction (Jones,1985). They are well suited for investigating interviewees' perceptions and opinions on complex and sensitive issues as well as enabling the interviewer to using probing techniques to gather more information and clarifications (Barriball and While, 1994). These aid in hearing the explanation and meanings participants offer, but also to move beyond these to a deeper level of analysis, which allow for underlying and hidden purposes to be studied.

Finally, the unit of analysis for this study is the interactions through which resource exchange is enabled between smart city actors. Interactions take place in the form of direct interaction in dyads in the micro level, in the form of indirect interactions in triads in the meso level and as networks in the macro level. Events that have a social dimension, are typically recognised from a macro perspective but are enacted through micro-actions at the micro level, thus the micro level is the starting point of study, which allows a better understanding of the way in which structures from a macro perspective are influenced by actions in the micro level, and how both the micro and macro level affect the meso outcomes (Archpru-Akaka et al., 2023). The smart city actors have been categorized according to the quadruple helix model in four categories, university, government, industry and civic society. The dyadic and triadic interactions though, do not take place in between the categories themselves, but between the organisations within the categories. Consequently, the unit of analysis at the micro and meso level is direct interactions between organisations, while the macro was studied through the other two levels. The next section will describe the design of the questionnaire, the participants of the study and the ethics that governed data collection.

6.3 Data collection

6.3.1 Interview topic guide design

As per the previous sections, in order to collect 'rich' data, that can be further analysed to reveal underlining attitudes (Easterby-Smith et al., 2008), semi-structured interviews were used. From these interviews 52 have been conducted in person, while 17 were conducted online or via phone, for reasons related to distance. A topic guide with the main subjects of the questions was created, for each of the groups (university, government, industry and civic

society) (Table 5 and 6). Topic guides are used in semi-structured interviews to guide the interviewer, as the natural course of the interview may lead to different subjects according to the interviewee's answers (Easterby-Smith et al., 2008).
The topic guide included questions on both the organisation and the projects. The topic guide focused on the mission and business model of the organisation and the variety of projects the organisation is involved in, as well as more detailed questions on the projects themselves including the funding structure, the processes and development of the project, the internal and external relationships between actors, the ownership of the resources deployed, the role of the user and the biggest challenges and enablers (see Table 5).
The language used in the questions was simple without any use of jargon. The use of jargon in the questions may create confusion to the participants, as terms may be used differently in different sectors (Rowley, 2012). Instead, the questions describe a concept without using the academic term. Terms such as service dominant logic, operant/operand, tangible/intangible were described but not directly used, to avoid confusion or misinterpretation. In addition to language, the order of these questions can heavily influence the outcome of the interview. They were presented in a way that was as self-evident as possible, leading to a natural 'flow' of the conversation (Rowley, 2012). The interviews have been recorded and transcribed verbatim.
A preliminary pilot study was conducted to ensure that the questions were comprehensive and that the structure of the interview will lead to the collection of valuable material. A preliminary pilot serves as a test of how comprehensive the questions are (Rowley, 2012). Its completion provided valuable feedback towards the further development of the topic guide. The questions were designed to avoid yes/no answers, multiple questions in one, being vague and leading to implicit assumptions (Easterby-Smith et al., 2008). Changes have been made to the topic guide according to the pilot study, as the initial guide was too long and there was significant time overrun in the interviews, as well as repetitive answers.
Finally, after all the interviews were completed and the contents analysed, focus groups with the participants of the study have taken place. A focus group is a group of participants interviewed together, inciting discussion (Babbie, 2016).

Focus groups are usually structured as steered conversations and have a more unconstrained form (Easterby-Smith et al., 2008). The preliminary results were shared and discussed with a group of experts in order to validate findings. The group dynamics has helped in confirming the early indicative findings and in the emergence of alternative aspects of the topic, through conversation and exchange of ideas, that may not have been brought up through one-to-one interviews (Babbie, 2016). Additionally, it has allowed for flexibility, high face validity and the capture of real-life data in a social environment. On the other side, literature indicates the data obtained may be difficult to analyse, the group moderator will have less control of the situation and the groups may have crucial variations between each other (Krueger and Casey, 1988). The focus group included a group of 18 experts from various fields that had participated in different projects, whom had individually already participated in the research. I presented the preliminary findings and then divided the experts in three tables to examine them. Each table discussed the findings and presented their key takeaways in a common discussion amongst all experts. The outcomes of this discussion reinforced the validity of the findings and influenced the direction of direction of the analysis.

Table 5 Interview topic guides divided by actor group.

Organisation	Government	University	Civic society
Organisation-based questions			
Main aim and scope	Main aim and scope	Main aim and scope	Main aim and scope
Business model	Sources of funding	Sources of funding	Sources of funding
Main clients/users	Structure and coordination	Structure	Coordination
	Main users		
General project questions			
General description of the project			
Aim, scope and end user			
Funding structure			
Collaborators involved			
Processes of intellectual property development			
Ownership of resources			
Organisation specific project-based questions			
Main collaborators			

Types and level of interactions with all project collaborators	Types and level of interactions with all project collaborators and other governmental agencies	Types and level of interactions with all project collaborators	Types and level of interactions with all project collaborators
Types and level of interactions with external project partners			
Resources exchanged within the project			
Involvement of clients and/or users in the processes of IP co-creation	Involvement of citizens and/or users in the processes of IP co-creation	Involvement of users in the processes of IP co-creation	Involvement of citizens in the processes of IP co-creation
Ownership and future use of IP			
Biggest enablers and challenges in the project			
Biggest enablers and challenges in the interactions			

Table 6 Type of information that can be collected through each item of the topic guide

Focus of question	Information that can be collected
Organisation-based questions	
Main aim and scope	Understanding how the organisation operates
Business model/structure	What the organisation plans to achieve from participating in the smart city project, what advantages they aim to gain?
Sources of funding	Funding streams
Main clients/users	Do they plan to acquire clients/users? Who is really the end user? That affects the goal and the indirect exchange of resources
General project questions	
General description of the project	Aims, goals, potential outputs. First glance at understanding the actors and the potential interactions of the interviewee
Aim, scope and end user	Specific goal and who will be the beneficiary of the value created from this project
Funding structure	Who pays for the project? Which are the monetary streams? Why these are the monetary streams? Does funding affect the decisions making process indirectly? What is the ultimate goal of the funding body? Was match funding needed and if yes in what form?
Collaborators involved	Which are the main collaborators involved in the whole project? Who played a pivotal role in the final outcome?
Processes of intellectual property development	What resources went into creating the intellectual property? What interactions needed to occur? What happens with this IP in the future?

Ownership of resources	Who owns each of the resources discussed and how do they offer them? What do they get directly and indirectly in return?
Organisation specific project-based questions	
Main collaborators	The actors the interviewee collaborated/interacted directly and indirectly with
Types and level of interactions with all project collaborators	Breaking down and analysing specific collaborations within the project actor group
Types and level of interactions with external project partners	Breaking down and analysing collaborations external to the project actor group
Resources exchanged within the project	What resources did you offer? Time, human skills included. What were the pivotal resources exchanged? How was IP created, what technology was used/created/tested?
Involvement of clients and/or users in the processes of IP co-creation	Did clients and/or users have an input at any part in the project? Why were they involved?
Ownership and future use of IP	Who owns the outputs of the project and how can they use them?
Biggest enablers and challenges in the project	Here significant information about the interactions between the actors, either one-to-one or collectively as a group, emerge. Typically, here the interviewees share personal opinions that provide significant clarity to what they have answered in previous questions.
Biggest enablers and challenges in the interactions	What favoured specific interactions but hindered others? How these helped both the interviewee and/or the project?

6.3.2 Recruitment of participants

In order to gain access to multiple and varied perspectives purposive supplying will be used. The participants of this study represent a variety of positions relevant to the context of the study. These positions illustrated meaningful differences between each other. The effectiveness of purposive sampling is contingent on the choice of aspects, thus the dimensions and categories, used to choose the interviewees (King and Horrocks, 2010).

Initially, in order to identify potential participants, the types of organisations that constitute the smart city actors had to be defined. The schematic according to which these were identified can be found in Table 7. The interviews were conducted with representative organisations from the university, government and industry. Interviews were achieved through recruiting representatives from universities, research institutes, regional and local level government as well as for profit international and local corporations, SMEs, NGOs and NPOs, which are considered indispensable for obtaining a holistic perspective of the smart city service ecosystem.

Table 7 Types of organisation per smart city actor.

	Smart City Actors			
	Universities	**Government**	**Industry**	**Civic Society**
Types of organisations	Universities and Colleges	United Nations (UN)	For profit organisations – International Corporations	Everyday users of SC services
	Research Institutes	European Union (EU)	For profit organisations – Local Corporations	Occasional users of SC services
		National Governments	For profit organisations - SMEs	Non users of SC services for accessibility motives/ lack of digital skills
		Regional (or State) Governments	Non- governmental organisations (NGOs)	Non users of SC services for accessibility motives/ financial
		Local Governments (Municipal or others)	Non-profit organisations/ Charities (NPOs)	
	Characteristics per category			
	Institutions with research as they main scope	Institutions with regulatory and monitoring power	Organisations	Civic society according to services usage

Using Table 7 as the base to select which organisations to interview, the participants of this study were selected through purposive sampling. They were members (preferably senior) of an organisation or institution actively involved in at least one (but typically more) official smart city project, for a significant period of time. To ensure this, they were selected according to their involvement in signature projects or programmes that fit the following criteria:

- They must be formal projects with established funding streams and defined contracts;
- Their main objective must be or directly related to urban innovation and the smart city agenda;
- They can be ongoing, in expansion phase, operation phase or concluded, but should have already officially launched for at least six months before the interview. Completed projects and projects close to completion were preferred;
- They are based on at least one UK city. EU projects that do not have a city in the UK as a main partner, were excluded;

The first and second criteria were crucial in order to make sure that the projects that were discussed about during the interviews, were comparable between each other and the experiences of the participants were of an overall uniform background. However, the main objective being directly related to urban innovation and the smart city agenda, still includes a significantly wide range of subject matters. The third criteria, was set in order to ensure that the participants had the time to form a concrete and solid opinion on the matters discussed, while the final criteria was set with a focus on the UK market in order to provide a degree of homogeneity by considering projects within the same regulatory domain.

These projects are usually funded by Horizon 2020 funds (H2020), EU Research and Innovation programmes or public innovation funds by different UK governmental departments.

The potential participants were contacted in person through industry, government and university organised, events, through recommendations from other participants and via email. Regardless of the method of initial communication, before agreeing to take part in the study, they received an email with an outline of the study, an information sheet and the participants consent form. Additionally, in all emails sent, the potential participants were always redirected to a page set up under the UCL domain, where additional information on the study, was provided along with again the information sheet and consent form in a version that could be downloaded.

(https://www.ucl.ac.uk/bartlett/construction/people/phd-students/angeliki-toli/studying-resource-exchange-through-actor-interactions-smart-city)

6.3.3 Ethics in data collection

The interviews performed were in compliance with the UCL research ethics. All the information retrieved was anonymised and confidential. The recordings of the interviews were stored securely and will be destroyed at the end of the study. The participants of the survey were informed that their responses will be anonymous, confidential and used exclusively for research purposes. Additionally, they were informed of their right to withdraw from the research at any time. The participant sheet with information for the interviewees can be found in Appendix A, along with the informed consent form that each interviewee received (Appendix B). Ethics approval was received from the Departmental Research Ethics Committee with the reference number 14741/001.

6.4 Data analysis

Following data collection, the interviews were recorded, transcribed and pseudonymized. There are numerous types of analytic paradigms that can be followed to analyse qualitative data. In this study the data collected were analysed in two stages (Figure 8).

STAGE 1: CATEGORIZATION	STAGE 2: THEMATIC ANALYSIS
a. Organisations b. Projects	1. Descriptive coding ↓ 2. Interpretative coding ↓ 3. Overarching themes

Figure 8 Stages of analysis

Firstly, in stage one, the data were categorised according to their attributes and characteristic, while in the second stage they were analysed following the principles of thematic analysis. The results of the first stage acted as the foundation of the second stage. In the first stage all interactions between the various actors were identified from the transcripts and mapped individually according to the type of organisation and the programme/project's characteristics. More specifically:

For organisations:

- Type of actor (industrial, hybrid, governmental, academic, civic society)
- Business model (for profit, non-profit, charity)
- Size of company
- Variety of services offered

For projects:

- Type (pilot, alpha/beta, demonstrator, scale-up, ordinary service etc)
- Focus (across sectors, infrastructure, transport, energy, digitalisation, planning, health, education, citizen engagement etc)
- Level of technology used
- Models of ownership of resources

This detailed project categorisation served as a stepping-stone towards recognising the different cases and attributes that were used in the second step of the analysis, the thematic analysis. Using the cases and the assigned attributes in the next stage, allowed for a better understanding of the interactions between actors and enabled project specific characteristics to be considered in the analysis. Given the wide variety of characteristics of projects, this step was essential, as it was necessary to categorise attributes and characteristics as a prelude to the thematic analysis. This allowed for the themes identified in the next step, to be linked to project specific characteristics. In the second stage, thematic analysis was used in order to identify, analyse and describe patterns, or themes, within the data collected (Braun and Clarke, 2006). This method looks at patterns of themes across the whole data set and identifies what interviewees have in common and where they differ (King and Horrocks, 2010). Themes can be defined as a pattern found in the data, that describe and organize the possible observations and aids in interpreting aspects of the phenomenon observed in each theme (Boyatzis, 1998). Themes capture important elements of the data, related in to the research question and they can be described as a type of patterned response or meaning within the data set (Braun and Clarke, 2006). Themes must be distinct from each other and recognizable, but some overlap between them is unavoidable (King and Horrocks, 2010). Additionally, the frequency of appearance of a theme in the data set, does not necessarily determine its importance (Braun and Clarke, 2006). In essence thematic analysis is a form of pattern recognition within data, where the resulting themes act as categories of analysis (Fereday and Muir-Cochrane, 2006).

While various authors present different systems of steps to be followed, King and Horrocks (2010), present a simplified version, referred to as a basic system, including three steps: descriptive coding, interpretative coding and defining overarching themes. In the first step the transcripts were well read and codes were assigned to sections of relevance and importance. Coding can be viewed as relating the data to ideas about these data (Coffey and Atkinson, 1996). Computer Aided Qualitative Data Analysis Software (CAQDAS), more specifically NVivo 12 was used to aid the process of coding the data. This is particularly useful for large sets of data (Easterby-Smith et al., 2008). During the second step, interpretative coding, the descriptive codes were clustered and the meaning of these clusters was interpreted (King and Horrocks, 2010). The final step was defining the overarching themes that describe the key concepts of the analysis (King and Horrocks, 2010). At this stage the depth of analysis was determined. Themes can be identified at different depths, at the manifest level, where directly observable information are used, and at a latent level, where the scope is to uncover underlying phenomena (Boyatzis, 1998). In this research, the thematic analysis was performed both at manifest level, related to the empirical world, and at latent level, related to the postulated actual world, where underlying ideas, conceptualizations and ideologies were identified.

The transcribed interviews were imported into the software NVivo, and were classified per type of actor, utilising the categories in section 2.1, namely, industry for profit, industry non-profit, industry charity, civic society (all), government local, government regional, governmental department, governmental funded institution/funding body/foreign government, university led consortium, institute within university/governmental centre within university and university department.

In the first step, descriptive coding, four orders of code were identified. The first three of these codes are presented in Table 8, while the fourth one is described below. After studying the descriptive codes, I have worked on elucidating the source of the interaction enabling factors, through clustering reoccurring and significant information into interpretative codes. Following the coding of the interpretative themes, I identified the overarching themes that acted as the basis of the analysis of the findings. These are cross code findings that encompass the underlying phenomena that affect actor interactions and resource exchange.

Table 8 Descriptive and Interpretative Coding and Overarching Themes

Descriptive Coding			Interpretative Coding	Overarching Themes
1st order	**2nd order**	**3rd order**		
Interactions per types of Resources	Human capital	Skills - specialised, analytical, leadership, managerial)	Experience via participating - critical skill	Alliancing capability Alliancing scope: individual benefit
		Labor		

	Knowledge	Development of skillset		
		Development of scientific knowledge		
		Gaining market insight	Future capability	Resourcing/future value propositions Alliancing scope: individual benefit
	Infrastructure	Public assets	Access to infrastructural assets	Access and accessing assets Alliancing scope: individual benefit
			Pivotal for testing of a service	Resourcing/future value propositions Alliancing scope: individual benefit
		Private assets		
	Technological assets and IP*	Technological access	Access to technology	Resourcing/future value propositions Access and accessing assets Alliancing scope: individual benefit
		Proprietary technology		
	Data*	Citizen sourced data	Access to data	Resourcing/future value propositions Access and accessing assets Alliancing scope: individual benefit
		Opinion based data		
		Governmental data		
		Privately owned data	Drawbacks of data dependence	Access and accessing assets Allocation reallocation flexibility Alliancing scope: individual benefit
		Open data	Public benefit	Resourcing/future value propositions Alliancing scope: individual benefit
	Client acquisition	Potential clients (direct collaboration)	Reputation - future resources - clients, collaborators	Resourcing/future value propositions Alliancing scope: individual benefit
		Potential future clients		
		Potential collaborators (direct collaboration)		

		Access to future ventures	Need access for proof of concept	Resourcing/future value propositions Access and accessing assets Alliancing scope: individual benefit
			Experience via participating - critical skill	Resourcing/future value propositions Alliancing capability Alliancing scope: individual benefit
	Funding	Funding for R&D	Expiring funding in public projects	Allocation reallocation flexibility Alliancing scope: individual benefit
		Funding for operations		
		Research grants		
		Payment for services		
	Public benefit **	City level	Future resources - jobs, business, taxes	Alliancing for a common scope Alliancing scope: individual benefit
			Reputation	Alliancing for a common scope Alliancing scope: individual benefit
		Government level	Future resources - efficiency, financial	Alliancing for a common scope Access and accessing assets Alliancing scope: individual benefit
		General benefits	Future benefits - envirronmental, quality of life	Alliancing for a common scope Alliancing scope: individual benefit
	Research output			

General Enablers	Operational Enablers		Leadership	Alliancing capability
			Management of operations	Alliancing capability Allocation reallocation flexibility
			Human capital - skills acquisition	Alliancing capability Allocation reallocation flexibility
			Financial enablers	Access and accessing assets Allocation reallocation flexibility
			Citizen engagement	Alliancing for a common scope

	Collaboration relationships		Shared vision	Resourcing/future value propositions
			Willingness to collaborate	Common approach
			Willingness to share	Common approach
			Good communication	Communication path
			Reoccuring relationships	Alliancing capability Common approach
			Flexibility in collaboration	Allocation reallocation flexibility Communication path
	Collaboration Gov-Industry		Support with actions	Allocation reallocation flexibility Common approach
			Need of industry for access to assets	Access and accessing assets Alliancing scope: individual benefit
			Need for proprietary technology	Access and accessing assets Alliancing scope: individual benefit
	Collaboration Uni-Gov		Dependent relationship with city councils	Alliancing capability Access and accessing assets Alliancing for a common scope
			Reciprocal need between each other	Alliancing for a common scope
	Collaboration Uni-Industry		Personal relationships	Communication path
			Financial dependancy	Access and accessing assets

General Barriers	Operational barriers		Lack of funding	Alliancing capability Access and accessing assets Alliancing scope: individual benefit
			Lack of human capital	Allocation reallocation flexibility Alliancing scope: individual benefit
			Difficult access to data	Alliancing capability Access and accessing assets Allocation reallocation flexibility
			Issues with technology not delivering as expected	Allocation reallocation flexibility
	Collaborations - relationships		Fear of sharing	Allocation reallocation flexibility Common approach

			Misalignment in vision and benefits	Allocation reallocation flexibility Common approach
			Misalignment in values	Common approach
			Miscommunication	Communication path
	Barriers in city level		Competitive municipalism	Common approach Alliancing for a common scope
			Lack of funding	Alliancing capability Alliancing scope: individual benefit
	Barriers in government level		Lack of centralised approach - Fragmentation	Common approach
			Lack of replicability - loss of funds	Resourcing/future value propositions Allocation reallocation flexibility
	Barriers in industry level		SMEs exhaustion of resources	Resourcing/future value propositions Allocation reallocation flexibility Alliancing scope: individual benefit
			SMEs misformation of viable business model	Access and accessing assets Allocation reallocation flexibility
	Barriers in academia		Lack of funding and access	Resourcing/future value propositions Access and accessing assets
	Barriers in citizen engagement		Negative effects of lack of citizen engagement	Alliancing for a common scope
			Superficiality in citizen engagement	Alliancing for a common scope
			Lack of funding	Alliancing for a common scope Alliancing scope: individual benefit
IP and data	IP and data created	Enablers	Motivation for alliancing	Alliancing capability Alliancing for a common scope Alliancing scope: individual benefit
			Innovative councils	Alliancing capability Access and accessing assets
			Actively enabling industrial actors	Access and accessing assets Communication path Common approach

		Challenges	Rigidity in dissemination	Allocation reallocation flexibility Common approach
			Source of friction	Communication path
	Open data	Enablers	Motive for collaboration	Alliancing capability Alliancing for a common scope Alliancing scope: individual benefit
			Potetial for value propositions	Resourcing/future value propositions Allocation reallocation flexibility
		Challenges	Dissemination open data	Common approach
			Open IP	Alliancing for a common scope
			Disruptive for industrial actors	Common approach
	Type - Pilots, testbed, demonstrator	Contractual joint ownership	Clear collaboration path - lack of ambiguity	Resourcing/future value propositions Communication path Common approach
			Demise of relationships - technology failure	Resourcing/future value propositions Allocation reallocation flexibility Communication path
			Inflexibility	Resourcing/future value propositions Allocation reallocation flexibility Common approach
	Type - Publicly/led owned projects	Undetermined (or not yet determined) ownership	Ambiguity uncertainty	Resourcing/future value propositions Common approach
			Potential for more future value propositions	Alliancing capability Resourcing/future value propositions Alliancing for a common scope
			Source of friction	Resourcing/future value propositions Communication path Common approach
			Flexibility	Resourcing/future value propositions Allocation reallocation flexibility Common approach
		Open ownership	Ambiguity uncertainty	Resourcing/future value propositions Common approach

			Unstructured management-maintainance	Alliancing capability Resourcing/future value propositions
			Loss of value	Resourcing/future value propositions Access and accessing assets
			Lack of clear vision (for now)	Resourcing/future value propositions
			Potential for public/common benefit	Resourcing/future value propositions Alliancing for a common scope

6.4.1 Descriptive coding

As presented in the section and table above, the first order of descriptive coding contains four codes:

1.1 *Interactions per type of resource: resources offered and resources received.*

1.2, 1.3 *General Enablers & General Barriers: factors that were stated by the interviewees to have acted as enabler or barrier or both in the project and in the collaboration.*

1.4 *IP and Data: interactions related to IP and data*

In the first Main code, "Interactions per type of resources", the nine codes were identified as: Human capital, Knowledge, Infrastructure Technological assets and IP, Data, Client acquisition, Funding, Public Benefit and Research output. Within each one of these categories, a further division of meaningful descriptive codes was identified. For interactions around public benefit, there is a fourth order of descriptive code presented below. For the rest of the resources, no meaningful interactions could be categorised in a fourth order.

The second main code regards General enablers of interactions. These were identified as Operational enablers, Enablers regarding the relationships within the collaborations and then Actor to actor specific collaboration enablers (government-industry, university-government, university-industry). The points regarding the collaboration with civic society were so limited, that they were included in the Operational enablers.

The same process has been followed for the third main code, General Barriers. The second order codes identified in the General Barriers, regard the Operational barriers, the Collaborative process and the Relationships between actors, the Barriers in city, government, industry and academia level, as well as Barriers in citizen engagement. There is a significant overlap between the interpretative themes within the General Barriers code.

Finally, the last main code is focused on two specific resources, intellectual property, and data. In this section the second order codes regard the IP and data created, Open data specific coded and the Type of project; whether it is pilots/testbed/demonstrator or publicly/led owned projects. In the third order I have clustered all the Enablers and Challenges in the data regarding IP and Data and Open Data, and identified ownership specific information. There is a fourth order of descriptive codes that address specific aspects of the third order codes, specifically related to Enables and Barriers.

6.4.2 Interpretative coding and Overarching themes

Following the conclusion of the descriptive coding, I proceed with the stage of interpretative coding. In the first main code "Interactions per type of resource", 16 interpretative codes where identified. These are: Experience via participating - critical skill, Future capability, Access to infrastructural assets, Pivotal for testing of a service, Access to technology, Access to data, Drawbacks of data dependence, Public benefit, Reputation - future resources - clients, collaborators, Need access for proof of concept, Experience via participating - critical skill, Expiring funding in public projects, Future resources - jobs, business, taxes, Reputation, Future resources - efficiency, financial, Future benefits - environmental, quality of life.

From the "General Enablers" descriptive coding, the following interpretative codes where identified: Leadership, Management of operations, Human capital - skills acquisition, Financial enablers, Citizen engagement, Shared vision, Willingness to collaborate, Willingness to share, Good communication, Reoccurring relationships, Flexibility in collaboration, Support with actions , Need of industry for access to assets, Need for proprietary technology, Dependent relationship with city councils, Reciprocal need between each other, Personal relationships, Financial dependency.

Through analysing the data in the “General Barriers” main code, I determined the following interpretative codes: Lack of funding, Lack of human capital, Difficult access to data, Issues with technology not delivering as expected, Fear of sharing, Misalignment in vision and benefits, Misalignment in values, Miscommunication, Competitive municipalism, Lack of centralised approach – Fragmentation, Lack of replicability - loss of funds, SMEs exhaustion of resources, SMEs mis-information of viable business model, Lack of funding and access, Negative effects of lack of citizen engagement, Superficiality in citizen engagement.

Finally, from the IP and Data descriptive codes, the following interpretative codes are found: Motivation for alliancing, Innovative councils, Actively enabling industrial actors, Rigidity in dissemination, Source of friction, Motive for collaboration, Potential for value propositions, Dissemination open data, Open IP, Disruptive for industrial actors, Clear collaboration path - lack of ambiguity, Demise of relationships - technology failure, Inflexibility, Ambiguity uncertainty, Potential for more future value propositions, Source of friction, Flexibility, Ambiguity uncertainty, Unstructured management-maintenance, Loss of value, Lack of clear vision (for now), Potential for public/common benefit

There is an evident repetition within the resource specific interpretative themes observed. This amplifies and asserts the validity of the findings.

The interpretative codes described above, act as the basis for studying the totality of the data as clustered information, allowing for the determination of patterns that allowed me to identify the following overarching themes: Access and accessing assets, Resourcing/future value propositions, Alliancing scope-individual benefit, Alliancing for a common scope, Common approach, Communication paths, Allocation reallocation flexibility, Alliancing capability. These themes are the foundations of the findings, discussed in the next chapter.

6.5 Reflexivity

It is imperative to recognize the value of reflexivity to this research. Reflexivity is the continuous awareness and consideration to the means via variant kinds of linguistic, social, political and theoretical elements are "woven together in the process of knowledge development, during which empirical material is constructed, interpreted and written" (Alvesson and Sköldberg, 2000). In other words, reflexivity is the unavoidable acceptance that social research is an active and interactive process that includes individuals with pre-formed emotional, theoretical and political conceptions (King and Horrocks, 2010). It has been described as a process of continuous internal dialogue and critical self-evaluation of the position of the researcher, and recognizing how this position may influence the research process and outcome (Bradbury-Jones, 2007).

During data collection and analysis, it may impact on research in three main ways. Firstly, it may influence access to interviewees as their willingness to participate may depend on similar positions they share with the researcher (De Tona, 2006). These positions may be related to gender, race, affiliation, age, political/social beliefs and other factors (Bradbury-Jones, 2007). Secondly, these positions may influence the relationship between the participant and the researcher, consequently influencing the information the participants are sharing (Berger, 2015). Thirdly, it may affect the findings and conclusions of the study, due to the way in which the researcher perceives and filters information (Kacen and Chaitin, 2006). These effects are all considered an inherent part of the study (Drake, 2010). Reflexivity aims to monitor them and aid the integrity of the findings, by taking the values, beliefs, knowledge and biases of the researcher, into consideration (Cutcliffe, 2003). It is essential throughout all the different phases of the research process, starting from the formulation of the research question, to data collection, data analysis and forming conclusions (Bradbury-Jones, 2007).

The notion of reflexivity is essential in establishing rigor in a qualitative research. Rigor means demonstrating integrity and competence, while conducting a study (Aroni et al., 1999). In order to conduct a rigorous study, in-depth planning, meticulous attention to the phenomenon of the study and the composition of productive and useful results, will be needed (Horsfall et al., 2001). There are no norms or universally acceptable rules to establish validity in this type of research (Miles et al., 1994). Nevertheless, specific validity issues are usually associated with different stages of the research process of in-depth interviewing (Kvale, 1995). I acknowledge that there are reflexive considerations in this research, which have been specifically discussed in section 8.5 on the effects of reflexivity in this thesis.

7 Findings

The findings are presented in three parts. The first part includes the findings of the thematic analysis presented per type of resource in order to depict the scope, enablers or barriers of each resource specific exchange. This part contributes in building a thorough understanding on what drives and moulds cross-actor interactions that act as the basis of resource exchange for each individual resource and presents the findings particularly related to two of the overarching themes that result from the thematic analysis. Utilising the findings presented in the first part, in conjunction with the rest of the overarching themes observed across the analysis, the second part presents how project partners interact between each other, while the third part focuses particularly on the resources of data and intellectual property, due to their significance in the smart city literature. More specifically, in subchapter 7.1, I discuss my findings focusing on all resources studied, based on the findings of the descriptive and interpretative coding and informed by findings in the "Resourcing/future value propositions" and “Access to assets” overarching themes (Figure 10). There is a section that focuses particularly on the aspect of access to assets in section 7.1.2.1. In section 7.2, I present the findings that stem from the other overarching themes identified, as well as how they are interconnected between each other. This section starts by discussing my findings on “the relationship between the delivery of a common scope and the creation of individual benefits of project partners”, which draws data from the respective overarching themes on “Alliancing scope: individual benefit” and “Alliancing for a common scope”. The following findings regard the uncertain nature of smart city projects and the need for resource reallocation and flexibility”, which conjunctively draws data from both the “Allocation reallocation flexibility theme” and the “Alliancing capability” theme. The final findings regard “the establishment of communication paths and a common approach”, which is based on the information that pertain the “Communication paths” and the “Common approach” theme.

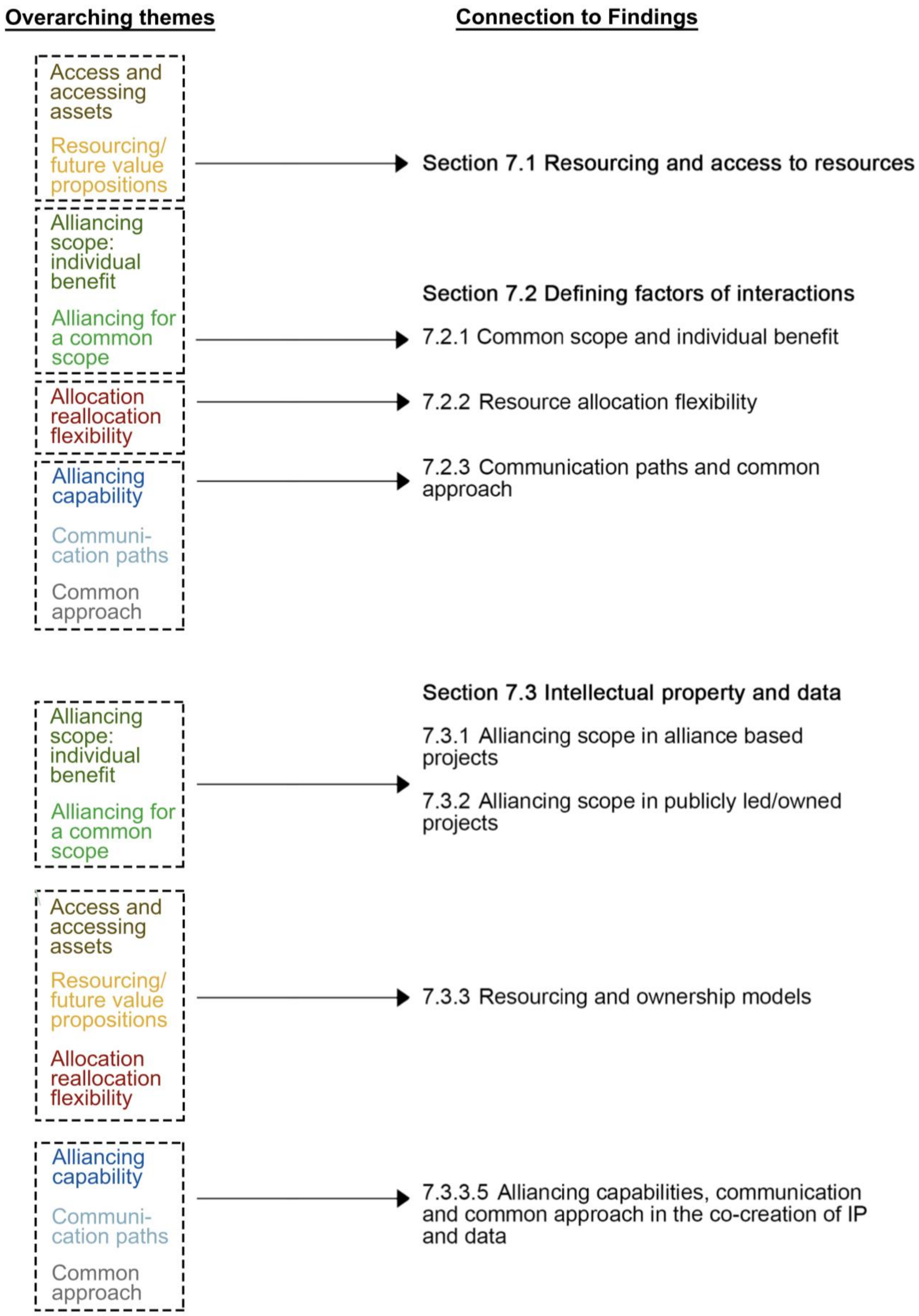

Figure 9 Connection between overarching themes and structure of the findings

An extensive analysis of the 69 interviews that were collected reveal that the majority (65) of the participants have collaborated between each other in various formations. The majority of the participants, 56 of the 69 interviewees, were senior members of their organisation or institution, while the rest (13) were mid-level members, directly involved in the projects. These provided complementary valuable information and clarifications on the operation side. The interviewees covered a broad spectrum of actor groups involved in smart city projects:

- 24 from various levels of the government of which 15 from local government;
- 17 from industry of which 15 from for profit companies;
- 8 from hybrids between governmental and industry organisations (governmental organisations with commercial portfolios or publicly funded private companies), three of which operate as a for profit organisation
- 16 from universities of which three were university led consortia;
- 4 representing the interests of civic society.

The salient characteristics of all interviewees can be found in Table 8.

Table 9 Characteristics of all interviewees.

Type of actor Industry	Position	Sector
For profit	CEO and founder of software provider and consultancy	ICT and citizen engagement
For profit	CEO and founder of software provider	Citizen engagement
For profit	CEO and founder of ICT provider	ICT
For profit	CEO and founder	Planning consultancy and citizen engagement
For profit	CEO and founder	ICT and citizen engagement
For profit	CEO and founder	ICT
For profit	COO and founder of technology provider	Transport
For profit	Head of infrastructure in consultancy	Infrastructure
For profit	Head of smart cities related department	ICT and infrastructure
For profit	Head of smart cities related department	Construction and infrastructure
For profit	Founder and Director	Across sectors
For profit	Head of smart cities related department	Digitalization
For profit	Business advisor	Across sectors
For profit	Strategy Manager	Transport
For profit - Industrial Alliance	Business advisor	ICT

Non profit	Senior programme manager	Across sectors
Charity	Senior Project Manager	Energy
For profit	Programme manager	Energy
For profit	Head of transport	Transport
For profit	Innovation manager	Health
Non profit	Director	Digitalisation
Non profit	Director	Digitalisation
Non profit	Senior specialist	Transport
Non profit	Technology lead	ICT
Non profit	Consultant	Transport
Civic society		
Charity	Programme manager	Community engagement
Smart city programme	Community engagement officer	Community engagement
Citizen group	Coordinator	Community engagement
University	Senior officer	Public engagement
Government		
Local Government	Smart cities strategy	Across sectors
Local Government	Smart cities strategy	Across sectors
Local Government	Head of smart city related programmes	Across sectors
Local Government	Head of smart city related programmes	Across sectors
Local Government	Innovation lead	Across sectors
Local Government	Innovation lead	Innovation
Local Government	Department lead in council	ICT
Local Government	Department lead in council	Transport
Local Government	Project leader in council-led programme	ICT
Local Government	Project manager in council-led programme	Energy
Local Government	Project manager in council-led programme	Transport
Local Government	Economic advisor	Across sectors
Local Government	Innovation manager	Innovation
Local Government	Project Manager in council project	Infrastructure and Digitalisation
Local Government	Project Manager in council programmes	ICT
Regional Government	Senior project manager in council-led programme	Energy
Regional Government	Strategy lead	Digitalisation
Government Department	Head of programme	Digitalisation
Government Department	Head of centre	Transport
Government Department	Principal Officer	Transport
Gov. funded institution	Project manager in regional programme	Across sectors
Gov. funded institution	Team Leader	Infrastructure
Gov. funding body	Innovation lead	Across sectors
Foreign Government	Programme manager	Across sectors
University		

University led consortium	Project leader and Professor	Across sectors
University led consortium	Partnership manager	Across sectors
University led consortium	Funding advisor	Across sectors
University led consortium	Head of Department	Across sectors
Governmental Centre within university	Director	Education and consultancy
Institute within university	Director and Professor	Education and consultancy
Institute within university	Head of Research	ICT and digital
Institute within university	Senior Researcher	Energy
Institute within university	Senior project officer	ICT and digital
Department	Professor	Education and public engagement
Department	Professor	Across sectors
Department	Head of the department	Across sectors
Department	Head of the department – Head of programme	ICT
Department	Deputy Director	Across sectors
Department	Research associate	ICT
Multi university programme	Fellow	Across sectors

7.1 Resourcing and access to resources

In the course of the interviews, over 80 distinct projects were mentioned by the interviewees. These had a variety of goals, typologies and funding streams. Most of these interviewees have participated in multiple of the projects studied, and had collaborated between each other in diverse combinations, as they were part of the same service ecosystem. They had collaborated between each other in at least the same 32 projects. This appears to be typical in this type of organisations as one common characteristic shared by the majority of the projects was that they operate in formal consortia as indicated in the literature and confirmed from the findings of this study. The majority of these were formal alliances in the form of contract-bound consortiums, where resource contributions and duties were pre-described. Additionally, there was also a number of projects that operated in a need-to collaborative bases. These were typically managed by a public entity or academic partner, who also acted as project owner. This entity coordinated partners who contributed resources voluntarily, without being bound by any specific contract. Finally, there were loosely formed collaborations of like-minded organisations that shared a same or similar goal and exchanged resources in order to achieve this goal. A high percentage of the projects analysed were digital service focused ones, followed by digital infrastructure ones, energy projects, cross-sectorial ones, transport infrastructure ones and health focused projects. The type of the project had some effect in the types of resources exchanged but the majority of the findings, especially the ones related to soft capital and the managerial and organisational aspects, appear to be common.

A full list of all the resources exchanged in smart city projects is presented in the table below. Five main categories of resources were identified, divided thematically, each of which is divided in subcategories found in Table 9:

- Human centred – Soft capital
- Technical centred – Hard capital
- Financial Resources
- Marketing - Client acquisition
- Public benefit

Table 10 Summary of the types of resources and capabilities exchanged

Categories of resources	**Resources and capabilities**	
Human centred – Soft capital	Skills based Capital	Specialized skillset and labour
		Analytical skills
		Leadership
		Managerial skills
	Knowledge	Scientific knowledge
		Informing policy making
		Gaining market insight
Technical centred – Hard capital	Access to Assets	Access to public physical and digital infrastructure
		Access to private assets
	Infrastructure	

	Technological assets and IP	
	Data	Governmental data
		Privately owned data
		Citizen sourced data
		Open data
Financial resources	Funding	Funding for research and development
		Funding for operations
		Research grants
	Direct payment	
Marketing - client acquisition	Access to potential clients through direct collaboration	
	Access to market via proof of concept and demonstrable marketing	
	Access to connections via networking and potential future collaborators	
Public benefit	On a local level (city, region)	Creation of jobs, decrease in unemployment, increase in local entrepreneurial activity
		Increase in urban quality of life for citizens
	On a central government level	Creation of jobs, decrease in unemployment, increase in entrepreneurship and evolution in upcoming industries
		Decrease in government spending
		Obtaining data that can inform policy
	For general public benefit	Research output
		Impact on the environment
		Impact on quality of life

By analysing the interactions between smart city actors in the form of dyadic and triadic interactions we can determine that the resources exchanged more frequently are:

skills and labour (soft capital), knowledge (soft capital), funding (financial resources), intellectual property (technical centred-hard capital), data (technical centred-hard capital), potential clients (marketing-client acquisition), access to assets (technical centred-hard capital) and reputational benefits (public benefit).

The resources were exchanged between the different organisations part of the project consortiums and with the project itself. The following sections will demonstrate the findings related to each type of resource identified starting from the human centred, continuing with the technical centred resources, the financial resources, the ones related to marketing and client acquisition and finally the resources related to public benefit.

7.1.1 Human centred – Soft capital

Smart city projects are inherently collaboration based thus are heavily dependent on human capital. Findings demonstrated that their explorational and experimental nature increased the need for the commitment of soft capital, such as specialised skills, labour and knowledge. More specifically the human centred resources reported included skill-based capital such as specialised skillsets and labour, analytical skills, leadership skills and managerial skills. Other human centred resources were related to knowledge acquisition such as scientific knowledge and any other type of knowledge that can inform public policy making and aid in gaining market insights.

7.1.1.1 Skill based Capital

The analysis indicates that one of the most significant resources in smart city projects was skill based human capital. This is due to the innovative nature of the projects that require ample time commitment of skilful individuals for the conception, design and execution of the project. Project partners typically offered such human resources to the projects they were part of, often with little or no monetary compensation. For example, universities provided analytical skills and knowledge/expertise to councils and in return managed projects and received data and access to the project (Figure 11 node 1). In many cases there was no financial input apart from the project's core funding. A head of research in one of the UK's leading projects stated "no partner gave another partner any money. The transactions between the partners were based on the project governance of collaboration to provide work packages that resulted to deliverables". Another interviewee supported that local authorities, who were typically the project holders, did not have the capacity or the capability to deliver technology projects on their own, “they're much more partnership-driven”. The commitment of human resources in innovative projects that involve multiple partners from radically different institutions (councils, universities, multinational corporations, SMEs, non for-profit organisations and others) bears in itself a significant risk as well as a sizeable time commitment. The head of a smart cities related department that has led multiple programmes observed that “the process of figuring out how can they all work together so that all of them [the project partners] have minimal risk exposure to violating their regulatory regime, actually, that was really, really hard”.

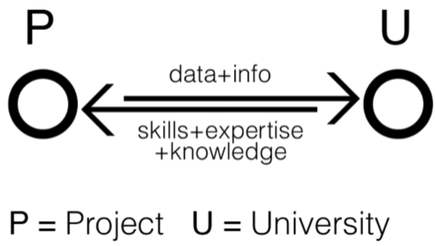

Figure 10 Node 1: Dyadic interaction between the project as a temporary organisation and the university

7.1.1.1.1 Specialized skillset and labour

Skills can either be offered or developed throughout the project. In order for the projects to be deployed, complex and specific technical and entrepreneurial skillsets are needed. This is because while smart city projects typically focus around technology, human skills are needed in order to develop this technology, test it, implement it and make sure it is accurately managed. As these projects are focused around innovation, human skills are additionally essential in their management and implementation.

A frequent stance amongst public sector interviewees was to underline that human capital is the most challenging resource to secure in a project. A senior contributor in a number of projects stated that “everybody thinks it's a great thing (smart cities) but nobody's got time to put much energy into.” This was attributed by many to austerity in public government that “has tended to result in salami slicing cuts in each area and people then tend to focus on the day to day job. They can't think in terms of investing any resource in transformation”, as a consultant in a city council supported. Councils appear to find difficulty in managing the added workload of smart city projects, which makes the acquisition of human capital challenging and of particularly high value.

7.1.1.1.2 Analytical skills

Analytical skills appear to be key in being able to run tech heavy projects. Specifically, as many of the data utilised in the projects were citizen sourced data, many interviewees recognised the need of an innovation/data officer in city councils, as critical for councils to be able to implement smart city projects as there are two components that need to be faced “governance of data and governance of technology”, according to a senior manager in a council. However, the head of a prominent institute stated that these officers were “there to help provide solutions but they aren't in a position to define what the council's priorities are. They need to have enough of a position and a recognition within the council” in order to make a meaningful contribution, pointing towards the need for strong leadership.

7.1.1.1.3 Leadership

The data strongly indicate that the most crucial skill offered in a project is leadership. The head of a council’s smart city department explained that “you usually have someone who will provide the [financial] resources, nobody to lead”. In government, particularly in city councils, projects need visible support from the top and “a fairly entrepreneurial mindset and a corporate culture which supports that kind of risk-taking”, as the head of another council’s smart city department added. Leadership can additionally bring in stronger industrial partners, through using the influence of prominent members of the council, as partnerships are “heavily relationship-based” according to the same interviewee. This appears to be particularly the case with smaller city councils that have the benefit of hosting strong industrial actors. These were able to pull resources and create partnerships more rapidly and easily than other councils, including the ones in bigger cities.

7.1.1.1.4 Managerial Skills

Managerial and operational skillsets in innovation led projects, appear to be specialised, thus cannot be provided by any type of organisation. From the data collected, these skillsets were mainly offered by specific organisations that are either hybrid forms of government and industry, or academic. These types of organisations have access to governmental resources, such as funding and data and collaborate heavily with industrial and academic partners, in order to distinguish ways in which novel technology and research can be applied on the public domain. They mainly act as enablers and “mediators” between the different types of actors within the projects, thus providing managerial input. However crucial, this input in itself cannot guarantee the successful development of a project.

7.1.1.2 Knowledge

Smart city projects and especially pilots are knowledge intense environments, that heavily involve the exchange of novel information and skills. Knowledge in these projects is frequently exchanged as a resource between actors, in three types of interactions:

- It can be provided to a project as a resource, when an actor offers their scientific, managerial, market etc. knowledge to the project;
- It can be developed as the end result of a project, thus can be provided to an actor in exchange for funding, skills or hard capital. This type of knowledge includes the development of scientific knowledge and knowledge that informs decision making; and
- It can be a capability developed from an actor of the project, through their involvement, such as developing a skillset or gaining market insight.

7.1.1.2.1 Skillset, scientific knowledge, tacit knowledge and informing policy making

Through collaborating with universities, other industrial actors, and public organisations, the actors advance their scientific knowledge and technical expertise. The actors not only offered knowledge as a resource to the projects, leading to the advancement of the project, but also received knowledge back in exchange. The next challenge for public administration was to take this learning and figure out how to disseminate it to other public institutions that were running similar projects and evolve from information sharing between councils to actual "genuine collaboration to enhance the sum of the parts", as a council officer added. In order for this learning to be disseminated and adopted in projects of public interest there need to be learnings related to public policy.

Many pilots and testbeds have as a main goal (or one of the main goals) to produce findings that inform policy making and future research in novel subjects, as well as evidence on how the introduction of new policies and/or technologies affects the cities. As a council officer explained "from our perspective, [the pilots aid in understanding] how that technology impacts the city". These pilots and testbeds have as a purpose the creation and/or capture of data that can inform policy and induce changes in formal procedures that stem from the rapidly paced developments in urban environments and transport.

Such complex innovational projects, that include numerous stakeholders of different nature, require analogous skillsets that allow for the understanding and ability to manage such complexity, while at the same time taking into account the intrinsic characteristics of the process of innovation. This skillset is in many cases a type of tacit knowledge acquired solely through working in such environments. Consequently, many actors particularly industrial ones seemed to get involved in such projects in order to acquire this tacit knowledge and skillset development which stems from experience. On the other hand, while city councils and other governmental agencies recognised the significance of this tacit knowledge, there is little provision to capture it or preserve it, as it stays with people rather than with the institution. The head of a number of smart city projects in a local council observed that they “lost not just the project when it ended, but [they] lost the expertise”. A senior governmental official in central government proposed that the grands and funding schemes need to change structure and “fund teams rather than projects or programs” in order to ensure the sustainability of operations, in the long term, as at the end of all programmes the knowledge and know-how in working as a team, is lost.

7.1.1.2.2 Gaining market insight

Gaining insight knowledge on how the market works, as well as how the potential clients operate, what are their current and future needs and how the products and services need to be developed in order to accommodate these, can be a tremendous source of competitive advantage, especially for industrial actors. A principal officer of a governmental department responded that industrial partners often invest heavily in pilots and testbeds “for the customer insight, for the insight into how customers are going to potentially respond to their services” adding that “they want to get that first-hand understanding” and in many cases since their client is frequently the public sector, “they (the industry) want a seat at our table to understand our thinking” and while in other cases they want to test the commercial case for their service (more on section 7.1.4). Whether this was achieved is however questionable, as from the analysis it is evident that most SMEs were highlighting the high cost at which this insight knowledge came for them, while some of them even question the quality of the information. Characteristically, the CEO of one of these SMEs adds “I think we thought that we would get some insight … but actually we didn't get as much anywhere near as close to that”, indicating on how expectations of benefits from participation were not met.

7.1.2 Technical centred – Hard capital

The technical centred resources exchanged between actors are related with the development of the harder capital. These are:

- access to the infrastructure and physical assets that are needed in order for the pilot to get tested or the project to run, including public and private assets;
- the infrastructure created as part of these projects;
- the technological assets and intellectual property created or tested as part of the project, and the technology offered to the project by partners in order for it to run;
- the data offered to the project and the data harnessed from the project, whether these are privately owned, governmental, or open data.

7.1.2.1 Access to Assets

7.1.2.1.1 Physical infrastructure - Digital infrastructure

Access to physical and digital assets is pivotal for the testing and development of novel technology as well as in the collection of city usage (urban) data. Without it, the services and products developed cannot be tested in real conditions, thus they can neither be optimized nor have "a proof of concept" that can lead them to market use and adaptation. Accordingly, for technological products and services that require the use of urban sourced data in order to deliver the service designed, access to assets is essential in order to ensure the correct collection and storage of this data. The collection can be either through using already installed equipment, thus access is needed in the digital infrastructure or through installing sensor equipment in the infrastructure system of the city (access to physical infrastructure).

The head of the smart city department in a prominent council summarised this as “industry needs to have locations where they can have reference projects or to trial things out themselves because they need to learn as organisations. That's an asset I can trade, be easy to work with and offering space to do stuff”. An industrial actor added that “to do any type of digital connectivity, you've got to be able to physically plug into things. The obvious one is street furniture, lamppost, bollards, all that type of stuff. Most councils own their own which means that they can sell them or rent them to anyone who wants access to them" and they note that councils are "very good at trading is assets".

But why were cities offering access to their assets to industrial actors? It appears that city councils had as a goal to create reputational benefit for their cities that would aid the creation of jobs, attract more business and decrease public spending (Figure 12 node 2). A senior council member summarised this accurately as "what we knew we wanted to do was to position ourselves as a city, as a centre for mobility innovation because that helps us attract the right kind of economic interests here, companies, skilled people, academics, and teams". This subjected will be further discussed in section 7.1.5.1.

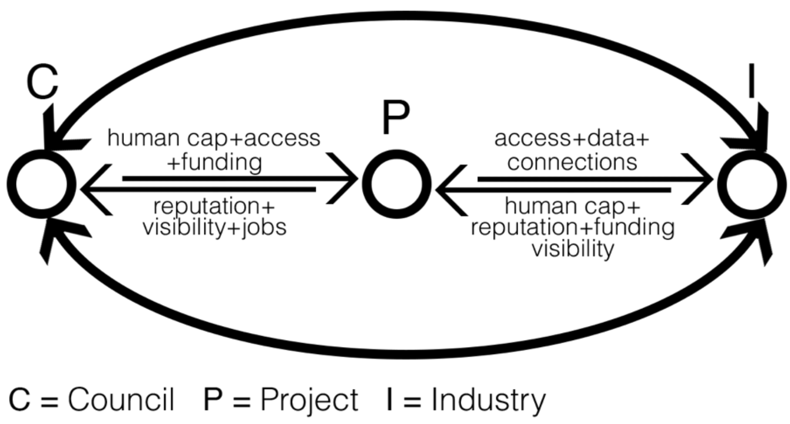

Figure 11 Node 2: Triadic interaction between the council that exchanges various resources with the project, which in return exchanges resources with the industrial partners

Some city officials adopted a "living lab approach", where they offer their assets as testing areas for innovative projects and pilots to test or experiment on novel technology in a real-life setting. This has helped some cities over time to develop clusters of organisations specialized in emerging sectors, and becoming a point of reference for future similar projects leading in obtaining more traction in gaining and engaging new projects.

How do cities achieve this? Findings suggest they do so by being an active partner rather than just passively allowing access to its spaces. They realise this by being involved in the management of the project and by being predisposed to collaborate. The predisposal to collaborate appears to be a crucial characteristic of a council that can be characterised as a capability in itself. A professor described it as “the collaborative nature of answering to what is an organic, growing and dynamic environment “and that it encapsulates the “little things that inspire, or act as catalysts for other activities to take place”. It is offering support in the process of bidding and in the process of operations, as well as opening up both facilities and data. The head of a smart city department described the council’s attitude towards the private sector as “come and develop [your service] and we will do everything we can to help you develop solutions to our long-held problems". If a council does not offer support along with the access to its assets it is “a big turn off to the private sector and they will look elsewhere” to test their novel solution, an industry consultant explained.

This predisposition demonstrated the ability of a council to collaborate with the industry beyond smart city projects and acted as a reputational benefit that may attract businesses. On this matter, the head of an ICT department of a smaller, yet very successful council in terms of attracting business, explained that when private companies are looking for investment “they'll test intensity, the willingness of authority to be open for business and there'll be a number of factors to test”. One of these factors is the existing infrastructure offered and in many cases the quality of the digital infrastructure in place, without which tech based and data-heavy companies cannot operate. Other significant factors appear to be how easy and rapid the railway connection is to London (not just the proximity) and other major urban clusters, the availability of large commercial spaces and in some cases the proximity to a prestigious university that may act as a recruitment pool.

7.1.2.1.2 Access to private assets

In other cases, access to private assets such as grids, buildings, campuses, stadiums or other private assets is essential for the testing of products or services, or the collection of data. For example, utility operators, who are frequent collaborators in smart city projects, often offer to a project, access to their physical infrastructure and full or partial access to consumption data as in node [3] (Figure 13). In this case, a utilities company offered lower tariffs to a group of residents, receiving their consumption patterns and data in return. The company gathered these data and provided them to the project. Project collaborators including a university, analysed the data and provided insight and metrics that allowed the utilities company to optimise its service provision. However, this access comes with sacrifices from the industrial partners, as they often need to provide human resources, such as specialists, managers and maintenance staff to aid with the installation, they sometimes offer access to intricate equipment that can be worth millions of pounds, where there is always a risk of damage and there might be loss of working payable hours for the service, in the installation and testing phase. Particularly since this regards novel technology, there is a high risk of failure associated to low or insufficient performance of the technology that might affect the day to day operation of the testing asset. Thus, instead of aiding in the advancement of a service provision, it might in effect hinder it. As a result, it is very challenging to quantify the disturbance caused by the access to private access, as well as associating it with a monetary value, that can be used to evaluate whether there is potential in resulting benefits from this exchange. A business consultant advised their industrial clients to “not underestimate the amount of intrusion, that this could have on your day-to-day” operations. From the side of the project holders, they advised to always predict and prescribe possible disturbances in contracts with industrial clients in order to avoid possible future barriers and pushbacks. They added that in case of a disturbance “we have to very gently go back and show them [the asset owners] the contract they signed saying we've got to do this and it's a big disruption”.

Access to assets appears to be the most rare and significant of resources, as it is held solely by a specific actor (governmental officials in each level, but for the most part councils) and without it most projects cannot be formulated.

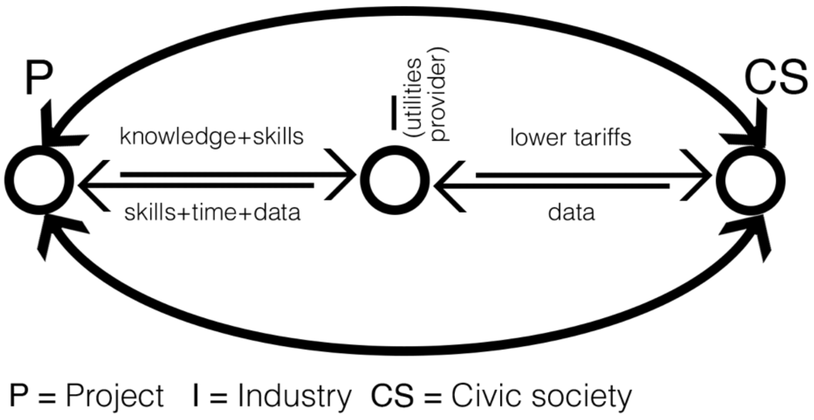

Figure 12 Node 3: Triadic interaction between the project, which exchanges various types of resources with the industry and the civic society

7.1.2.2 Infrastructure

A number of projects include building and developing hard infrastructure, such as buildings, roads, pedestrian zones, pavements, bus stops, lampposts and other street furniture. Typically, such projects are heavy in funding and are part of larger scale programmes, as one of the deliverables. In some cases, the programmes involve the creation of a smart district or a smart building that includes multiple sub-projects and acts as a testbed of multiple technological solutions and/or as a source of collecting different types of data. In these districts and buildings there is typically mixed use of various actor groups (university, institutions, industry, non for profit organisations, council and citizens), in different combinations. Their goal is to act as innovation hubs and create opportunities of interaction by housing a mix of actor groups. A senior staff of one of these projects adds that “there will be a lot of value added just in the building itself”, where the facilities provided along with its design will allow for testing of novel technology and smart urban solutions.

7.1.2.3 Technological assets and IP

7.1.2.3.1 Technological assets - Proprietary technology

There are two types of technological assets that are being exchanged:

- already developed products and services, and
- proprietary technology that is being developed during the project.

The development of proprietary technological products and services and their intellectual property appear to be a key resource, due to the nature of what smart cities are considered to be. Technological assets are developed and used by all actors (industry, academia, public) and many times sit at the core of the project. It includes the development of software and hardware. These technological assets are created and developed by either individual industrial and -in some cases- academic actors, or by the project consortium as a whole. Through analysing the data, it is observed that early-stage proprietary technology is being brought into projects primarily by start-ups and young SMEs that make use of the funding of the project as a way to fund their R&D activities. The CFO of a fast-growing SME explained that they “spend now about £1 million a year on R&D and if [they] get any portion of that, even 70% funded, that's a massive win for [them] because [they] have got more R&D than [they] have got innovation funding coming in. You look at all of these things as being loss-making but actually no, the R&D is loss-making and they [the project is] making it less loss-making”.

Finishing-stages developed technologies are typically being brought in by multinational companies that aim to use the project as either a testing ground for their solution, a rollout exercise, a proof of concept or as part of their marketing strategy. A senior consultant in a multinational company explained that their main commercial partner “really did want to use [the programme] as a mechanism to refine and rescope, recalibrate the technology that they had deployed”. The lead of the smart cities team in a multinational company that is part of numerous projects explained that “we have a central team that understands the issues, and we have developed tools which could potentially apply in various places". They highlighted the importance of participating in smart city projects in order to either test and adapt the solution to each urban environment, and/or to establish a relationship with the city. They added "if you haven't got anybody local, who understands the situation, and you can actually follow up with, then you're just wasting your time. We have to make sure that we also have people on the ground who also have the relationships. If you've not managed to go to x council, and you've not been introduced to everybody in x city, you probably don't have a link with x city, unless we have somebody locally, who can get us in there and build the relationships or actually understand what are the issues."

Ultimately, for the industrial actors that contribute their intellectual property to the project, "it's about access to markets, so testing their technologies with a view to rolling them out, if successful in other areas", a senior consultant in a multinational company concludes.

In some cases, technological assets developed through the R&D funding of one project, were used in other projects and in other cities, either for no fee, as a project collaborators part of a consortium [node 4] (Figure 14), or with a fee as a supplier. The CFO of one of the companies that managed to achieve this, commented "we are leveraging the IP that was developed through that x project…it has helped us massively, and the IP developed during x is 100% being used". This demonstrates interaction not just between the actors but maximized utilisation of public funding for research and development in SMEs, with all the public benefits deriving from this, discussed in section 7.1.5.

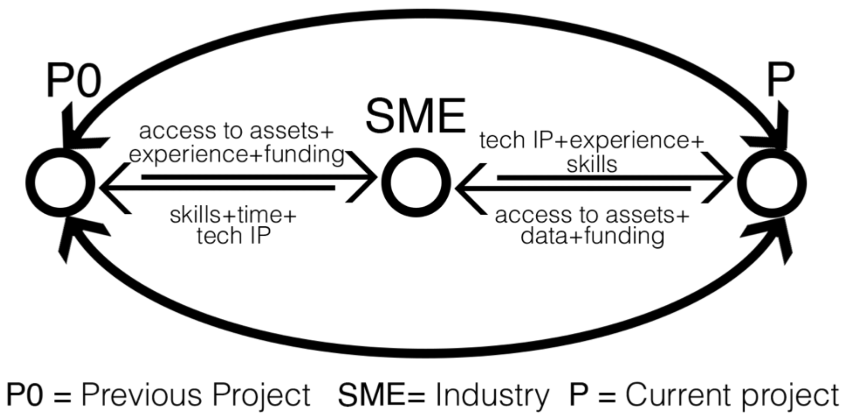

Figure 13 Node 4: Triadic interaction that demonstrates how an SME utilized the tech IP developed in one project to another one.

When actors bring in already developed intellectual property in the project, they typically keep its ownership, while IP developed during the collaboration process as part of a consortium of actors is "owned according to [their] individual collaboration agreement which is different" the head of numerous projects stated. They clarified "the way that we arranged it was that each organisation retained their own IP. If we contributed our own IP, we retained it. Then we all have access to any new data that was generated as a result of the project. Then if any new IP is generated as a result of the project, it will be subject to a new agreement". As the creation of intellectual property, as well as obtaining access to data appeared to be as a pivotal goal for smart city actors, this subject has been separately studied. A complete analysis on the different types of IP ownership resulting from smart city projects can be found in section 7.3.

While technology sits at the core of most smart projects, most of the interviewees made it abundantly clear that "technology is only an enabler. It's a question of what we're going to do with it that matters most. That is the fundamental problem with it all" the CEO of an ICT company stated. Technology "underpins the improvement of services" and is "the enabler of change" a consultant of a council added. Thus, technology develops into something more multidimensional, becoming dependant from the way in which it is deployed from the actors within the project, as it morphs according to (a) the institutional capacity of an actor to deliver it and (b) its reception from the citizens. The head of infrastructure in a consultancy summarised this as “It's not just a technology but it's institutional capacity to deliver it. It's how it'll be culturally and economically received by citizens, businesses, people who are going to be affected by it. It's all the behavioural cultural factors”.

7.1.2.4 Data

Following technological assets, data appears to be central to the deployment of smart city projects. “I think data governs the activities of smart cities these days”, a university professor observed. Multiple types of data are both provided to the projects by the actors, and collected from the projects themselves. In opposition to most of the other resources, data can be categorised according to three characteristics: who owns them, who uses them, and from whom they were collected. According to their ownership, data provided in smart city projects can be governmental, privately owned, open or joint ownership between the project partners. This is extensively discussed on section 7.3. The data collected can be:

- environmental (related to the performance of a technology in the urban environment);
- citizen sourced (related citizen behavior, habits and preferences) and
- citizen opinion based (data related to the perception of citizens on matters).

7.1.2.4.1 Governmental data

Governmental data are collected by public entities for their own use, through public or private means. Typically, these types of data are collected with indirect or no consent. These data are used by public entities in order to enhance decision making processes and allow for “better informed decisions” as the head of ICT of a council explained. They are provided to the projects for analysis, for tech development or for testing. Data provided for analysis, have as a purpose to make use of rich datasets in order to bring light into urban issues such as mobility and transport, health and energy production, and usage. A university professor described this as "we wanted to understand the complexity of data and the challenges of data acquisition and curation in influencing the services that are delivered to a city and the transactions needed, particularly the data-driven transactions needed to influence the services".

Governmental data is a unique and rare resource that is, however, underused largely due to data quality and lack of human capital to analyse it. Quality of data appears to depend on the means by which they are collected, the frequency, the consistency and their ability to be accessed. These aspects are directly related to the process of digitalisation in which the government seems to be falling behind compared to the private sector, as "at the minute, there's a big disparity between the private sector and the public sector in terms of digital transformation", as the director of digitisation at a publicly funded organisation observed. This is the reason why many of the publicly funded smart city projects are related to digitalisation. While the process of digitalisation in the public sector is intensifying, the subject of opening up governmental data was widely discussed from the interviewees and has also been the subject of some of the projects.

However, opening up governmental data is not such a simple and straightforward subject, as it is disruptive to the market. From one point of view, it creates more equalized opportunities and provides a means via which SMEs and individuals, gain access to data that allows them to create new value propositions. From the other point of view, it might be proven disruptive for the companies that are already part of this market, many of which are SMEs with business models built around the notion of collecting and selling specialized data. A senior officer of a governmental department explained "there's two things that kills the marketplace. One of them is information, missing information, the other one is public goods. If you're selling something and then a government makes that freely available, then it's quite hard. Unless you're really adding value, your business is in trouble. There are people making money out of the problem that we're trying to solve".

7.1.2.4.2 Privately owned data

Privately owned data are data collected and owned by private companies. They are collected via private means (sensors, servers etc) and are offered to the projects by private companies, who assume the role of data providers, in order to be analysed and used for insights. A simple way to distinguish a private asset is its maintenance status. An asset privately maintained, is privately held. The CFO of an SME described this as “we're liable for it, therefore we own it”.

A particularly interesting observation is the collaboration stream between industry and academia. In many occasions it appears that a number of universities have established partnerships with industrial actors, typically multinational companies, but also SMEs, where privately owned data are being provided to universities for researchers and students to analyse and use in academic research. The head of a university department explained that “quite a large amount of my time at the moment is given over to just keeping relationships going between us and external partner organisations who have data and a desire to do stuff with that data and want to take advantage of our student resources to help them do something with their data” (Figure 15 node 5)

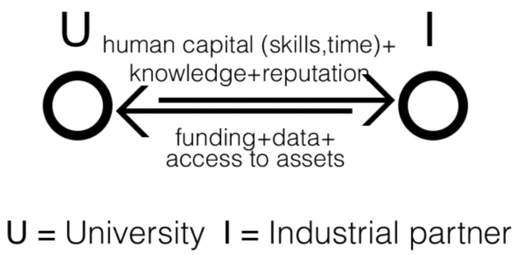

Figure 14 Node 5: Dyadic interaction and exchange of resources between university and the industry, where the university offers human capital and knowledge to industrial partners that are in need of data and advanced analytical skills.

7.1.2.4.3 Citizen sourced data

The collection of citizen sourced data can be related to their behaviour, habits and preferences and typically occurs through sensors installed in public infrastructure or private buildings, through cell phones, wearable technology or other personal devices and through satellite usage. Some of the most prominent were: energy consumption, transport usage, street usage and geolocational data. These data can be collected with direct consent, indirect consent or many times with no consent at all. Citizen sourced data can additionally be about their opinion. Opinion based data are related to the attitude of citizens on matters. These data were collected within the projects from the citizens with direct consent, as they were either asked about their opinion directly, or offered the possibility to enter their opinion through a platform. The collection of this type of data however appears to be a controversial subject as it is still unclear whether the data collected truly are used for the benefit of citizens. The deputy director of a university department explained “if you're going to ask people to give their consent, it seems sensible to make sure that the data is primarily used for the collective group that create the data in the first place, which would mean for purposes which are directly beneficial to the group”.

7.1.2.4.4 Open data

Open data are existing or collected data that are accessible to anyone with no financial -or other- compensation in exchange. The premises of many of the projects that were examined was the creation of open databases or/and opening up different types of data collected, each to the extent possible. This was particularly the case in projects with heavy involvement of hybrid public-private organisations, as their purpose revolves around bridging the innovation gap between industry and the public sector and providing new opportunities for market growth. While many elements of the projects remain commercially sensitive, as the head of a smart city department in a council explained “again if it's our data and we've brought data in from the council, we try to keep it as open as possible but sometimes you do get data that you have to keep, that you're not able to open up because it's commercially sensitive”. Apart from essential for growing businesses, open data have an additional dimension. They offer citizens the possibility to comprehend the power of their own data and how to best utilize it. Some projects created environments where citizens could experiment with their own data and get accustomed to the benefits and downfalls that can result from them.

During the interviews, a point of conflict was observed. There seems to be a disparity between opinion on the issue of the storage of open data. While some actors supported that open data storage is a significant issue that may hinder the ability of organisations to provide data openly in the long term, other actors supported that "we knew people were collecting data so we started to build the capability for storing data and we realized it wasn't the storage that was the issue, it's being able to get insights from it. It's the analytical side of it that people really struggle with". Interestingly, the contradicting opinions originated mainly from university actors. Indisputably, the lack of people and skills to analyse such data is a barrier, however the inability of providing adequate data storage to open data undermines its most significant aspects, their unhindered accessibility.

7.1.2.4.5 Drawbacks of data dependence

While innovation driven projects increasingly appear to have data at their core, there are some points of caution. Firstly, data are not neutral. As mentioned above, their quality depends from a number of factors including who is collecting them and for what purpose. The director of a university-based institute explained that "the choices that you've made about what data you collect already skew the data set. The uses that you put that data to are inevitably going to be conditioned by your own perspectives…therefore, we have to be very careful about, how we govern our use of data, our choice of data, what we're going to do with it". Secondly, data is still immature and the market around data is also at preliminary stages. This means that the state of the market is rapidly changing, and business models based on data need to be agile and frequently revisited. Interviewees mentioned that the path towards which industry needs to swift is analysing data instead of selling them. Thirdly, datasets are incomplete. As a government director observed "very basic information of data is missing or it's very hard to find. When we find it, it's very hard to understand it and then when you finally understand it, it's very hard to trust it's been going to be kept up to date”. Furthermore, data needs skills to analyse. Without skills, which as discussed above are in scarcity, insights cannot be drawn from datasets. A university staff stated “data is great, and we collect it so anyone can have it. But actually, the insight and the context is more important”. Concluding, as the head of a smart city department supported “data is not the new oil”. Even though there is a significant amount of sensors in urban centres collecting data, this market is still immature, data is still incomplete and smart city actors have not found a way yet to use them at their full potential.

7.1.3 Financial resources

One of the resources most frequently exchanged between actors, are financial resources that come in the form of either direct funding or payment for services. Payment of services is simply monetary exchange in the form of direct payment in exchange for services delivered to the project by a supplier, that is usually not part of the project team. Direct funding streams in the projects explored derive from European funds, funds from the UK government distributed either through government departments or through funding mechanisms (UKRI and the research councils and others) and funding coming through institutions and organisations with specific agendas (for example focus on health, environmental sustainability, aging population etc). In some cases, there can be joint funding from two different streams covering different aspects of the project.

These funds were distributed in projects in order to support activities that are in the public’s interest, according to predetermined agendas, typically around sustainability, creation of jobs, increase of health and quality of life, education and digitalisation. Financial resources were distributed to cover the following aspects:

- **Funding for research and development**: Funding to be used on the advancement of existing technologies or on the creation of completely new intellectual property that responds specifically to a challenge, or funding to test such a technology and act as a proof of concept.

- **Funding for operations:** Funding to hire human capital skills, spaces offices the technology (not the one to be tested), servers, data storage platforms, funding to run training, seminars and day to day operations.

- **Research grants:** Financial grants that have as a scope the collection of data (from primary or secondary resources). These are used for academic purposes, as industry reports, market reports, evaluation of specific project or scoping.

To summarize the way in which governmental funding works, a director in a central funding mechanism explained “We identify the scope of challenges that we're interested in exploring, and then we put that scope out into the market and invite consortia made up of industrial, academic, and sometimes local government bodies to bid in to the competition for funding to take forward the project. Those projects are on a match-funding basis, so central government puts up half of the funding and the consortium would put up the other half”. The match funding required is not half/half in all projects and it is rarely in money but typically in human resources (skills and time) and physical resources.
Funding was described as one of the biggest challenges by the interviewees, but at the same time the majority supported that there were ample different sources of funding streams in the UK. Why is funding such a big challenge then? The head of a public department explained that what is missing is “funding for the organisation itself. You can get project funding. What you can't get is the funding to support the development of the project”. This is essential as in order for an organisation to participate in such projects they need to engage organisational resources, such as human capital, infrastructure and space, which many of them have in scarcity. Thus, engaging them in such projects, instead of their day to day operations puts the organisation at risk. Scarcity of financial resources for operations is an issue extending from private organisations to public ones.

7.1.3.1 Competitive municipalism: councils repeatedly bidding for projects

Innovation and smart city departments and teams in councils appear to operate on a project to project basis, where money is utilised for essential council operations including salaries. A council consultant described this process as a "(funding body) junkie", while a senior officer in a publicly funded organisation portrayed the funding model of councils as "constantly bidding to do stuff", which appears to be "the fault of the government [for] trying to make local government smaller, to reduce the size of government and so rather than funding things properly, they force Councils to bid for it". This has been described from a consultant of such projects as "competitive municipalism" adding that "the attitude of the central government has been to pit local authorities against each other. You're competing for new housing, you're competing for jobs. You're competing for inward investment, you're competing on all these measures". Councils appear to acknowledge this practise and be against it but "it's just the way that central government has made local authorities scramble around for every last scrap of money, and then they reduce their funding further" a technology lead added.

This competitive municipalism generates negative effects in the relationships between councils, hindering them from actively and effectively collaborating, sharing information and best practises and exchanging ideas and knowledge. These are not only affected by councils bidding against each other but additionally by the lack of public funding that they have been suffering from in the past years. An industry executive explained that "their [council] resources have been under terrible pressure for many years. Many of them have lost 40% to 60% of their staff and their budget. It's actually if they've got those few resources, how could they have the time to talk to each other, and tour around the country and find out what's happening elsewhere? I think, just practically speaking, that can be difficult to do". "That is quite a political thing and local authorities are quite good at just making do with what they've got in difficult situations, which is why they're very good natural innovators. Even though people say they're not, when someone reduces your funding by 50% and you still have to deliver the same, that's good innovation if you can carry on existing" observed a senior official in a hybrid organisation.

Consequently, councils are obligated to bid against each other to cover up their depleted funding, in many cases using these funds to cover basic needs such as staffing and operational expenses, leading them to constantly coming up with innovative solutions to operate and run novel projects.

However, there are some councils that have managed to get grants repetitively over the past year. The head of the smart city departments of one of these councils stated that the way they have achieved this, is by being able to "put together strong propositions. Also, we've developed a very strong reputation, we've been able to get things done". Other interviewees added to these enablers for securing funding: strong relationships with the industry, collaboration with local universities that have experience in writing bids and upper management support in the bidding process.

Finally, in addition to competitive municipalism many interviewees expressed concerns regarding the way in which funding distribution works. These concerns were related to "elitism" and uneven distribution between either wealthier and poorer councils, where more wealthy councils appear to undertake more projects, or larger and more central cities versus more secluded cities. In addition to that, interviewees flagged a lack of flexibility in funding distribution that does not allow for creativity which is a crucial aspect of innovation. This inflexibility was additionally evident in the types of organisations allowed to participate, as well as in the match funding requirement (as discussed above) where SMEs struggled to participate due to lack of funding to run the organisation. A project lead in a government funded institution clarifies that "funding shouldn't be a barrier to participation and we just need to find better ways of bringing communities together to tackle a problem regardless of business models and funding".

7.1.4 Marketing - client acquisition

Many of the organisations interviewed, took part in smart city projects in order to augment their R&D capabilities, and others to get access to data, and test and further develop their technology. However, from the analysis the most prominent reason for industrial actors to participate and engage resources in smart city projects was client acquisition. The ability to acquire future clients is considered an organisational capability (operant resource) that the actors, particularly the industrial ones, aim to attain via their participation in the project. The actors may offer human resources, their novel technology, data or private infrastructure in order to gain:

- Access to potential clients through directly collaborating with them in the projects;
- Access to market via proof of concept and demonstratable marketing;
- Access to connections via networking and potential future collaborators (clients, suppliers and future projects)

The CEO of an SME summarised the above as "We decided that what we thought we would get out of it was profile and that was important to us because we were small. We thought we would get relationships with some of the partners in the collaborative group consortium, which would be valuable. We thought we would get some research that we could accomplish and value up for our marketing. We thought we would benefit most from but actually benefits the least from was the actual development of our platform as a sales project."

7.1.4.1 Access to potential clients through direct collaboration

Access to potential clients is directly working with an actor (or multiple actors) in a project, that has the potential to become a future paying client. Many companies started as project partners in a consortium, where they were funded on a zero-profit capacity. One of the predominant reasons companies and particularly SMEs choose to participate in these projects is because in this way they work hand in glove with their future potential clients. Consequently, frequently the councils appeared to subcontract them for future projects or renew their collaboration with them on a paid, rather than zero-profit, basis. However, questions related to the procurement process have risen. Additionally, these subcontracting jobs were typically very small compared to the contribution to the project, thus there is limited return.

The participation of the industrial partners appeared to frequently be "a mechanism for them to sell their services to some of the public sector partners", a consultancy director disclosed. Referring to a specific project they added "I think essentially some of the SMEs were clearly commercially minded and wanted to sell their products and services…[even though] the public sector partners were always pretty clear that that wasn't the purpose of it, so there was a difference in terms of commercial expectations”.

On the other hand, interviewees also highlighted the need for councils (or other governmental bodies) to aid in supporting the commercial case of the industrial partners involved, particularly the SMEs. Few councils achieved this via helping the industrial partners to get scale ups. In this way, the companies offered to the project an initial service and if the project required additional services or a scale up, these were incorporated into a new commercial contract. From the data, this did not appear to be a frequent practise and it has been observed solely when certain circumstances occur. Either, the SME cannot financially continue to support the project without payment for services, risking project failure, or when a strong industrial actor (multinational company for example) owns a unique technology that the project is in need of and uses this as a leverage.

7.1.4.2 Access to market via proof of concept and demonstrable marketing

A proof of concept was in many occasions an essential starting point in demonstrating the utility of a service. This was particularly applicable for technologies on urban innovation, due to their scale and specificity. In some cases, it is a demonstration of how a technology works, in other cases it is demonstrating that the organisation can collaborate with other actors and respond to their needs. Interestingly, the latter interests more governmental actors, than industrial ones. This is because via these projects, different governmental bodies and frequently the councils, create a branding for their city and enhance their reputation. The head of one of the most known smart city projects explained that the project has been “the catalyst for those things happening and the proxy for engaging other people in”. The project was “about the brand” and “was a successful piece of work to catalyse other activity”. One of the ways to achieve this is by bringing on board “a larger company that supports you, that makes it look like this is a big thing. Then these companies, sometimes, often they don't do anything. They justify the balance of budget", as a university actor revealed. Certain councils were especially interested in building international reputation, which drew in more opportunities for future collaborations. A strategist in a council specified "I think over the years, we've got an international reputation for being innovative in the areas of mobility and transports, so people often come to us to trial a project. Reputationally, I think it's helped build a reputation [x city] is the place for innovation".

7.1.4.3 Access to connections via networking and potential future collaborators

Through the involvement in the projects (contractual or not contractual) the project partners had frequently access to meeting key people in companies or public organisations, that could be future collaborators (suppliers, co-workers, partners, talent) or even future clients. According to a professor, maintaining good relationships is "the biggest enabler. Having good relationships with individuals in different organisations, being able to demonstrate that what we can do could really be of great benefit to them". Participating in a project even in a limited capacity, might not yield immediate benefit but it appears to be the way to enter into new projects. Once someone is part of a project "opportunities are revealed, because you don't always see or hear about opportunities unless you're inside the relationship" as the head of a smart city programme explained. This is the potential of being invited to future projects and future bids. Most project teams work together in multiple projects. Councils and universities will go back to partners that have demonstrated their willingness and ability to work. This is evident from the amount of overlap of interviewees working in multiple different projects simultaneously. A senior officer in a governmental agency revealed "we're more inclined to share those opportunities or to work together on other projects and we see that time and time again". This is particularly important for SMEs and start-ups that would otherwise struggle to get into public bids and collaborations. A senior industry consultant reported that at the end of a testbed project "some of the SMEs came out of it really well, in terms of their approach and what they've done and I know that they have then started to work collaboratively with some of the larger public sector partners as a consequence of the project”.

7.1.5 Public benefit

Throughout the findings, I have described the exchange of resources via interactions between actors in smart city and urban innovation projects. I have explored how the funding bodies provide financial contributions to project consortiums, that distribute these to other project partners to fund human capital, operations and R&D. But why do the funding bodies provide this funding in the first place? From the interviews conducted it appears that public funding bodies allocate grants to selected projects that fit their wider agenda and strategic planning. These are typically medium to long term strategies that are either based on political reasoning, may be part of a response to European or UN Calls for Action, or a response to the changing economy and citizen needs. The agenda related to smart city projects and projects of urban innovation in general appear to aim to achieve either of the following:
On a local level (city, region):

- Creation of jobs, decrease in unemployment, increase in local entrepreneurial activity
- Increase in urban quality of life for citizens

On a central government level:

- Creation of jobs, decrease in unemployment, increase in entrepreneurship and evolution in upcoming industries
- Decrease in government spending
- Obtaining data that can inform policy

For general public benefit:

- Results from evidence based research
- Improvement of the effects on the environment
- Improvement of citizens’ quality of life

7.1.5.1 Public benefits on a local level (city, region)

Funding allocated to projects that are focused on cities or regions, appears to aspire to either aid with the creation of jobs, decrease in unemployment and increase in local entrepreneurial activity; in the increase in quality of life for citizens or; in a decrease in government spending. Cities aim to attract businesses in order to bring in more taxes and create more job opportunities for their citizens. They do that through creating a reputational benefit that acts as a competitive advantage in their favor. They use smart city projects as either a marketing tool to demonstrate their ability to foster innovative activities and attract more businesses, or as a way to develop and advance the infrastructure and services they offer as a city, through the project's funding streams (Figure 16 node 6). As discussed in section 7.1.2.1, city councils participate in projects of urban innovation partly in order to develop their reputation. They do so in order to "position [themselves] as a city, as a centre for mobility innovation because that helps [them] attract the right kind of economic interests here, companies, skilled people, academics, and teams", the head of smart cities of a council, demonstrated.

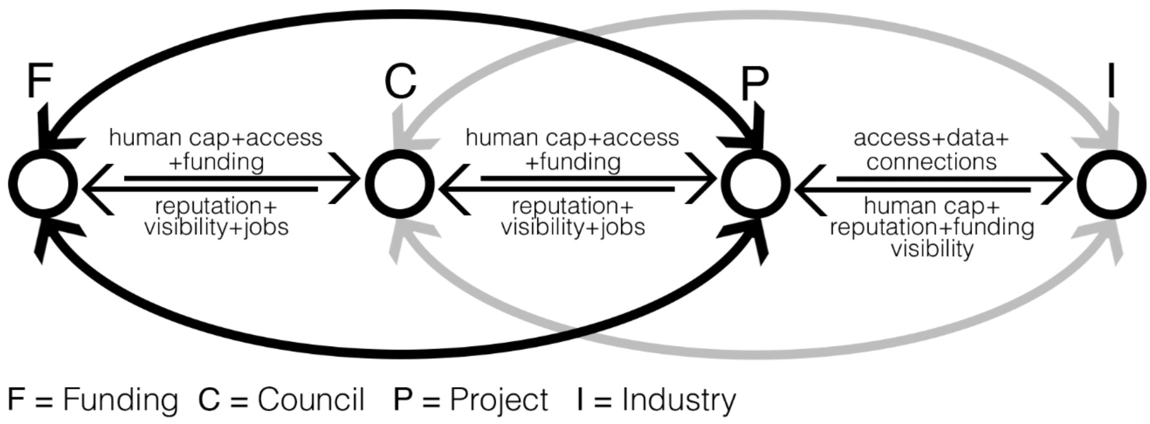

Figure 15 Node 6 extension of node 2 (a triadic interaction between the city council, the project and the industry) with the addition of the funding mechanism

Furthermore, considering the advances in the tertiary sector and the increase in automation, as well as the changing environment in traditional production units, which are typically located in the peripheral areas, many councils appeared concerned regarding their employment levels both current but most importantly future. In order for such councils to have the capabilities to respond to the changing environment, they undertook smart city projects in order to bring up to date or possibly provide innovative infrastructure. This appears to be essential when aiming to attract innovative businesses, as they have different needs such as advanced network connections, flexible spaces, electric vehicles (EVs) capabilities and others. If the infrastructure is not in place, business will move to a different city. The head of transport at one of these councils explained “looking at the social side of it, the impact of tech on society and how we can improve employability for those occupations displaced. By having that link there, not only is it the right thing to be doing as a council, to make sure our citizens have a job. We're also going to be engaging with the larger companies such as the [multinational company] and the people like that around the table. Through that, then comes other opportunities for funding sources as well”. The head of innovation in the same council added “for me, that digital layer is a really important asset and a very important unique selling point”. Through bringing in highly valued businesses, councils estimate that they will not only “hire a range of people, but they will use goods and services in the city as well and create a more stable and sustainable economy”, a council officer specifies. Local governmental agents, additionally aim for an increase in the quality of life for citizens. This occurs through offering advanced transport systems, real life data that will allow for more efficient planning, digital public services and potentially "beautifying" the city. This may lead to a decrease in time spent to run errands, increase in quality time, decrease in stress. While all of the local government interviewees, mentioned areas of improvement in the quality of life for citizens, mostly related to the environment and transport, most of them were quite vague.

7.1.5.2 Central government level

In some cases, funding is provided to smart city or urban innovation projects that respond to a wider need or agenda. These projects were frequently managed by departments of the government or by certain governmental institutions that have as a goal to tackle specific problematizations that affect the wider country or might affect sectors of the economy and the economy as a whole. These funds were allocated in order to aid in the creation of jobs, decrease in unemployment, increase in entrepreneurship and evolution in upcoming industries (as discussed in the section above); decrease in government spending; and obtaining data that can inform policymaking.

7.1.5.2.1 Decrease in public expenses

Decrease in public expenses might occur via the deployment of technology or managerial systems that will reduce public spent through:

- integration of services
- more accurate allocation of resources
- increase in efficiency of the delivery of public services
- decrease in employees needed
- overall, more accurate knowledge of the status quo and more accurate predictions for future issues.

From the interviews conducted it is evident that the majority of the interviewees, including government officials, heavily criticized the austerity and constant restrictions of public spending, as well as the conditions of competitive municipalism the councils are facing. Investing in projects that look into decreasing public spending via alternate ways such as more accurate allocation of resources and increase in productivity appears to be a forward looking, sustainable point of view. These projects appear to be heavily funded, involve very strict contracts and are closely monitored and regulated. In some cases, they involve the participation of one or more councils, but the results are not focused on benefiting a specific urban environment. Nominal examples are the 5G testbeds, automated vehicle testbeds, new transport systems and energy production and consumption related projects. The head of innovation of a council that is partner in two of these projects specified “for public sector partners it's about economic development. Raising productivity within their own rural areas”. An industrial consultant in a heavily funded high-tech project explained “There is a little bit of urgency now that says even to keep our heads above water, we need to make sure that we are competitive. If you look at our European neighbours, we are not competitive. It's not because we're stupid, it's because we've chosen a route of increasing our manpower, whereas they have chosen to increase technology. Our unemployment levels are probably healthier than theirs, but it means that we look sluggish compared to them and that there is bigger overhead attached to our work”.

7.1.5.3 General public benefit

Finally, few projects aim at the creation of public benefit for “the greater good”. These are frequently projects that either focus on producing research output via aided academic or industrial research that will provide data driven insights, or, in response to EU and UN directives, projects that have as a goal to advance the agenda of environmental sustainability and/or increase in quality of life.

7.1.5.3.1 Research output

University and research institutions are one of the main actor groups in smart city projects and appear to have a pivotal and indispensable role in smart city and urban innovation projects. They bring in skilled human resources, knowledge and experience on working in experimental environments with novel technology. Moreover, interviewees indicated that universities, due to their reputation, provided a sense of validity and sometime attributed prestige to a project, drawing in more industrial partners and additional funding. They additionally have experience in writing and executing funding applications, in opposition to many, of the other actors involved in these projects and have access to additional sources of funding via research councils and other grant mechanisms. While the expected reason for universities to be taking part in these projects, would typically be the ability to collect data that will inform their research output, in reality it appears that academics engage in these activities frequently for their (and/or the university’s) reputation and academic interest, as well as to have an impact on the industry. A university director stated “we're keen that the research that we're doing has an impact", while a research associate explained that from "most of the work [they] have done, [they] couldn't publish anything", as it was overly technical and project specific. From the other side, institutions typically have as a goal to produce reports that are sector specific and typically combine both the view of the industry and academia. A senior researcher in a governmental institution described that "what we wanted to do was to pull all the relevant information together that's been undertaken by industry and academia, both in the UK and internationally, so that as a collective community, we've got a better picture about what the challenges are, what the opportunities are, and how we can move forward".

7.1.5.3.2 Impact on the environment and quality of life

Finally, many projects have as a main goal to deliver a service that will have a positive impact on the environment and/or the quality of life of citizens. Some funding bodies did this directly by incentivising "green" projects, while others had sustainability (environmental, societal, economical) as one of the goals. Some of the most representative goals were: reduction in emissions coming from transport (Electric Vehicles (EV), Autonomous Vehicles (AV), parking sensors), improving air quality (tracking sensors and microclimate creation), reduction in energy non-renewable consumption (tracking energy consumptions and optimizing the grid, switching to renewable resources), reduction in waste. A senior officer in a council narrated how a novel technology employed through one project, aimed at improving the quality of life of a group of citizens "the technology underpins the improvement of services that we're looking to and in some extend improve the quality of life for people who need to live at home whether they are elderly or not and don't want to go into a care home. Technology enables them to live where they want to live for as long as they can, and should help us optimise the service delivery that is what I suppose a city is about, what communities is all about. That's the role of technology".

7.1.6 How does a smart city project work?

Following the analysis of the resources exchanged between the actors taking part in smart city projects, the interactions of a sample project are presented below, in order to aid in the comprehension of how smart city projects work (Figure 17). The project selected is deemed as the most representative, amongst more than 80 projects studied throughout the interviews, as it was of an average size and budget, involved all actor groups, as well as many of the reoccurring actors between projects and presented the most common interactions between these actors.

As in almost all projects, the funding mechanism provided funding to a city council in order to organize and deliver a project of urban innovation. The funding body offered this funding in order to boost the local economy, via aiding the city to engage with a developing industry and new urban technologies. The goal was for this to lead in the creation of a new market for that specific city and the establishment of new job opportunities for its citizens. In addition to that, these urban technologies would aid in the more efficient management of the city and a decrease in public expenditure as well as a presumed increase in the quality of life of citizens. The city council, who was the project owner in this specific case offered the funding to the project consortium (created by all registered legal partners) along with, human resources to manage and run the project and ample access to the city access, such as local transport infrastructure, public lighting system, access to pavements and squares, and public sensors. The city aimed to gain knowledge on how these projects work, as well as to build its reputation, as a city that welcomes innovative companies and embraces new technologies. The project is additionally managed by a non for profit that is a local industrial alliance, that offered administrative support to the consortium.

This project included a number of SMEs and few bigger multinational companies, as well as some local universities. It was additionally supported and monitored by a hybrid organisation of public interest. Finally, there was extended citizen involvement in direct manner (offering opinions, feedback and inputting data) and indirectly (via utilizing areas with sensors and monitored spaces). The city council, through the project consortium, offered to all industrial partners access to the city assets for the installation of the novel technological assets part of the project. Some of these were used to collect urban sourced data regarding citizen behavior and direct data from citizens. The SMEs were offered significant R&D funding from the project, which they had to match fund (offer back) in-kind, through offering their tech IP and services for free, in addition to their human resources and knowledge. Apart from R&D funding and access to city assets, they had the possibility to produce a demonstratable proof of concept of their IP and services, which aids in access to market, and work hand in glove with the council that is a potential future client of theirs. The larger companies were offered more limited financial aid and had to offer a more substantial match funding contribution. There was friction created due to these requests, but this was later solved. The project benefited from the involvement of such large industrial players as this added significantly to its reputation, both in partner recruitment and gaining access to market.

The university partners had extensive involvement in this project, as, they offered their own tech IP which they furthermore developed throughout the project, they contributed to the analysis of parts of data collected by the other partners and access to their buildings and infrastructure for other project partners. They additionally provided support and knowledge to the other project consortium members. They also collected data from citizens, which added in the development of services that have as a goal the improvement of urban quality of life. Apart from funding and access to project data that can be used for research output, the academic partners participated in the project to test the tech IP that they had developed, and to gain experience in participating in future projects of this kind, which they later on used in larger programmes. Finally, support and knowledge from past experience was provided to the project from a hybrid public private organisation, that has been involved in multiple projects. The organisation also supported the partners separately and monitored the final results produced.

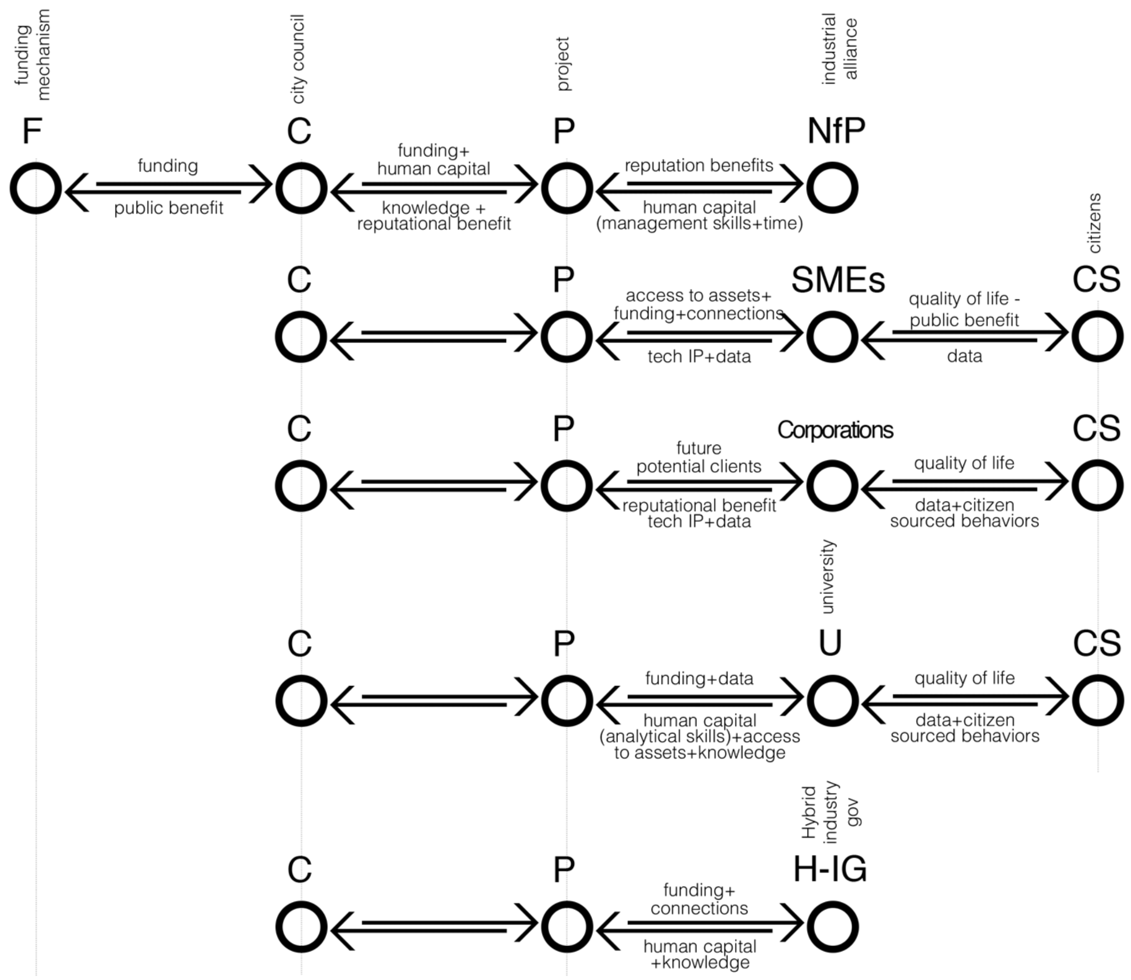

Figure 16 Interactions within a sample smart city project

7.2 Defining factors of interactions between project partners

The above sections showcase the main resources exchanged between actors involved in smart city projects, the intentions that drive these exchanges and how these resources are integrated through collaborative practises. The interactions in the section above are clustered per resource to allow for a comprehensive understanding of the micro-actions that occur in the micro level, which is a stepping-stone for studying the macro and the meso (Archpru-Akaka et al., 2023). This section presents the overarching themes that I have identified through analysing the micro level and correspond to macro-level observations that connect the resource specific findings to the themes that dominate the enablers and barriers codes. As per Figure 10, these themes are: “Alliancing scope: individual benefit” and “Alliancing for a common scope”, “Allocation reallocation flexibility” and “Alliancing capability” theme, and finally the “Communication paths” and the “Common approach” themes.

The findings of this study corroborate the indications of the literature and demonstrate that smart city projects are prodigal, multifaceted and complex projects that require a sizable and diversified amount of resources that need to be accumulated from multiple different actors. Simultaneously, through collaboration in such projects, there appears to be potential to yield significant benefits to the actors involved in them, as well as lead to the creation of public benefit. This collaboration occurs via the process of alliancing. The way in which actors engaged in alliancing practises, i.e. how actors worked together, interacted and exchanged resources appears to have an effect on the outcomes of their collaboration and as a result, affected the outcome of the project. Thus, it becomes increasingly important to investigate what influences this alliancing process. This process in smart cities appears to be convoluted and complex, with multiple actors constantly exchanging numerous resources between each other directly and indirectly, via dyadic and triadic interactions. The analysis of the findings presented above demonstrates that there appear to be three themes that shape these interactions and their outcomes:

(a) The relationship between the delivery of a common scope and the creation of individual benefits of project partners;
(b) The uncertain nature of smart city projects and the need for resource reallocation and flexibility;
(c) The establishment of communication paths and a common approach.

These three themes are deeply interconnected and complementary. Smart city actors enter in alliances to fulfil a common scope, i.e. deliver a specific smart city project. However, they do so in order to serve a personal scope and attain an individual benefit through their involvement in the project. These have been extensively discussed in the previous sections. In summary, findings show that partners aim to either: gain access to a specific skillset or develop a specific skillset through their involvement, gain tacit knowledge and experience, attain access to scientific knowledge, research outputs and market insight, get access to public or private digital infrastructure and assets, be able to use data (governmental, privately owned, citizen sources or others) and be able to access funding for research and development, operations, research or others. Moreover, they are interested in gaining reputation and access to potential clients and/or future partners through collaboration and networking as well as get access to market via proof of concept through technology testing that acts as demonstrable marketing. Finally, the scopes of -typically- public actors and institutions are related to the creation of public benefit such as creation of jobs, decrease in unemployment, increase in entrepreneurship and evolution in upcoming industries on local and central level, as well as decrease of environmental impacts and increase in quality of life.

7.2.1 Common scope and individual benefit

Partners enter in alliances in order to fulfil one or (in most cases) more of the above individual scopes. On the other hand, the mutual or common scope of the partners is the completion of the deliverables of the project they are part of. Most of the projects were focused on providing solutions to urban challenges (transport, waste, aging infrastructure etc.) or making an urban process more efficient. These smart city projects were innovation-based projects which were dependent on the development of proprietary technology or the application of existing technology in a new context. As a result, challenges came up that affected the delivery of the common scope and subsequently influenced the fulfilment of individual scopes and expected benefits of the contributing project partners. This is because the development of proprietary technology within the projects has been unanimously -by all interviewees- deemed as a slow process, characterised by uncertainty and continuous need for flexibility in the decision-making processes of the partners. There is a need for constant reallocation and in many cases increase of the amount of resources allocated (particularly financial and human).

In opposition to the well written strategies and plans presented to funding committees the reality of actually developing the technology was significantly different. “That's the nature of smart city projects that despite the technology, that is supposed to make everything look easier. Actually, to implement it it's a very slow process”, a senior council officer observed. The vast majority of the interviewees reported challenges in delivering the project. Another senior council officer and lead of a funding intensive project admitted that “we had some delays in some of the pilots being made available, some of the data being available, so it meant some of the things that I'd promised on x [name of project] based upon what we thought was going to happen, I wasn't able to deliver at the time”. An additional barrier to the development of technology is the predetermined timeframes that in many cases were too restrictive. This is due to the way in which governmental organisations and funding institutions work, where funding is typically allocated for a specific amount of time and expires if not used, thus it cannot be migrated to next stages of the project. An example was a publicly funded project that was organised and run “last minute” as many of the interviewees stated, where x millions needed to be spent rapidly and with no substantial use, just to be able to secure the funding for the next stages. The proprietary technology at the core of that project, could not be developed in the prescribed time and there was no flexibility from the part of the funding body, thus millions of pounds were not efficiently used, as unanimously stated by the interviewees part of that project. However, while millions of pounds were spent, neither the mutual project scope was delivered, nor the project partners fulfilled their individual scopes.

On the other hand, in some cases there was misalignment in comprehending the project scope and/or what was expected as a contribution from each member of the alliance. A senior member of an industrial partner part of a smart city project explained that “we felt we were delivering the contract. The local authority felt we were underdelivering the contract. What was absolutely for sure was [company] was doing everything that it could afford to do. In retrospect, the contract was negotiated in a way that, as it transpired, was not possible to deliver”. This highlights not only the issue of lack of understanding of what partners need to contribute and deliver, but also misjudgement of expected benefits in return for said contribution. Indeed, the head of a university department part of many smart city projects underlined that one of the biggest barriers in implementing the projects is "alignment. Because a smart city is really a complex set of initiatives and interactions, you need lots of things to align. You need the various interested stakeholders to align. By aligning, I mean knowing what their contribution, what their activities play into that particular problem". A project lead from the industry added "you've got a whole range there of very different partners with slightly different vested interests, so aligning them around the vision is challenging, such that they all have clear roles and responsibilities. Governance around that and leadership is really critical and key, and falling from that, I guess, is affecting program management. It's defining what their clear roles and responsibilities are and the ability to just deliver around those, but I think having them aligned is always a challenge because you get conflict between them". This demonstrates how challenging it is to maintain a balance between project scope, individual benefit creation and expected resources allocated by each actor.

7.2.2 Resource allocation flexibility

In general, this variance in commercial expectations many of the partners reported on while entering a project, seemed to be a source of friction and conflict that created project viability issues down the line, as well as damage in the relationship with the potential future clients. This additionally occurred because, as mentioned in section 7.1.1.1, it was significantly difficult to accurately quantify from the start of a project, the investment in terms of time, human skills and resources, the actors needed to commit, to achieve project completion. Subsequently, numerous interviewees highlighted the need for flexibility in terms of resource reallocation. The organisations that showed flexibility, particularly industrial actors, either perceived that the expected benefits from the projects would balance the additional cost on resources or reiterated their expected benefits by treating this as an opportunity. Other actors were flexible because they had simply "too much to lose" from the project failing. It is evident that the nature of smart city projects requires that partners

demonstrate a degree of flexibility and disposal to communicate and collaborate. A senior member of a government funded organisation that has participated in numerous smart city projects throughout the years, explained that their approach is to “be prepared to be very enabling and to just find time to spend with people understanding what they need and going away to try and make it happen quickly, treating their interests as important rather than as being a burden and so on”. When discussing about a specific project they added “we committed to it and then we had to make it work, rather than trying to find out all the answers and to manage all the risk before we made a commitment.”
However, it is crucial to highlight that not all organisations have the possibility to be this flexible. In particular SMEs faced an increased risk when participating in projects as they had more restrained resources to offer and a project failure would have a higher impacted on them compared to other partners. As a result, they were less flexible in reallocating resources. The CFO and founder of an SME explained that joining a prominent smart city project was “a hard decision actually. We had some debate about it both at the beginning and through the interim project because as a small company, we were very small at that point. Putting in that kind of resources is quite a risk and you do have to take a leap of faith that it's going to pay off”. The COO and founder of a different SME added that as a small organisation participating in a large project, they allocated the majority of their internal resources to work for multiple months for zero profit, meaning that they had too limited capacity to undertake any other project that was profit-making.

7.2.3 Communication paths and common approach

Circling back to the need for the alliancing partners to have an “enabling” attitude towards the project, the evidence presented in section 7.1 of this study showed that the primary enabler was a shared predisposition to collaborate and communicate. Specifically, these resource specific findings are presented in sections 7.1.1.1.3 Leadership, 7.1.1.1.4 Managerial skills, 7.1.1.2.1 Skillset, scientific knowledge, tacit knowledge and informing policy making, 7.1.2.1.1 Physical infrastructure - Digital infrastructure (especially in page 146 on the paragraph that discusses the “predisposal to collaborate”), 7.1.4.1 Access to potential clients through direct collaboration and 7.1.4.3 Access to connections via networking and potential future collaborators.

Moreover, the head of a smart city programme in a council stated that “collaboration underpins everything that we do”. A professor and head of various projects added “the biggest enabler is…having good relationships with individuals in different organisations”. This leads to recurring collaborations between the same actors, which as mentioned at the start of the section, is supported by the fact that the majority of the interviewees have collaborated repeatedly in more than one projects. Findings show that these repeated collaborations occur because actors have already established successful communication paths with specific partners. Interestingly, whether or not a communication path was dimed by the interviewees as successful or not, in many cases was irrelevant to whether the project scope was fulfilled. Simply put, many partners in projects that were “unsuccessful” -did not deliver the expected scope-, worked again together with other project partners in new projects, because they could communicate effectively between each other. One interviewee explained this as having “align[ment] in terms of having a common language and a common approach”. This common language and approach was not only a facilitating factor in the operational aspects of project delivery, but in many cases also in comprehending the underlying individual scopes of partners and aiding in accomplishing them. The findings show that accomplishing individual scopes combined with the mutual project scope, are determining factors on a project being dimmed as successful or not.

7.3 Intellectual property and data

This section of the findings is a deep dive on two resources particularly significant for smart cities, intellectual property and data. Firstly, the main IP and data ownership models that result from the data analysis are presented followed by a categorisation of the findings per project type (consortia-based projects and publicly led/owned projects) and a section on how these types affect ownership models. Finally, the main enablers and challenges in the co-creation of IP and data are presented.

The analysis of the findings demonstrate that the main IP and data ownership models appear to be the following:

1. Previously developed IP or data brought into the project by a partner is always owned by them. IP and data created during and through the project by only one specific partner in the vast majority belongs to the partner that generated them but in very limited cases can be used by other official project partners. IP and data created jointly through formal collaboration processes, are typically under a joint ownership agreement, which usually allows partners to exploit both the IP and the data. In the rest of the cases, individual collaboration agreements are formed to determine what will happen. This model is mostly applicable in consortia of actors that operate under formal contractual agreements.

2. Various actors from all actor groups provide data that they own, aggregated typically by a public entity or, more rarely by a non profit organisation and integrated into bespoke platforms or tools, created to accommodate specific needs of the public entity or organisation. The IP of the platform is typically owned by the public entity, but in some cases it is co-owned with a commercial actor that provided parts of the technology. The imported data are typically from existing databases or can be collected only for the purposes of this project. In any case, all the data imported are the property of the actor groups that provided them. Some of these data become public, but this is currently limited. This model is mostly applicable but not limited to government funded projects.
3. All the data shared and created become open data with variations of IP ownership. The IP is typically retained by the project partners in a joint ownership format, while there are cases where the IP becomes open as well. The latter is frequently found in partnerships between universities and hybrid organisations. If the IP is knowledge based, it is shared through academic dissemination such as publications and conferences, while software-based IP is shared through open software. This model

can typically be observed in projects were the main partners have research related agendas and do not view the project as a revenue stream.

4. When organisations are involved in the project as subcontractors and not as part of the consortia or as a formal partner, they receive compensation to either license a technology they own or create a solution for a project and keep the ownership of their IP. When subcontractors are working with data collected by them for the project in most cases they keep this data, but in few instances they can keep and use the data solely for the duration of the project and subsequently need to hand it in.

There have been very few cases of alternative ownership models:

5. As a variation of the first model, IP created in joint partnership cannot be used at all by the industrial partners and is retained by the public partners, in an individual ownership regime.
6. The IP and data created in a consortium between industrial and public partners, are bound to stay with the lead industrial partner, as a contractual term imposed by the funding body. This was only observed in one case.

The particular characteristics of the projects appear to have an effect in both the way in which data and IP offerings are made by the main actors to the project consortium and in the ownership of the IP and data created through the course of the project.

7.3.1 Alliancing scope in alliance based projects

As indicated above in order for such projects to be enabled, the actors quite frequently need to work in consortia as part of alliances. This is particularly applicable to pilots, testbeds and demonstrator projects. These projects are funded by Horizon 2020 funds (H2020), an EU Research and Innovation programme or public innovation funds, or directly by innovation funds provided by different governmental departments.

In technology and funding intense pilots and testbeds of significant financial value (such as infrastructure connectivity ones), the consortia operate under strict contracts that prescribe the type of relationships between the partners, what will be offered and who owns every single element produced. The interviewees support that in such contracts early involvement with the project is of outmost importance. A senior consultant that manages these relationships adds that for companies that want to get involved and benefit from such testbeds “either they become part of the consortium, but you have to do that right from the beginning. You can't come to join the consortium midway through because of who owns things… or they are a supplier to one of the consortium partners, in which case really, they're at arm's length”.

However, there are numerous smart city projects that are not that technology focused, but appear more open to collaboration between actors guided by more loose rules. Regarding the IP ownership in that, an interviewee indicates that “rule of thumb, the person who can benefit most gets to own it. That's generally how IP works” in such projects. As observed, in such projects typically the IP stays with its creator. One of the reasons for this, is the significant number of actors involved within them. Some of these are cross-sectorial programmes, divided in different projects.

Many of the collaboration-based pilots have a strong facing citizen element. They either develop services directly for the citizens or use citizen input to develop their services. In certain projects they use citizen generated data to gain better understanding of specific sectors. The partners collect specific data generated by a targeted group of people, for a determined period of time. “We're trying to empower citizens to take ownership of their own [data] and empower them to use it more responsibly in a way to combat climate change” a council officer stated. Enabling this process, is obviously a demanding task that requires coordinated collaboration between a variety of industrial actors that provide the technology needed -both hardware and software-, access to citizens, which typically happens through citizen engagement focused organisations and access to urban infrastructure. All interviewees involved in such projects highlighted the importance of investing time and effort into maintaining good relationship within the consortia. These complex structures of data collections are also reflected in the complicated IP and data joint ownership agreements. Usually, here all partners, even subcontractors, appear to keep ownership or right to use of the data they have collected through their own solutions.

The data indicate that in pilot projects that heavily involve the creation of data hubs, universities play a leading role. Typically, these data hubs are not the main goal of the project per se, but are parts of larger cross-sectorial projects with very significant budgets which in many cases are H2020 funded. Again, the data is owned by the entity that provided them. Local governments appear to trust universities in creating/facilitating data repositories for them, due to the security they offer and their limited commercial agenda. When urban data is collected through technologies such as sensor systems, specifically created by industrial partners for the pilots (usually funded by governmental bodies or H2020), the data belongs to the council that provided access to their infrastructure, while the IP of the technology always belongs to the industrial partner. In very rare cases when a disruption in the relationship between the council and the industrial partner occurs, urban sourced data can pass to the property of the industrial partner, leading to loss of public value for the council. The industrial partner explaining the situation concluded that “we're liable for it, therefore we own it”.

7.3.2 Alliancing scope in publicly led/owned projects

Digital service focused projects are publicly led projects that offer advanced digital services to both citizens and businesses. These are data heavy tools or platforms, for which a bespoke technology has been created by the project partners. They are typically funded by governmental budgets, either central or local, while in some specific cases they tap into Horizon 2020 funds, only as one of the deliverables of cross sectorial programmes. When funded by governmental budgets instead of consortia their goal is to create an ongoing urban service or scale up from a previous pilot. In this case they operate in partnerships, where the project owner is mostly a governmental entity, only data and feedback on the service is provided by partners and the technological solutions are developed by subcontractors, adhering to the second and fourth model presented. When they tap into H2020 funding they always operate under the first model and they are typically part of cross-sectorial pilots.

The data imported in the tool, which play a central role in these services, come from either the public entity itself, in combination with other public players, such as institutes and selected but crucial industrial partners. In these cases, the data is always owned by the actor that provides them, while the IP of the service belongs to the public actor that developed it.

Some significant examples of such projects are the following:

In the case of a digital platform highly sensitive data came from Public Interest Entities (utilities, transport, energy etc) for the purpose of better future strategic planning both for the businesses and the public authorities. The data providers were the ones owning the data, the public authority provided a platform -which they owned- that integrated all these data along with their own. Access to this sensitive information was given only to public actors and companies that produced services of public interest. In another case, a local governmental player with a similar platform as above, which instead offered open access to most imported data, continually enriched their platform by aggregating all data produced by their projects. Most of these were open data, while there were some commercially sensitive that as above were available on a need to bases, on the premises of public benefit. From the other hand, other public projects were created with open data and open IP, as per the third model. As one interviewee coordinating one of these projects said, the councils creating these “are sinking their money into R&D and everyone is going to benefit, but they're the ones that pay the money for it”, with a positive connotation.

7.3.3 Resourcing and ownership models

In short, from these formal consortia, there appear to be two main outcomes in terms of co-created intellectual property and data. Either the intellectual property and data belong to a single partner (single ownership) or the IP and data are jointly owned. This study focuses on studying the co-produced and jointly owned intellectual property and data. From these it appears that through pilot and test-bed projects the actors of the consortia co-create joint intellectual property and data that works in three ways:

- Contractual joint ownership
- Undetermined (or not yet determined) ownership
- Open ownership

The findings suggest that contractual joint ownership models are typically found in projects that come from technology heavy consortia, while undetermined and open ownership models are found in projects where the consortium is focusing more on collaboration and knowledge exchange rather than developing new technology per se (Figure 18). The following sections will initially describe each of these ownership models and how they operate and consequently will present enabling factors and challenges that affect the process of intellectual property and data co-creation.

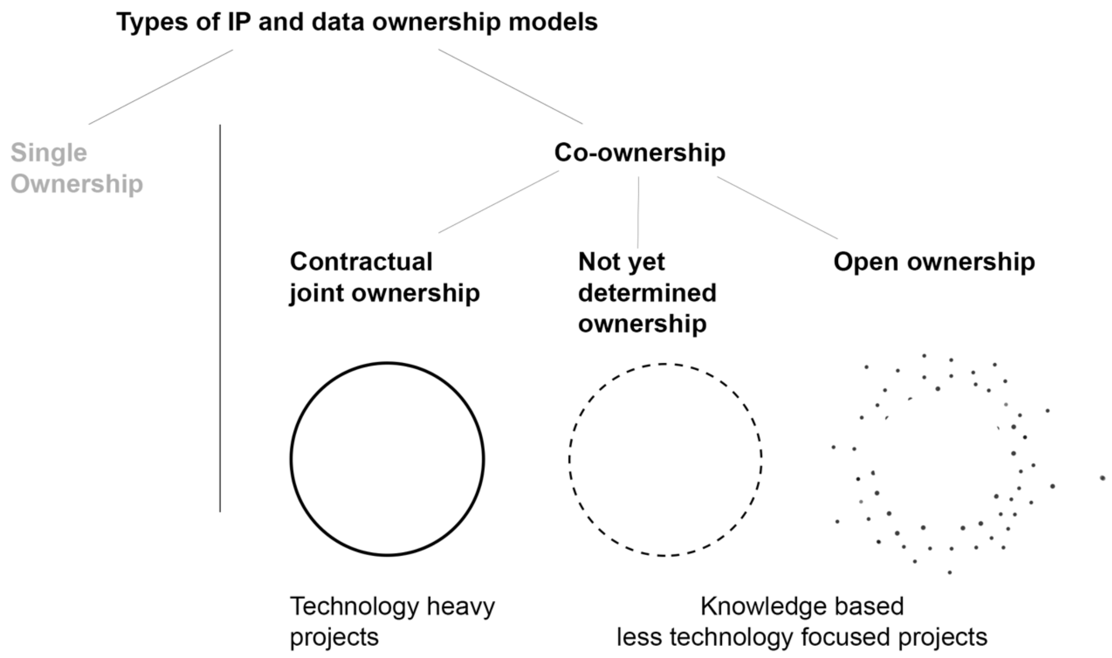

Figure 17 Overview of the main intellectual property and data ownership models.

7.3.3.1 Contractual joint ownership

In technology and funding intense pilots and testbeds (such as those focusing on infrastructure connectivity), the consortia operate under strict contracts that prescribe the type of relationships between the partners, what will be offered and who owns every single element produced. The interviewees reported that in such contracts it is imperative to be part of the consortium from the start. At the end of the project, no open material including the resulting IP is expected to be created. In another technology intense project that includes multiple industrial partners, the IP and data jointly generated has been already used by all partners, under contracts determined from the start of the project. In two of the projects, it was not only the output that was strictly prescribed in the contracts, but the resources spent by the actors as well.

Throughout the projects, some actors asked for re-negotiations of the contracts according to their new contributions, while in other cases some industrial actors declined to participate in re-negotiations.

A challenge frequently encountered in technology intensive consortia is the unwillingness between the industrial actors to share intellectual property or even communicate with potential competitors. A key member of such a project, reported “I've had a number of instances where one commercial partner has told me they will not join an activity because a specific other commercial partner will be in the room and they will not sit in the same room as them.” This unwillingness is particularly present in projects that produce intellectual property of joint ownership. A professor vividly explained that when trying to collaborate with multinational industrial actors “their legal team couldn’t quite handle that model. They were just in stasis; therefore, they didn't come on board.” Another interviewee who was part of a large consortium explained that frequently these “challenges of being responsive and dynamic in smart cities come from very reasonable ethical, legal, financial considerations that need to be made. Often more complex processes exist certainly within local government and with the large corporates”. Consequently, the rigidity of the joint ownership agreements in technology and industry consortia undoubtedly severely impaired the open sharing or dissemination of the intellectual property and data generated.

7.3.3.2 Undetermined ownership

In less technology heavy and more open collaboration-based pilot projects, the actors had less rigid structures and were seen as being more willing to share resources such as learnings, expertise and data between each other. They were interested more in investing in the process of co-creation of value and less in just developing technological solutions. This may be related to the fact that industrial partners wanted to create long term relationships with the councils and other public actors, as they will be their future clients. As one of the interviewees coming from a major industrial partner in many projects stated, it’s about “working hand in glove with public sector partners to refine it [the technology]. It is not just about the technology itself, it is actually how you deploy it and work with other partners.” In such projects, the implementation of the joint ownership of the data and intellectual property created was sometimes more obscure due to the difficulty in determining knowledge-based intellectual property or intellectual property of softer nature. As a member of such a consortia observed regarding the agreements on potential commercialization and use of jointly owned IP “again, the provision was made to make it as lightweight as possible to do”. Interestingly, neither the IP nor the data resulting from this project have been used since the conclusion of the project in 2016. Most of the actors have not kept relationships between each other and no further intellectual property related discussion occurred after the end of the project. In another project, two of the actors had a significant fallout that led to the termination of both formal and informal discussions between them. At the conclusion of the project and since no other discussions occurred, the industrial actor kept the urban sourced data and utilized a small part of them, while the governmental partner has not utilised them, or tried to access them, since project conclusion. In at least three other projects, the jointly created and owned intellectual property has been used only to produce some industry reports or academic papers, but not in any further projects. In these less rigid agreements, the potential fluidity of ownership in some projects led to stagnant situations where it was simply not used.

7.3.3.3 Open ownership

A number of projects have as a goal to provide open data but few aim to provide open intellectual property. These are only encouraged by publicly or university led consortia. A university interviewee head of key projects explained that they wanted to “build an environment that people could experiment with their own data and other data”, to foster understanding. But the benefit of opening the data goes beyond citizen understanding to actively make an impact on public services. One of the leading partners in such projects suggested that “the assumption that we have is that if we open or at least make everything public sector license we’ll be able to increase the capabilities of the public sector, which will then allow them to digitize, to at least the level of the private sector, and create quite a significant market for new ways of doing things”. This is particularly important for organisations representing the public’s interests as “there's a big disparity between the private sector and the public sector in terms of digital transformation.” Again, the “openness”, even in public entities, is limited to protect commercially -or other- sensitive information, with no interviewee providing an exact explanation of what these include. Moreover, there were practical challenges that prevented some projects from making all data available. As explained by a university professor leading one of the projects “the default approach is that everything was open, but you then have the practical issues are actually making this open”. These practical issues have to do with aspects such as maintenance of data platforms or access platforms, quality and updating the data and the need for human resources to facilitate the process of sharing. One university actor observed that data storage was not the issue but “it's being able to get insights from it. It's the analytical side of it that people really struggle with”. Indicating that simply making some data open may not in itself be enough.

A public sector interviewee that focuses on open data reported that “I think I was probably a bit naive to start off with thinking, when you see all the blogs and stuff, and it's like data is the new oil, and dah, dah, dah. Yes, I get that, but I think there's still some way to go, to be honest with you. I don't think we've got to the point. I think once we've got a lot more IoT sensors, and vast amounts of data being collected, things might change.” This indicates that even though there are some processes for open data collection in place, they are still limited, thus impacting the quality of the data created. The low quality, related to insufficient collection techniques such as the number of available sensors, has been pinpointed by a number of interviewees, part of all actor groups.

7.3.3.4 Dissemination and Open IP

While the quality of open data might be a challenge, an even bigger challenge appears to be how to disseminate open intellectual property. Having university actors actively involved in the project and not just in a research capacity appeared to facilitate the dissemination of the results and knowledge based open IP resulting from the projects. Nevertheless, issues arose as according to a professor “academics are quite territorial. If you’re wanting to try and do a collaborative project, one of the big challenges that you have is actually pulling together disparate partners”. Additionally, the interviewees observed that some actors appeared to be reluctant to share important soft findings from the projects (sometimes referred to as knowledge based intellectual property), even if they were obligated to do so by the funding body, in order to not affect relationships between the project partners. This is an additional practical limitation to making IP and data open. Consequently, the relationships between the actors within a project appear to significantly affect the value co-creation process.

7.3.4 Alliancing capabilities, communication, and common approach in the co-creation of IP and data

As indicated above, a significant impact factor on the process of value co-creation appears to be the way in which collaboration occurs with public institutions. The COO of one SME highlighted the importance and benefits offered by an open and collaborative council, explaining that “since we started working with them, the level of engagement, trust, support, just off the scale." This is in comparison with an opposite experience with another council where the process of collaboration in a known and otherwise successful project in terms of deliverables, was described as unproductive and difficult as" in every step of the way with [council name], they threw another barrier up, another barrier up, another hurdle, another barrier". The long-term success of a project within a publicly funded consortium is reported to "all been enabled by a client that has been willing to see innovation, willing to support it, willing to talk to us about the eventual business case". The client referred to here is a local council. But why is the collaboration with public actors so pivotal? In the value co-creation process, councils and other local government actors offer to consortia access to their physical city assets (such as street furniture, lamp posts, bollards etc). The willingness of the councils to 'exploit' their assets by offering access to them, coupled with the innovative culture in some councils, act as enablers of value co-creation in consortia and formal collaborations. The role of councils as enablers goes beyond offering access to their assets to bidding for funds that help them bring economic development and prosperity to their city and region. The head of innovation of one council explained that "we've always wanted to support the ecosystems in [city name]. We wanted to support the smaller companies in [city name], the people with new ideas that were growing, to develop in [city name], to solve problems that are in the region and hopefully turn into new, bigger, and exciting companies." All interviewees in similar positions in councils agreed with this view and support the view that these types of programmes have helped local SMEs grow. SMEs appear to be utilizing such collaborations for the past years, in order to develop, test or scale up their services, in other words to create, refine or prove commercially exploitable intellectual property.

Making data open to the public can be sometimes proven disruptive for industrial actors that benefit from trading data. The head of one of these governmental projects explains that "if you're selling something and then a government makes that freely available, then it's quite hard. Unless you're really adding value, your business is in trouble. There are people making money out of the problem that we're trying to solve". While this may be a challenge for certain companies, it appears to be a significant enabler for others that have steered their business model to create new value propositions through analysing and providing insights rather than trading data, as well as to SMEs that use these data as resources to inform the development of their solutions. In many cases implications of opening up the data does not seem to be the main challenge but rather the format, limited number and usability of these data.

8 Discussion

Parting from the pursuit of responding to the research questions on how actors within project alliances exchange and integrate resources to co-create value and what factors influence their interactions in the process of resource integration, the data collection focused on the elements that affected the interactions between smart city actors and the resources they exchange between each other within a project. The findings of this research include a thorough categorisation of the resources exchanged within smart city projects, as reported by the interviewees. Following the categorisation, the characteristics and a description of how each resource is exchanged between the alliancing partners, are presented. Studying the way in which the resources are exchanged is crucial in order to understand the intricate mechanisms of value co-creation, which are enabled by convoluted interactions founded on individual benefit creation. Simply put the description of how and why the interactions occur for each resource allows for observing the motives of the actors behind the exchanges, what resources they offered to the project in return and the barriers and enablers in their process of exchange. Through analysing these, three reoccurring themes that mould the outcome of these interactions, arise. The first determining factor regards the balance between the delivery of a common scope and the creation of individual benefits for the project partners. The second factor, prompted by the uncertain nature of smart city projects, is related to the need for resource reallocation and flexibility. The final factor is the establishment of communication paths and a "common approach". The concluding section of the "Findings" chapter isolates the findings on technology, intellectual property and data, and further elaborates on these findings, providing ground-breaking insights on how these pivotal resources are exchanged between alliancing partners.

Building on these findings, the discussion will be divided in three parts, each tackling a different aspect. The first part of the discussion focuses on alliancing in innovation-driven environments and the capabilities and resources needed to respond to such fast-paced complex environments. The second part discusses the complementarity between accessing assets which is a dynamic capability and access to assets a valuable resource, both sources of competitive advantage. In correspondence to the findings, the third part discusses on intellectual property and data as co-owned resources.

8.1 Alliancing and resource integration

From the analysis it is evident that smart city projects, as is the case for numerous innovation driven projects, are enabled through convoluted processes of alliancing and intricate integrations of resources. Alliancing appears to be necessary as the internal technological resources and capabilities of a single organisation, are insufficient to respond to the development of technology focused projects (Cesaroni and Duque, 2013). These processes are heavily dependent on the characteristics of the environment that set the context for these interactions to occur. Organisations that operate in complex and uncertain environments heavily driven by technological innovation, face a rapidly changing, fast paced environment in which resources (especially dynamic capabilities) are costly and time consuming to create or acquire, while at the same time they might become expeditiously obsolete. Moreover, these accelerating technological changes along with industry convergence and globalisation have led to the destabilisation and increase in uncertainty in otherwise stable environments as well (Huang et al., 2015).

In order for actors to work together in these alliances, which are essentially project consortiums, they appear to have already developed searching and sensing capabilities as organisations. Searching and sensing capabilities allow organisations to identify changing market needs, threats and opportunities and competitive developments (Augier and Teece, 2007). They are not dynamic capabilities in themselves but rather managerial and organisational processes that enable the development of dynamic capabilities (Helfat et al., 2007) other-wise described as the micro foundations of dynamic capabilities (Teece, 2007). Without these, the organisations would not be driven to pursue entering the emerging market of smart cities or respond to calls for urban innovation and consequently entering into alliances to achieve this. Thus, searching and sensing appear to be pre-requisites in order for organisations to work within alliances and be predisposed to offering their resources. How is alliancing and resource integration enabled in heavy tech driven environments, though? As interaction is the defining component of resource integration and value co-creation (Coimbatore Krishna Prahalad and Ramaswamy, 2004) in service dominant logic, an enabler of value co-creation appears to be the quality of the interaction. Not all interactions have positive outcomes and may be hurtful to the process of value co-creation, leading to value co-destruction which occurs when an interaction process culminates in a negative outcome (Järvi et al., 2018). The term "quality of interaction" is defined here, as the set of distinguishing characteristics that determine whether an interaction resulted in the co-creation of positive value or negative value (value co-destruction).

The empirical evidence presented in this thesis indicates that the quality of interaction comprises the following components: *(a) mutual scope and reciprocal benefit creation, (b) resource allocation and reallocation, and (c) the shared institutions and the predisposition to share, underpinned by the fundamental capability that enables all exchanges, communication.*

8.1.1 The establishment of a mutual project scope in relation to reciprocal benefit creation for alliancing actors

While in common service ecosystems, value is co-created by multiple separate actors of the ecosystem, always including an actor that is the beneficiary of the service (commonly referred to as the customer), where value is unequivocally uniquely and phenomenologically determined by this beneficiary (Vargo and Lusch, 2016), in alliances this clear distinction between the roles of actors is blurred and unclear. Alliances appear to work as a coalition of distinct organisations that come together under pre-described contracts in the form of consortiums or as formal partnerships and they are typically project based, formed with the legal basis of fulfilling a specific project with a predetermined scope. All organisations within the alliance, exchange resources in order to achieve this scope. Thus, there is no unique beneficiary that can be determined within the alliance, by definition. However, a project and consequently the alliance that occurs in order to enable the development of this project, operates as a temporary organisation. This temporary organisation, nonetheless, has no capability to operate autonomously and is completely dependent on the resources of the alliancing partners (Winch, 2009) and consequently driven by the fulfilment of the unique scopes and the creation of individual benefits of each actor. In short, while the temporary organisation has a shared scope, the alliancing partners have unique scopes and individual expected benefits. This shared scope has been defined by (Taillard et al., 2016) as "shared intentionality" which acts as a motive for collective agency. This leads to the first defining component of the quality of interactions between actors in alliances and project collaborations: *the establishment of a clear agreed project scope, mutual to all actors and the delineation of the expected benefits that the actors will receive and contribute back to the project in the form of value offerings.*

Although, this appears quite obvious the findings show that determining the mutual scope of the alliance and simultaneously setting the expected benefits to alliancing partners and expected contributions from them, proved to be challenging for all types of actors. This appears related to how common it is to overestimate the potential value co-created in alliances and at the same time underestimate the challenges in the process, as their resolution seems to be a collective issue (Adner, 2006)**.** While the project scope appeared well defined from the beginning, in many projects there was confusion caused by the foundational approach of different actors: was the project focused on solving a specific urban problem, or was the project focused on developing a specific technology to solve a problem? Simply put, there were conflicting goals that demonstrated a lack of shared intentions in the service ecosystem. When actors in an ecosystem do not share common goals, the success of the ecosystem is in danger (Frow et al., 2019). Since the field of smart cities is relatively new and still developing, this core issue proved challenging, as significant resources, including sources of funding, were spent in developing technological solutions that proved to fall short in actually responding to the urban problem set at the beginning of each project. This situation was frequently compounded by the fact that the contributing actors each had their own agenda and expected benefits from the project. Public actors were interested in solving a specific urban problem, while industrial actors were interested in serving their business case, through developing or testing their technology in order to sell it at later stages, collect data or gain access to new clients through marketing. At the same time, universities were interested in fulfilling their research goals through developing technologies and collecting data and non for profit organisations were interested in responding to their set agenda.

In projects based on innovation, such as smart city projects, where the solution is under investigation and constant reiterations, the scope, might become blurred. As the data confirm technological solutions often failed and the process of innovation was slower than expected. Industrial actors were often against changes in the technology developed in the project to solve a specific problem, as this no longer fitted their individual scope and did not yield the expected benefits. The existing situation of the smart city market is indeed being described as formed by two forces, the technology-push and the demand-pull, where industrial actors rush to quickly advance technological solutions "driven by supply, regardless of the expressed needs of society" (Angelidou, 2015). This conflict between scopes and expected benefits from different actors might lead to value co-destruction or negative value creation for an actor (Järvi et al., 2018)**.** When the expected benefits are being altered, the resources provided from an actor will inevitably change as well. This leads to the second component that defines the quality of an interaction, *the expected allocation and inevitable need for reconfiguration of allocation -or re-allocation- of resources from an actor.*

8.1.2 Flexibility in resource allocation and reallocation

Alliances are considered habitats of exchange in which organisations develop, exchange and combine their resources (Balakrishnan and Koza, 1993), in order to achieve a mutual goal, as seen above. However, the findings in line with the literature, suggest that the process of innovation is not linear and multiple challenges may arise: technologies have been proven insufficient to solve a problem, their development has failed or it has proven more costly -in terms of resources spent- than expected. Failure in these ecosystems may often be the result of these technological challenges, or in other cases the result of lack of coordination of the process of innovation (Adner, 2006). The data show that numerous interviewees noted that the initial expectations of amounts of resources employed by each organisation in the project were largely underestimated, particularly human skills and labor, making it imperative to reassess the allocation. Moreover, it is evident that the project alliances, which included organisations that demonstrated flexibility in resource reallocation, produced more favourable outcomes than the ones with more rigid structures. We define a favourable outcome in alliances, as one that nurtures superior value creation than what each organisation could achieve on their own, based on (Adner, 2006) the definition of ecosystem success. The organisations that showed flexibility, particularly industrial actors, either perceived that the expected benefits from the projects would balance the additional cost on resources or reiterated their expected benefits by treating this as an opportunity. Other actors were flexible because they had simply “too much to lose” from the project failing.

Through the data it is evident that the willingness of an organisation to reallocate resources appears to vary according to three aspects: the expected benefits, their organisational structure and the individual drive of the managers of these organisations. The expected benefits of an organisation involved in smart city projects, go beyond the notion of imminent profitability, to working hand-in-glove with future clients and to the access to unique resources that the organisation would otherwise not be able to attain outside of the alliance. This can be a technology, access to city infrastructure (discussed below), knowledge, human skills and most importantly experience in the form of tacit knowledge and others. Tacit knowledge gained through systems of resources of human nature and their routines, as well as specific skillsets that are developed throughout the process of alliancing and go beyond individual knowledge, are inimitable (Wright et al., 2001) thus become a competitive advantage for an organisation, particularly an industrial one. Industrial partners notably engage in resource reconfiguration through alliance management, in order to gain knowledge and improve firm performance (Jiang et al., 2010). Knowledge and skills may be transmitted directly, through education or indirectly through embedding into objects (Michel et al., 2008). Moreover, there is additional knowledge gained simply through the process of participating in the alliance through developing alliancing capabilities (Porrini, 2004). This knowledge is indispensable for organisations in urban innovation projects as value co-creation in public services typically occurs through cross-sector collaborations (Hartley et al., 2013). Simply put, actors that form alliances in smart city projects gain inimitable experience that is indispensable in order to work in urban innovation environments. This occurs in addition to the resources gained through the project itself. However, in order for actors to be able to be flexible, the appropriate organisational structure and culture needs to be in place. There are organisations that inheritably have rigid structures in place, such as universities and public institutions, as well as some multinational corporations, that cause significant delays in their decision-making processes. Additionally, these usually work with limited and pre-allocated budgets and scarce resources and many times depend from the support of managers in leadership positions that need to endorse the vision of the project and take responsibility for the excess resource allocation. On the other hand, SMEs, due to their looser and more horizontal corporate structure where there is typically a shortened power distance gap, have the ability to reallocate resources more easily.

Consequently, there is a multifaceted benefit in alliancing that extends beyond the expected future resource acquisition. However, what happens when the actors do not reallocate resources? This appears to occur when actors do not estimate a superior value creation than what their organisation could achieve on their own, due to change of business model, or because simply the said resource is exhausted, or they do not posses it anymore. When actors do not accept to integrate a resource they possess (Plé and Chumpitaz Cáceres, 2010) or when actors simply do not own a resource (M. Smith, 2013), it may lead to value co-destruction or negative value creation (Järvi et al., 2018). This will lead to a failed interaction and a decrease in the ecosystem's wellbeing (Prior and Marcos-Cuevas, 2016). Thus, this will impact negatively the value co-created in the project as a whole and lead to a costly failure (Adner, 2006). Nevertheless, a similar decline in the well-being of the ecosystem might occur, if actors during the process of reallocation, exceed the beneficial for them amount of resources invested in an alliance. Thus, alliancing creates a new set of risks for an organisation due to the establishment of new dependencies (Adner, 2006)**.** The findings suggest that this risk increases significantly in smart city projects due to the sizable commitment of human resources and time needed as well as due to the radical difference in the type of organisations involved.

8.1.3 Shared institutions and institutional arrangements

The ability of the actors to allocate and reallocate resources in the process of resource integration to facilitate value co-creation for a mutual scope and reciprocal individual benefit creation, delineates the quality of the interactions in alliances. These are enabled and simultaneously constrained by shared institutions and institutional arrangements that govern the interactions. These interactions may be direct (Grönroos, 2011), through dyadic interactions, or there can be direct service-to-service exchanges enfolded by indirect interactions (triadic or ecosystemic) (Lusch and Vargo, 2006). These interactions occur within a specific social context that frames the way in which resource exchange occurs (Chandler and Vargo, 2011). Organisations assure and protect their position in a specific institutional context by acting in compliance with its prescribed norms and rules (Meyer and Rowan, 1977). The context of smart cities is constituted from various types of actors that congregate in order to innovate in the delivery of public urban services, as a common goal. As mentioned above the actors have already developed searching and sensing capabilities in order to operate in this context. These capabilities act as a foundation that delineate the institutions under which the actors in the ecosystem operate. In addition to this, this study shows that actors need to have in common a predisposition to share, and an understanding that as innovation stems from integrating resources in unique and novel ways (Greer et al., 2016), collaborative resource integration is imperative to achieve this common goal.

The findings of this research demonstrate that actors that were open to share knowledge with other actors, either within an alliance or in informal collaborative settings, had established their position within this new market. The organisations that joined the market at an early stage and demonstrated willingness to share and a collaborative culture through taking part in alliances, had already started capitalising significantly on their initial investment in resources at the time of the interview. The industrial actors achieved this by (1) establishing relationships with public actors (the typical client of smart city services) that they had already collaborated with, to which they offered paid services (2) “word-of mouth” where the positive feedback of a collaboration with a public institution, led to other institutions seeking to work with them (marketing resource) and (3) getting a “proof of concept” for their service that allowed them to demonstrate that their service works. At the same time they gained indispensable experience and know-how on how to collaborate with a public actor, through developing alliancing capabilities (Porrini, 2004)**,** as well as collaborative capabilities. This success appears heavily related to the institutional arrangements followed by these actors. *The pre-disposition to share is not just an action, but an institutional arrangement embedded in the culture of an organisation which guides its practises.* This has been proven difficult to imitate, thus proving a source of sustainable competitive advantage for an industrial actor (Kabue and Kilika, 2016)**.**

Findings show that the public actors that partook place in smart city projects benefitted from their early involvement via demonstrating openness in innovation and willingness to enter in a dialog with industrial partners. This is particularly applicable to cities, that lured companies into maintaining, or in some cases even reallocating their corporate offices into a specific city, by establishing themselves as an innovation hub. Additionally, by being open to collaborate and co-innovate, findings show that the public sector managed to improve their infrastructure and public service provision by securing technologies developed by industry or universities at a fraction of the cost they would spend, if procured outside of a project alliance.

8.1.4 How is collaborative value co-created through shared institutions – avoiding project alliancing failure

The institutional arrangements described above, govern the smart city ecosystem on a macro and meso level as they delineate generic rules of interaction rather than guiding behaviours. However, direct interaction that is the bases of value co-creation, occurs in the micro level, in dyads. The findings demonstrate that these dyadic interactions are based on complex human relationships and are governed by institutional arrangements heavily influenced by the power dynamic between the actors. Simply put, when public officers, industrial and organisational representatives, and academics interacted, the way in which they collaborated depended on the most part from their interpersonal relationships. Many actors based their decision-making processes on who to collaborate with and how, mainly on personal connections and positive past experiences, as well as on what is commonly referred to as "chemistry". These relationships, although personal, are significantly influenced by the institutional power of each actor group. Through the data, I noted that this institutional power might be financial, political or reputational. Subsequently, the way in which a dyad of actors will collaborate on the micro level, is additionally governed by institutional arrangements influenced by institutional power dynamics between these specific actors.

It is evident that resource exchange on a macro, meso and micro level, is enabled through collaboration. As discussed above, findings demonstrate that the institutions that govern collaboration revolve around the willingness to innovate, the predisposition to share and the flexibility for the creation of mutual and simultaneously individual benefit. Collaboration is not just a transactional operation, but rather a reciprocal process in which actors participatively share common responsibilities, decisions, consequences, as well as benefits (Stank et al., 2001). This dialogue between actors is based on trust, learning together and adapting to each other (Ballantyne, 2004) while it is facilitated via closeness, transparency and rapport (Jaakkola and Hakanen, 2013). On the other hand, when actors operate under different institutional logics, conflicts related to competing interests, goals and priorities might arise (Jaakkola et al., 2019). Indeed, when examining individual cases of projects that did not have the expected outcome, there was almost always a conflict between actors, internal to the project, reported by the interviewees. Data shows that the conflict was arising from one -or from a combination- of the components that determine the quality of the interaction, that we have delineated above: (a) mutual scope and reciprocal benefit creation, (b) resource allocation and reallocation, and (c) the shared institutions and the predisposition to share. Additionally, these need to be underpinned by the fundamental capability that enables all interactions, which is communication.

Accordingly, in the literature, failure in communication has been identified numerous times as a barrier to co-creation, potentially leading to value co-destruction (Vafeas et al., 2016). This is because, without communication actors do not have any means to take part in the shared intentions (Taillard et al., 2016) and process of value co-creation. The findings show that typically lack of communication or miscommunication was accompanied with the decline in the well-being of the ecosystem due to a disturbance in at least one of the components of the quality of interaction. We have observed that the most significant decline in quality, as well as quite a frequent one, was the misalignment in the expectations between the common project scope set by the actors and the actors' individual benefit, resulting from inadequate communication between the parties. Essentially, some actors in alliances had to deal with unprecedented changes of scope due to technology failure, others unintentionally misunderstood or miscalculated the expected returns of investment of resources, while other actors knowingly entered in alliances without being able or willing to deliver. There were cases that this misalignment was confronted through effective communication based on reciprocal understanding and flexibility, that led to resolving this by finding alternative benefits for the actors involved. On the other hand, when there were cases were the parties did not manage to -or did not try to- come to a mutual agreement, the decline in the well-being of the interaction was significant and evident. Literature shows that it is quite probable that there will be no further collaboration in the future, following the decline in the wellbeing of the interaction (Prior and Marcos-Cuevas, 2016). In order to avoid this, the necessary institutional arrangements, need to be in place and the actors need to have developed appropriate skillsets.

8.1.5 Enabling innovation through alliancing – necessary skillset

Service innovation is embedded in social structures and actors inevitably embrace certain social positions and roles (Edvardsson and Tronvoll, 2013). Institutional arrangements are social and cultural context specific (Akaka et al., 2023). This social context is additionally influenced by the enactment of the current practices applicable and typical in this particular context (Akaka et al., 2013b). As observed above, these practices revolve around sharing and flexibility, thus are indeed related with the cultural willingness to share amongst partners, which is considered a precursor of the collaboration capability (Fawcett et al., 2011). Consequently, according to (Adams et al., 2014) the collaboration resource adheres to Madhavaram and Hunt's (2008) composite view of operant resources and may be a source of competitive advantage. In short, according to the findings of this study organisations that aim to take part in alliances in tech intensive environments need to have developed alliancing and collaborative dynamic capabilities, that allow them to be able to realise superior value and respond to rapidly changing environments, through the abilities they offer to integrate, re-allocate, acquire and abandon resources as a reaction to market change (Eisenhardt and Martin, 2000). Dynamic capabilities are not the solution to a one-off event, but rather acquired characteristics embedded in the organisational routines of the actors, that allow for repeatable behaviours (Schreyögg and Kliesch-Eberl, 2007). As such, they are path dependent and lengthy to develop, consequently they are difficult to imitate (Cardeal, 2012). In fact, while individual human practices can be imitated, practices attained through interaction within human systems, may be proven unique to an organisation and lead to the creation of a specific human skillset (Wright et al., 2001), offering an additional source of competitive advantage. This skillset is a part of what has been described above as gaining tacit knowledge.

According to the findings, this skillset extends beyond gaining knowledge on how to deliver or operate a specific urban technology or collect data, to developing analytical skills related to management and leadership capabilities, which are more dynamic in nature. More specifically, from the discussion above it is obvious that some of the dynamic capabilities developed are related to the capability of organisations to sense the internal changes and developments within the project alliance, particularly the change of scope, rather than predominantly external changes in context, as mostly studied in the literature. In order to be able to identify these changes, organisations need to have developed analytical skills that let them “read” the ongoing development of the project and interpret the progress as well as the relationships within the alliance. This allows them to comprehend the dynamism between resources invested and benefits gained. Following this, the next step is to adjust/adapt; which in addition to analytical skills, requires managerial skills on how to implement that change. Even the most valuable, rare, inimitable, non-substitutable resources will provide no benefit to an organisation, if managed by unskilled people (Katkalo et al., 2010), thus their competitive advantage will be lost. In extension to this, the findings demonstrate that benefit will be lost if the resources are mis-integrated, in line with the literature (Plé and Chumpitaz Cáceres, 2010), This is particularly due to lack of skills essential for collaboration, such as communication, empathy, trust and flexibility as well as leadership. Leadership, according to the research findings is a pivotal skill in enabling the collaboration within an alliance and included both communal leadership (leading/advocating for the project as a whole) and individual leadership (each organisation having a leader that can support the interests of the organisation within the project).

8.2 Access to assets

Studying the way in which actors integrate resources within smart city alliances in depth, permitted the identification of unique resources that are enabled solely through the process of alliancing and are rarely accessible otherwise. The data demonstrate that one of these resources is "access to assets" encompassing access to public assets and access to private assets. As explained in the findings, I define access to assets as *an actor allowing other actors to utilize their physical, digital and human infrastructure in order to develop and/or test solutions of urban innovation (smart city services), in return for a benefit.* In this case, public actors provided access to their assets to gain reputation and attract more businesses, create additional funding streams, decrease costs and increase the quality of life for their citizens. Private actors had more convoluted interests revolving around data collection and R&D. Why is access to assets so pivotal for the process of value co-creation though?

From the findings of this research, in addition to the alliancing and collaboration capabilities discussed above, the capability of accessing assets appears as key in innovation intense tech environments. Access to assets describes the capability of an actor to act upon infrastructural assets (an operand resource), or human assets (operant resource) in order to co-create value, encapsulating the essence of what an operant resource is. Access to operant and operand resources, in general, is considered one of the determining factors of value co-creation (Akaka et al., 2012)**.** In technology intensive environments, such as smart cities, organisations seek access to physical resources and to capabilities that allow the exploitation of other human and organisational resources that may lead to them gaining an advantage in the market (Newbert et al., 2008)**.**

We observe that in smart city projects, this is pivotal as without access to public infrastructure, urban innovation technologies and services cannot be tested or even fully developed. Thus, lack of accessing resources becomes a barrier or a resistance that needs to be removed in order for potential resources to be made useful (Lusch et al., 2008), as value co-creation occurs when a potential resource is transformed in an explicit benefit (Morrow Jr et al., 2007). The findings show that removing this barrier is a demanding process that depends largely on the human factor and power relationships between actors. Drawing from sociology, balance of power affects actor dependency, where dependency fuels a pressure to adhere to the wishes of an actor that may withhold resources (Crossley, 2022). Power positions are indeed the determining factor of resource dependency (Turner, 2005). As discussed in section 8.1.5 removing the barriers is contingent on the intricate interpersonal relationships and the institutional power balance between city managers and company representatives, academics and other public officers. While these relationships are personal, the dynamic of such relationships is typically underlined by the institutional power held by the organisations collaborating. When these relationships failed, collaboration could no longer go forward and resources could not be transformed.

8.2.1 Accessing assets – an industrial dynamic capability

Accessing assets, or resources, is theorized here, as the capability of an organisation to remove the resistances in their environment in order to be able to fully exploit both their own resources and the ones of the rest of the alliancing members through resource integration with other actors. It can be characterized as a dynamic capability as it is developed by organisations, to create, process and attain resources in the long term (Ambrosini and Bowman, 2009). This dynamic capability as an operant resource may not only be a fundamental source of strategic benefit (Vargo and Lusch, 2016), but also a source of competitive advantage (Madhavaram and Hunt, 2008). Competitive advantage emerges solely through the ability of an organisation to advance capabilities that aid in resource integration (Eisenhardt and Martin, 2000), as indeed occurs with the capability of accessing assets. Accessing assets is in its core conceptualised not as a capability that is a source of competitive advantage in its own right but rather as a capability that acts as a prerequisite for the actualisation of any type of value creation, both short and long term. This is because if an organisation does not possess it, they can simply not partake in the resource integration process. This has significant theoretical and practical implications for both the organisation that needs this resource and for the owner of “access”. Consequently, in a specific context the value that the resource has for the actor that needs to acquire it, is significantly increased (as value is always determined by the beneficiary), thus providing the owner with a significant bargaining power and consequently contributing to the creation of power dependency, as they can now attain more benefits from its utilisation, in a service interaction.

8.2.2 Access to assets – a competitive advantage for the public actor

This conceptualisation along with the empirical evidence that I have gathered allow me to study the resource of access to assets and the way in which it becomes a source of competitive advantage for their owner, in the context of urban innovation projects. In smart cities, urban assets are owned by public actors and typically councils. While another tier of public actor might have influence on public assets, the findings demonstrate that the municipality needs to grant access to its infrastructure for any project to take place on its grounds. This appears to be for accountability and operational purposes. For example, when a governmental department wanted to run a testbed for a specific technology in collaboration with a consortium of industrial partners, they came to agreement with a specific council that offered its estate to the project and became an active collaborative partner in the alliance. While the funding came from the specific governmental department, the council assumed a significant part of the responsibilities -and risk- involved. So, while there is a competitive advantage there is still risk involved. But why do city councils need a competitive advantage? City councils aim to attract businesses. Attracting businesses seems to be a common goal for all councils as it leads to the creation of jobs, decrease in unemployment and increase in local entrepreneurial activity. Additionally, improving the city infrastructure through smart city programmes, acts as an enabler for attracting more business, as well as a decrease in government spending due to more efficient infrastructure and increase in quality of life for the local citizens. However, these grants are distributed through funding mechanisms according to competitions that the councils need to enter.

8.2.2.1 Competitive municipalism

The findings show that councils actually are in constant competition between each other, in order to gain external funding from government funding mechanisms. They are constantly entering in a process of competitive municipalism where in order to fund their everyday operations and provide services to their citizens, they need to bid against other councils in central government schemes and innovation grants. This is because in the UK as well as in many European and Northern American countries, the World Recession of 2008-2009 had long term impacts to the economies (Reserve Bank of Australia, 2022), that led to five years of consecutive budget cuts in the UK (ONS, 2018) and severe austerity in governmental spending which heavily impacted the local government, an austerity that according to the interviewees was still ongoing at the time of the interviews. Competitive municipalism as a term was introduced by one of the interviewees that took part in this research. It may be a source of both positive and negative value creation according to who the beneficiary is and how public actors manage it. This is in line with the literature, as value co-creation and co-destruction can exist at the same time (Chowdhury et al., 2016). On the one hand, the competition pushed the councils to innovate and start developing more effective services, as well as investing in their reputation. On the other hand, value co-destruction appears to be the outcome of the lack of communication and collaboration that was observed between the councils. The competitive climate under which they operate led them to not sharing resources such as knowledge, technology, data and connections in order for them not to lose their advantage. This resulted in public funding being spent double and triple times on the development of a solution to solve the same urban problem, or even in some cases the development of the almost identical solution. When looking at this from a public value creation perspective, there was a substantial loss of collective value observed. While the reduction of public spending has been the subject of a large part of the literature in public policy, there is very limited research on public value co-destruction (Osborne et al., 2016), and especially in the indirect loss of value that results from reoccuring municipal competition.

8.2.2.2 Location characteristics as an attribute of competitive advantage

However, why do actors choose to collaborate with specific public actors? While in managerial literature, there is a tendency towards generalisation of findings, the answer to this question is the specific intrinsic characteristics of specific geographical locations. When studying the perceived value of resources, externalities related to geographic clustering present significance (Håkanson, 2005). Spatial clustering reinforced by social proximity facilitated the access and potential exploitation of resources in an organisation's environment (Newbert et al., 2008). As a result, geographic and social clustering may be perceived as resources that affect an organisation's knowledge, innovation outcomes and success (Ganesan et al., 2005). The findings suggest that the factors for industrial actors to choose with which public actor they will collaborate were geographically bound and ranged from proximity of location to main corporate offices, proximity to a university and potential pool of skills, quality of existing infrastructure, particular characteristics of location and size of council. However, there was one determining factor, the demonstrated willingness of the city council to collaborate with the industrial actors and the amount of support the council was disposed to provide. This depended from the reputation of the council in terms of interest in collaborating with the industry and from the socially constructed relationships that individual industrial partners had formed with members of the council. Additionally, from the findings it is evident that there was disproportionately more demand from the industry for public actors to collaborate with, than supply, as the number of councils that have the capabilities in terms of human and financial resources to respond to a smart city project, is quite limited. Finally, as demonstrated above, the evidence suggested that gaining access to public infrastructure is a prerequisite for industrial actors that cannot be substituted. Thus, these public actors hold a resource that is perceived as valuable, rare, inimitable and non-substitutable, making the access to assets a resource that is a source of competitive advantage (Barney, 1997).

In order to wield this competitive advantage, I have found that access to assets should be viewed and studied as a bundle of critical resources that when organised and grouped together lead to superior value creation. This is supported by the literature where a single resource in itself cannot be a source of competitive advantage (Enz, 2008) and multiple critical resources need to be organised in a novel way (Peteraf and Barney, 2003) in order for superior value to be created. Findings show that the critical resources needed in order for smart city projects to take place are of multifaceted nature and are related to human resources, physical and digital infrastructure, facilitated accessibility (by train or airplane) from other major cities, and citizen data. This competitive advantage is crucial for the councils as they can use it as a leverage to gain more benefits from their collaboration with the industry. These benefits according to the data, were related to gaining reputation, that attracts more businesses and improving their infrastructure. Thus, the empirical evidence indicates that the competitive advantage of a public actor is strongly linked to the benefit of reputation and how it transforms into a capability that offers potential for future value creation. Reputation is considered a key operant resource for an organisation (Branco and Rodrigues, 2006) and in itself may be a source of competitive advantage (Morgan et al., 2006). It may be an imperfectly imitable resource as a result of the socially complex phenomena that form it (Barney, 1991)**.** Councils aimed to appear as spaces that welcomed innovation and facilitated it actively. In a few cases they invested in becoming a kind of “living lab” which companies and universities could use as a testbed. These allowed councils to respond to the newly emerged need for the creation of smart urban services and additionally created the potential to facilitate the attainment of long-term benefits for councils. These in combination with the difficulties in imitating, may transform reputation from just an operant resource to a dynamic capability. I have observed that the reputational capability was enabled through the willingness of the public actor to allocate human resources to the operation and management of a project as well as an openness to collaborate in a meaningful way. Meaningful collaboration with the councils was described by industrial actors as a responsive reciprocal relationship that looked at the long-term business case of the industrial actors, instead of the short-term benefit creation that served solely the purposes of the present project. In short, councils offer access to their assets to industrial actors in order to gain reputational benefit.

8.2.3 Market proof of concept – a resource with a temporary competitive advantage

This part of the discussion has explored both how industrial actors work towards attaining an access to assets capability, and how public actors may treat access to assets as a resource. In order to properly comprehend how truly significant this access is, we need to study the main resource that industrial actors aim to gain through access, which is the ability to use the city grounds as a testbed in order to gain a proof of concept for their service. Proof of concept or service testing appears to be indispensable for the deployment of a tech intensive service. In technology intensive markets such as the newly developed smart city market, the nature of the provision of services differs. This is because technological advancements change the way in which service is delivered, innovated and managed (Bitner et al., 2010). Thus, testing becomes essential to be able to fully develop and roll-out a service, especially an urban one with larger-scale applications. Testing is needed not only in order to verify the operability of the service, but also to prevent tech misalignment by ensuring that it responds to the urban problem it aims to solve. Findings show that while these risks, operability and tech misalignment are elevated in the development of smart city solutions, due to the complexity of the problem itself and the multiplicity of stakeholders involved, if they manage to be the first to market it will allow organisations, both industrial and academic to become technology leaders and capture returns from the process of innovation (Adner and Kapoor, 2010).

How valuable the proof of concept of a technology as a resource is to an industrial organisation is directly related to the value of the technology itself. The value of a technology to an organisation is determined by the degree to which it is being utilized (Adams et al., 2014). As the perceived value can only be determined by the beneficiary (the actor using the resource), when a resource makes a disproportionate contribution to providing superior value for the beneficiary, it is deemed as the most defensible test for the resource's distinctiveness (Day, 1994) allowing it to be attributed as rare. As discussed above, accessing assets is a prerequisite for value co-creation, as data analysis demonstrates that proving that a technology works, is the only viable way to allow it to get to market, while it may also work as a source of indirect marketing via word-of-mouth, making the resource non-substitutable. Market proof of concept is path dependent (constraint by past and future decision making of public actors) and socially complex (Cardeal, 2012). This is because it is enabled through collaborative and alliancing capabilities with a multiplicity of other actors making it inimitable. This is further supported by the long timescales it would take for another actor to imitate it (Wills-Johnson, 2008). Consequently, market proof of concept via technology testing is considered as a potentially valuable, rare, inimitable and non-substitutable resource, that can be a source of competitive advantage. However, disruptive environmental changes in innovation driven technology intense markets, make these resource attributes vulnerable to become obsolete (Newbert et al., 2008) leading to making this resource a source of temporary competitive advantage (Kabue and Kilika, 2016). The industrial hyper-competition in this environment, particularly noted in the data, may make this competitive advantage transient and short lived (Ambrosini and Bowman, 2009), yet at the same time indispensable to have. This barrier in value co-creation can be overcome if the organisation has developed dynamic adjustment capabilities that allow the utilization of short-term competitive advantages (D'Aveni et al., 2010), in line with the foundations of the alliancing capability in the first section of this discussion, which may allow for exploitation of the outmost potential of the resource. The higher the intensity of a resource and the longer it may be utilised, the more of value it can be (Gibson et al., 2021). The process of developing and preserving a competitive advantage is, after all, a continuous activity (Hung et al., 2010).

8.3 Intellectual property and data

It is evident from the findings that smart city actors form project-specific formal consortia in order to integrate their resources and co-create value. The type of the project appears to be a determining factor on the type of ownership agreement. Technology intense projects seem to have more rigid contracts in place, while open-collaboration projects, that are less technology intense, have less rigid contracts of undetermined -or open- ownership.

These smart city actors are part of a service ecosystem, which appears to be moderately configurated, with actors moving between projects. This can be observed by the overlap of the actors in a number of projects. The smart city service ecosystem appears to be driven by its will to innovate and create new value propositions. the strength and quality of the relationships between the partners within the consortia, especially between the councils (or other governmental agencies) and the industrial actors serve as both enablers and challenges to achieve this.

As service innovation is embedded in social structures and within specific social systems (Edvardsson and Tronvoll, 2013), smart city actors adopt specific social positions that enable them to co-create intellectual properties. Councils typically appear to act as catalysts for the consortia to be formed and funding to be obtained. This is because the councils hold access to operand resources, such as physical assets and citizen data without which the industrial actors cannot innovate. On top of that they hold access to operant resources in the form of soft capital, specifically skills and knowledge. They also have the ability to set limits in the use of their resources, thus delineating the possible value propositions. They typically enter in these types of consortia to boost the economic development of their city, rather than create exploitable intellectual properties, as well as collect data that will help them in decision making processes.

As innovation is a process of rearrangement of the institutional structure prevalent in the service ecosystem, conflicts and tensions can arise (Koskela-Huotari et al., 2016). These tensions affect the value co-creation process and have led to industrial partners falling out, feeling mistreated or disenabled from participating in the consortium. Moreover, following the conclusion of the project, conflicts between the public, private and university partners have led to ambiguity and uncertainty about the use of the joint IP that has been co-created. Certain actors were not willing to enter into discussions with each other, thus resulting in situations that hinder the value-in-use of the urban service co-created by the consortia. In short, in collaboration-based projects with softer outputs, after experiencing conflicts, the actors frequently did not engage in conversations to clearly determine IP and data ownership, which had a negative effect in the value-in-use of the service.

Similar outcomes were observed in open ownership models. Certain intellectual properties and data were not created for commercialization purposes, but to be made open. The findings demonstrate how public actors and universities are making efforts to create open data which speaks to the literature suggesting that open data create innovation possibilities for both public and private actors (Zuiderwijk et al., 2014). However, the findings did not demonstrate how or if these open IP and data are ever used. The challenges on quality and technical issues discussed above have an impact on value-in-use to the extent that relatively little value may realised. As Chan (2013) suggests, there is no affirmation that the results of such projects actually lead to purposeful or beneficial collaboration. Thus, while adopting an open ownership model in theory appears beneficial, in practise, it might hinder the realisation of co-created value-in-use.

In contrast, in technology heavy consortia, where financial investment was also much higher, the quality of the relationships between the partners had much more limited effect on the value output and the future use of the co-created IPs and data. This is because the initial IP agreements were particularly rigid and clearly indicated how the joint IP could or could not be used by each of the actors and what resources were expected to be offered by the partnering actors. As beneficial as this rigidity appears for potential future use of the intellectual properties and data, the actors indicated that this had negative effects on the process of innovation. The process of innovating is becoming more open, necessitating change in the way industrial actors manage it, which is evident by the increasing prominence of the need for use of external knowledge resources (Chesbrough, 2004). In these types of projects, the inflexibility shown by specific industrial actors to share resources beyond what has been contractually established, appears to hinder the consortium's ability to co-create value. Furthermore, as indicated in the findings, some industrial actors, typically multinational firms, refused to participate in the consortia at all, out of "fear of sharing". Innovation in smart cities is a process that involves high numbers and different categories of actors (Angelidou, 2015), thus the unwillingness of many industrial actors to share resources, such as their existing intellectual properties, with other actors may in the mid to long term lead to loss of value for them. The paradigm of open innovation indicates that industrial actors should use resources both external and internal to the firm, in order to advance their technology, or use external channels to generate additional value (Chesbrough, 2004). While this has been established by the literature for quite some time, some key players in the sector have yet to accept the argument and rise to its challenges.

The "fear of sharing" demonstrated by some industrial actors appears to be contrary to the institutions and institutional arrangements typically present in smart city consortia. Smart cities are considered territories of high innovation and learning capacity. In order to transform urban environments into smart cities, innovation in planning, management and operations is considered essential (Naphade et al., 2011). As mentioned above, the findings demonstrate that in pilot and testbed smart city projects, in order for the actors to gain indispensable resources to innovate, they need to co-create value in consortia. In order to be able to work between each other, they need to abide by the endogenously generated institutional arrangements of the service ecosystem that govern the resource exchange and value co-creation (Vargo and Lusch, 2016). The findings suggest visible disruptions in the co-creation processes, due to distance between the institutional arrangements under which certain actors operate and those governing the smart city service ecosystem. The ecosystem appears to work on beliefs and narratives based on the advancement of urban services and in some cases in the improvement of citizens' urban experiences. The complexity of the interactions required to achieve these goals calls for open collaboration models where flows of information are exchanged beyond what is strictly prescribed in contracts. In other words, in order to be able to collaborate, these organisations presuppose a cultural willingness to share information among their partners (Fawcett et al., 2011), without which the project will not produce any IP or data. This is in line with Mele's (2009) view that emphasizes the socio-cultural nature of resource integration and the significance of the expectations, needs and capabilities of the actors in the value co-creation process.

8.4 Limitations of this research

This study is based on empirical evidence collected using qualitative methods. I used semi-structured interviews to unveil the intricate dynamics characterized by reciprocal resource exchanges between actors, that affect value co-creating mechanisms in smart city projects. Qualitative methods due to their nature, may present limitations related to bias (Easterby-Smith et al., 2008). While bias cannot be eliminated, in this research I attempted to minimize it by following a descriptive interview topic guide (presented in the research methods), that was structured to aid interviewees in a step by step recollection of what transpired in each project that they participated in. This helped in the reconstruction of more rigorous descriptions and a more accurate reminiscence of the attitudes of interviewees towards the events. This meant that the interviews were lengthy, with some lasting over two hours long. Other limitations may be related to the sample of the data. The recruitment of participants was based on the projects in which they took part in. Since there is no single official register of all the smart city projects, smaller collaborative initiatives, or projects that were non-collaboration based, might have been overlooked and not included. Additionally, this research considers smart city projects in their current format, meaning alliance-based projects that are a coalition of public, private and academic actors with some input from the civic society, funded mostly through public financing. In the future, this structure could change, rendering many of the findings of this thesis less relevant. Moreover, it is evident that there is limited input from the civic society. While citizens are the users of the urban infrastructure and they should be involved in the process of development of smart city services, I was able to find and interview very few representatives of citizens, which were part of citizen engagement groups. There were additionally some interviewees of the public sector that were occupied specifically with community and public engagement. Nevertheless, the limited input from citizens still poses a limitation.

Other limitations of this study may be related with the theory that underpins it, the service dominant logic. The limitations of SDL have been discussed in section 3.8 and are related to the limited acknowledgement of cultural, societal and political aspects of the collaborations and the motives of the actors (Arnould, 2006; Flint, 2006; Schembri, 2006), through minimizing the importance of the political dimensions of markets (Hietanen et al., 2018) and deemphasizing the impact of cultural influence (Peñaloza and Venkatesh, 2006) on the interactions and collaborations. While I have tried to take these aspects into account – for example by recognizing reputation as an expected benefit in public interactions, which may be a political aspect –, there were still limited findings considering cultural, societal and political aspects. Another limitation of the service-dominant logic, is related to its limited applicability to practice and long-term results (Arnould, 2014). I recognize this limitation and have attempted to address it, through translating empirical findings into solid managerial insights and recommendations. However, I acknowledge that there is still a gap in transferring all the theoretical contributions into strong guidelines for practitioners.

8.5 The effects of reflexivity on this thesis

In this research I acknowledge that I have certain experiences and personal pre-formed emotional, theoretical and political conceptions, as well as cultural and societal beliefs that affect my data collection and the way in which I interpret and analyse my findings. Throughout the journey of my PhD I have noted the significant changes in the way in which I perceive both the literature and the data. At the start of this PhD I was a full-time research student with limited work experience, but during the second semester of my third year, I started working in the construction industry. When I joined the industry, I gradually noticed a change in my logic and in the way in which I interpreted my findings and how I connected them to the literature. As part of my job is working in a joint venture, I started noticing the different dynamics in the operations of alliance-based projects compared to non-alliance-based ones. The findings of this research strongly reinforced this. Moreover, while going through the literature I observed a scarcity of practice-based applications of the findings both in the smart cities and service dominant logic research. Consequently, this shifted part of my analysis process to include findings that can contribute both to theory and practice.

9 Theoretical implications

This study focused on understanding how smart city actors co-create smart city services, through exchanging resources. The findings addressed the gaps and limitations in theory, identified in the literature, related to how actors interact, integrate resources and co-create value in alliances, the key factors of success or demise of these interactions and how the alliancing (or collaboration) ecosystem is affected by the outcome (Elo et al., 2023; Sebesta and Archpru Akaka, 2024). In order to achieve this, in line with Mustak and Plé's (2020) identified criticism on the lack of diversification of the nature of interactions in SDL, I distinctly chose to study resource exchange in tightly coupled interactions, by concentrating on distinct alliances. In response to multiple criticisms in the literature regarding positivity bias in SDL, I distinguish between and discuss on negative and positive value co-creation and increase and decrease in ecosystem wellbeing.

Additionally, this research with empirical findings, directly challenges the underlying assumption that actors have both the ability and willingness to integrate theirs and other actors' resources, that stems from the connotation of positive terminology in SDL, through focusing on access to resources, identification and definition of critical resources and addressing withhold of access due to power imbalance, an identified limitation of SDL, and contributing to the developing literature on alliancing capabilities. Finally, after studying the process of resource integration that leads to positive or negative value co-creation, with empirical data, I contribute to the literature gap on how actors within the ecosystem can create value propositions (Verleye and Reber, 2022), and what they encompass (Payne et al., 2020), as well as the need for empirical research on the processes and practices of how they are created (Lee and Park, 2023). The latter is addressed bilaterally, through examining how neutral resources are transformed through resourcing and how actors make use decisions based on access to critical resources and the development of future value propositions; and by studying how co-owned resources (a resulting product of the value co-creating process) may morph into future promises of value. In both processes, value co-destruction has been addressed.

Through qualitative data collection I studied how actors engaged in prominent smart city projects based in the UK, interacted between each other and integrated resources in consortia, in order to deliver smart city projects. Through studying these interactions via the lens of service dominant logic it is evident that the fact that these projects work as formally established consortia, demands that their actors are studied as members of alliances instead of as unique actors. Establishing that interaction in smart city projects occurs in the form of alliances, a narrowly researched field in SDL literature, allows for certain theoretical implications to be made. These regard: the introduction of the service sub-ecosystem as level of analysis for the alliances, proposing the notion of quality of interactions as a determining factor of ecosystem wellbeing, identifying critical resources and their contribution in future value propositions, and examining their accessibility. Due to their innovative nature, driven by consecutive developments in advanced technology, smart city projects are an example of a contemporary, multi-actor, innovation driven environment, allowing for the findings of this research to cross the boundaries of context-specificity. Thus, these can be generalized to alliances and joint ventures in all industries driven by technological innovation.

9.1 The formation of service sub-ecosystems through alliancing

Alliances allow for organisations to access complementary resources to develop a competitive advantage (Gulati, 1999), in technology intensive industries (Newbert et al., 2008). Given the increasing demand for accelerating innovation rates and shorter time-to-market (Deloitte, 2019), as well as the temporality of technology-driven competitive advantages demonstrated in this study, the need for forming strategic alliances in technology intensive industries, appears to be exponentially increasing. Consequently, alliance focused research becomes increasingly essential. Recently, Akaka et al. (2024) highlighted the need for research on collaboration ecosystems in a call for papers on the "nested nature of nested nature of collaboration technologies in markets, as well as networks of actors and their dynamic relationships that support collaboration practices, processes, and outcomes" for the "International Conference on System Sciences" (pg 1).

It is evident that the way in which alliancing works is still largely under-researched (Comi and Eppler, 2009). A deeper understanding in how collaboration ecosystems are shaped (Randhawa et al., 2022) and on how particular organisations engage in the process of collaboration (Sebesta and Archpru Akaka, 2024) is needed. Accordingly, the way in which value is co-created specifically between alliancing actors, also needs further investigation, with the acknowledgement that there is both positive and negative value co-created (or co-destructed) (Randhawa et al., 2022). Value is co-created via aggregated meaningful exchanges in nested and imbricated service ecosystems (Vargo and Lusch, 2016). Service ecosystems have been described as relatively self-contained, self-adjusting systems of actors that integrate resources, governed by shared institutional logics, where mutual value creation occurs through service exchange (Lusch and Vargo, 2014). These actors are essentially the multiple stakeholders operating within a specific context (Frow et al., 2014). Through the findings, it is evident that alliances may be perceived as operating as an ecosystem in themselves. This is because they have formed delineated systems of resource-integrating actors that work according to shared institutions. However in reality, alliances that are formed for projects are temporary organisations.
Drawing from project management theory, projects are theorised as temporary organisations, perceived as open systems continually interacting with their dynamic context (Engwall, 2003). Throughout the life cycle of a project, it will be constantly influenced by new advancements, changes and events (Pinto et al., 2009) that are external to the alliance ecosystem, yet affect its course. In addition to that, many current and future customers and/or users, as well as suppliers are external to the alliance ecosystem. Consequently, it is evident that while an alliance might assimilate a service ecosystem in its own right, in reality it is a sub-ecosystem operating as a separate actor within the wider service

ecosystem (Figure 19). Fehrer and Bove (2022), use the term sub-ecosystem as a “lower order” compositive element of service ecosystems and utilise it to describe a part of an organisation (for example a faculty with a university). In the context of formal collaborations and alliances, I propose an alternate definition. An alliance sub ecosystem is a structure within the wider service ecosystem, formed by tightly coupled interactions between collaborating actors that operate towards a mutual scope and under a unique set of institutional arrangements that cannot be imitated or generalised to the wider service ecosystem.

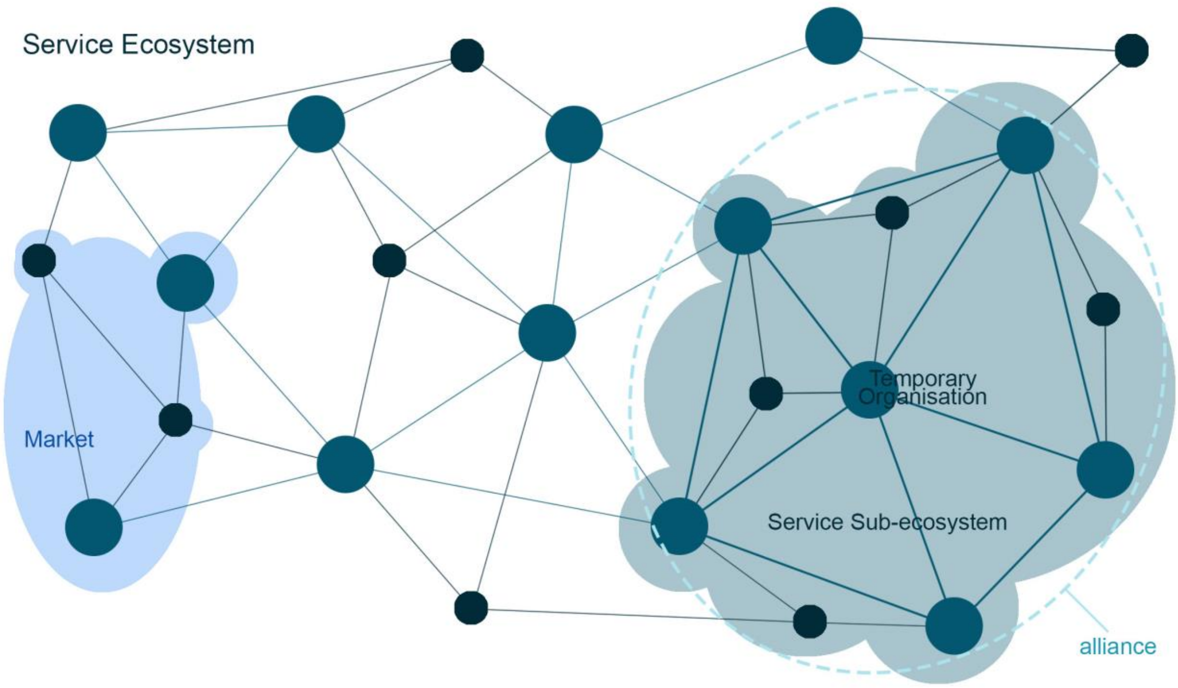

Figure 18 Sub-ecosystems and markets within the service ecosystem

At the centre of this sub-ecosystem lays the temporary organisation which exchanges resources internally with alliancing partners and at the same time engages in service tightly coupled interactions externally (outside of the sub-ecosystem) with suppliers and customers/users. As a sub-ecosystem, alliances aim to co-create collaborative value with a common scope, while at the same time each actor aims to fulfil their individual scopes. As such, when conducting research on how value is co-created via the involvement of alliances, the unit and level of analysis need to be explicitly defined. If research is conducted on the service ecosystem level (macro and meta levels), then the temporary organisation can be studied as a separate actor that interacts with the wider ecosystem based on the generally established institutions and institutional arrangements. Each alliancing actor participates in the ecosystem as a separate entity that has its own individual service interactions with other actors. On the other hand, when studies are project and organisation based, where the aim is to study intra-project dynamics and/or inter-organisational interactions and dependencies as units of analysis, on the meso and micro level of interaction, then research needs to be conducted on a sub-ecosystem level. This is because the sub-ecosystem will have developed its own institutional arrangements under which it is operating. These institutional arrangements are endogenously generated and dynamic, continually forming and reforming through recursive interactions between the actors (Akaka et al., 2013b). Thus, they are unique to each sub-ecosystem and cannot be imitated or generalised to the wider service ecosystem.

The notion of diversified institutions within the same ecosystem is not uncommon, as Vargo and Lusch (2013) have already highlighted the significance of the cultural aspects of markets that exist within an ecosystem. Markets have been described as social structures that shape via common experiences of individual actors, where value is co-created in systems of symbols and service exchange (Akaka et al., 2015). Essentially, markets are socially created systems within the service ecosystem that have formed institutions through common cultural interactions. They arise, often in a non - predictable way, from the interactions that occur within complex and dynamic contexts (Vargo et al., 2023a). Markets can be further conceptualised as institutionalised solutions (Archpru-Akaka et al., 2023; Lusch and Vargo, 2014) and as such they can be integrated as resources via value co-creating practices (Archpru-Akaka et al., 2023). The difference between markets and sub-ecosystems of alliances, is that alliances integrate resources, under prescribed contracts, towards a formally established common scope, while markets are open-ended systems of interaction between individual actors with individual scopes, defined solely by their shared institutional logic. Studying alliances as sub-ecosystems of a wider service ecosystem, underpinned by the empirical findings of the study, allow for extensive theoretical implications that may foster a better understanding of value co-creation mechanisms between alliancing partners.

9.2 Quality of interactions: a determining factor of ecosystem and sub-ecosystem wellbeing

In the sub-ecosystem of an alliance, value is co-created through service exchange which occurs through interactions of partners. These interactions -or alternatively micro-actions- that originally occur in the micro-level, as the drivers of individual and collective value co-creation, form the foundations of studying value co-creation in the macro and consequently in the meso level of aggregation (Archpru-Akaka et al., 2023). We have established that these interactions are governed by the institutions and institutional arrangements of the sub-ecosystem. The institutions may govern the interaction, but they do not explicitly determine a positive or negative value outcome of the interaction. For this reason, I have introduced the quality of an interaction as an umbrella term, that aids in understanding what influences the process of value co-creation within alliances. I define the term “quality of interaction” as a determining attribute of ecosystem wellbeing. It is the set of distinguishing characteristics that determine whether an interaction results in the co-creation of positive value or negative value (value co-destruction). Negative value is the result of a decline in the wellbeing of an ecosystem. The empirical evidence suggests that the decline in the wellbeing of the alliance sub-ecosystem can be because of conflicting scopes between the alliance mutual scope and the unique actors’ scope, disparity in resources exchanged and variance in the institutions and institutional arrangements between alliancing actors. Mutual scope, equilibrium and flexibility in resource exchange and likeness in institutional logic, thus, are the distinguishing characteristics of the quality of interaction in alliances. Collaborative flexibility is considered as a crucial aspect of collaboration capital and is conceptualised as relational norms, willingness to change and/or the disposition to respond to changes in the collaborative relationships (Madhavaram et al., 2024). The evidence demonstrated the significance of flexibility the processes of resource exchange and the interdependence between resources and expected benefits, a finding in line with resource dependence theory (Pfeffer and Salancik, 2015), a primary theoretical perspective to study interorganisational relationships (JVs, alliances, research consortia and others) (Hillman et al., 2009).

These characteristics are underpinned by the capability that enables all interactions, communication. Lack of communication or absence of information is a source of potential value co-destruction (Vafeas et al., 2016). Findings of this study showed that lack of communication lead to the decline of the ecosystem's well-being. This is because there can be no satisfactory course of a relationship, without the interacting actors reciprocally deciding and effectively communicating with each other, what they regard as value and their expected benefits (Ballantyne and Varey, 2006). As service exchanges are formed by recurrent interactions between the alliancing actors in the sub-ecosystem, the actors need to establish paths and patterns of communication to enable the reciprocal disclosure of their value offerings. These paths and patterns are dynamic since, as institutional arrangements, they are endogenously generated and continually changing with every interaction, thus affecting the quality of the interactions in the sub-ecosystem.

The quality of an interaction is nor a static view of the sub-ecosystem, neither a screenshot in a given moment. On the contrary it describes the "momentum" of the interaction. It is a dynamic term that reflects the continually evolving nature of the institutions that govern the service exchange as well as the changing relationships between actors. As such, the quality cannot be characterized as "positive" or "negative" but rather as "increasing" or "declining". The sub-ecosystem continually evolves until the completion of the project and the termination of the temporary organisation, which leads to the disintegration of the alliance. Following this termination, the sub-ecosystem may morph into a market, thus a social structure within the ecosystem that is governed by common institutional logic (Akaka et al., 2015) and the shared intentionality between the actors evolves into shared actor experiences. These shared experiences serve as the basis for repeated interaction, as communication paths and patterns have already been established. This is supported by the empirical findings that demonstrated that actors choose to repeatedly collaborate with the same actors in smart city alliances, throughout the years, even if the project might have ended in a negative outcome. These sections examined how value is co-created within alliances for a mutual benefit, but what about fulfilling an actor's individual scope? The next section determines what actors regard as a critical resource for forging future value propositions and how these can be accessed in alliances.

9.3 Transforming neutral resources in future value propositions through resourcing

Through this study it is already established that in specific contexts, such as innovation driven environments, alliances are pivotal in order for value to be co-created. This is because alliances allow for resources to be transformed in particular benefits, an activity defined as resourcing (Lusch et al., 2008). Resourcing in alliances takes place through resource creation, integration and resistance removal. Lusch, Vargo and Wessels (2008) define the latter as the ability of an actor to remove the resistance of a resource by overcoming barriers or transforming the resistance to an opportunity and emphasize that almost all resistances are of intangible and attitudinal nature. However, the term resistance implies an active process of prevention which in its term implies agency. While there might be actors (owners of resources or parties with competing interests) that may pose an active resistance, resources in themselves are neutral. This is because, according to Zimmerman (1933) "resources are not, they become", thus human agency is needed in order for a resource to become a resistance, making resources that 'come in the way' of value co-creation more similar to a potential barrier, when encountered in their neutral state. Accordingly, human agency is needed for a resource to be transformed in an explicit benefit via processes of resourcing, that consequently leads to value co-creation (Morrow Jr et al., 2007).

The process of resourcing occurs via “use decisions” made through operant processes, that in essence are organisational strategic decisions (Constantin and Lusch, 1994). My findings show that these use decisions are taken on the organisational level and are typically related to preparing for the future, by anticipating prospective changes and building on future infrastructure and developing new business models. Thus, the use decisions that actors make, are based on future value propositions. Whether these resources are valuable or not, cannot be accurately determined at the moment that the use decisions are being made, as the beneficiary or the context might change, especially in innovation driven environments such as the context of this research, where frequent reconfigurations of the ecosystem take place. This is because resources have no intrinsic value; their value is determined by the way in which they are integrated (Lusch et al., 2008) and is inherently contextual (depending on the context and on the characteristics of the ecosystem) (Akaka and Chandler, 2010). Consequently, even if certain resources have the potential to lead to the creation of valuable services, these value propositions remain dormant and neutral, until the organisation acquires or develops the capabilities needed in order to use them (Newbert, 2008). For this reason, organisations enter in alliances in order to access complementary resources of an alliancing actor, that will allow them to leverage the value of their own resources (Lavie, 2006), that would have other-wise remained neutral, and instigate value propositions that otherwise would have stayed dormant.

9.4 Accessing critical resources through alliancing decisions

The empirical evidence of this study in combination with findings from the service dominant logic and the resource-based view, have allowed me to study how key resources are accessed by actors within an alliance in order to develop their unique and distinct value propositions. While the previous section focused on actors integrating resources for a common scope, these findings elaborate on key resource integration with the scope of individual organisational value offerings. This study has identified how certain resources act as principal deciding factors in alliancing decisions. These can be defined as critical resources, due to their disproportionate effect on the "use" and "alliancing" decisions of actors. This is because when integrated, these critical resources lead to the creation of competitive advantage (Peteraf and Barney, 2003). Whether a resource is critical or not, should be uniquely determined by each actor. Additionally, the critical resource is not a source of competitive advantage in itself (Enz, 2008), but needs to be bundled with other resources in novel ways (Peteraf and Barney, 2003) in order to lead to the creation of future value propositions that may be a source of competitive advantage. In an alliance the actor-owner possesses the access to the critical resource, while in order to attain it the alliancing partner needs to develop accessing capabilities (Figure 20).

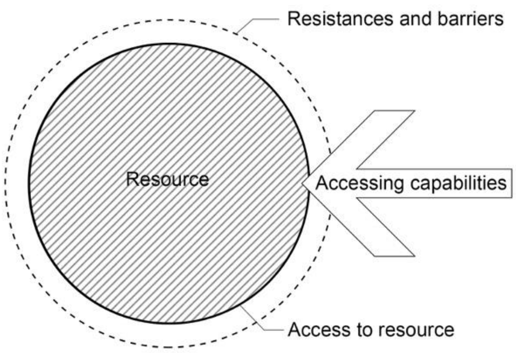

Figure 19 Developing accessing capabilities to surpass the resistance and barrier posed to acquiring or utilising a resource

The diversified theorization of accessing resources and access to resources, allows for advancing a collective understanding of their interchangeable dynamics and their effect on resource integration in alliancing sub-ecosystems. Resources (operand or operant) are owned (or rented) by an alliancing actor. In themselves they are neutral, until they are transformed by actors. *Access to resources, is theorized here as an operant resource and describes the choice of the actor-owner of a resource to permit to an alliancing partner, to utilise their resources.* If the resources are rare, inimitable and non-substitutable to the alliancing partner, they will be a factor of competitive advantage to the actor-owner and a subsequent bargaining mechanism to attain the maximum benefit possible from granting access to their resource. Inevitably, there are barriers in the accessing process, some of which are of neutral nature, meaning they are bound to physical characteristics such as location and exhaustibility or lack of appropriate knowledge to utilise a resource. Others are active resistances such as actor groups with conflicting interests, directly or indirectly affected by the access. Thus, *accessing resources is defined as the dynamic capability of an alliancing partner to remove the resistances and surpass the neutralities in their environment in order to be able to fully exploit both their own resources and the ones of the rest of the alliancing members through resource integration with other actors.* As a dynamic capability, it is developed over time and is essential for actualising any value creation both in the short and long term.

These types of resources are engaged in relationships of mutual dependency and can be described as complementary. It has already been established that actors enter in alliances to access complementary resources to develop a competitive advantage (Gulati, 1999). When these actors perceive that their scopes are complementary and not antagonistic and utilize this notion as the basis of their negotiation, the likely value outcomes may be augmented (Glaser, 2006)**.** As Ballantyne and Varey (2006) observe, the reciprocal promises of value between the actors need to be based on seeking an equitable exchange. Consequently, the service offerings between the alliancing actors need to be mutually beneficial. Accordingly, the individual value propositions that will be developed following the establishment of the alliances, need to be -if not complementary- at least not of competing interests, with both the individual value propositions of the other collaborative actors and the mutual value proposition. The latter brings attention to individual vs collective agency The negotiation between alliancing parties depends primarily by how critical the resource is perceived by its receiver for the realisation of benefits in the future and secondary by the benefits that the owner seeks to receive in return. The criticality of a resource is dependant from its perceived value by its beneficiary, in addition to its rareness, inimitability and non-substitutability (Barney 1991). However, these characteristics are of temporary nature. The findings show that these characteristics are prone to change, making the competitive advantage that stems from them, a temporary competitive advantage. This is common in innovation intense environments as a result of accelerating technological advancement (Huang et al., 2015). Thus, future value propositions formed by alliancing actors need to account for the temporality of the advantages of their resources and include adaptive mechanisms, as the market context shapes the value proposition (Bolton et al., 2004). With the growing need to form alliances to pull resources external to the organisations in order to respond to accelerating innovation rates and shorter time to market (Deloitte, 2019), future research on value co-creation mechanisms of alliances and particularly into resource integration and the formation of future value propositions that take temporality into account, is essential.

9.5 Co-owned resources: IP and data in smart cities

The findings of this study suggest that smart city ecosystems produce new types of resources that are not simply co-created, but potentially co-owned. While it is widely known that resource integration into value propositions can occur between both multiple actors and a network of actors (Ballantyne et al., 2011), what happens with the resulting co-owned resources has been given little to no attention. The findings suggest that there are three types of co-ownership of resources: contractual joint ownership, undetermined or not-yet-determined ownership and open ownership. As indicated in the discussion each ownership model can have a significant effect on the value-in-use of the service and on future value propositions.

9.6 Development of future value propositions

The fourth axiom of SDL indicates that value is always determined by the beneficiary (Vargo and Lusch, 2016), but in this case who is the beneficiary? While in traditional SDL literature, the beneficiary is the firm receiving the service or the customer (Vargo and Lusch 2008), in this study the beneficiary cannot be intuitively determined. In order to answer this question, instead of perceiving interaction as integration of resources between two actors (Vargo and Lusch, 2008), it can be perceived as interaction between the alliance and each of its members. Simplistically, the actor offering the value proposition is the alliance, while the beneficiary is each of the members of the alliance. Thus, the co-owned resource has different value-in-use for each one of the different actors, independently of the fact that they jointly own it.

For contractual joint ownership models, the value-in-use appears to be straightforward: value is determined by the beneficiary as indicated above. When the ownership of a resource is undetermined or not yet determined, the value-in-use cannot be currently evaluated as the beneficiary is still unknown. Consequently, it depends on future promises of value (Ballantyne and Varey, 2006) thus on future value propositions rather than the current outcomes of the project. These future value propositions, amongst others, stem from:

- The potential for investment in future relationships with actors, such as the creation of a new partnership or introduction to new clients/collaborators
- the potential to enter in new markets, existing or not yet existing
- the development of operant knowledge-based resources, that may offer a sustainable competitive advantage to the organisation
- the co-ownership of operand resources, such as data and/or intellectual property that may be integrated with newly developed/acquired resources.

Consequently, in the undetermined or not yet determined ownership model the interactions between actors may acquire an additional value in the mid or long-term, thus making the future value-in-use more challenging to determine. The same applies to the open ownership model, where the value-in-use depends on whether actors will act upon the resources in the future. As per above, in this model future value can be co-created through the resource integration of the co-owned open resources with other resources. However, in the case of open ownership models, the actors that will utilize these resources will, for a significant part, be unknown (or ‘not yet determined) and not necessarily part of the current service ecosystem. In short, both current and future actors - external to the service ecosystem- have the possibility to use these co-owned resources to create value in the future. Since this is unknown, in line with the increasing research on the potentials of sharing economy and open data, the future value propositions created might result in negative value-in-use for some of the current actors. Consequently, the level of openness of the co-owned resources may offer to the actors within the ecosystem, both significant possibilities for future value creation and at the same time may impact negatively their prospective value-in-use.

9.7 Creation of sustainable competitive advantage through co-owned resources

Additionally, theoretical implications emerge related to the types of co-owned resources. These can be found in Figure 21. Operand resources, which require action to be performed upon them (Constantin and Lusch, 1994), are more intuitive to attribute ownership to, or divide with other actors. Consequently, their future value-in-use can be determined or assessed by the actor. In this way it is also more evident, understandable and clear to the actors, why they need to invest in their development. On the other hand, for operant resources which act upon other resources, such as knowledge and capabilities, it is very challenging to determine how a co-ownership model can work. Drawing from the resource-based view, as the interactions within the alliances become more multidimensional and more interconnected, co-owned resources transform into interconnected operant resources which are more difficult for competitor actors, external to the alliance, to acquire or develop (Madhavaram and Hunt, 2008). This may become a source of competitive advantage for the actors (Barney, 1991).

This is particularly applicable to alliances that integrate resources with the goal of technological innovation (Cummings, 1991), where no single firm possesses sufficient knowledge and human resources create innovations in services that can compete in the global market (Lusch et al., 2010). In this sense, even though operand resources might appear as a more sensible investment for the consortium actors to invest in the first place, the interconnected operant resources yield more opportunities for the creation of a sustainable competitive advantage in the long term. This is especially applicable in innovative business environments, of which smart cities are an example where traditional business models have not been established yet and these industrial partners are still in the process of developing sustainable business models and future value propositions. Consequently, it is determined that co-owned resources, regardless of their ownership model, have the possibility to create sustainable competitive advantage for the actors that possess them and potentially lead to the creation of new business models through future value propositions.

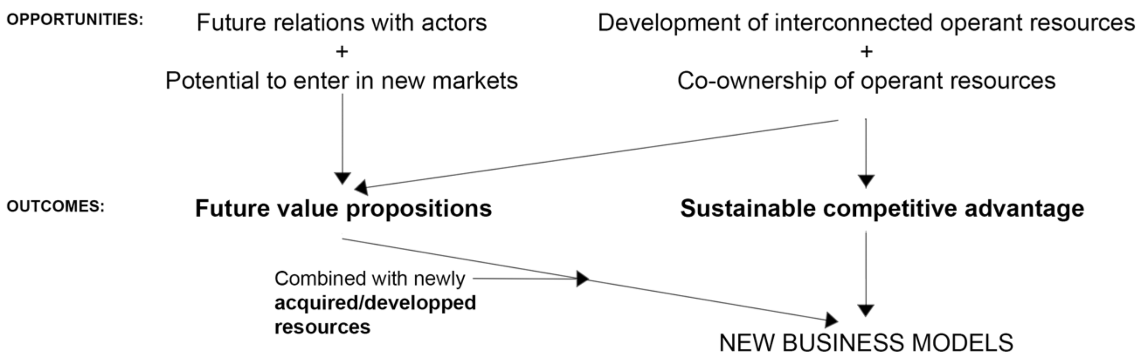

Figure 20 Potential outcomes for future value co-creation

10 Practical implications

10.1 Practical implications specific to the smart city context

While many of the findings of this research are widely applicable, others are specific to the smart city context. Through 69 interviews with participants involved in over 80 distinct smart city projects in the UK, I have gained an extensive understanding on how organisations from different actor groups interact between each other. Through these findings it is evident that many of the industrial organisations that had early involvement in smart city projects had started observing significant returns on their initial investment in resources at the time of the interview. Specifically, there were three areas that the industrial actors focused in, in order to achieve this: (1) proof of concept, (2) direct client acquisition and (3) reputation.

- Proof of concept for a service developed by an industrial actor, allows them to demonstrate if and how the service works. It is essentially viewed by companies as free R&D, that allows them to test and improve their service. This appeared to be essential in order to be able to provide a service on a larger scale.

- Direct client acquisition involves establishing collaboration channels and lasting relationships with public actors and most specifically councils, which are the typical client of smart city services. While the services offered by the industrial actors were partially reimbursed via funding acquired for specific projects, after the conclusion of the project many councils choose to continue collaborating with industrial actors that had established good working relations, through fully paid contracts.

- Reputation via “word-of mouth” in smart city communities appears to be vital in order to engage new clients. This is because the community is generally defined and the actors within it are familiar with each other. Thus, reputation is key and positive feedback from past relationships is a significant enabler for new relationships.

While industrial actors strategically focused on developing capabilities in these areas, these points are all closely related to gaining experience and investing in alliancing capabilities.

It must be noted that we refer to the benefits of actors participating in projects with early involvement, as these were the ones for which there was sufficient evidence, as the process of urban innovation is slow and it may take time to yield measurable results. However, while early involvement is favourable, it did not appear to be a constrain for organisations that joined the smart city market at a later stage, as it is still a developing market (PWC, 2019).

10.1.1 Accessing and access to public assets: an essential source of market proof of concept

While in the previous chapter I address the theoretical implications of accessing critical resources through alliancing decisions via demonstrating the complementarity between accessing resources and access to resources, in this chapter I elaborate on how this is applied on smart city projects, where the resource of focus is public assets.

The diversified theorization of accessing assets and access to assets, allows for advancing a collective understanding of their interchangeable dynamics and their effect on resource integration. Accessing assets is studied as a dynamic capability that industrial organisations need to develop, while access to assets is the resource owned and traded by public actors with these industrial organisations (amongst other actors). In short, in the technology intensive environment of smart cities, the public actor holds the access to its physical, digital and human infrastructure, which is a resource that the industrial actors that have developed services applicable on city infrastructure or city management systems need in order to test their service. In order for the industrial actor to gain access to this resource they need to develop the appropriate dynamic capabilities that allow them to remove the resistance of the public actor. Thus, the dynamic capability of accessing assets is heavily influenced by alliancing and collaborating. The reason that the industrial actors are in need of accessing the public infrastructure is in order to test their urban services and gain a market proof of concept. This proof of concept is a source of temporary competitive advantage and needs to be exploited quickly.

On the other hand, public actors hold access to their assets, which is a resource that if properly exploited can be a proven source of competitive advantage. In essence, the city councils can utilise this access to their assets as a way to bargain substantial benefits. These benefits are related to developing or maintaining reputation of the council as a place that fosters innovation and is open to collaborate with the industry, bringing in their headquarters of industrial actors and increasing their revenue and quality of life for citizens, while decreasing their unemployment and upgrading their infrastructure. It is evident that these two resources, accessing assets and access to assets are complementary and are enabled through alliancing.

Simply put, while an actor might own resources deemed as highly valuable in the smart city context (such as advanced sensors, rare dataset or unique technology), their resource might never actuate its expected value if they are unable to gain access to a particular public infrastructure (such as a transport network, traffic lights, power grids or public urban furniture), to either develop it using real life information, or test whether it actually works, when applied to a real urban environment. Thus, access to public assets becomes a resistance posed from the owner of the public asset, which in smart cities is typically the city council, that needs to be surpassed from the other actors in the smart city market, (predominantly industrial actors). I found that industrial actors surpassed this barrier through directly collaborating with city councils in the form of: alliances, paid contracts or relationships of mutual benefit exchange.

10.1.2 Practical implications related to resource co-ownership models

While each of the three models of ownership proposed in the chapters above have positive and negative aspects (Table 10), they all have a common trait: if the actors that adopt them do not take into account the demanding nature of innovation in collaborations or do not abide by the institutions on predisposition to share governing the ecosystem, the value co-creation process will be hindered and the value-in-use of the resulting service with be negatively affected. Throughout this value co-creation process there are three main aspects that emerge as crucial in the projects within the smart city ecosystem. These stem from both the findings on the current practises followed in the projects and the theoretical implications of such findings.

10.1.3 Future value-propositions for actors

Firstly, the potential for co-creation of value-in-use for the actors within the project alliance does not necessarily lie within the project itself, but in the future value propositions that might result not only from the collaboration and the co-creation process. As discussed above, this is particularly applicable to undetermined and open models of ownership. In order to benefit from this, industrial partners should be willing to provide access to the organisation's resources, mainly existing technological intellectual property and datasets and invest human capital, thus not allowing the culture of "fear of sharing" to affect their ability to create future value propositions. Accordingly, public actors and universities and particularly councils need to provide access to the resources they uniquely possess, such as access to urban data and physical infrastructure.

10.1.4 Development of new business models

The provision and access to resources is directly related to creation of a sustainable competitive advantage. This can be created through the interconnected operant resources that result from the resource integration process between the different actors within the consortium. As discussed above, this competitive advantage may lead to potential new business models. This is particularly relevant to the field of smart cities, where the majority of the SMEs involved in these projects are still in the process of shaping their business model, while multinational companies are in the phase of investing in R&D.

In order to achieve the creation of new propositions, both industrial and public actors need to be predisposed to offer abundant capable operant resources essential for the development of the projects, mainly human skills and knowledge. This is particularly applicable to industrial actors that offer knowledge-based services such as consultants. This again leads to the final crucial aspect related to flexibility in the managerial and operational part of the consortium.

10.1.5 Managerial and operational considerations

Flexibility in operations and the established contractual agreements appears to be the key in this case. This is because the existence of rigid contractual joint ownership models cannot ensure value co-creation, due to the potential lack of communication or lack of disposition to share resources between the other actors in the consortia. At the same time undetermined or not yet determined ownership models negatively affect the value-in-use resulting from the project, as the intellectual property and data frequently go unused due to ambiguity on ownership, thus hindering the potential for the creation of future value propositions. Interestingly, similar results appear to be yielded with open models as well, where the intellectual property and data is so open that no one from the project partners within the consortia considers using it for commercial purposes. In these cases, typically academics use the intellectual property for dissemination, while in others, companies -particularly SMEs-, external to the ecosystem might use the open intellectual property to inform their services.
In order to avoid this, all project actors need to establish intellectual property and data contracts at the start of the project, with a clear understanding that innovation is an ongoing process and additional resources might be required in later stages. Managers from the industry need to discuss from early stages dissemination of knowledge related to intellectual property and communicate clearly their needs and future goals. Additionally, they need to be flexible to reiterate the contract according to recent developments and changes, in order to avoid problems in the project due to rigidity. From the other side, managers from the public sector need to demonstrate understanding of the needs and

interests of the industry and be accessible and supportive especially to SMEs. Finally, it can be observed that the lack of use of the open data resulting from the project might be related to the low quality of some of the outputs, especially the ones coming from projects with no continuous stream of funds. Nevertheless, the creation of open IP and data is certainly a step towards building valuable databases and creating familiarity of citizens and businesses with how they can use these.

Table 11 Characteristics of each ownership model.

Type of ownership	**Contractual joint ownership**	**Undetermined ownership**	**Open ownership**
Degree of flexibility	Low	High	High
Possibility to evaluate current value-in-use	High	Moderate	Low
Potential for creation of not yet determined future value propositions	Low	High	High
Potential for the development of resources that can lead to new business models	High	High	High
Potential for future value-in-use	Moderate	High	High

10.2 Practical implications generalised to innovation centric projects

Following the theoretical implications, this research has identified significant practical implications that have an impact beyond the smart city industry. As established above while this study is focused on smart city projects, the findings can be generalised to any innovation driven sector that is driven by technology. This is because smart cities are rapidly paced environments fostering urban innovation, that involve numerous partners across many different actor groups and industries. Smart city projects are typically developed via the formation of alliances. Alliances appear to work as a coalition of distinct organisations that come together under pre-described contracts in the form of consortiums or as formal partnerships and they are typically project based, formed with the legal basis of fulfilling a specific project with a predetermined scope. They are formed in order to facilitate organisations to access resources beyond their organisational boundaries (Pavitt, 1999)**.** Alliances can be identified as pooling or as complementary (Lavie, 2006). In pooling alliances partners pool their resources in order to achieve superior competitive advantage, while in complementary alliances partners main goal is to achieve synergies through combining distinct and rare resources. As the smart city industry is new and still developing, as well as requiring a rare set of resources, most of the alliances in smart cities appear to be of complementary nature.

Through the findings of this study, I have determined how the quality of the interactions between actors in alliances affects the outcomes of the alliance and what capabilities the alliancing actors need to develop in order to attain enhanced benefits.

10.2.1 Quality of interactions: how it affects practitioners

Resource integration occurs through interactions that enable resource exchange. Thus, I have defined what characterizes the quality of an interaction, what it consists of and what underpins it through empirical evidence in a newly developed innovation-based environment based on collaboration. The quality of interaction is characterised as the set of distinguishing characteristics that determine whether an interaction resulted in the co-creation of positive value or negative value (value co-destruction). These characteristics are: (a) mutual scope and reciprocal benefit creation, (b) resource allocation and reallocation, and (c) the shared institutions and the predisposition to share. How do these characteristics affect the process of value co-creation though and how can industry practitioners use these to maximize their personal and collective benefit for these alliances?

Alliances are formed on the basis of mutual scopes, however the alliancing partners still have unique scopes and individual expected benefits which heavily influence intra-project service interactions. According to the findings the benefits of alliancing organisations are related to: the creation of future value propositions in opposition to solely imminent profitability, the access to unique resources complementary to a company's existing resources, working hand-in-glove with future clients, acquiring indispensable tacit knowledge related to experience and developing particular skills and capabilities. Actors that have complementary rather than antagonistic scopes and take that into account in their negotiation process, enjoy enhanced value outcomes (Glaser, 2006)**.** However, it is still inevitable for organisations within an alliance to not have some type of conflict within their goals, at some point within the collaboration process. *When forming an alliance, organisations need to ensure that the individual expected benefits are not antagonistic to each other. The expected individual and common benefits need to be clearly stated from the start of the project, in addition to individual constrains, limits and restrictions in resource allocation. Emerging conflicting scopes need to be acknowledged and a mutually beneficial solution needs to be set, immediately when identified.*

The findings demonstrate that at the start of the project it is common to overestimate the potential value co-created in alliances and the individual benefits and at the same time underestimate the resources needed to invest. Due to the unpredictable and complex nature of innovation (Chae, 2012), technological solutions developed in the projects often failed, unexpected delays were created and additional -or different- resources were needed. These may affect one or more expected benefits of the alliancing partners. Consequently, the alliancing organisations needed to show flexibility and reassess resource allocation. The findings demonstrate that alliances with less rigid structures and more flexible organisations, produced more favourable outcomes, where by a favourable outcome we intend one that nurtures superior value creation than what each organisation could achieve on their own, based on (Adner, 2006) the definition of ecosystem success. The organisations that showed flexibility, particularly industrial actors, either perceived that the expected benefits from the projects would balance the additional cost on resources or reiterated their expected benefits by treating this as an opportunity. Other organisations were flexible because they had simply "too much to lose" from the project failing. I found that the willingness of an organisation to be flexible on resource reallocation, depended from the expected benefits, their organisational structure and the individual drive of the managers of these organisations. When actors do not reallocate resources, it will lead to a failed interaction and a decrease in the ecosystem's wellbeing (Prior and Marcos-Cuevas, 2016) which will impact negatively the value co-created in the project as a whole and lead to a costly failure (Adner, 2006). Additionally, it will damage interrelationships with other project partners, who are future clients. However, an analogous negative impact might occur, if actors exceed the beneficial for them amount of resources invested in the project. *From the start of the alliancing process, partners should acknowledge and accept that amounts of resources in excess from the ones predicted, will be needed, and prepare accordingly. When weighting out the benefits versus the drawbacks from reallocating resources the following points emerge as significant:*

Can the organisation provide these resources without depleting their day to day business?

Will there be new opportunities emerging from the change?

In the case of non-reallocation will relationships with potential clients be affected?

In the case of non-reallocation will other significant expected benefits be lost?

Since these resource exchanges occur within the service sub-ecosystem of the alliance, they are enabled and simultaneously constrained by the shared institutions and institutional arrangements that govern the sub-ecosystem. Organisations protect their position in the specific institutional context they operate in by acting in compliance with its prescribed norms and rules (Meyer and Rowan, 1977). On a macro and meso level these revolve around the willingness to innovate, the predisposition to share and the flexibility for the creation of mutual and simultaneously individual benefit. On a micro level, it is an actor to actor exchange (dyadic) that is heavily influenced by collaboration, thus dependent mainly on personal connections, positive past experiences, and "chemistry". These relationships, although personal, are significantly influenced by institutional power dynamics between the organisations and specifically financial, political or reputational power. Interactions on the micro and meso level are enabled through collaboration. Collaboration is not just a transactional operation, but rather a reciprocal process enabled through communication. Failure in communication shows that actors do not have any means to take part in the shared intentions (Taillard et al., 2016) and process of value co-creation and is accompanied with a decline in the system's wellbeing. The most significant decline in quality, as well as quite a frequent one, was the misalignment in the expectations between the common project scope set by the actors and the actors' individual benefit, resulting from inadequate communication between the parties. In some cases, this misalignment was confronted through effective communication based on reciprocal understanding and flexibility, that led to resolving this by finding alternative benefits for the actors involved. *Practitioners in alliances should recognise the adherence to sub-ecosystem institutional logics as a vital element of the alliancing process. The pre-disposition to share instead of just an action should be viewed as an institutional arrangement embedded in the culture of an organisation which guides its practises. In order for these recommendations for practitioners to be applicable, the findings demonstrate that organisations need to have developed the following dynamic capabilities: searching and sensing, alliancing and accessing resources.*

Searching and sensing act as the foundation that delineate the institutions under which the organisations in the sub-ecosystem operate. Accessing resources is the capability of an alliancing organisation to remove the resistances in its environment in order to be able to fully exploit both their own resources and the ones of the rest of the alliancing members. Finally, the dynamic capability of alliancing, underpinned by the capability of collaborating, describes the ability of an organisation to combine its resources with other organisations through collaborative practices, to fulfil a common goal and simultaneously generate individual benefits. These benefits are either (1) of superior advantage and value for the organisation, than non-alliancing (2) impossible to achieve outside of an alliance. In conclusion, when actors commit to working in an alliance, the following institutional arrangements are indispensable: understanding of the collaborative process and the dynamic nature of innovation that leads to continually changing needs for investment of resources and dynamic potential for future benefit creation. The social structures and particular capabilities need to be in place in order for the actors to be able to comprehend and exploit the opportunities that arise from these changes.

11 Concluding Remarks

11.1 Conclusions

This thesis parted from the premise of understanding the value co-creation mechanisms in the smart city service ecosystem and was guided by the foundational premises of the Service Dominant Logic (SDL). In order to comprehend these mechanisms, I studied how smart city actors interacted between each other in the form of alliances and how they exchanged resources, through conducting 69 qualitative interviews with senior staff from representative organisations. These interviewees have participated in over 80 distinct projects, in 32 of which, some interviewees have collaborated between each other. By analysing the interactions between smart city actors in the form of dyadic and triadic interactions, I have determined that the resources exchanged more frequently are skills and labour, knowledge, funding, intellectual property, data, access to clients, access to assets and reputational benefits. Investigating how these resources are exchanged between each other is pivotal for establishing a well-rounded understanding of the complex mechanisms of value co-creation.

The findings demonstrate that in smart city projects value co-creation is enabled through convoluted processes of alliancing and intricate integrations of resources. The empirical findings of this thesis indicate that a determining factor of the outcome of these processes is the quality of the interactions between alliancing partners. The term "quality of interaction" has been defined as the set of distinguishing characteristics that determine whether an interaction resulted in the co-creation of positive value or negative value (value co-destruction). Three elements have been identified as influencing factors of the quality of interaction: (a) mutual scope (shared intentionality) and reciprocal benefit creation, (b) flexibility regarding resource allocation and reallocation, and (c) the shared institutions and the predisposition to share. The quality of an interaction is not static but rather describes the "momentum" of the interaction. It is a dynamic term that reflects the continually evolving nature of the institutions and institutional arrangements that govern the service exchange as well as the continually changing relationships between actors. Through further analysing the mechanisms of value co-creation between these alliancing actors, this research has additionally demonstrated how project-based alliances operate as a service sub-ecosystem within the smart city service ecosystem. The alliancing actors within the sub-ecosystem aim to deliver the project (common scope) and at the same time attain personal benefits (individual scopes). The sub-ecosystem develops its own institutional arrangements under which it is operating, which are unique to each sub-ecosystem and cannot be imitated or generalised to the wider service ecosystem. It continually evolves until the completion of the project and the disintegration of the alliance. Following project completion, the sub-ecosystem may morph into a market -a social structure within the ecosystem that is governed by common institutional logic- and the shared intentionality between the actors evolves into shared actor experiences. While the findings above delineate the context that governs resource exchange, the successive findings focus on the relationship between resources and value propositions.

The literature establishes how interactions enable resources to be transformed in particular benefits, an activity defined as resourcing, which occurs via 'use decisions' that require human agency. The empirical findings of this thesis demonstrate that in innovation driven environments, like smart cities, these use decisions are being taken on organisational level and are related to preparing to respond to anticipating prospective changes. Consequently, use decisions of resources trigger future value propositions and till they are taken, the resources -and the value propositions- remain dormant and neutral. Findings show that these neutral resources were often not utilised because the actors lacked the capabilities, or complementary resources to put them in use. Gaining access to such capabilities and other resources was the actors' primary reason for entering in alliances. Such resources that act as principal deciding factors in alliancing decisions have been defined as 'critical resources' and may lead to the creation of competitive advantage for the resource owners. Through alliancing, the resource owner may offer access to its critical resource to alliancing partners that possess resource accessing capabilities. Access to resources and accessing resources are mutually dependant and can be described as complementary. Access to resources is defined as an operant resource and describes the choice of the actor-owner of a resource to permit to an alliancing partner, to utilise their resources. Accessing resources is defined as the dynamic capability of an alliancing partner to remove the resistances and surpass the neutralities in their environment in order to be able to fully exploit both their own resources and the ones of the rest of the alliancing members through resource integration with other actors.

The findings above regard the process of resource integration, however what occurs with the resources developed through this process? The empirical findings of this study demonstrate that alliancing ecosystems produce new types of resources that are not simply co-created, but potentially co-owned. There are three types of co-ownership of resources: contractual joint ownership, undetermined or not-yet-determined ownership and open ownership. Each ownership model has a different effect on the value-in-use of each resource. This value-in-use depends on the potential of each resource to create future promises of value, thus future value propositions. The potential future value-in-use of operand co-owned resources can be determined or assessed by the actors more intuitively and forthrightly. On the other hand, the potential future value-in-use of operant co-owned resources, such as knowledge and capabilities, can be very loosely assessed. Since the interactions within the alliances become more multidimensional and more interconnected, the co-owned resources that result from these interactions, are transformed into interconnected operant resources which are more difficult for competitor actors, external to the alliance, to acquire or develop. The literature indicates that interconnected operant resources, become a source of competitive advantage for the owner of the resource.

Apart from contributions in theory, this thesis has produced strong practical contributions both specifically regarding smart cities and generally regarding innovation driven contexts. In the smart city context, the findings demonstrate how the public actors hold the access to their human resources and physical, and digital infrastructure, which is a resource essential to industrial actors that develop urban services. This access to public assets may be used from the public actors as a way to bargain substantial benefits such as creating reputation of the council as an inviting place that fosters innovation, gathering industrial actors, increasing the quality of life for citizens, while decreasing unemployment and upgrading infrastructure. On the other hand, industrial actors that develop services applicable on city infrastructure or city management systems need access to these public assets in order to gain proof of concept (test their services), achieve direct client acquisition and enhance their reputation. Additional benefits to these include developing experience in working in smart city projects and developing alliancing capabilities, which is a transferable skill. Industrial actors are heavily dependent on access as their offered services and invested resources, might never actuate their expected value, without it. The findings show that the industrial organisations that were involved at the early stages of the smart city 'trend' had already started observing returns on their initial investment at the time of the interview.

It is evident, that the actual potential for co-creation of value-in-use for the actors that take part in the project alliance does not solely lie within the project itself, but in the future value propositions that might result from the process of collaboration and alliancing. The operant resources that result from the value co-creation process have a strong potential to lead to the creation of a sustainable competitive advantage for the alliancing actors. However, due to the nature of innovation driven project competitive advantages related to technology bare the risk of being temporary advantages and should be exploited rapidly.

As demonstrated throughout this thesis, many of the findings may be further applied to all innovation centric projects that operate as alliances, not solely in the smart city sector. Some of the sectors where alliances are frequently encountered are: telecommunications, renewable energy, transport, biomedicine and others. The findings in combination with the literature demonstrate how individual organisations may need to collaborate to get access to critical resources that will enable the development of a service that can be exploited (complementary alliances), or pool resources in order to develop a service that has a competitive advantage compared to others, with reduced individual expenses (pooling alliances). Alliancing actors in both have as a goal the development of future value propositions. To achieve this, and per the theoretical findings related to the quality of interactions presented above, I suggest a number of recommendations to practitioners. Firstly, alliancing organisations need to ensure that their individual expected benefits are not antagonistic to each other. The expected individual and common benefits, as well as the common goal need to be clearly stated from the start of the project. Misalignment in the expectations was the most frequent reason for the decline in the quality of an interaction. Additionally, individual constrains, limits and restrictions in resource allocation should be addressed at early stages. Emerging conflicting scopes should be acknowledged and mutually beneficial solutions should be explored. As it is common to either overestimate the potential return of resource investment from project partners, or underestimate the resources needed for project completion, flexibility appears to be key. From the early stages of the collaboration, project partners should prepare on how to face the need for additional resources by reflecting on the effects of this reallocation to organisation. More specifically, points of reflection are: the effects of the reallocation of resources on day to day operations of an organisation, the potential new opportunities that may emerge, how the relationships will be affected in case of non-reallocation and what benefits will be lost. Finally, members of alliances need to share common institutional arrangements, such as demonstrating a predisposition to share. In order to achieve this organisations need to have developed the dynamic capabilities of searching and sensing, alliancing and accessing resources.

11.2 Future research

Concluding this thesis, the theoretical and practical implications presented lead to formulating propositions for future research. Studying alliances as sub-ecosystems part of a wider service ecosystem, allows for extensive theoretical implications that may foster a better understanding of value co-creation mechanisms between alliancing partners. The increasing need and trend for innovation centric alliances, calls for additional research into service sub-ecosystems in order to understand the context that underpins value co-creation in such collaboration driven environments. As a sub-ecosystem, alliances aim to co-create collaborative value with a common scope, while at the same time each actor aims to fulfil their individual scopes. As such, when conducting research on how value is co-created via the involvement of alliances, the unit and level of analysis need to be explicitly defined. If research is conducted on the service ecosystem level (macro and meta levels), then the temporary organisation can be studied as a separate actor that interacts with the wider ecosystem based on the generally established institutions and institutional arrangements. Each alliancing actor participates in the ecosystem as a separate entity that has its own individual service interactions with other actors. On the other hand, when studies are project and organisation based, where the aim is to study intra-project dynamics and/or inter-organisational interactions and dependencies as units of analysis, on the meso and micro level of interaction, then research needs to be conducted on a sub-ecosystem level. This is because the sub-ecosystem will have developed its own institutional arrangements under which it is operating.

Moving forward, the conceptualisation of critical resources as resources that have a disproportionate effect on the "use" and "alliancing" decisions of actors, creates an avenue for further investigating their effect as enablers or barriers on value co-creation. Future research should focus on how actors can develop the capabilities to access these critical resources and how their added value can be maximised. Additional research on how critical resources may become a significant source of competitive advantage for both owner and resource users, is pivotal. From a different point of view, in economics future research may focus on the rent (surplus value) that critical resources may produce. Regarding co-owned resources, future research on co-ownership models of operant resources is imperative to determine how co-owned resources may positively -or even potentially negatively- affect the future value-in-use of the participating actors. Additionally, future research on the impact of interconnected operant co-created resources on future value propositions and the new resulting business models, is imperative.

The practical implications of this thesis serve as a starting point for further research on four aspects: quality of interactions, accessing capabilities, temporary competitive advantage and co-owned resources. Firstly, empirical findings on how the quality of interactions affects organisations and how they collaborate between each other, will aid in identifying industry specific aspects that affect the process of value co-creation. These findings may provide insights on improving collaboration and project delivery. Secondly, the development of accessing capabilities and the complementarity of these capabilities to the 'access to critical resources', ought to be further explored. This is because empirical findings are essential in understanding how organisations can acquire and advance these accessing capabilities, while from a different perspective how resource owners can leverage them as bargaining power. Thirdly, while this thesis included multiple empirical findings on how organisations can attain competitive advantages through resource leverage there were limited findings on the characteristics of these advantages and most specifically on their temporary nature. Further empirical research to unveil the effects of these characteristics on organisations, is needed. Finally, future research may additionally focus on better comprehending how co-owned resources can enhance future value propositions for both industrial and public actors and how they can trigger the creation of new sustainable business models. Furthermore, future research should address how open intellectual property and data can be more effectively transformed in order to be more usable, as well as how intellectual property agreements can be modified to allow for the degree of flexibility essential to all service innovation projects.

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13 Appendices

13.1 Appendix A: Participant Information Sheet

Participant Information Sheet

UCL Research Ethics Committee Approval ID Number: **14741/001**

Studying resource exchange in the smart city ecosystem

Department: UCL Bartlett School of Construction and Project Management

Name and Contact Details of the Researcher:
Angeliki Maria Toli, angeliki.toli.15@ucl.ac.uk

The aim of this project is to identify **the interactions and resources exchanged** between actors in smart cities. We seek to identify how organisations like yours interact with other organisations and what type of resources you exchange between each other. These resources can be *raw materials, technology, knowledge, data, connections or monetary*. Identifying these will allow us to understand how the way you **interact** with other organisations leads to the creation of value and will contribute to the optimisation and efficient management of cities and their resources.

The interview process

You will be participating in an interview, based on a topic guide. The interview will approximately last **one hour** and will be recorded.

The **audio recordings** of the interview will be used only for transcription purposes. The transcribed text will be **anonymised** and then used for analysis. No other use will be made of the anonymised transcriptions without your written permission, and no one outside the project will be allowed access to the original recordings.

It is up to you to decide whether or not to take part.

You can withdraw without giving a reason up to two weeks after the interview. We will provide you with the audio recording of your interview to offer you the possibility to amend any errors of fact.

Benefits and disadvantages

Your participation will contribute in fostering **a better understanding** of how organisations involved in the smart city agenda interact between each other. At the end of the study you can choose whether you would like to receive **an executive summary of the outcomes** of this research, available exclusively to participants.

Since the data will be **anonymised** and kept in **confidentiality**, there will be no direct link between you and your statements. This study is in compliance with GDPR 2018 and Data Protection Act 2018.

Limits to confidentiality
Please note that assurances on confidentiality will be strictly adhered to unless evidence of wrongdoing or potential harm is uncovered. In such cases the University may be obliged to contact relevant statutory bodies/agencies.

Data Protection Privacy Notice
The data controller for this project will be University College London (UCL). The UCL Data Protection Office provides oversight of UCL activities involving the processing of personal data and can be contacted at data-protection@ucl.ac.uk. UCL's Data Protection Officer can also be contacted at data-protection@ucl.ac.uk.
Your personal data will be processed for the purposes outlined in this notice. The legal basis that would be used to process your personal data will be public interest.
***Your personal data will be processed so long as it is required for the research project**. We will anonymise or pseudonymise the personal data you provide and will endeavour to minimise the processing of personal data wherever possible.*
If you are concerned about how your personal data is being processed, please contact UCL in the first instance at data-protection@ucl.ac.uk. If you remain unsatisfied, you may wish to contact the Information Commissioner's Office (ICO). Contact details, and details of data subject rights, are available on the ICO website at: https://ico.org.uk/for-organisations/data-protection-reform/overview-of-the-gdpr/individuals-rights/

Thank you for reading this information sheet and for considering to take part in this research study.

13.2 Appendix B: Consent Form

Participant Consent Form

Studying resource exchange in the smart city ecosystem

Department: UCL Bartlett School of Construction and Project Management

Name and Contact Details of the Researcher:
Angeliki Maria Toli, angeliki.toli.15@ucl.ac.uk

This study has been approved by the School Research Ethics Committee.
I confirm that:

- I have read and understood the Information Sheet of the study and agree to participate
- I have had an opportunity to consider the information and what will be expected of me
- I understand that my participation is voluntary and that I will be able to withdraw my data up to two weeks after the interview without providing a reason
- I understand the benefits and disadvantages of participating in this study
- I consent to my interview being audio recorded and understand that the recordings will be stored securely
- I understand what will happen to the data collected from me for the research

- I understand that anonymised quotes from me may be used in the dissemination of the research

If you would like your contact details to be retained so that I can contact you in the future to invite you in follow up studies to this project, please tick the appropriate box below.

Yes, I would be happy to be contacted in this way

No, I would not like to be contacted

If you would like to receive an executive summary with the results of this study, please tick the appropriate box below.

Yes, I would be happy to be contacted in this way

No, I would not like to be contacted

Please send me the results of the study in this email: ______________________

______________________	______________	________________
Name of Participant	Date	Signature
______________________	______________	________________
Name of Researcher	Date	Signature

13.3 Appendix C: Most significant Quotes

Below I present some of the most significant quotes from my data collection. I have not connected the quotes specifically to the anonymised participant, in order to protect them from the risk of identification.

Type of actor	Quote
Government	…that's the nature of smart city projects that despite the technology, we're supposed to make everything look easier. Actually, to implement it, it's a very slow process. We're going to need to ramp up the development time to bring these new technologies through to delivery really, particularly if we're going to meet our climate change and targets.
	I think we're really in danger of losing sight of the fact that our social behaviors will determine whether technology is successful or not.
	There's two things that kills the marketplace. One of them is information, missing information, the other one is public goods.

	If you're selling something and then a government makes that freely available, then it's quite hard. Unless you're really adding value your business is in trouble. There are people making money out of the problem that we're trying to solve.
	Opportunities are revealed because you don't always see or hear about opportunities unless you're inside the relationship and you can work closely with people and you are very accommodating. Often it's the usual thing about relationships.
	What do I think about smart cities is that we have not progressed as far as fast as we could have done
	There is a parochialism in local government which is a fact of life. Maybe, it may be because we've not seen strong business cases, strong economic cases.
	There being cuts will be one of the problems. Innovation wherever it is needs resources and innovation can be risky you can't manage the risk. I think it's perhaps not much politics but culture in local authorities where there were no prizes for civil servants to take risks. There's no real incentive, and so it's almost force majeure when we got to change, and then they need to think about change… I would say the austerity has tended to result in salami slicing cuts in each area and people then tend to focus on the day to day job. They can't think in terms of investing any resource in transformation.
	It's great getting the money, but what we don't want is to create divide and investment can do that… Myself and others have made [city] a well-connected city because we had an appetite and I had a very clear steer from a leader a long time ago
	the urban challenge properly requires cross-discipline working. That means bringing together organizations for a start just different business models, different organizational structures. We work at different scales. We've got different visions and

	priorities, and we have different levels of understanding of different topics… We need to be more creative about how we bring those people together and funding models need to be more flexible to address that. Some will be able to fund their own contribution, some won't. Funding shouldn't be a barrier to participation and we just need to find better ways of bringing communities together to tackle a problem regardless of business models and funding. I think that's a real challenge for us to focus on.
	There was loads of distraction around buying hardware and stuff which was completely unnecessary. It's classic in government projects that you have loads of capital money but you have no money for people. People are much more useful than capital things. That's the sort of thing that you hear is really common, that you get capital funding because then you have an asset which is valuable. Or you have a redundant thing that you've never been able to work out how to use it because you haven't got any people to use it.
	We were established because there'd been a tendency to have projects that came and went. The idea was that you lost not just the project when it ended, but you lost the expertise.
	Leadership, really. Yes, leadership. We have very strong leadership in the city, but the leadership is around core business. It's making the case that this could be core business… They want leadership from us as a city, but it's not our area of specialism or strength.
	Innovation will always outpace policy development… What was also blatantly obvious was the lack of information and lack of preparedness with some of the decision makers.

Type of actor	Quote
Industry	You've got a whole range there of very different partners with slightly different vested interests, so aligning them around the vision is challenging, such that they all have clear roles and responsibilities. Governance around that and leadership is really critical and key, and falling from that, I guess, is affecting program management. It's defining what their clear roles and responsibilities are the ability to just deliver around those, but I think having them aligned is always a challenge because you get conflict between them. There's a stance in which some of the business organizations, particularly the small ones felt that this was a mechanism which they could sell products and services into the public sector partners, that's not what it was about.
	There was always a challenge between the abilities of small and big tech companies to work collaboratively, not least because of the concerns the smaller ones would have around their own IP. Academic institutions, I think it depends who you work with, but getting them into a place which is the real world as opposed to research, because this was a demonstration not a research piece, so that was quite challenging. Then for public sector partners, it's around capability, capacity to be involved in the project to get them harnessed to work together.
	I think for public sector partners it's about economic development. Raising productivity within their own rural areas. I think that's for them a key one. For the private sector partners it's about access to markets., so testing their technologies with a view to rolling them out if successful in other areas.
	I'd say leadership and then governance, because they're slightly different, put them together, but that leadership and governance is, at the end of the day, going to be absolutely

	critical to determine who gets to this end of the dial, who doesn't because the very nature of cities in terms of the way there's infrastructure assets, or services are delivered by a whole range of different organizations.
	It's defining what their clear roles and responsibilities are the ability to just deliver around those, but I think having them aligned is always a challenge because you get conflict between them. There's a stance in which some of the business organizations, particularly the small ones felt that this was a mechanism which they could sell products and services into the public sector partners, that's not what it was about.
	it's frustrating to work with cities in the market because they are slow, the market is complex, things are hard from my experience on the market, the biggest blocker has been always about money, about financing for smart city adoption.
	From my experience on the market, the biggest blocker has been always about money, about financing for smart city adoption… The biggest problem, especially in cities, are always been financing. However, the market is not in shortage of money, which means that this money is somewhere. There's a city in need of financing, but there's no link.
	I think this is where we've got the detachment between public sector, who I think they feel like they're holding more value, than they really are.
	It's a shame because they're not failures. What we've done so far is not failures. That's how you learn… Some people say therefore it failed because it didn't deliver this wonderful, fictitious environment to anything. Therefore, maybe that's not what should have been sold, because you have to do baby steps to it
	It's a vendor-led approach, the vendors have got something sat on the shelf they can sell you, and there we go, we're down to

	the technology being the outcome, and that's really the real problem.
	That's all been enabled by a client that has been willing to see innovation, willing to support it, willing to talk to us about the eventual business case.
	We've worked with them to build the business case of where the data could add value to them so that they could fund it at all. We get to the end of the entire thing and they turned around and said, "Well, the budget that we were implying would be available for this never existed or has been cut recently"
	I think projects funded by innovation grants are great, but once the grant's gone away, what happens then? Unless the local authority is prepared to make a policy change, or change the way it procures things, then you're not ever going to achieve real change.
	we felt we were delivering the contract. The local authority felt we were underdelivering the contract. What was absolutely for sure was [company] was doing everything that it could afford to do. In retrospect, the contract was negotiated in a way that, as it transpired, was not possible to deliver.

Type of actor	**Quote**
University	Now we come and think as to why the project was a success and I think it was all about the design of the project. We looked at the triple helix model of government, industry, and higher education but we planted citizens very firmly in the middle of that. What we didn't want was any one of those three actors leading with their agenda. We had to have a collaborative agenda around these places, but the key thing was to understand the citizen focus of the thing.
	I defy anyone to say that any particular smart city project as a single thing, has delivered something that's specifically concrete

	unless it's of such a size financially and has enough time to really make the thing happen.
	When we started our [project] we had at least two global tech providers turn up and say, “look, smart cities it's really, really easy”. All you have to do is buy all of our products, install all of our hardware around your city and everything will be fine because we've got this wonderful platform. But of course, that's just not going to happen because a smart city should have an organic interoperability connection between all of the actors that are dealing with different things to understand the changes in the market.
	As a colleague said recently, you step over homeless people to go and do a deal for £100 million. That's an unacceptable future for [city] as far as we're concerned.
	If you're going to ask people to give their consent, it seems sensible to make sure that the data is primarily used for the collective group that create the data in the first place, which would mean for purposes which are directly beneficial to the group or if the data is sold for commercial purposes is not directly beneficial to the group then it finds that the ongoing operation
	The biggest enabler is having good relationships with individuals in different organizations. Being able to demonstrate that what we can do could really be of great benefit to them.