REPLICATE PROJECT

REnaissance of PLaces with Innovative Citizenship And Technology

Project no. 691735

H2020-SCC-2015 Smart Cities and Communities

Innovation Action (IA)

Deliverable 2.2

Report on the Business Models of the Lighthouse cities

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1. REPLICATE: background information

The main goal of the REPLICATE project is to develop smart city business models and tailor-made solutions in the areas of energy, transport and ICT in three Lighthouse cities: Donostia/San Sebastian (Spain), Florence (Italy), and Bristol (UK). Specific districts have been selected in each city to test the proposed solutions: Urumea Riverside (Donostia/San Sebastián), Novoli (Florence) and Ashley, Easton and Lawrence Hill Neighbourhood (Bristol). In summary, there will be pilot actions in energy efficiency, efficient and sustainable transport and integrated ICT infrastructures. The focus on ICT infrastructure will be a key element for the integration and development of cross-sectorial solutions. Three follower cities also participate in the project: Essen (Germany), Nilüfer (Turkey) and Lausanne (Switzerland).

As a demonstration project, another of the project's principal concerns is the REPLICABILITY of solutions. It will be necessary that the project results could be applicable and scaled up throughout the lighthouse cities and in other cities that want to evolve towards the 'smart city' concept. To facilitate the large-scale deployment of the innovative technologies that are successfully demonstrated in the Lighthouse city districts, the project will also carry out specific studies about the demonstrated solutions to explore how they can be scaled-up and replicated.

The Lighthouse cities can build on previous collaboration. Prior to participating in the REPLICATE project, San Sebastian, Florence and Bristol collaborated in the STEEP project (Systems Thinking for Comprehensive City Efficient Energy Planning), in which the cities created their own Smart City Plans. The STEEP project has defined a collaborative and participatory methodology to reach the objective of defining an Action Plan for particular districts of each city.

The main objective of the REPLICATE project is the development and validation of a sustainable City Business Model in the three Lighthouse cities. The City Business Model will facilitate the transition process to a smart city in the areas of the energy efficiency, sustainable mobility and ICT/Infrastructure. It will provide the cities with a tool to assess holistically the deployment of innovative technologies, organisational and economic solutions to significantly increase resource and energy efficiency, improve the

sustainability of urban transport and drastically reduce greenhouse gas emissions in urban areas.

1.1. Relation to Other Project Documents

This document collects the lessons and insights gathered during the workshops conducted in task 2.1. It therefore, builds on deliverable 2.1 "Report on the delivery of the three workshops", and builds on the conceptualization of the city business model that was first introduced in that report. This document also aims at contributing to the following report in the work package, deliverable 2.3 "Internal report on findings." Deliverable 2.3 will use the conceptual framework proposed in this document to analyse the project's findings internally and to continue the discussion on the balance between economic, environmental and social concern introduced here. Finally, deliverable 2.4, "report on the replication potential of the City Business Models" will continue to apply the concept of a City Business Model proposed here and will use the analytical framework to analyse its replication in a comparable way.

The definition of the work plan of the REPLICATE project is essential for achieving and effective innovation management system. The Communication Materials complements, the Communication Plan, the Project Management Plan and the District Management Plan in order to achieve impact and market objectives.

In the event of discrepancy between documents, this Communication Materials overruled by the Project Management Plan (PMP), the contract with the EU (Grant Agreement) including its Annexes, and by the Consortium Agreement (CA).

1.2. Reference documents

This document is based in the following projects level documents:

Ref.	Title	Description
REPLICATE Grant Agreement signed 240713.pdf	Grant Agreement	Grant Agreement no. 691735
DoA REPLICATE (691735)	REPLICATE Annex 1 - DoA to the GA	Description of the Action

REPLICATE Consortium agreement signed December 2015 (7th December version)	Consortium Agreement	REPLICATE project - Consortium Agreement
REPLICATE Project Management Plan	D1.1 Project Management Plan (v.1) (29/04/2016)	REPLICATE Project Management Plan
REPLICATE District Management Plans	D1.4 District Management Plan San Sebastian D1.5 District Management Plan Florence D1.6 District Management Plan Bristol	REPLICATE District Management Plans
REPLICATE Communication Plan	D11.1 Communication Plan	REPLICATE Communication Plan

These will also be stored on the shared online platform.

Where there are contradictions, the documents listed above supersede this plan. The Grant Agreement is the contract with the European Commission so takes precedence over all other documents.

1.3. Abbreviations list

GA	Grant Agreement
CA	Consortium Agreement
DoA	Annex I-Description of the Action
EC	European Commission
H2020	Horizon 2020
PC	Project Coordinator
PL	Pilot Leader
PMP	Project Management Plan
TC	Technical Coordinator
WP	Work Package
WPL	Work Package Leader

2. Introduction

Cities all over the world are currently facing the challenge of managing urban growth in a way that is economically prosperous, environmentally sustainable, and socially inclusive. How can their governments promote a growth model that achieves this balance? This is the main goal of the **Lighthouse Cities** of the **REPLICATE** project, **Donostia/San Sebastian (Spain)**, **Florence (Italy)**, and **Bristol (UK)**. Many of the proposed solutions to the challenge of sustainable growth include 'smart' services, which are reliant on Information and Communications Technologies (ICT). However, there are still many challenges in the transition to smart growth and cities lack models to assess how the broad range of options being developed in the context of their 'smart city strategy'. In this report, we argue that applying a business model logic, albeit adapted to the unique context of urban governance, can help the city councils of the Lighthouse Cities manage their transition to smart growth in a holistic way.

Unlike a firms' business model, which is empirically grounded and aims at articulating specifically how the firm delivers and captures value, **a city business model** is meant to guide a City Council in articulating how it will accomplish the objectives of its smart and sustainable city strategy. Since there currently no generally used method to understand city business models, the purpose of this report is to present a framework for analysing the business models of the Lighthouse cities involved in the REPLICATE project. This framework—the City Model Canvas—shows the key stakeholders of smart services (who can benefit but who can also be disadvantaged from the transition), the key partners that will help the city deliver smart services and the key resources that can be harnessed to finance new smart services.

This City Model Canvas has a twofold purpose. It can be seen as **a tool for city governments to articulate their role in the smart city service system** and to use it as a starting point for creating new services. In this sense, it is a descriptive framework. Used over time, the city business model can be used to analyse the evolution of the different elements that are important for the development of a smart economy. This perspective acknowledges that cities are dynamic ecosystem whose key players, political priorities and communities are in constant flux. This model is therefore open to innovation as the cities gain expertise with smart services. As such, the idea of the city business model and its accompanying city model canvas should be understood as elements of the city's broader strategy for becoming a smart and sustainable city.

To show how the Lighthouse cities can use the CMC, we make a preliminary application of the model to each of the cities at the level of the sectors addressed in the REPLICATE project, **energy efficiency**, **mobility** and **ICT**. Based on this analysis, we also draw conclusions about what specific 'types' of models can already be observed in the cities. The models range from direct provision to public-private-academic partnerships and co-creation with users.

The rest of this report is organised as follows: section 2 introduces the concept of the business model and discusses why smart cities need to develop business models that can help them understand and govern the transition to a smart economy and a smart society. In this section we also identify key trends that smart city business models have to consider: the role of ICT, the role of big data, citizen co-creation, and the knowledge economy. This section also discusses the three pillars that underpin the business models of 'smart and sustainable' cities: economic viability, social inclusion, and environmental sustainability. Section 3 introduces the methodology for analysing business models at the city level. For this report, we apply an adaptation of the 'Business Model Canvas', which is a visual tool that is useful for identifying the key elements of an organisation's business model. The adapted version of the canvas methodology is applied, as a preliminary and demonstrative exercise, to the EU Lighthouse cities of Donostia/San Sebastian, Florence, and Bristol in sections 5, 6, and 7. Finally, sections 8 and 9 summarise and discuss the insights of the city case studies. The report ends with some brief conclusions and recommendations.

3. Business Models for Smart Cities

3.1. The need for developing city business models

A good business model is essential for any firm because it allows the organisation to articulate the underlying logic of how it creates, captures and delivers value, and to organise its activities accordingly (Osterwalder & Pigneur, 2010). For a firm, a good business model specifies exactly for whom it creates value (its customers), how it will deliver that value to them, and how it will produce that value consistently in a way that is economically viable in the long term (i.e. in a way that yields profits). The logic of defining a business model is now also seen as advantageous even for firms whose goal is not to maximise profits, but to create other type of value, such as environmental or social gain (i.e. non-profit organisations or the so-called social enterprises).

The need for *city* business models, however, is less clear. This report argues that cities—steered by their city councils—also need a framework for articulating the logic of how they will create value for *and with* their citizens in the long term. This value encompasses economic prosperity, personal health, educational and professional opportunities, vibrant communities, and affordability. It also includes the assumption that these goals should be achieved in a way that is environmentally sustainable so that the cities can be resilient in the face of the current and future environmental challenges of climate change. In this context, the City Business Model is defined as ***the logic of how a city can create and deliver value through the development of smart services that are economically and socially viable, while reducing the city's overall environmental footprint***. While the Lighthouse cites of REPLICATE already include these goals in their strategic plans, the logic of a city business model can facilitate a more holistic governance framework centred on the creation and delivery of value for their citizens based on a thorough analysis of the city's needs and of how well different proposed solutions solve those needs.

Cities also need business models because their role in the ever more complex value creation ecosystem of public services is currently changing. The increased complexity of the challenges that cities face and the plurality of stakeholders means that governments are resorting to new models of collaboration and co-production in the design and delivery of services. City governments and local service providers are, therefore, no longer the only parties responsible for delivering value to their residents, but instead, have become one of several actors charged with this (Osborne, 2010). Private actors, including large firms, small and medium enterprises (SMEs) and non-profit organisations, are now seen as important partners in delivering public value. Service users and their communities also play a vital role in co-creating and co-producing public value in this governance framework because they are ultimately the ones that can best identify their needs and evaluate how current and proposed solutions address those needs. What this means for city governments is that they are operating in a service **system**, where value creation depends on the engagement of a wide range of stakeholders (Anttiroiko, Valkama, & Bailey, 2014). In this service system, the role of the city government is increasingly one of guiding and overseeing the delivery of services, rather than one of only creating and delivering services to passive consumers (Osborne, Radnor, Vidal, & Kinder, 2014; Osborne, Radnor, Kinder, & Vidal, 2015).

A city business model should be seen as an element of the strategy that articulates in a structured logic the key elements of how an organization will achieve those objectives.

A city's strategy sets its overall objectives and goals, such as 'sustainability' or 'inclusive growth' and articulates in broad terms how those objectives will be reached. The business model articulates in a more structured way how to reach those objectives through specific actions.

As an element of the city strategy, the CMC can be used dynamically over time as the smart city strategy evolves. The city model canvas recognizes that the public services that cities offer are **continuously evolving** to adapt to **citizens' needs** and to the **changing urban environment,** so city managers need a model to assess those dynamics holistically. Furthermore, this framework is useful, and necessary, because it raises the focus from the particular individual business models of the many firms and organisations involved in smart services to the holistic level of city. At this level, the city must ensure that the combined efforts of its many actors are moving towards balanced economic, environmental and social sustainability. The city business model can help city governments actively assess the net balance of their actions in terms of economic viability, environmental sustainability, and social inclusion and acceptability and make changes when the outcomes are not in line with the city's strategic objectives.

3.2. Key crosscutting trends for the smart city business model

The dynamic nature of cities means that a first step in the development of their business models is to understand current trends that are shaping their economy and society. As the literature on smart cities grows, scholars and practitioners have identified some characteristics that seem to be common to most successful smart cities. These characteristics are investment in ICT infrastructure, the use of big and open data, active encouragement of user co-creation, and a focus on the knowledge and creative economy (Caragliu, Bo, & Nijkamp, 2011; Walravens, 2015). These four characteristics are briefly described below. Smart city business models have to consider if and how these characteristics are present in each of the EU Lighthouse cities.

ICT infrastructure: one of the most important elements of the transition to 'smart cities' is the need to invest in cities' ICT infrastructure. ICTs in the context of smart cities are seen as a valuable resource for achieving 'strategic urban development goals' such as improved access to transport and low-carbon growth (Schuurman, Baccarne, De Marez, & Mechant, 2012, p. 51). It is therefore crucial for smart cities to develop the infrastructure for these technological services. This includes the development of ubiquitous wireless networks that offer connectivity opportunities not only for citizens

using personal mobile devices but also for the deployment of wireless sensors that connect to each other and collect data about urban activity.

A key element related to ICT and the deployment of sensors is the 'Internet of Things' (IoT), a term that describes a ubiquitous network in which items, equipped with sensors, are connected to each other via wireless internet connectivity and can collect and transmit real-time data on a vast number of factors (Gubbi, Buyya, Marusic, & Palaniswami, 2013). Smart city applications of the Internet of Things, some of which are being introduced in the EU's Lighthouse cities, include 'smart lighting posts' that adapt their brightness to income traffic and collect data on temperature, pollution, and congestion and 'smart bins' that can notify the trash collection service when they are full to optimize collection routes and schedules. Obviously, this type of information can be very helpful either for improving or for increasing the efficiency of the services being provided.

The importance of this trend needs to be considered in any smart city business model. According to Forbes magazine, the Boston Consulting Group has recently estimated that the market size for the Internet of Things will exceed EUR 200 billion by the year 2020 (Columbus, 2017). It will, therefore be important for cities to understand what opportunities and challenges they will encounter in this area.

Big data and open data: one element that is inextricably related to 'internet of things' applications is data (Komninos, Pallot, & Schaffers, 2013; Komninos, 2014). Any street infrastructure set up with wireless technology (such as sensors) will collect vast amounts of data related to different aspects of life in the city, such as movement and traffic flows, commercial activity and residential energy use. One of the arguments in favour of collecting so much data is that it can be analysed and used to improve the efficiency of certain processes and services, such as the frequency of public transport or the most efficient trash collection schedule. Data is such a ubiquitous concept nowadays, and is assigned so much value from the private and public sector, that it will be a central element to any smart city business model.

One important issue related to this is the concept of 'open data', which refers to the practice of governments making their datasets publicly available. Open data can be useful for developers, firms or even other government organisations to develop new services or new ways of analysing the data, and some cities are even regularly organising 'hackathons' or competitions to encourage such actors to propose new ideas (Kassen, 2013). However, there are two important challenges that cities will face in this regard:

first is the quality and usability of the data. There is no standardised way of collecting, cleaning or storing the data so different organisations might be unable to use each other's data even if they are willing to share it with each other. Second, there are legal and private barriers to sharing data. From the perspective of firms, who often profit from selling big data, there are few incentives to share it freely. From the perspective of governments, there are legal barriers related to collecting, storing and sharing data (even if it is aggregated) due to citizens' privacy concerns (Janssen, Charalabidis, & Zuiderwijk, 2012). Within governmental organisations, sharing data can also be challenging due to policy divisions and competition between organisations.

More fundamentally, regulatory models for open data will have to address the role of citizens in sharing their data and in deciding how it will be collected and used. Local and national governments must address the fact that companies or organisations with access to big data and machine learning will have a great deal more power than those who do not, such as regular citizens or smaller organisations (White, Burger, & Yearworth, 2016). A recent cover story of 'The Economist' magazine claiming that data is to this century what oil was to the last one is a testament to the economic power of data as a current driver of economic growth ("Data is giving rise to a new economy," 2017).

One way that cities can address this asymmetric balance of power created by access to data and data-analytics is by creating 'living labs', which are spaces where citizens, organisations and companies can interact with different types of technology and experience how their data is generated, how it can be accessed by various actors, and how it can be used for different initiatives (ibid). These spaces also empower citizens to engage in policy discussions about data. Further work into such data visualisation platforms where citizens can take ownership of how their data is used can also ensure that ICT solutions actually address their needs and are scalable in the medium- to long-term.

The knowledge and creative economy: A third important element that smart city business models will have to take into account is the growing importance of the knowledge, high-tech and 'creative' economy as a motor of urban growth (Caragliu et al., 2011; Tranos & Gertner, 2012; Hollands, 2015). This requires cities to invest in human capital. Research shows that developing an educated labour force will tend to build on itself, attracting more skilled labour in the future (Caragliu et al., 2011). In one study, Berry and Glaeser found a 52 percent correlation between the initial share of adults with college degrees in 1990 and the growth in the share of adults with college

degrees between 1990 and 2000 across several cities (Berry & Glaeser, 2005), which shows that cities with an educated and highly skilled labour force tend to grow more rapidly and develop more competitive, innovative local economies (Glaeser & Berry, 2006). In practical terms this means that city governments must aim at attracting and retaining such creative, high-skilled workers. Of course, as Caragliu et al. (2011) argue, the presence of a creative class will not guarantee economic success, but it will certainly play a significant factor in the following years and decades. This is an important resource to consider in the development of smart city business models.

Underlying the emphasis on the knowledge and creative economy is an assumption, often made in the smart city literature, that the smart urban development will be primarily driven by businesses (Söderström, Paasche, & Klauser, 2014). Certainly, businesses have so far played a leading role in smart service innovation and will continue to be key partners in their production and deployment. Nonetheless, from the perspective of the smart city, it is important to ensure that the pursuit of economic growth be completely aligned with the goals of social inclusion and environmental sustainability. For this, the engagement of public organisations and citizens is central. Moreover, social and environmental considerations can be equally important to attracting and retaining the human capital that is at the heart of the smart city. In fact, as this report will often point out, the main challenge of the transition to a smart city is to balance its economic viability with social inclusion and environmental sustainability.

User co-creation: The fourth trend to take account of in the business models of smart cities is the changing role of the city resident in the creation and delivery of services (Walravens, 2015). In line with the service system view of the city, city residents and service users are increasingly seen as important co-creators and co-producers of public services who should be actively engaged in various stages of the service production process, from designing to delivering services (Vargo & Lusch, 2004). As the ultimate beneficiaries, their experience and needs are an important resource for improving services, and ultimately, for fostering innovation (Hemment & Townsend, 2013). In the public sector, this marks a departure from a service delivery framework in which residents were seen as passive end-users or just consumers of services.

The concept of co-creation is not only important for the public sector but also for private firms (Voorberg, Bekkers, & Tummers, 2015). As corporations face challenges to increase their efficiency and productivity, their customers' experiences with products and services are increasingly seen as an important source of value, cost reduction, and

innovation (Vargo & Lusch, 2004; Grissemann & Stokburger-Sauer, 2012). As a result, firms can actually increase their competitiveness in the market. The paradigm of co-creation as an integral component of service production and delivery can be a driver of economic growth as well as social acceptability.

There is much enthusiasm in the smart city literature about how the widespread use of ICTs in the city can provide increased opportunities for citizen co-creation. In some cases, ICTs have enabled citizens to provide feedback directly to their government and local administration about the quality of the services they receive and about their expectations on various issue (Shepard & Simeti, 2013). One prominent example of this is the British application 'Fix My Street', which enabled citizens to report problems or maintenance issues in the urban infrastructure directly to the responsible authorities (King & Brown, 2007). ICT has also allowed local government to provide the space and infrastructure for citizens, not only firms, to propose innovative smart services in activities such as 'hackathons' or Living Lab experiments in which citizens can test out their ideas in the city (Schuurman et al., 2012). Such ideas can be integrated into smart city business models. However, it would be a mistake to assume that ICTs are always enablers of co-creation because they can also become barriers for people or communities who are excluded from the decision making process about when and how to use ICTs in the creation and delivery of services. It is important that City Councils first engage with citizens and their communities to identify their problems, and as a second step, consider whether and how ICTs offer valuable solutions to address their needs. City business models can be useful for articulating and communicating that logic.

3.3. The triple bottom line: economy, environment and society

The discussion on the trends that are currently shaping urban economies and societies throughout the globe also points to three overarching objectives that smart cities hope to reach: economic viability, environmental sustainability and social inclusion.

While the need to develop new business models for smart cities most obviously addresses the economic challenges of urban development, the transition to smart cities must also be socially and environmentally sustainable to succeed in the long term. As this report will argue, the main governance challenge to make smart cities sustainable is to develop business models that balance these three values: economic viability, social inclusion, and environmental sustainability.

Economic viability: As already mentioned, economic viability is often the main focus of efforts to develop new business models. From the point of view of the city, it is important to promote actions that will eventually be able to finance themselves, even if in the beginning they require state funding or other type of financial support. Traditional sources of revenue for the city include taxation (e.g. property taxes), the collection of user fees for services (such as from public transport, business rates and intergovernmental transfers (although these are usually earmarked for particular programmes). New sources of revenue will continue to emerge as new Smart City models are developed. The sharing economy, for example, is currently a challenge for many cities but also represents a source of new revenue, either through the creation of new economic activities, new taxable income or through the creation of non-economic assets, such as data that could be shared, possibly in return for a fee payment for corporations (Cannon & Summers, 2014; Schor, 2016). There are several issues related to economic viability that cities will face. Among these, cities will have to decide on a mix of public spending and private investment in energy, transport and ICT measures. Public spending will be especially relevant where the goal is to incentivize citizens to change a particular behaviour (e.g. switch from private to public transport) or to adopt particular technologies or programs (e.g. retrofit their homes). To do this, governments can resort to financial incentives, such as a tax credit to homeowners who are willing to retrofit their homes, or a free use of toll highways to people who are willing to buy an electric or hybrid vehicle instead of traditional gasoline ones.

Where public investment is insufficient, however, private actor will be key partners in the transition to a smart economy. This is especially likely to be the case in large-scale infrastructure projects, such as installing a district-heating system and developing the city's wireless connectivity infrastructure. By some estimates, the global market for smart city technologies is already worth more than USD 400 billion globally (Smedley, 2013). This clearly offers a vast range of opportunities for existing and new companies to develop smart services over the next few years and spur new economic activity in cities.

It is worth noting here that in this report, funding from the Horizon2020 project is an important resource to set in motion the smart city initiatives that will be tested in the Lighthouse cities. One of the challenges that smart city business models will help address is how to scale the smart city strategy beyond such funding schemes.

Environmental sustainability: Of the three 'pillars' of the smart city strategy, environmental sustainability is in some ways the most clearly defined one. Many of the projects and policies being pursued by smart cities, including the Lighthouse cities that are the focus of this report, are either directly aimed at reducing the environmental

impact of the urban environment or they have an indirect positive effect on it. This is true for most of the interventions occurring in the domain of energy efficiency and renewable energy integration, and in the transport sector. Clear examples of interventions whose primary aim is environmental in these sectors include: the development and integration of building retrofitting solutions to improve the energy efficiency of buildings by reducing heat and cooling loss, the development of district heating systems, the setup of demand-side platforms to improve the efficiency of energy use and distributions, the integration of electric vehicle fleets into the public and private sector, and improvements to the public transport system, such as expanding the reach of public transport and introducing ways to integrate different modes of public transport through ICT platforms.

Social sustainability: The third sustainability pillar of the smart city business model is social inclusion. This entails ensuring that all groups of society have access to the benefits of the 'smart city' and that the introduction of smart services is carried out in a way that engages diverse stakeholders to ensure that the needs of citizens are understood well and that the proposed solutions address those needs adequately. The consequence of not doing so can be that some stakeholder groups can become excluded from services because these services do not solve their problems, or because their local governments have not worked with them to develop the skills necessary to keep pace with technological changes affecting economic growth.

This concern is especially relevant as it relates to the ubiquity of ICT in smart cities. On the one hand, the 'democratization' of ICT has opened up vast opportunities to exchange information and knowledge between citizens and between citizens and governments. Nonetheless, a blind reliance on ICTs can exacerbate the challenges of the 'digital divide'. This term refers to the differences in access to ICTs between different social groups, where some people may be in danger of being 'left behind' as more and more services and economic activities rely on ICT use (Nam & Pardo, 2011; Cocchia, 2014). Again, this can happen when governments introduce smart services unilaterally without engaging diverse communities to identify their needs, develop appropriate solutions and help them develop the necessary skills to take advantage of current technology when it offers good solutions. For cities, this means that despite the enormous potential of ICTs to improve services and communications, they must be mindful of increasing the gap between information-rich and information-poor segments of society (Norris, 2001). This also means acknowledging that the city's problems will not always be best addressed through ICTs, despite the strong focus placed on them in the smart city discourse.

Having explained the 'triple bottom line' logic of the Smart City Business Model, the following section describes four key trends that any smart city business model must take into account to ensure a successful transition to a smart economy.

4. Methodology for defining a city's business model

Although the literature does not offer a definition of ´business model' that has been widely accepted, we understand it here as the way an organisation, typically a firm, creates, delivers and captures value. For firms, this usually translates into how it will make and sustain a profit over the long term (Stewart & Zhao, 2000). For the city, as already discussed, the 'business' model has to show how the city will create and sustain value for its citizens. Value in this context, encompasses social welfare and environmental sustainability as well as economic prosperity.

While there are several existing tools for understanding the business models of private firms, the literature does not offer similar tools for analysing a smart city's business models. Addressing this need, we propose a framework for identifying the key elements of how a city creates and delivers value through smart services. This tool, which we call the City Model Canvas, or CMC, can be used by city municipalities to assess their business models in a governance context.

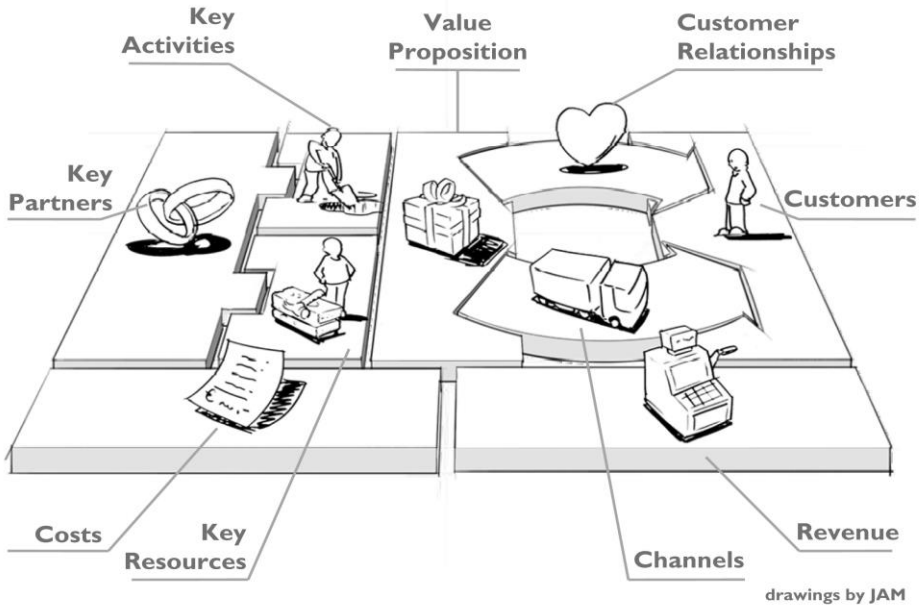

Figure 1: Original BMC by Osterwalder and Pigneur (2010)

The City Model Canvas is an adaptation of the Business Model Canvas (BMC), a tool originally developed by Alexander Osterwalder and Yves Pigneur (2010) for visually representing a businesses' logic and its way of organising its operations for creating and delivering value. The BMC consists of a template composed of nine building blocks, each of which addresses a specific aspect of the business model (see figure 1). This structure also allows firms to develop innovative business models by reorganising or reimagining the contents of any one of its nine blocks to unveil a new market and business opportunity.

The City Model Canvas also borrows from the BMC for mission-driven organisations and from the 'triple layered' BMC. The first of these is an adaptation of the traditional BMC that is more suitable for organisations whose primary aim is not to maximise profit, but to achieve a particular mission (Osterwalder & Pigneur, 2010; Blank, 2016). This Business Model Canvas for Mission-driven Organisations re-labels some of the key elements in such a way that its logic reflects that of a mission-driven organisation (such as a government or non-profit organisation) (see Appendix 1).

The second adaptation of the BMC, the triple-layered business model canvas (Joyce & Paquin, 2016), is a three-layered canvas according to which a firm articulates not only how it creates economic value, but also how it creates environmental and social value. The CMC integrates this concept and refers to it as the 'triple bottom line'.

The City Model Canvas for smart cities is an adaptation of these three templates but re-arranged to represent the role and the goals of a city municipality. Whereas the original and the mission driven BMCs consist of nine elements, the CMC, is made up of fourteen building blocks. The 'additional' four elements represent the aforementioned triple bottom line. The CMC is shown in figure 2.

Figure 2: The Smart City Model Canvas

1. Mission achievement: What is the ultimate goal that the city seeks to achieve?

<table>
<tr><td rowspan="2">6. Key partnerships
Who can help the city deliver the proposed value to the beneficiaries? Who can access key resources that the city council does not have?</td><td>7. Key activities
What must the city council do to create and deliver the proposed value?</td><td rowspan="2">2. Value proposition
What specific problems does the proposed service solve or alleviate?</td><td>4. Buy-in & support
Whose buy-in is needed in order to deploy the service (legal, policy, procurement, etc.)?</td><td rowspan="2">3. Beneficiaries
Who will directly benefit from the proposed services?</td></tr>
<tr><td>8. Key infrastructure & key resources
What key resources does the city council have to create and deliver the value?</td><td>5. Deployment
How will the city solve the problems of the Value proposition specifically?</td></tr>
<tr><td colspan="3">9. Budget costs
What costs will the creation and delivery of the proposed services entail?</td><td colspan="2">10. Revenue streams
What sources of revenue for the city do the proposed services provide? What other sources of revenue does the city have?</td></tr>
<tr><td colspan="3">11. Environmental cost
What negative environmental impacts can the proposed services cause?</td><td colspan="2">12. Environmental benefits
What environmental benefits will the proposed services deliver?</td></tr>
<tr><td colspan="3">13. Social costs
What are some of the potential social risks that the proposed service entails? Who is most vulnerable as a result?</td><td colspan="2">14. Social benefits
What social benefits will the proposed services bring about? For whom will these benefits materialise?</td></tr>
</table>

4.1. The city business model as a rehearsing strategy

As mentioned in the introduction, the city business model and the proposed canvas to analyse should be considered as an element of the city's wider strategy to become a smart and sustainable city.

According to O'Brien and Dyson, strategies can have two 'feedback loops': an enacting strategy and a rehearsing strategy (2007). These two feedback loops are shown in figure 1. In enacting strategy processes, proposed initiatives are directly implemented and

corrections are made incrementally as problems arise or as performance measures indicate that improvements are necessary. In contrast, a rehearsing strategy consists of testing and validating different strategic options before implementing them. These can be tested through models or robustness tests whose results can be evaluated to assess how initiatives can be improved before these are enacted. This type of strategy process allows organisations to collect feedback about the possible outcomes of a decision process and, when these outcomes are suboptimal, either change some elements of the proposed initiative or prepare for those outcomes (Kunc & Bhandari, 2011).

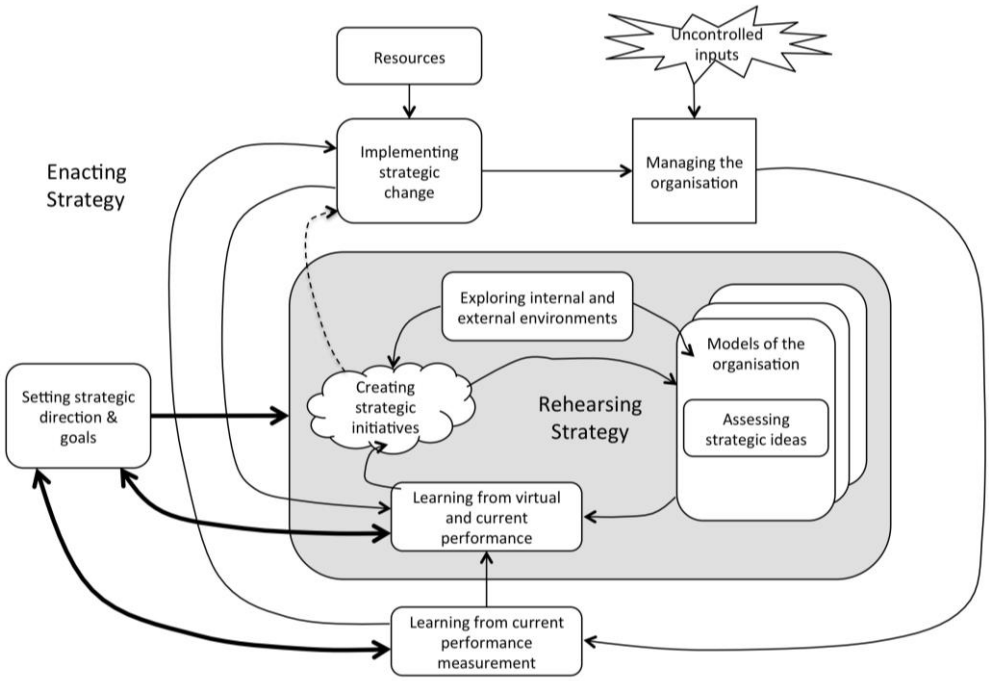

Figure 3: Model for strategy development by O'Brien and Dyson (2007).

The Smart City Business Model that will be introduced in this report can be understood as a tool in the rehearsing strategy feedback loop. It is meant to be useful for city council managers to articulate the logic of how they can create and deliver value in a way that meets the objectives of their smart city strategy, and to assess the possible economic, environmental and social impact of these actions. As city managers use the CMC to rehearse different choices and assess their impacts, they will also be able to identify trade-offs between the elements of the triple bottom line and make adjustments before 'enacting' their initiatives.

4.2. Elements of the City Model Canvas

In this section, we introduce the City Model Canvas (CMC) as a framework for analysing the business models of Smart Cities.

To begin with, business models usually have four parts. The first and central part is the value proposition: what exactly is the value that the organisation is offering? In the case of cities, the overall value proposition encompasses improved quality of life in an urban environment that is economically prosperous, environmentally responsible and socially inclusive. The second part of the business model includes the elements that are associated with delivering the value to the public. This includes a definition of who are the direct beneficiaries of smart services, where are the potential barriers to delivering that service, and in what form will the services be delivered. The third part of the model includes all elements that are associated with producing that value: these are the resources, activities and partners that will enable the organisation to create a product or service, or in this case, a 'smart service'. The fourth element of the business model relates to 'the bottom line, or the net benefits of the model. For firms, this net profit consists of the 'revenue streams' minus the 'cost structure' of the model. In the Smart City Business Model, this element was expanded and labelled as 'the triple bottom line' because it consists of the economic, environmental, and social costs and benefits that the smart city model will bring for the city.

Together, this structure translates into fourteen individual elements that describe a city's business model. Additionally, each canvas should start out with a concrete mission that can be written at the top of the template. This articulates exactly what the ultimate goal of the business model is. The fourteen elements of the CMC are summarized below. The elements that have been added or changed from the original BMC are marked with an asterisk (*).

Part 1 of the Smart City Model Canvas: The value proposition

1. Mission statement

The mission statement is a short declaration of the overall aim that the city wants to reach through its City Business Model. While this is a general statement, it should be concrete enough for the City Council to be able to assess whether its business model has helped it achieve the mission or not. Example of mission statements include 'reducing the city's greenhouse gas emissions' or to 'improve the city's wireless connectivity'.

2. Value proposition

The value proposition is the central element of the City Model Canvas as it is of the BMC. It states what benefits are created by the organisation. In the case of the CMC for smart cities, the value proposition states the benefits that are expected from smart services. The value proposition should address specific identified needs or 'pain points' felt in the population and provide a clear picture of how those needs will be addressed by the CMC model. Typically, there should be at least one value proposition for each type of beneficiary identified.

A clear value proposition in the CMC will guide cities in the organisation of the smart service model by focusing all key activities, key partners and key resources on the delivery of that value. This is important to ensure that smart services actually serve to alleviate a particular need of the population and are not just being implemented to follow a trend or satisfy corporate interests.

Part 2 of the Smart City Model Canvas: Delivering value

3. The direct beneficiaries (*)

This element is taken from the Business Model Canvas for mission-driven organisations, which is an adaptation of the original BMC. In the original BMC, this element appears as 'customer segments' and is defined as the firm's target population. The adapted BMC for mission-driven organisations, recognizes that in such organisations, the idea of a 'customer' is not always appropriate, and that there are more complex relations between the organisation and its stakeholders. In the example of a prison, for example, the direct user is the inmate, but they can hardly be considered a 'customer' in the traditional sense. In the CMC, this element asks the city to identify exactly who is positioned to benefit directly from the value proposition.

Direct beneficiaries in the CMC include those audiences for which the city strategy or specific project proposes to solve specific needs or problems ('pain points'). Of course, smart services can also have *indirect* beneficiaries. An example of an indirect beneficiary of electric vehicle is a person who will not directly use one but will still benefit from cleaner air in the city. For this section of the canvas, however, only direct beneficiaries are included in order to keep the analysis framework specific and concrete. Indirect beneficiaries can be considered in the 'social costs-social benefits' element, which is broader and is meant to capture societal welfare effects.

Clearly identifying direct beneficiaries is important because it will guide decisions about *how* smart services will be produced and delivered. Will some beneficiaries also be engaged as key partners in the co-creation and co-production of services? An example could be a particular citizen association or a particular start-up company that is somehow selected to become actively engaged. Moreover, who is being excluded from the beneficiaries segment and what must the city do to avoid unintended consequence for those segments? This is a particularly important question to ensure that communities are engaged from the outset and to foster trust and a sense of ownership in the project's aims, which will impact the social inclusion bottom line of the smart city business model. Other important questions include whether beneficiaries will be asked to pay for certain services? If so, how and how much can they be expected to pay? The answer to these questions will reveal where there may be contested outcomes to the smart city strategy that must be negotiated with communities. This analysis will thus frame decisions about the economic and social sustainability of the smart city model.

4. Buy-in & support (*)

This element refers to the individuals, groups or entities (such as firms, NGOs or other governmental organisations) whose acceptance of the proposed project is necessary for its successful implementation. One way to address this element is through a stakeholder analysis that classifies stakeholders according to whether they have high or low power/influence on the project and whether they have high or low their interest in the project's outcomes (Varvasovszky & Brugha, 2000). Individuals, groups or entities with high influence and high interest are usually those whose buy-in is vital to the project's success because they can block the project's implementation and success if they are not properly considered in the model and managed accordingly. Unlike key partners, who will be described below and who are important but not indispensable, the stakeholders in this box can block the project's realization if they do not support it. Understanding this element will help the city mitigate the risks of major decisions or projects within the model.

5. Deployment & delivery (*)

This block corresponds to the element 'Channel' of the original BMC. It states how the value proposition will be delivered to the customer or beneficiary segment. In the case of the CMC, the element of deployment and delivery are examined through the different concrete measures that will be developed. For example, if the value

proposition of a model is to reduce the economic and environmental cost of heating, the deployment of this value can be achieved through a building retrofitting scheme accompanied by tax incentives. The important point here is that the smart city services provide options for delivering the ultimate value, rather than being the end value in and of themselves.

Here it is also important to ask how the city will define successful deployment of the strategy. For example, will successful deployment be defined in terms of users reached, time spent or money saved? For this it is important to use objective indicators that address the model's value proposition.

Part 3 of the Smart City Model Canvas: Producing value

6. Key partner(ship)s

This block refers to the partners that will enable the city to produce the value. Key partnerships can range from loose relationships between organisations to exclusive contracts for a particular purpose. However, not all of the possible partnerships are *key* partnerships. Key partnerships are those that offer the best opportunities to access more resources to develop the smart city projects. Together with the beneficiaries and the segments whose buy-in are essential, the key partnerships complete the model's stakeholder analysis.

Some key beneficiaries will often become key partners in the service production and delivery system. To distinguish these to some extent, we argue that direct beneficiaries can include, for example, a broad market segment of start-up firms or energy service companies (ESCOs), but only specific ones that have been selected to be actively engaged are included as key partners. Similarly with co-creation activities, a wide segment of the population would be included as a direct beneficiary but only a certain selection would probably become involved as key partners.

7. Key activities

These are the activities that need to be undertaken for the business model to be effective. Just as firms will focus on business activities, the key activities of Smart Cities must include the governance of the smart city strategy and a primary activity will be a thorough stakeholder management. This includes, for example, persuasion and negotiation with the stakeholder identified in the 'buy-in & support' and in the 'Key partner(ship)s' building blocks of the CMC.

8. Key resources and key infrastructure (*)

For a company, its key resources are the main assets that it needs to create the value proposition and deliver a product or service to its targeted customers. Depending on the company's goal, its most important resource can be human capital, money, patents, brands, or machinery. In the case of the city, the key resources are not only the financial and physical assets it can use, but also political and strategic resources that it can deploy in favour of certain policies. Political resources include the authority to levy taxes or offer grants or credits and the right to issue permits or restrictions that reward particular behaviours, and strategic resources include aspects such as geography or a particular 'city brand' or reputation that attracts capital and people.

Key resources in the context of the city also include infrastructural elements that can either help or handicap certain smart city interventions. Infrastructural elements include physical assets such as the public transport fleet and system, the energy grid and the wireless network (e.g. a 5G network). Equally important are the intangible infrastructural elements, such as the legal and regulatory frameworks that must be taken into account. Other intangible resources relate to the economic ecosystem of the city: is it dominated by a few large firms? Are there many start-ups? These can all represent important resources that the city can leverage in the transition to a smart economy.

Despite the vast variety of resources mentioned here, it is important to focus on those that are essential (*key*) to the success of the business model and those that can distinguish this city from others.

Part 4 of the Smart City Model Canvas: The triple bottom line

9. Economic costs

The economic cost structure refers to the costs the city will incur when implementing smart city services. In the original BMC, this element is referred to as the 'cost structure' of the business. In the CMC we specify that this element refers to the *economic* costs to differentiate from two other types of costs that will be considered: social and environmental ones. These costs will range from the initial investment of infrastructure projects, such as in the installation of an ICT network and the construction of district heating plants, to 'soft' incentives that will be offered to users, such as tax credits for the use of electric vehicles.

Two elements that are closely linked to the cost structure at the city level are all key activities and all resources and infrastructure that are needed to implement and replicate smart services. Every one of these is likely to add to the cost structure making it important for cities to analyse whether the activities and resources are fundamental to delivering the value proposition or not.

In the deployment of certain smart services, cost reductions can be achieved with economies of scale. When economies of scale are achieved, higher volumes of a particular unit bought or sold can lead to a lower average cost per unit. For instance, in the case of purchasing electric charging stations for e-vehicles, the city might be able to save when placing larger orders from the manufacturer by gaining a stronger negotiating position and by allowing the manufacturer to reach economies of scale. The same applies to the purchase and installation of smart lighting posts (i.e. the 'humble light post'), which most Lighthouse cities foresee installing and of which many units would be required. Collaboration between the cities or between districts within cities to purchase large quantities of such items could provide opportunities for economies of scale.

10. Revenue/income streams

Equal in importance to the cost structure is the revenue stream element of the BMC. This refers to all sources of income that the municipality will have from smart services and will include any revenue generated from user fees or other types of levies that will be required in exchange for smart services. Cities have a range of revenue streams to evaluate, including taxation, user fees for smart services, and external grants. Alternative revenue streams might come from creating entirely new economic segments in these three sectors. City councils can also choose to include here the savings they will capture from the initiatives, such as from retrofitting or smart lighting. While these savings are not actual income streams, and cities should watch for double-accounting of income, they are important economic benefits that will help them analyse how to finance different interventions.

Analysed with the cost structure, this element will show whether the chosen business model is economically viable, or whether other sources of financing will have to be considered.

11. Environmental costs (*)

The second 'bottom line' of the smart city business model is the environmental balance of the planned interventions. As Joyce and Paquin (2016), the creators of the 'triple layered business model canvas' explain, the main objective of this line is to compare how the strategy planned in one sector generates more environmental benefits than negative impacts. While it is clear that the smart city strategy aims at producing an environmental *benefit*, it is important to consider what its negative environmental impacts might be. These include land use impact, water and fuel needs, greenhouse gas emissions along the production chain, etc. Environmental costs can be tracked through indicators when data is available.

12. Environmental benefits (*)

This element 'seeks to extend the concept of value creation beyond purely financial value' (Joyce & Paquin, 2016, p. 1479). The environmental benefits of the overall city strategy in each of the sectors can also be tracked with indicators where there is available data. Where there are none, this can be a useful exercise to determine existing data needs and information gaps. The exercise of weighing environmental impacts and benefits of its smart city strategy in each sector will help the city obtain a clearer picture of where it should focus its attention and resources.

13. Social impacts(*)

The third bottom line of the smart city business model canvas focuses on social sustainability. The social impacts element refers to negative costs that the smart city strategy can have on a city's residents and communities. The challenge here for the city is to define what social impacts to consider and how these should be measured. Examples of current social welfare effects that can be measured with indicators include fuel poverty, access to public transport, digital literacy and diversity of housing within the city's neighbourhood. As mentioned earlier, issues like the 'digital divide' among the population due to differing levels of comfort with ICTs can lead to the unintended consequence of further excluding certain groups from digitally-operated services.

14. Social benefits(*)

The social benefits element focuses on the positive social value creating aspects of the Smart city strategy. These should be those elements that specifically derive from the smart city interventions but can include indirect benefits (Joyce & Paquin, 2016).

A bike sharing programme, for example, directly reduces carbon emissions, but it also indirectly improves health outcomes by reducing the amount of air pollution that residents are exposed to. As with the social impacts, social benefits must be measured with selected indicators that will enable the city to evaluate over time whether its smart city interventions are having a positive or negative impact on its society's social wellbeing.

4.3. Applying the CMC to the Lighthouse Cities

The description of the CMCs key elements is meant to help City Councils use this template as a tool in 'rehearsing' initiatives conceived under their broader smart city strategy. They can then assess the outcomes of this the actions by analysing the balance of the triple bottom line: what economic goals were achieved? Do the environmental benefits meet proposed targets? Are there more social benefits than costs? This analysis will show whether there are trade-offs in these choices and whether there may be contested outcomes, where some social groups benefit from an initiative while others are disadvantaged.

By identifying the key elements that enable a city to achieve a particular mission through the creation and delivery of smart services, the CMC can also be used as a tool for replication. Different cities using this template can compare each other's strategies and assess how they vary. For example, follower cities can compare the results of their own CMC to those of Lighthouse cities to assess what elements (e.g. specific resources or partnerships)they still need to foster and which they can already leverage. It would be beneficial for the replication element of the project for each city to collect qualitative data and quantitative data (especially to assess the balance of the triple bottom line) to complete its own CMCs and make the results public.

The next section applies this framework to the three Lighthouse cities as a demonstrative exercise of how the CMC can be used as a tool in a city's rehearsing strategy. While only the Lighthouse cites are in a unique position to define their own CMC, this exercise is helpful for analysing what specific models are being applied in the context of the REPLICATE project. As the Lighthouse cities continue to develop their smart services, their CMCs can be revised as needed and updated with quantitative and qualitative data for the triple bottom line.

To achieve greater analytical specificity, we apply the CMC here at the level of each sector: energy efficiency, mobility, and ICT. It is possible for each city to use it a lower

level of analysis for a more specific value proposition, but an overall perspective should be maintained to capture as much of the city's context as possible. It should also be noted that at this level of analysis, the most variance between the cities can be observed in the key partners, key resources, and key beneficiaries. The other elements, at least in this exercise are relatively similar due to the low level of specificity and the lack of precise data for each case. For this same reason, the CMCs do not focus uniquely on the activities developed in the context of the REPLICATE project, but also include some of the cities' broader smart city strategy. This includes existing resources from before REPLICATE that are nonetheless useful and some activities that go beyond the scope of the HORIZON2020 funding, such as continuing to explore financial streams and maintaining political support for the strategy.

As a final note, the CMCs are applied from the perspective of the Lighthouse City Councils. The partners, activities, resources, etc. are therefore written from that perspective, attempting to identify the key elements that would allow a City Council to enact its smart city interventions.

5. The city business models of the Lighthouse Cities

In this section we apply the City Model Canvas to each of the lighthouse cities in an effort to demonstrate how this tool can be used by each city council. Since each Lighthouse city is in the unique position to understand the key elements of their own models, this is should be understood as a preliminary application of the tool whose aims are to 1) show how city council can apply the framework, and 2) discern some initial business models that can be replicated.

The framework should also be used as a dynamic tool. This also means that the following models represent a starting point for smart services and that as they evolve, new partners, activities, resources, etc. can be added. For the same reason, some of the elements of the business models include generic terms, such as 'political groups'; these should be specified by each city in respect to its own context.

5.1. Smart City Business Model: Donostia/San Sebastian

The municipality of Donostia/San Sebastian is the capital of the province of Guipuzcoa in the autonomous community of the Basque Country in northern Spain. It has a population of approximately 186,000 people. Despite being a relatively small city,

Donostia/San Sebastian has gained importance as one of Spain's main tourist destinations due to its coastal scenery and renowned cuisine (it has the second highest number of Michelin-starred restaurants per capita in the world). The city was also designated as the 2016 European Capital of Culture,[1] an EU recognition meant to bring attention to the cultural richness of European cities. Other services, especially in commerce and transport, are also important drivers of the city's economy.

Donostia/San Sebastian has a trajectory of several years in developing a wide range of 'smart city' interventions. The city has been identified in the top five Spanish smart cities in a 'smart city index' launched by the International Data Corporation (IDC), an American analysis and advisory firm that specializes in information technology. It has also been promoted for its initiatives in smart city innovation at the national and EU level. In 2012, Donostia/San Sebastian was given the CIVITAS award, an EU co-financed initiative that awards successful efforts in the field of sustainable urban mobility across Europe, and in 2010 it was recognized as a City of Science and Innovation by the Spanish Ministry of Science and Innovation (Micinn). Donostia/San Sebastian also led a previous EU financed, FP7 [2] project—STEEP-- through Fomento San Sebastian. In this project, all three Lighthouse cities of REPLICATE developed their smart city plans using a common methodology based on systems thinking and an action plan for the interventions in the Urumea district. This experience is a valuable resource for this city.

Within the context of the REPLICATE project, several pilot projects are planned in the area of the Urumea river district. The district has the city's largest green park, the Ametzagaina Park, and a large industrial park called the *Poligono 27*, which houses over 300 companies that employ almost 4.500 people.

[1] https://ec.europa.eu/programmes/creative-europe/actions/capitals-culture_en

[2] Seventh Framework Programme

Figure 4: Location of Donostia/San Sebastian in Spain.

Source of figure: www.google.es/maps/

It has also been vulnerable to flooding from the river, which is a problem that has gradually been addressed. One of the challenges REPLICATE will tackle in this area is improving the district's connectivity to the rest of the city through public transport, improving the internet connectivity through a high speed connectivity network, and improving the energy efficiency of its buildings. This district is the target of many measures to improve quality of life, including the construction of approximately 1,500 new homes that will create a new neighbourhood, building a district heating plant and installing a smart lighting system.

To understand the main elements of Donostia/San Sebastian's smart city business model, the City Model Canvas methodology was applied to the energy efficiency, mobility and ICT sectors using information from literature review, document analysis and interviews conducted with representatives of the municipality.

City Model Canvas 1.1: Energy efficiency in Donostia/San Sebastian

Mission of the business model: To reduce the city's greenhouse gas emissions from energy

<table>
<tr>
<td rowspan="2">Key partnerships
✓ GIROA company
✓ Home owners
✓ Tecnalia
✓ Eurohelp (involved in open data)</td>
<td>Key activities
✓ Oversee deployment of projects
✓ General management of relationships with partners, beneficiaries and others
✓ Citizen awareness campaigns and citizen engagement activities
✓ Regulation activities of market
✓ Maintain political mandate</td>
<td rowspan="2">Value proposition
✓ To improve energy efficiency and reduce energy consumption within the Urumea district.
✓ To offer energy saving solutions to tenants and owners
✓ To create business opportunities in the area of energy efficiency and renewables</td>
<td>Buy-in & support
✓ Residents of the Urumea river involved in building retrofitting
✓ Political buy-in</td>
<td rowspan="2">Beneficiaries
✓ Existing residents (who will benefit from energy savings or see increased access to heating and energy)
✓ New residents who have or bought homes or plan to in Urumea district
✓ Businesses who win construction/retrofitting bid and ESCOs who participate in the market
✓ Start-ups and local businesses selected to get involved in projects</td>
</tr>
<tr>
<td>Key infrastructure & key resources
✓ Fomento San Sebastian (FSS)</td>
<td>Deployment
✓ Building retrofitting
✓ District heating system
✓ Demand side management platform</td>
</tr>
<tr>
<td colspan="3">Budget costs
✓ Upfront costs of building district heating plant (can be outsourced to key partner) and
✓ Cost of retrofitting and ssubsidies for building retrofitting actions
✓ Cost of connecting homes to district heating and equipping homes for its use</td>
<td colspan="2">Revenue/Income streams
✓ Horizon 2020 grants
✓ Taxation
✓ Expected revenue from district heating plant and expected savings from retrofitting</td>
</tr>
<tr>
<td colspan="3">Environmental cost
✓ Depending on source of electricity, increased electrical consumption due to lower price
✓ Environmental impact of new construction</td>
<td colspan="2">Environmental benefits
✓ Reduced energy waste through district heating system and less heat waste from retrofitting
✓ Reduced emissions from better energy production & lower consumption
✓ General energy use awareness from users (from demand-side management)</td>
</tr>
<tr>
<td colspan="3">Social costs
✓ Possible increases to housing price due to retrofitting
✓ Possible gentrification due to more attractive living conditions</td>
<td colspan="2">Social benefits
✓ Improvement in living conditions due to more efficient heating system, improved access to clean energy, and improved attractiveness of district with a sustainability distinction to new economic segments, and improved home prices for current home owners</td>
</tr>
</table>

City Model Canvas 1.2: Sustainable Mobility in Donostia/San Sebastian

Mission: To enable people and goods to move across the city in a way that saves time and reduces greenhouse gas emissions.

<table>
<tr>
<td>Key partnerships
✓ DBUS (municipal company)
✓ Ikusi
✓ Euskatel
✓ Tecnalia (involved in demand side platform)
✓ Eurohelp (involved in open data)</td>
<td>Key activities
✓ Oversee deployment of projects
✓ Manage relationships with beneficiaries, partners, etc.
✓ Negotiate with companies to integrate e-vehicles
✓ Negotiate for charging station infrastructure development
✓ Citizen engagement activities with owners affected from retrofitting
✓ Maintain political mandate
Key infrastructure & key resources
✓ Fomento San Sebastian (FSS)
✓ Award of a green emblem to recognise companies using EVs</td>
<td>Value proposition
✓ To offer low-carbon mobility solutions
✓ To offer expanded public transport options
✓ To increase the efficiency of public transport use
✓ To reduce congestion
✓ To create new business opportunities in the mobility sector</td>
<td>Buy-in & support
✓ Companies and other municipal departments to incorporate e-vehicles
✓ Political buy-in
Deployment
✓ Acquisition of 2 electrical buses for the line 26
✓ Installation of charging stations
✓ Acquisition of electrical vehicles for distribution fleet & municipal fleet, including electric motorcycles.
✓ Transport management system</td>
<td>Beneficiaries
✓ Passengers with improved access to work and home
✓ New residents who have or bought homes or plan to in Urumea district
✓ Electricity providers
✓ EV manufacturers, e.g. IRIZAR
✓ Start-ups and local businesses selected to get involved in projects
✓ Citizens proud of using an electric vehicle (either private car or public bus).</td>
</tr>
<tr>
<td colspan="3">Budget costs
✓ Cost of expanding infrastructure (e.g. for the charging stations)
✓ Cost of purchasing e-vehicles</td>
<td colspan="3">Revenue/Income streams
✓ Horizon 2020 grant (short term). ✓ Taxation; fees; user payments for transport
✓ Potential fuel savings from integration of e-vehicles</td>
</tr>
<tr>
<td colspan="3">Environmental cost
✓ The impact of increased electrical consumption (to varying degrees depending on the source of electrical power)</td>
<td colspan="3">Environmental benefits
✓ Reduction of greenhouse gases from more efficient transport, from use of electric vehicles, and from potential reduction in private vehicle use</td>
</tr>
<tr>
<td colspan="3">Social costs
✓ Possible increases to housing prices and potential of gentrification due to improved accessibility of the Urumea district</td>
<td colspan="3">Social benefits
✓ Improvements to the bus line, such as increased frequency of because of the two new electric buses</td>
</tr>
</table>

City Model Canvas 1.3: ICT sector in Donostia/San Sebastian

Mission: To improve the city's capacity to exploit ICTs

<table>
<tr>
<td rowspan="2">Key partnerships
✓ SISTELEC
✓ Leycolan (company who will install smart lighting)
✓ Eurohelp (involved in open data)</td>
<td>Key activities
✓ Oversee deployment of projects
✓ Manage relationships with beneficiaries, partners, etc.
✓ Regulation of data ownership and data use policy (incl. open data)</td>
<td rowspan="2">Value proposition
✓ To increase connectivity capacity
✓ To offer real time data about the functioning of services, movement and conditions in the city in order to optimize decision-making
✓ To create new public services
✓ Create new business opportunities.</td>
<td>Buy-in & support
✓ Political buy-in
✓ Large technology companies who can dominate market</td>
<td rowspan="2">Beneficiaries
✓ Existing residents who will benefit from improved connectivity
✓ New residents who have or bought homes or plan to in Urumea district
✓ Large companies that will develop infrastructure (e.g. SISTELEC)
✓ Start-ups and local businesses selected to get involved in projects
✓ Data management companies</td>
</tr>
<tr>
<td>Key infrastructure & key resources
✓ Fomento San Sebastian (FSS)</td>
<td>Deployment
✓ Smart city ICT platform
✓ High speed wireless connectivity
✓ Smart lighting system
✓ Mobile communications system in district of Txomin/Urumea to improve connectivity</td>
</tr>
<tr>
<td colspan="3">Budget costs
✓ Costs of purchasing and installing public lighting
✓ Cost of developing new ICT infrastructure
✓ Cost of maintaining and operating new infrastructure</td>
<td colspan="3">Revenue/Income streams
✓ Horizon 2020 grants (short term)
✓ New revenue streams from using data to create new services, taxation; fees; user payments
✓ Savings from smart lighting systems</td>
</tr>
<tr>
<td colspan="3">Environmental cost
✓ Increased energy use from more intensive use of servers</td>
<td colspan="3">Environmental benefits
✓ Use of 'big data' to increase efficiency of service delivery, which can reduce emissions (e.g. by only turning on lights to incoming traffic)
✓ Ability to monitor emissions through improved ICT and to calculate saved emissions</td>
</tr>
<tr>
<td colspan="3">Social costs
✓ Exclusion of social segments with no access to ICT applications of with insufficient literacy to use them
✓ Possible increases to housing prices and potential of gentrification due to improved connectivity of the Urumea district</td>
<td colspan="3">Social benefits
✓ Creation of new business opportunities
✓ Job creation through growth in the business sector (e.g. through start-ups)
✓ Improvement in living conditions due to improved connectivity</td>
</tr>
</table>

Analysis of Donostia/San Sebastian's City Model Canvas

Below is a brief overview of the main elements of Donostia/San Sebastian's CMC as applied to each of the three sectors. As already mentioned, this level of analysis, the most variance between the cities and between the sectors can be observed in the key partners, key resources, and key beneficiaries so only these will be discussed here in greater detail.

Smart City Model for Energy efficiency

The direct beneficiaries of this city model are the current and future residents of the Urumea district, who will benefit from energy savings. Nonetheless it is important to ensure that they do not suffer unintended consequences from rising prices in their district to the improved quality of the residential stock. Other beneficiaries include business, who will benefit from partnering with the pilot projects or from new business opportunities.

To achieve the city's goals in this area, the municipality, through Fomento de San Sebastian, will deploy this strategy in the context of REPLICATE is through building retrofitting, building a district heating plant, and developing a demand side management platform. The key partners for the city include Fomento de San Sebastian and the city council's various departments in charge of these sectors and importantly, GIROA, which is the company that will be involved in building retrofitting. Eurohelp is also an important partner, who will be involved in open data activities. These partners are essential for the success of these projects. Tecnalia will also be a key partner developing the demand-side platform.

In terms of key resources, the city can count of existing experience and current political commitments. The city council of Donostia/San Sebastian has made the commitment to reduce the energy consumption of its own infrastructure by 40% of 1990 levels by the year 2020. These policies are specified in the Covenant of Mayors, which Donostia/San Sebastian has signed, and are in agreement with the National Energy Plan established by the Spanish central government and with the Basque Energy Plan set by the Government of the Basque Country. To achieve this goal, the city council has selected several tools that it would use. These include the establishment of local policy requiring new construction projects to meet several energy efficiency criteria, a tax incentive (i.e. reduction) for people who use energy efficient vehicles or invest in energy efficient appliances at home, and direct subsidies for building retrofitting.

It is interesting here to note the important and interesting role played by Fomento de San Sebastian (FSS), a publicly owned organisation that oversees economic development policy within the municipality. FSS itself, which will own and operate the district heating plant will benefit from any revenue generated from it, which it can then reinvest in other energy efficiency measures. In the model, it is included as a key asset that the city has to enact its smart city strategy in an effective way.

Smart City Model for Mobility

In the area of mobility, Donostia/San Sebastian has planned to introduce two new electrical buses into it bus line 26, which connects the pilot project districts to the city centre. It will also install charging stations for e-vehicles in these districts and simultaneously encourage companies and municipal departments to introduce e-vehicles into their fleet.

The direct beneficiaries of this city model are the current and future residents of the Urumea and Txomin district, who will benefit from improved frequency of transport to the city centre. Other beneficiaries include business, who will benefit from partnering with the pilot projects or from new business opportunities due to improved transport access to the area.

The main key actor for the deployment of this strategy is the City Council and the municipal departments in charge of transport, and DBUS, the bus operator. Fomento San Sebastian will be engaged as a key partner in the deployment of the strategy. Ikusi, Euskaltel, Tecnalia and Eurohelp will also be key partners in the pilot projects in this sector.

In the area of smart mobility, Donostia/San Sebastian has some advantages and resources it can leverage. The city is involved in several other projects whose aim is to improve the sustainability of the city's transport and infrastructure. One such project is the EU-financed European Bus System of the Future 2 (EBSF-2), which aims at improving the efficiency and attractiveness of public bus systems, partly through the design of the actual bus.[3] Another was SmartCEM (Connected Electro Mobility),[4] another EU project that ran from 2012 to 2015 that aimed at analysing how electric and hybrid vehicles

[3] http://www.dbus.eus/es/la-compania/proyectos/

[4] http://cordis.europa.eu/project/rcn/191756_en.html

could be better integrated into the urban infrastructure. One strong advantage in this area is that DBUS, the bus operator, is a publicly owned company, which makes it easier to align its goals with those of the municipality. Likewise, the city counts with the support of IRIZAR, the bus manufacturer.

Smart City Model for ICT

The ICT projects foreseen in the project are the development of a smart city ICT platform, a smart lighting system equipped with sensors, and a high speed connectivity network for the city and the Urumea Riverside to improve their connectivity.

The **direct beneficiaries** of this city model are the current and future residents of the Txomin/Urumea district, who will benefit from improved connectivity. It is important though to ensure that that user segments are not excluded due to an increased digital divide in this area. Other beneficiaries include business, who will benefit from partnering with the pilot projects or from new business opportunities due to improved connectivity in the area. The municipality will also benefit from energy savings generated through the smart lighting system and from the data it will generate. **Key partners** of the municipality include the department in charge of ICT, as well as SISTELEC and Leycolan (a company with expertise in smart lighting), which will be involved in the smart lighting system. Eurohelp will also be a key partner in the open data strategy.

Outside the context of the REPLICATE project, Donostia/San Sebastian has already made some progress on integrating ICTs into the urban environment. One example of an existing project (not included in REPLICATE) is 'Smart Kalea', which is Basque for 'Smart Street'. The SmartKalea project is an initiative led by Fomento San Sebastian to establish a public-private collaboration model that engages citizens, business, local technology companies and municipal departments in the testing, validation and replication of smart applications, such as smart energy meters to help users regulate demand and smart lighting posts that increase or dim the light according to car and pedestrian traffic, and that are also equipped with sensors that provide free *wifi* connection and collect data on activity on the street. Such experiences are a valuable resource that the city can leverage in REPLICATE.

5.2. Smart City Business Model: Florence, Italy

Florence is the capital of the Italian region of Tuscany. With approximately 383,000 inhabitants in the core city and over 1 million in the greater metropolitan area, it is the region's most populous city.

Figure 5: Location of Florence in Italy.

Source of figure: www.google.es/maps/

Due to its historical and cultural heritage, tourism is the city's most important industry but production and commercial activities remain important economic drivers, especially in the greater metropolitan area. The city is often in the top 10 most visited cities in the world with approximately 10 million tourists staying in accommodations in the city and about 2 million more visiting through cruise ship and city day-tours. This high number of visitors presents a significant challenge for the city administration: while it represents the main source of income for the city it is also increasingly seen as a threat to the city services and management and to the quality of life of residents who live in the highly congested central urban zones.

The city is also a signatory to the Covenant of Mayors and has pledged to reduce its CO2 emissions by 20% of 2005 levels by the year 2020 (last year monitoring achieved -35% overcoming the expectations); Florence has also joined the Adapt and the Compact initiatives in line with the COP21 targets subscribed. Within the context of Replicate, the smart city pilot projects will be implemented in the district of Novoli in north-west Florence. Novoli expanded significantly during the 1950s and 1960s, when Florence experienced a construction boom. Today the area has mixed public, commercial and residential buildings, including the Social Science Campus of the University of Florence.

To understand the main elements of Florence's smart city business model, the City Model Canvas methodology was applied to the energy efficiency, mobility and ICT sectors. The rest of this section provides a brief analysis of the elements of Florence's City Business Canvas.

City Model Canvas 2.1: Energy efficiency in Florence

Mission of the business model: To reduce the city's greenhouse gas emissions from energy

<table>
<tr>
<td rowspan="2">Key partnerships
✓ E-distribuzione (electricity distributor and grid manager)
✓ Casa spa (third party managing the social housing)
✓ Silfi (third party managing the smart lighting network)
✓ Neighbourhood associations (tenants, buildings managers…)
✓ university of Florence
✓ SPES consulting
✓ Thales (videosurveillance)
✓ Mathema (app provider for energy users)</td>
<td>Key activities
✓ Manage relationships with beneficiaries, partners, etc.
✓ Maintain political mandate
✓ Negotiation with energy company & other partners
✓ Dissemination plans, citizen engagement activities
✓ Engage owners and tenants affected from retrofitting</td>
<td rowspan="2">Value proposition
✓ To improve energy efficiency and reduce energy consumption within the Novoli district
✓ To offer energy saving solutions to tenants and owners
✓ To create business opportunities in the area of energy efficiency and renewables
✓ To improve city resilience and security</td>
<td>Buy-in & support
✓ Political buy-in
✓ Novolia residents, especially with people affected from retrofitting intervention
✓ Building managers associations (in retrofitting)</td>
<td rowspan="2">Beneficiaries
✓ Existing residents who will benefit from energy savings or see increased access to heating and energy
✓ Businesses who win construction/retrofitting bid
✓ Start-ups and local businesses selected to get involved in project solved in projects</td>
</tr>
<tr>
<td>Key infrastructure & key resources
✓ The municipality's third parties, CASA spa and Silfi
✓ Public lighting network
✓ Smart electricity grid</td>
<td>Deployment
✓ Building retrofitting
✓ District heating system
✓ Smart Grid
✓ Demand side management platform
✓ Smart lighting</td>
</tr>
<tr>
<td colspan="3">Budget costs
✓ Upfront costs of building district heating plant
✓ Tax incentives for building retrofitting actions
✓ Cost of installing smart lighting and demand side management platforms</td>
<td colspan="3">Revenue/income streams
✓ Horizon 2020 grants
✓ Taxation, user fees
✓ Expected revenue from district heating plant and expected savings from smart lighting</td>
</tr>
<tr>
<td colspan="3">Environmental cost
✓ Environmental impact of new construction, such as storage construction</td>
<td colspan="3">Environmental benefits
✓ Reduced energy waste through district heating system/led lights/retrofitted substations, reduced heat waste from retrofitting, reduced emissions from better energy production & lower consumption
✓ General energy use awareness from users (from demand-side management)</td>
</tr>
<tr>
<td colspan="3">Social costs
✓ Possible increases to housing price due to retrofitting
✓ Possible gentrification due to more attractive living conditions</td>
<td colspan="3">Social benefits
✓ Improvement in living conditions due to more efficient heating system
✓ Improved attractiveness of district to new economic segments</td>
</tr>
</table>

City Model Canvas 2.2: Sustainable Mobility in Florence

Mission: To enable people and goods to move across the city in a way that saves time and reduces greenhouse gas emissions.

<table>
<tr>
<td rowspan="2">Key partnerships
✓ E-distribuzione (super-fast recharging provider)
✓ Vehicle providers (Renault)
✓ SPES consulting
✓ Taxi association
✓ SILFI (thirp party of the municipality managing the recharging infrastructure)
✓ Mathema (app provider for e-taxi)</td>
<td>Key activities
✓ Manage relations with beneficiaries, partners, etc.
✓ Negotiate with taxi association to integrate e-vehicles (incentives), negotiate for charging station infrastructure development
✓ Citizen awareness campaigns and citizen engagement activities for public transport and adoption of e-vehicles
✓ Maintain political mandate</td>
<td rowspan="2">Value proposition
✓ To offer low-carbon mobility solutions
✓ To offer expanded public transport options
✓ To increase the efficiency of public transport use
✓ To reduce congestion
✓ To create new business opportunities in the mobility sector</td>
<td>Buy-in & support
✓ Political buy-in
✓ Taxi associations to incorporate e-vehicles
✓ Companies and other municipal utilities to incorporate e-vehicles</td>
<td rowspan="2">Beneficiaries
✓ Electricity providers who benefit from use of recharging station
✓ EV manufacturers (auto companies)
✓ Recharging stations producers
✓ Start-ups and local businesses selected to get involved in projects</td>
</tr>
<tr>
<td>Key infrastructure & key resources
✓ Ability to issue permit to restricted zones to early adopters of e-vehicles
✓ Public recharging network
✓ E-public transport (tramlines, e-car sharing) and Municipal e-fleet</td>
<td>Deployment
✓ Improve recharging infrastructure, including fast charging stations for taxis
✓ Advanced mobility services, such as applications to find closest/best recharging option</td>
</tr>
<tr>
<td colspan="3">Budget costs
✓ Cost of expanding infrastructure (e.g. for the charging stations), electricity costs, Cost of purchasing e-vehicles
✓ Financial incentives for early adopters of e-vehicles</td>
<td colspan="3">Revenue/income streams
✓ Horizon 2020 grant (short term)
✓ Taxation and Fees & user payments for transport
✓ Potential fuel savings from integration of e-vehicles</td>
</tr>
<tr>
<td colspan="3">Environmental cost
✓ The impact of increased electrical consumption (to varying degrees depending on the source of electrical power)</td>
<td colspan="3">Environmental benefits
✓ Reduction of greenhouse gases and local pollutants (and noise) from more efficient transport, from use of electric vehicles, and from potential reduction in private vehicle use</td>
</tr>
<tr>
<td colspan="3">Social costs
✓ Possible increases to tourist flow and potential of gentrification due to improved accessibility of the district</td>
<td colspan="3">Social benefits
✓ Access to transport for previously unreached areas; positive health impact from emissions reduction; some job creation through expansion of transport system and recharging infrastructure</td>
</tr>
</table>

City Model Canvas 2.3: ICT sector in Florence

Mission: To improve the city's capacity to exploit ICTs

<table>
<tr>
<td rowspan="2">Key partnerships
✓ Università Degli Studi di Firenze (UNIFI)
✓ TELECOM Italy (capillary network and IoT provider)
✓ Mathema (app developer)
✓ E-distribuzione (smart electric grid manager)
✓ Thales italia (data security)
✓ Silfi (third party of the municipality, smart city control room manager)
✓ SPES consulting</td>
<td>Key activities
✓ Creation of a city control room to manage the city (traffic, security, services…)
✓ Improvement of open data policy
✓ Social engagement activities to reduce digital divide challenges</td>
<td rowspan="2">Value proposition
✓ To increase connectivity capacity
✓ To offer real time data about the functioning of services, movement and conditions in the city in order to optimize decision-making
✓ To create new services
✓ Create new business opportunities.</td>
<td>Buy-in & support
✓ Political buy-in
✓ Large technology companies who can dominate market</td>
<td rowspan="2">Beneficiaries
✓ Large companies that will develop services (e.g. TELECOM, e-distribuzione)
✓ Start-ups and local businesses selected to get involved and who will be able to use ICT platform for new business opportunities
✓ Public lighting manufacturers
✓ Data management companies</td>
</tr>
<tr>
<td>Key infrastructure & key esources
✓ Silfi (SCC manager)
✓ Traffic supervisor
✓ Laboratory platform at university
✓ Open data municipal portal
✓ Digital manifesto</td>
<td>Deployment
✓ ICT Smart city platform
✓ Smart public lighting system</td>
</tr>
<tr>
<td colspan="3">Budget costs
✓ Costs of purchasing and installing smart city control room (location, equipment, personnel...)
✓ Cost of developing new ICT infrastructure</td>
<td colspan="3">Revenue/income streams
✓ Horizon 2020 grants and ERDF grants
✓ Taxation , fees & user payments</td>
</tr>
<tr>
<td colspan="3">Environmental cost
✓ Electric consumption from smart services</td>
<td colspan="3">Environmental benefits
✓ Use of 'big data' to increase efficiency of service delivery, which can reduce emissions (e.g. by only turning on lights to incoming traffic)
✓ Ability to monitor emissions through improved ICT</td>
</tr>
<tr>
<td colspan="3">Social costs
✓ Exclusion of social segments with no access to ICT applications of with insufficient literacy to use them</td>
<td colspan="3">Social benefits
✓ Creation of new business opportunities
✓ Job creation through growth in the business sector (e.g. through start-ups)
✓ Improvement in living conditions due to improved connectivity</td>
</tr>
</table>

Analysis of Florence's City Model Canvasses

Below is a brief overview of the main elements of Florence's CMC as applied to each of the three sectors. As already mentioned, this level of analysis, the most variance between the cities and between the sectors can be observed in the key partners, key resources, and key beneficiaries so only these will be discussed here in greater detail.

Smart City Model for Energy efficiency

The municipality of Florence will deploy its energy efficiency strategy in the Novoli district through a building retrofitting scheme, a district heating plant, and a smart grid and demand side management platform. The direct beneficiaries of this city model are citizens, especially the residents of the 300 flats of Le Piagge directly involved in the district heating project, who will benefit from energy savings. Nonetheless it is important to ensure that they do not suffer unintended consequences from rising prices in their district to the improved quality of the residential stock. Other beneficiaries include business, who besides being a partner will benefit from partnering with the pilot projects or from new business opportunities in construction and retrofitting. The municipality will also benefit directly from retrofitting social stock and government buildings because the administration will be the one to capture the savings from that investment since it is the owner of the buildings and is making the investment.

One important key partner for the deployment of this strategy is Casa spa (third party managing the social housing) that has been involved in the design of the retrofitting, district heating and storage system and is in contact with all the families of le Piagge. Other key partners include e-distribuzione (electricity distributor and grid manager), Silfi (third party managing the smart lighting network) Neighbourhood associations (which include buildings managers), the University of Florence, Thales (which provides video surveillance services for smart lighting) and Mathema (app provider for energy users). Another key partner is SPES consulting, which supports the city in REPLICATE and has been working together with the Municipality since STEEP project (that leaded to the approval of the smart city plan of the city). The diversity of these stakeholders shows the breadth of the energy efficiency strategy, which increases the likelihood that it will be sustainable in the long term. At the same time, it means a more complex stakeholder governance activities for the municipality.

Regarding key resources and infrastructure, a main challenge for Florence relates to the legal framework, which is often changed in an attempt to keep up with the pace of the

energy efficiently technology, but has the unintended consequence of affecting ongoing projects timing and future investment plans.

Smart City Model for Mobility

In the context of the REPLICATE project, Florence will deploy its mobility strategy through several actions. It will promote the integration of electric vehicles into public transport with special focus on taxi fleets, expand the recharging infrastructure, including fast recharging stations for taxis, and develop an advanced mobility services for users, which include, for example, mobile applications to find the closest recharging point. One important resource that Florence can leverage to incentivize the uptake of e-vehicles is to issue permits for early adopters to enter restricted transit zones. Another is to offer taxi drivers significant discounts on their licenses if they use electric vehicles.

The direct beneficiaries include the electricity providers, who will benefit from increased consumption to the uptake of electrical vehicles, the manufacturers of e-vehicles and recharging stations and some businesses who will be able to get involved in developing new business models in this market (e.g. app developers focused on mobility). Taxis will also benefit, if they are willing to adopt e-vehicles in the first place.

In the context of mobility, Florence's main challenge is to respect the historical heritage of its old town decreasing traffic congestion. Within the city, the old town centre traffic has been heavily restricted with the creation of Limited Transit Zones and pedestrian areas. Only buses, taxis and resident with permits are allowed to drive in LTZ zones. Congestion is further worsened through daily commuters. Being the commercial centre of the metropolitan area, which includes 11 other surrounding municipalities, Florence attracts approximately 160,000 commuters daily. Florence has already undertaken several measures to address its mobility challenges. The city has constructed the first street tramline to connect Florence to the municipality of Scandicci and other two lines are supposed to be finished in March 2018. This is expected to reduce commuter traffic. Together with park and ride facilities and sharing services.

Smart City Model for ICT

Florence's ICT model will be deployed through the development of an ICT platform for the city (Smart City Control room) and the installation of a smart public lighting system, equipped with sensors, and some IoT test technologies (smart waste, smart watering, smart bench). The direct beneficiaries of this model are citizens. Other beneficiaries include business, who will benefit from partnering with the pilot projects or from new business opportunities due to improved services and technologies in the city.

The key partners that will support the municipality in this area are Silfi, Università Degli Studi di Firenze (UNIFI), E-distribuzione, Thales, SPES Consulting, Telecom Italy, Mathema. According to information provided within the context of REPLCIATE, Florence municipality has the advantage of already having good relationships with the private sector and with the citizenship.

For Florence, one of the main challenges identified by the city council is the apparent lack of incentives for private actors to share data with each other and with the city council. This is not only due to regulation that limits what companies can do with their users' data but also to the idea of economic value of this data. A related challenge for the City Council is to develop policy on how they will manage data collected from smart services, such as that collected by smart streetlamps. Remaining challenges in this sector are related to relative unwillingness between businesses and public sector organisations to share data with each other. This is partly due to the lack of legal frameworks to regulate such exchanges.

5.3. Smart City Business Model: Bristol, U.K.

Located in South West England, Bristol is the United Kingdom's eighth most populous city, with a population of 437,500. The greater metropolitan region surrounding Bristol has over one million inhabitants. Bristol is widely considered a very prosperous city. Together with the three other councils that make up the 'Bristol and Bath city region', North Somerset, South Gloucestershire, and Bath and North East Somerset, it has the highest productivity and highest household income of any metropolitan region in England outside of London ('London-upon-Avon,' 2016). The banking and financial sector drives a large section of its economy, which give Bristol one of the highest concentration of finance jobs in England (ibid). The city's economy also relies on the aerospace, defence, media, information technology, and tourism industries. Bristol also has two universities, the University of Bristol and the University of the West of England.

Bristol is one of a few cities in the UK to have a directly elected mayor.[5] The current mayor, Marvin Rees, is the second person to hold this office since it was introduced in 2012 in Bristol as part of a move in the UK to transfer some power over resources from the central government to local governments.

[5] According to the Local Government Act of 2000, council have to be led either by a council leader and cabinet or by a directly elected mayor. Most councils opted for the first option.

Figure 6: Location of Bristol in the UK

Source of figure: google.maps.com

In May 2017 people will vote for a 'combined authority mayor', also referred to as a metro mayor, who will have authority over a larger region. For Bristol this will be the West of England Mayor, who will be responsible for three of the local authorities in the region: Bath & North East Somerset, Bristol and South Gloucestershire. The Metro Mayor will have political authority over spending in the region and over transport, housing, and adult education in skills, all of which have previously been decided and funded by the central government.[6]

Bristol is considered one of the leading smart cities in the UK due to some of its investment and use of ICT and attempts to reduce its greenhouse gas emissions. In 2015 Bristol was also selected as European Green Capital. It has also been recognized as a 'Future City Demonstrator' from which lessons can be drawn by the UK's innovation agency and as a 'Super Connected City', a recognition awarded by the UK government to 10 cities who will share £100 million to install and deliver ultrafast internet to their residents and businesses (Lee, 2012). The rest of this section provides a brief overview

[6] https://www.westofengland-ca.org.uk/about-us-2/

of the progress Bristol has made in each of the three sectors of interest (mobility, energy and ICT) and the challenges it still faces.

In the context of REPLICATE, Bristol will focus its smart city pilot projects in the Ashley, Easton and Lawrence Hill Neighbourhood partnership area. Neighbourhood partnerships are intended to encourage neighbourhoods to work together in a way that gives local residents influence over policy decisions that affect their area. In this particular partnership area, 44 percent of residents are black or minority ethnic citizens in comparison to the city average of 16 percent. The area is experiencing a rapid rise in population with higher than average rates of new households located in this area. Approximately 46 percent of the area's residents have no access to a car, which is the lowest level of car availability in the city. Nonetheless, residents here experience higher than average noise and air pollutions levels. Two of the districts in this area are also in the top 10 percent of households in fuel poverty and almost one-third of areas of the neighbourhood are among the 10 percent most deprived areas in the UK. Despite these challenges, the partnership area is perceived to have a cohesive, active and creative community.

In this section, the City Model Canvas methodology was applied to the energy efficiency, mobility and ICT sectors of Bristol, with specific focus on this city area. The rest of this section provides a brief analysis of the elements of Bristol's City Business Canvas

City Model Canvas 3.1: Energy efficiency in Bristol

Mission of the business model: To reduce the city's greenhouse gas emissions from energy

<table>
<tr>
<td>Key partnerships
✓ Community energy organisations
✓ Energy supply companies(including municipal owned)
✓ University of Bristol and the University of the West of England
✓ Other public services that are large energy prosumers (police, fire and NHS)
✓ National Grid (transmission network)
✓ Western Power Distribution (distribution network)
✓ REPLICATE partner businesses
✓ Pension funds and other investors</td>
<td>Key activities
✓ Manage relationships with partners, beneficiaries, etc.
✓ Negotiate construction, retrofitting and procurement agreements
✓ Citizen engagement activities
✓ Maintain political mandate
✓ Finding ways of integrating renewables
✓ Securing significant investment (public and private)

Key infrastructure & key resources
✓ Lighting infrastructure
✓ Social housing
✓ Climate and energy security framework
✓ European Green Capital Award
✓ District heating networks</td>
<td>Value proposition
✓ To improve energy efficiency and reduce energy consumption
✓ To offer energy saving solutions to tenants and owners
✓ To create business opportunities in the area of energy efficiency and renewables</td>
<td>Buy-in & support
✓ The Bristol mayor's and the metropolitan mayor's political commitment
✓ Neighbourhood associations, especially residents affected by retrofitting
✓ Private companies and local businesses
✓ Local charities and social organisations
✓ National government buy-in

Deployment
✓ Retrofitting buildings
✓ District heating system
✓ Community Solar PV
✓ Smart demand side management</td>
<td>Beneficiaries
✓ Existing residents who will benefit from energy savings or see increased access to heating and energy and new residents who have or bought homes or plan to in the partnership area
✓ Users of community solar PV
✓ Businesses who win construction/retrofitting bid
✓ Start-ups and local businesses involved in project
✓ City Council - meeting objectives and creating sustainable returns on investment
✓ Other public and private organisations that partner on developing interventions</td>
</tr>
<tr>
<td colspan="2">Budget costs
✓ Upfront costs of building district heating plant ✓ Cost of installing smart lighting and demand side management platforms ✓ Tax incentives for building retrofitting actions</td>
<td colspan="3">Revenue/income streams
✓ Horizon 2020 grants ✓ Taxation, fees & user payments ✓ Expected revenue from district heating plant ✓Private and public investment including prudential borrowing</td>
</tr>
<tr>
<td colspan="2">Environmental cost
✓ Depending on source of electricity, increased electrical consumption
✓ Environmental impact of new construction</td>
<td colspan="3">Environmental benefits
✓ Less energy waste through district heating system and less heat waste from retrofitting
✓ Reduced emissions from better energy production & lower consumption, shifting peak demand and enabling better utilisation of renewable energies and general energy use awareness from users (from demand-side management)</td>
</tr>
<tr>
<td colspan="2">Social costs
✓ Possible gentrification and increases to housing price due to retrofitting (if mismanaged so that some communities can no longer afford their rent in the neighbourhood)</td>
<td colspan="3">Social benefits
✓ Improvement in living conditions due to more efficient heating system and Improved attractiveness of district to new economic segments</td>
</tr>
</table>

City Business Model Canvas 3.2: sustainable mobility in Bristol

Mission: To enable people and goods to move across the city in a way that saves time and reduces greenhouse gas emissions.

Key partnerships

- ✓ Private transport providers, such as First Bus
- ✓ Local government in other West of England authorities
- ✓ Government agencies
- ✓ University of West of England and University of Bristol
- ✓ REPLICATE partner businesses
- ✓ Autonomous vehicle R&D partners

Key activities

- ✓ Negotiate with companies to integrate e-vehicles (incentives)
- ✓ Negotiate for charging station infrastructure development
- ✓ Citizen awareness campaigns and citizen engagement activities for public transport and adoption of e-vehicles
- ✓ Maintain political mandate
- ✓ Manage internal council teams in transport
- ✓ Encourage EV uptake

Key Infrastructure & key resources

- ✓ Incoming met mayor to integrate policy
- ✓ Climate and energy security framework
- ✓ European Green Capital Award

Value proposition

- ✓ To offer low-carbon mobility solutions
- ✓ To offer expanded public transport options
- ✓ To increase the efficiency of public transport use
- ✓ To reduce congestion
- ✓ To create new business opportunities in the mobility sector including development of 'mobility-as-a-service'
- ✓ Increase use of shared transport

Buy-in & support

- ✓ The Bristol mayor's and the metropolitan mayor's political commitment
- ✓ Private vehicle drivers
- ✓ Taxi drivers
- ✓ Car clubs
- ✓ Bike hire providers
- ✓ Businesses and other organisations (delivery, fleets etc.)

Deployment

- ✓ E-bikes for corporate use and expanded e-car club
- ✓ EV on-demand bus (buxi)
- ✓ Charging infrastructure
- ✓ Advanced mobility services

Beneficiaries

- ✓ Residents of the area who currently have no access to car
- ✓ Electricity providers who benefit from use of recharging station
- ✓ EV manufacturers (auto companies)
- ✓ Start-ups and local businesses selected to get involved in projects
- ✓ EV manufacturers
- ✓ City Council – meeting city objectives, better run transport network
- ✓ Commuters (less congested roads)
- ✓ Residents / visitors (better air quality)

Budget costs

- ✓ Cost of expanding infrastructure (e.g. for the charging stations), cost of purchasing e-vehicles and financial incentives for early adopters of e-vehicles
- ✓ Loss of income through incentive policies (free parking etc.)

Revenue/income streams

- ✓ Horizon 2020 grant (short term), taxation and fees & user payments for transport
- ✓ Potential fuel savings from integration of e-vehicles
- ✓ Public and private investment

Environmental cost

- ✓ The impact of increased electrical consumption (to varying degrees depending on the source of electrical power)

Environmental benefits

- ✓ Reduction of greenhouse gases from more efficient transport, from use of electric vehicles, and from potential reduction in private vehicle use

Social costs

- ✓ Possible increases to housing prices and potential of gentrification due to improved accessibility of the district (negative if mismanaged and displaces communities)

Social benefits

- ✓ Access to public transport for previously unreached areas
- ✓ Positive health impact from bike sharing use
- ✓ Some job creation through expansion of public transport system

City Business Model Canvas 3.3: ICT sector in Bristol

Mission: To improve the city's capacity to exploit ICTs

<table>
<tr>
<td rowspan="2">Key partnerships
✓ University of Bristol (in particular high performance networks team)Bristol is Open Ltd. and partner businesses
✓ Community and social partners including living labs
✓ Open Data institute
✓ High tech & sme incubators</td>
<td>Key activities
✓ Governance of data ownership and confidentiality
✓ Stakeholder governance
✓ Prioritize spending decisions
✓ Social engagement activities to reduce digital divide challenges
✓ Public procurement of smart lampposts / sensor platforms</td>
<td rowspan="2">Value proposition
✓ To increase connectivity capacity
✓ To offer real time data about the functioning of services, movement and conditions in the city in order to optimize decision-making
✓ To create new public services
✓ Create new business opportunities.</td>
<td>Buy-in & support
✓ The Bristol mayor's and the metropolitan mayor's political commitment
✓ Large technology companies who can dominate market
✓ Citizen buy-in</td>
<td rowspan="2">Beneficiaries
✓ Existing & new residents who will benefit from improved connectivity
✓ Large companies that will collaborate to develop infrastructure
✓ Start-ups and local businesses selected to get involved and who will be able to use ICT platform for new business opportunities
✓ Public lighting & sensor manufacturers
✓ Data management companies
✓ City Council – better management of city including better decision making</td>
</tr>
<tr>
<td>Key infrastructure & key resources
✓ Existence of accelerators/living labs
✓ Bristol is Open
✓ Open data platform/data infrastructure
✓ 3D Data Dome
✓ Strong tech-business ecosystem
✓ Team within the council dedicated to smart city innovation</td>
<td>Deployment
✓ Network operating system
✓ Smart lighting enhancement with sensor platforms
✓ Smart City ICT Platform</td>
</tr>
<tr>
<td colspan="3">Budget costs
✓ Costs of purchasing and installing public lighting, Cost of developing new ICT infrastructure</td>
<td colspan="3">Revenue/income streams
✓ Horizon 2020 grants (short term); new revenue streams from using data to create new services; taxation; fees; user payments</td>
</tr>
<tr>
<td colspan="3">Environmental cost
✓ Increased energy use from more servers</td>
<td colspan="3">Environmental benefits
✓ Use of 'big data' to increase efficiency of service delivery, which can reduce emissions (e.g. by only turning on lights to incoming traffic) and ability to monitor emissions through improved ICT</td>
</tr>
<tr>
<td colspan="3">Social costs
✓ Exclusion of social segments with no access to ICT applications of with insufficient literacy to use them and possible increases to housing prices and potential of gentrification due to improved connectivity of the neighbourhood partnerships area (if mismanaged)</td>
<td colspan="3">Social benefits
✓ Creation of new business opportunities and job creation through growth in the business sector (e.g. through start-ups), and improvement in living conditions and business / employment opportunities due to improved connectivity</td>
</tr>
</table>

Analysis of Bristol's City Business Model Canvasses

The rest of this section provides a brief overview of the main elements of Bristol's CMC as applied to each of the three sectors. As already mentioned, this level of analysis, the most variance between the cities and between the sectors can be observed in the key partners, key resources, and key beneficiaries so only these will be discussed here in greater detail.

Smart City Model for Energy efficiency

Bristol city council will deploy its energy efficiency strategy through a building retrofitting plan, a district heating system, the installation of a community solar power project, and the development of a demand side management platform.

Among the key beneficiaries will be mainly the residents of the Lawrence Hill, Easton and Ashley Neighbourhood partnerships who will benefit from energy savings. Especially in this area, where many people still live in fuel poverty, the city council can achieve significant social benefits through these measures.

In the context of the pilot projects supported by the REPLICATE project, key partners for the Bristol city council are energy suppliers, including a publicly owned energy provider, such as for example, Bristol Energy. Technology companies will also support them in the development of the smart energy demand management platform. Future key partners in in this strategy will be large public sector prosumers like the universities, the National Health Service (NHS) and fire and police services, which are large consumers of electricity and could be interested in collaborating on energy efficiency measures and demand side management that they would eventually benefit from.

In terms of resources and infrastructure in this sector, Bristol's strategy can capitalize on current achievements and political commitments at the national and local level. At the national level, the UK has committed to reducing its carbon emissions by 80% of 1990 levels by the year 2050. In line with this target, the current mayor of Bristol, Marvin Rees, promised during his election campaign to help make Bristol run entirely on renewable energy and become a carbon neutral city by 2050 (Cuff, 2016). This indicates an existing political will to implement projects in the area of energy efficiency, such as district heating systems and building retrofitting schemes. In this area, City Councils have greater ability to influence policy than on other policy areas because they can focus on increasing the energy efficiency of their own buildings and vehicle fleets. Additionally, they can support similar measures in school buildings and social housing. The City

Council has already set a target of 30,000 energy efficient installations in the city and has launched initiatives such as sending letters to homeowners explaining their options to assess their property energy efficiency (Fearn, 2015).

Smart City Model for Mobility

In the context of REPLICATE, Bristol will promote an e-bicycle program, particularly for corporate use, and an expanded use of e-vehicles in car clubs. It will also develop an electric on-demand bus system called Buxi. The city council will expand the charging infrastructure for e-vehicles and will also develop advanced mobility services, such as mobile applications to help users find the closest public transport option, or to call the Buxi.

In the transport sector, Bristol faces some challenges in the transition to smart mobility. Personal car ownership and usage is still the most common mode of transport, which has led Bristol to become one of the most congested cities in Britain, just behind Belfast, Edinburgh and London ('Four wheel fever,' 2014). One obstacle to bicycle and pedestrian mobility is that Bristol is very hilly, which means few people choose these options. Nonetheless, bicycle use has grown by approximately 25 percent since 2003, according to The Economist (ibid). This has not replaced car usage though, with figures for car use remaining stable over the same time.

Bristol is one of the few cities in England to have an elected mayor but the office has little political control over public transport. Power to implement changes is mostly limited to negotiating with the privatized bus operators to extend routes, add to the fleet and cap fares to incentivize bus use. Nonetheless, the area has recently elected a metropolitan mayor who will have more political power to promote changes that include the other authorities of West England. The metropolitan mayor will therefore be an important partner for Bristol city council in this sector. Another key partner is the company Frist Bristol, which operates most buses and routes and which will be central to any attempted change regarding new routes or the adoption of electric buses.

Smart City Model for ICT

Under REPLICATE, Bristol will continue to build a network operating system for the city and will also test the value proposition for investing in an enhanced smart lighting system. Because of their expertise, key partners in this area are the University of Bristol's high performance networks team, the Data Dome, Bristol is Open Ltd., and the Knowle West Media Centre (KWMC), all of which are local actors. Bristol Is Open also has a

number of large corporations it is partnered with who are interested testing interventions in the city.

Policy to promote the ICT sector has advanced rapidly in recent years. In 2015, a joint venture between the Bristol City Council and the University of Bristol launched 'Bristol is Open,' an initiative that aims to install an ICT platform in the city that would be openly programmable for private and public actors who want to test different digital services. New technologies, such as 5G Broadband connectivity, could be tested on this platform. 'Smart' devices, such as lampposts that sense movement and collect data on traffic, will also be connected to the platform to generate data. Bristol is Open also includes partners from the media and technology sector, such as Nokia, NEC and InterDigital. In 2016, Bristol won the Smart City Award category of the World Communication Awards (WCA) organised by Total Telecom and its owner Terrapinn because of this project. Within the project's framework, the City Council has also opened up nearly two hundred datasets including ones on traffic flows and energy use. The idea behind this is that private and public actors can use this 'big data' to develop new services, such as traffic congestion. The main goal, according to media statements made by the City Council is to create a 'programmable city'.

As for the other cities, a main challenge will be to ensure that the development of solutions are co-created and co-produced with citizens. This co-creation can help ensure that the solutions proposed adequately address the needs that citizens and communities have identified themselves. Solutions that are co-created with citizens are also likely to be more inclusive over the long term, and are more likely to be adopted by citizens.

6. Types of business models identified

As discussed in the introduction to this report, the business model at the city level can be understood as a framework for rehearsing the city's strategy for implementing smart services. The framework requires the city council to articulate precisely what is the value proposition it offers through smart services, how it will deliver that value to its residents (e.g. through a series of pilot projects) and what key partnerships, activities and resources it needs in order to deliver it. In this section we analyse whether particular combinations of these elements can be categorised into general 'types' of models for creating and delivering value in the smart city.

Using the proposed framework of the City, we can discuss at least five general business models that the three Lighthouse cities, Donostia/San Sebastian, Florence and Bristol have applied to the delivery of smart services within the context of the REPLICATE project. These four general models are: **direct public provision (DPP), public private partnerships (PPP), public-private-academic partnerships (PPAP), public-private-people partnerships (PPPPs),** and **citizen co-creation (CCC)**.

Although these are the models that were identified at this stage of the REPLICATE project, it certainly does not mean that there are no other models for designing and organising smart services. It is also important to emphasize that these models can co-exist with each other within a single city's urban development strategy. Nevertheless, these models offer a useful categorisation for thinking about how cities can organise the creation and delivery of value depending on its available resources and its stakeholder analysis of key partners and beneficiaries. In this section, we also make some preliminary conclusions about how each of these models fares in terms of the triple bottom line.

6.1. Direct public provision (DPP)

Direct public provision is the most straightforward model for organising services. In the Lighthouse cities, it can be best observed in the case of Donostia/San Sebastian and Florence. For instance, Donostia/San Sebastian's district heating project will be publicly owned and managed by Fomento San Sebastian, the municipality's economic development arm. Similarly in the transport sector, Donostia/San Sebastian has the advantage of working with a publicly owned bus operator, DBUS, to implement some of the mobility projects. In Florence, the municipality has followed a direct public provision model in certain areas, such as retrofitting and district heating.

There are several advantages to direct public provision in terms of the environmental and social bottom lines of the overall smart city model. In terms of the financial bottom line, direct public provision faces some challenges. In the case of public transport, for example, Donostia/San Sebastian's model shows that direct provision through a publicly owned bus operator can facilitate the introduction of new services, such as electrical buses, new bus routes and ICT applications for passengers. In contrast, in the case of Bristol the city must negotiate transport routes with a private bus operator facing a different set of incentives in its own business model.

For citizens, the direct public provision of services can be beneficial in terms of accountability. Under this model, there is a direct link of responsibility between the local

government and administration and their citizens for the design and deployment of the service (Forrer, Kee, Newcomer, & Boyer, 2010). This can help, although not guarantee, that citizens' voice will be taken into account. In terms of the City Model Canvas, this means that direct public provision can help the city balance the social element of the triple bottom line. By establishing its own priorities and working directly with citizens, the municipality can ensure that social interests are not lost to concentrated special economic interests in the transition to a smart city.

The challenges of direct public provision are related to the financial element of the City Model Canvas. Budget restrictions across Europe, but especially in southern countries, have made it more difficult for governments to allocate funds to new smart services (Donald, Glasmeier, Gray, & Lobao, 2014). Involving external actors, from private firms to service users and their communities, in the production of smart services can alleviate some of the financial burden. Service systems with external actors also tend to have greater innovation capacity than system of direct delivery because of the wider range of ideas and experiences they provide (Ysa, Esteve, & Longo, 2013; Voorberg, Tummers, et al., 2015; Brogaard, 2017). This downside of direct public provision must be taken into account in the replication of this model as some cities might have more difficulty financing services directly than others.

6.2. Public-private partnerships (PPP)

Another model of service provision observed in the analysis of the Lighthouse cities is the public-private partnership (PPP) model. We borrow here from Forrer, Key, Newcomer and Boyer to define a PPP as an 'ongoing agreement between government and private sector organisations in which the private organisation participates in the decision-making and production of a public good or service that has traditionally been provided by the public sector and in which the private sector shares the risk of that production' (2010, p. 476). In this report, we limit the definition of the PPP to arrangements with private firms. Later in this section we discuss adaptations of this model that include other types of partners, such as universities and citizen groups.

An instance of the PPP model that can be observed in the Lighthouse cities relates to the installation of recharging stations for electric vehicles, especially fast recharging stations for taxis, who spend more time circulating and need to recharge in shorter periods of time. In the case of Florence, for example, this particular intervention can be achieved through a partnership between the local government and ENEL, Italy's main producer

and distributor of electricity and gas. The same applies to the development of a smart electricity grid in the selected district of Novolia. In the presence of such a partner, this model is particularly suitable for replication not only within the city but also across Europe.

The involvement of private investors and operations in the provision of services can also be a significant advantage for smart cities in projects that require significant innovation capacity. The public management literature has often argued that various types of partnerships with private actors have more innovation capacity than public organisations acting alone (Steijn, Klijn, & Edelenbos, 2011; Brogaard, 2017). Especially in the area of smart services, private firms have the advantage of greater access to research and development and to adapt to the market more quickly than public organisations. Another advantage of innovating with private partners is that the public administration is able to transfer some of that innovation risk to the private sector.

In terms of the triple bottom line, one can argue that PPPs are particularly advantageous for balancing the financial aspect of the City Model Canvas, especially for services that require an investment and maintenance of infrastructure (Grimsey & Lewis, 2002; A. Ng & Loosemore, 2007). They can also lead to innovative solutions for environmental sustainability. However, they have been critiqued for leading to unforeseen negative social impacts when they do not engage citizens in the value creation chain and when risks materialize that city must absorb.

6.3. Public-Private-Academic partnerships (PPAP)

A third model we observe in the Lighthouse cities, particularly in Bristol, is the Public-Private-Academic partnership (PPAP). As the name implies, these partnerships can be defined as agreements or organisational structures where responsibility for an outcome is shared between the public, private, and academic sectors (Anderson, Michael, & Peirce, 2012). This model can be understood as an evolution of the traditional PPP, but one whose focus is broader than the delivery of services and the transfer of risk from the public to the private sector. In a PPAP, the academic partner not only participates in the delivery of a services, it also benefits from the active learning process while the public and private partners benefit from harnessing the research capacity of the university (Murphy, Tocher, & Ward, 2016).

PPAPs can offer increased innovation capacity because universities' non-profit orientation and emphasis on knowledge give them the ability to explore new ideas that

might not be commercially viable yet but may eventually be profitable (Anderson et al., 2012). This type of model is especially suitable for large-scale experimental projects, so called 'Big Science' and 'Big Data' undertakings. These types of projects, which are usually funded in the millions and billions of euros (ibid), tend to involve one or more governments and consortia of private and academic partners.

This applies most likely to the ICT sector of smart cities and specifically to projects like developing an ICT infrastructure and integrated service platforms for firms and users. We can see this in the case of Bristol's approach to developing an ICT platform, 'Bristol is Open.' This initiative, which is a key resource for the city (see City Model Canvas3.3) is pursued in collaboration with the University of Bristol, the City Council and several partners from the media and technology sector, such as Nokia, NEC and InterDigital. The model can also be observed in Florence, which is collaborating with the Universitat Degli Studi di Firenze (UNIFI) and the Consiglio Nazionale delle Richerche (CNR).

In terms of the triple bottom line, the advantage of PPAPs is that by including a larger variety of stakeholders, they are more likely to integrate the 'social acceptability' dimension of the smart city model. However, this is likely only the case when there is open engagement with communities outside the scientific or business community. PPAPs can otherwise create asymmetric power relations in which citizens and their communities are either not given any opportunities to participate in developing scientific solutions (but will nonetheless often provide their data) or, are only given the opportunity to provide feedback at the end of a project, but not throughout (Callon, 1999). This in turn can result in scientific solutions that will not be adopted by citizens for being too far removed from their real needs. PPAP models should, therefore, also include citizen co-creation.

Their innovation capacity can also facilitate solutions with positive environmental impacts. The challenge is likely to make these partnerships economically viable, as they often require heavy financing in the short term but may only provide profits in the medium to long term. These partnerships can be especially depending on governmental financing.

6.4. Public-Private-People Partnerships (4P)

The analysis of the Lighthouse cities also revealed strong interest in further developing models to maximise citizen engagement in the design and delivery of smart services. A way of achieving that is through **public-private-people partnerships** or **4P** processes.

This type of partnership can also be understood as another variation of the traditional PPP model. It has emerged recently in response to some of the challenges inherent to the traditional PPP model, including the accountability challenges discussed above. Specifically, PPPs have been critiqued for developing a framework of service or project delivery that overlooks the interests and views of the general public (S. T. Ng, Wong, & Wong, 2013). The 4P model, in contrast, aims at providing a framework where mechanisms to include social concerns are embedded at different stages of the development and delivery process (S. T. Ng et al., 2013). According to this model, public organisations overseeing a particular project should create opportunities to provide information about proposed ideas to the public and create opportunities for the public to give feedback or become involved in the project conception and deployment.

In the Lighthouse cities we observe interest in pursuing the 4P model for projects that require citizen buy-in to be successfully implemented. This is the case for the building retrofitting proposals across all three Lighthouse cities. Across all three City Model Canvas models, the Lighthouse cities identified the people living in the selected districts as central stakeholders whose engagement in this intervention was crucial to its success.

In terms of the triple bottom line, this model offers cities the opportunity to balance the three elements: economic viability can be achieved by involving private firms, environmental sustainability can be promoted through strict goals and criteria enforced by a political mandate, and social acceptance ensured through active engagement of users and communities. This should not suggest though that this particular model is a panacea for smart city services but that it provides a framework for the governance of projects that possibly entail significant social costs (e.g. increased costs of housing).

6.5. Citizen co-creation & co-production (CCC)

A more direct model of citizen engagement observed in the Lighthouse cities is that of co-creation. **Co-creation** can be defined as the **active involvement** of end users and their communities in the various stages of the public service value chain (Voorberg, Bekkers, et al., 2015). A closely related term is **co-production**, which although often used interchangeably with co-creation, focuses more on the delivery side of public services than on the initial design process (Vargo & Lusch, 2004). These models differentiate themselves from the 4P process in that they imply a direct two-way relationship between the public and the local government or administration.

In a governance context, co-creation and co-production serve two important purposes. First, end-users can be a source of innovation in the production chain because they contribute unique experiential knowledge of the service that can lead to significant improvements. Second, this model ensures that the interests and concerns of users and their communities are built into the proposed projects. This leads to greater citizen satisfaction and to citizen ownership of the new services (Pestoff, Brandsen, & Verschuere, 2013).

Instances of co-creation and co-production were observed in the Lighthouse cities especially in the area of energy and ICT. One intervention that requires significant co-production is the demand-side electricity consumption management platform envisioned across all three cities. The installation of smart meters in people's home allows them to monitor their own energy consumption, but the decision to actively manage that consumption with the goal of reducing their overall carbon footprint is left to the users. Since the goal of demand management interventions is to change a behaviour, working actively with consumers to develop new ways of reducing consumption is likely to create ownership over the solutions and be more effective in the long term. Another co-created intervention is the instalment of the community solar PV in Bristol, which will likely require strong engagement from the community to operate and manage.

Similarly, the interventions that involve the collection and analysis of data also rely strongly on co-creation and co-production. Since it is users' data which will be collected, and since this data is seen as a critical resource for smart city services, the Lighthouse cities will face pressures in the upcoming years to actively engage citizens in the various stages of the development of their data policy.

Regarding the balance of the triple bottom line, the main challenge of this model is to ensure that co-creation is genuine (Loeffler & Bovaird, 2016; Voorberg, Bekkers, & Tummers, 2015). Citizen engagement can often be interpreted as a relatively simple citizen consultation process where citizens are only involved once a solution has been proposed (Voorberg, Bekkers, Timeus, Tonurist, & Tummers, 2017). Where citizen co-creation has a strongest impact is in the social acceptance bottom line because it increases the likelihood that any possible social risks of the smart city services are taken into account in the early stages of the intervention. Regarding the economic viability of this model, there is still very little literature to make any claims about how resource-intensive this model is, especially since its long-term impacts have not been measured

(Loeffler & Bovaird, 2016; Williams, Kang, & Johnson, 2016). In terms of environmental net benefits, citizen co-creation can be limited in terms of the scale of the projects, but is not necessarily always the case.

7. The city as a platform: a future business model?

The final business model that can be discerned in the Lighthouse cities is what we can call 'the city as a platform' model. Although this concept is not new, it is still currently being defined in the academic or practitioner literature (Walravens & Ballon, 2013). Similarly in the Lighthouse cities it is a model that is still in development and whose parameters will likely evolve over the next few years. In any case, we can define the 'city as a platform' model roughly as a city business model in which public value is created by a wide range of interdependent actors working collaboratively. According to this model, an important role of city governments is to actively foster business-, academic- and citizen-led innovation that can be integrated into the city ecosystem.

At the heart of the 'city as a platform' model is the idea that in smart cities, control over the production and delivery of public value is shared among interdependent actors. As can be observed in the models described above (DPP, PPP, PPAP, etc.), the actors involved in smart services include, not only governmental organisations, but also large corporations, small and medium enterprises (including start-ups), non-profit organisations, universities and research institutes and private citizens. The 'city as a platform' model is a framework for city governments to find ways of engaging all of these actors in service delivery (Anttiroiko, Valkama, & Bailey, 2014; Hollands, 2015).

In line with this paradigm, however, we can see how large corporations with access to data and data-analytics can increasingly take ownership of smart cities. An example of this is when companies, such as Alphabet (parent company of Google) who has recently created a subsidiary Sidewalk Labs to develop smart city interventions (Brown, 2016). This raises questions about who will own the city's infrastructure and who will control access to its services. As cities increasingly become more platform-like, they will have to grapple with such questions.

The central element of the 'city as a platform' model is open data. Open data, which is data that can be freely used by anyone, invites cross-sectorial and inter-organisational cooperation with government in a way that enhances opportunities for small and

medium enterprises, third sector organisations and private citizens to become more engaged in shaping the city. An example of such engagement is the organisation of 'hackathons', which are competitions that allow individual or grouped developers to propose innovative ways of using or visualising the city's data. We can see initiatives to develop and improve Open Data platforms in all three Lighthouse cities. Bristol is Open is one such example. Naturally, the main challenges are legal—the cities need to develop the appropriate legal frameworks for regulating who data can be collected and used—and technical—there are still issues of interoperability, quality and readability of the collected data. Nonetheless, all cities seem on track to gradually address these challenges in the near future.

As data becomes an ever more valuable resource in the creation of public value, the issue of who owns the city's data will be particularly important going forward. This is especially important in regard to what is viewed by some critics as the 'corporatization' of the smart city. As is evident in almost all smart cities, large firms are investing very large sums of money into marketing strategies and ICT projects to capture some of the profits that the smart city market offers. Not only ICT companies are interested in getting involved, but also engineering firms, property developers, construction companies and other major companies (Hollands, 2015). While a corporate city model is not apparent in the Lighthouse cities studies in this project, it is certainly visible in cities across Asia, where corporations such as Cisco and Fujitsu are strongly involved in building entirely new cities (Anttiroiko et al., 2014; Hollands, 2015) and critics point out that these are in danger of becoming overly dominated by such powerful interest. In some ways, the 'city as a platform' model is a response to the alternative of the 'corporate smart city model'. As cities transition to a smart economy and society, the 'city as a platform' model will likely become a framework for 'smart governance' as well.

8. Conclusions

This report has argued that smart cities need to develop business models to guide the transition and governance of a 'smart economy' and 'smart society', which is one that is increasingly reliant on ICTs to promote growth, environmental sustainability and social inclusion. The challenges of balancing these three pillars can be at the very least assessed, and ideally tackled, through holistic models for cities. In this sense, the Smart City Business Model can be seen as a governance model that requires the city to make a

final balance of costs and benefits along economic, environmental and social dimensions to assess the overall viability of the chosen smart city strategy.

Based on an adapted model for analysis firms, we have also offered a tool for analysing the business models of smart cities, the City Model Canvas (CMC), and applied it to the Lighthouse cities of the REPLICATE project at the analytical level of three sectors: energy efficiency, mobility and ICT. The aim of this exercise was twofold: first, to show how the tool can be applied so that each city can utilize it separately capitalising on the knowledge it has of its own resources and operations. Secondly, the application of the CMC to the Lighthouse cities, based on their proposals and actions in the context of REPLICATE, allows us to discern some concrete models that they are using to develop smart services.

The models that we can draw from the canvas exercise range from traditional ways of organising services, such as direct public provision and public-private partnership, to more innovative ones, such as 4P processes (public-private-people partnerships) and user co-creation. Each of these models has different strengths and weaknesses and is, therefore, likely to be most appropriate for different services. For example, direct provision can be best option for cases where there is strong resistance among citizens to private sector involvement and a PAPP can be the best model when there is a strong need for innovation but no certainty of results in the short or medium term. City governments are ultimately in the best position to use this tool to analyse their unique configuration of resources, partners and citizens and select or create a model of provision that best leverages those elements.

More importantly, it is meant to facilitate a more holistic vision of a city's goals and activities in the different dimensions of the 'smart economy'. The smart city business model can thus be a first analytical step for identifying or creating new models that can be exploited by specific firms, research organisations or private citizens. This is much more difficult to do with a fragmented vision of who is creating and capturing value in the city. For example, the mobility CMC can be used by a municipality to make a business case to a partnership of the national health institute, a ministry for environment and a private company: the municipality can show that there is economic value to be captured in reductions to health expenses (from healthier citizens) and in fees paid by users, as well as environmental value to be captured from lower carbon emissions. Such a proposition is more difficult in the absence of tools that can show the many actors that benefit from participating.

As the Lighthouse cities of Donostia/San Sebastian, Florence, and Bristol continue to strengthen their smart economy, it is clear that many of the assumptions included in this report will change. Because cities are dynamic environments, new key partnerships, resources and beneficiary segments will surely continue to evolve. Tools such as the CMC can be used over time to capture changes in how the city chooses to create value and balance the economic, environmental and social pillars of their smart city business models.

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Appendix: The Business Model Canvas for Mission-driven Organizations

Mission: statement about overall mission

<table>
<tr><td rowspan="2">Key partnerships</td><td>Key activities</td><td rowspan="2">Value proposition</td><td>Buy-in & support</td><td rowspan="2">Beneficiaries</td></tr>
<tr><td>Key resources</td><td>Deployment</td></tr>
<tr><td colspan="2">Mission Budget/Cost</td><td colspan="3">Mission achievement/impact factors</td></tr>
</table>

Source: Alexander Osterwalder and Steve Blank (2016). Available at http://blog.strategyzer.com