Discovering Business Model Viability for the Open Data Smart Mobility Context and Ecosystem

HAMK
HÄMEEN AMMATTIKORKEAKOULU
HÄME UNIVERSITY OF APPLIED SCIENCES

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Sharon Peltonen

HÄMEEN AMMATTIKORKEAKOULU
HÄME UNIVERSITY OF APPLIED SCIENCES

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Author	Sharon Peltonen	**Year** 2020
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Supervisor(s)	Mikko Mäntynevä	

ABSTRACT

The objective of this thesis study was to research how to discover business model viability related to creating applications and services in the Open Data Smart Mobility context. The examination was primarily from the local ecosystem perspective but also considered factors from the larger ecosystem and related concepts, e.g. interoperability, re-use and replication. The first part of the research, the theoretical part, researched the latest concepts and ideas behind Open Data, Smart Mobility, business models and related theory behind creating viable products and services: Design Thinking, Lean Startup, Lean Product Process, Agile, co-creation, and elements related to ecosystem design.

The research was carried out in two areas. The general survey quantitative data was collected first by a questionnaire to determine what insights related to business aspects and practical usage could be drawn by asking data re-users, e.g. developers and Smart City representatives that are directly working in the area of Smart Mobility using Open Data. The quantitative data was complemented by two descriptive illustrative case studies in order to illustrate what cities can do to enable the ecosystem. The first case study illustrates how Design Thinking can be used to help Open Data re-users design for digital wayfinding and ensure consistent look and feel of applications even if they are produced on different platforms. The second case study examines ecosystem factors, i.e. how an existing solution is addressing the interoperability challenges by scaling solutions across cities with comparison and drawing insights from comparable solutions.

Key findings from active ecosystem participants and Open Data re-users are that related methodologies, e.g. Design Thinking, Lean Startup, Agile are in use and they are working to some extent in practice. The case examples provide related best practice recommendations and examples for cities on enablers for developing their ecosystem. The conclusion is that business models related to product and services on top of Open Data can be profitable, but in order to enable that, there are considerable business and ecosystem factors to be considered.

Keywords Open Data, Smart Mobility, Smart City, Ecosystem, Business Model
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1 INTRODUCTION

Open Data and the wide variety of data that has been opened and freely available to citizens is extensive with data sets being opened continually. Open Data is freely available to citizens, and there is growing interest in ensuring that data is re-used and that re-users can discover viable business models related to re-use. The first part of this research, the theoretical part, researches the latest concepts and ideas behind Open Data and the Smart Mobility context, business models and related theory behind creating viable products and services, e.g. Design Thinking, Lean Startup, Agile, co-creation, and elements related to ecosystem design. The second phase focuses on data collection including a general survey/questionnaire and research related to two case studies to give a comprehensive perspective. The third phase analyses the data in order to summarize, formulate conclusions and provide a proposals and recommendations.

2 OBJECTIVE AND THE RESEARCH QUESTIONS

The objective, subordinate objectives and research questions are listed below.

Objective:

To determine the business aspects needed to make Open Data product/service development successful and profitable for citizens and businesses in the Smart Mobility context.

Research question one:

- In the Smart Mobility Open Data applications/service context, can certain business model aspects i.e. revenue and growth be improved by analysing and improving certain business aspects e.g. using Design thinking or Lean Startup methodology?

Research question two:

- What are the challenges and what should municipal cities do to enable the ecosystem e.g. residents/citizens (UX designers, developers, technical experts), start-ups, and small to large companies to benefit and profit from Open Data?

When defining the research questions, there is an underlying theoretical framework that business models related to product and services on top of Open Data can be profitable. Examining the Open Data Smart Mobility area by using certain business aspects, e.g. Design Thinking, Lean Startup, Agile, can provide insights on the business model aspects that are relevant for successful/profitable business ventures. In addition, examining ecosystem factors, e.g. interoperability, replication and re-use, and by scaling solutions across cities, can provide insights into creating an open ecosystem, which can result in more successful business ventures. The questionnaire should bring out insights into these issues and the business model aspects related to Open Data and practical usage scenarios, e.g. so what is working/profitable (in actuality) for individuals and/or businesses. The case studies examine enablers to address the challenges within the ecosystem, using Design Thinking to improve digital wayfinding and scaling interoperable mobility solutions across cities.

3 THEORETICAL BACKGROUND

3.1 Open Data, the Smart City and Smart Mobility concepts

This section gives background information related to Open Data, how its value can be extended by Big Data and personalization, the related roles needed for a sustainable Open Data businesses, value and economic benefits of re-use, and the progression from Open Data portals to data marketplaces. There also is background information on the Smart City, the city as a platform and the Smart Mobility context, including a mobility value modelling framework.

3.1.1 Open Data, drivers and maturity models

The underlying concept of Open Data is that it should be freely accessible, so that others, e.g. the public at large, could freely modify or share for other purposes. If Open Data is understood that way, then it can be seen as a free resource for application and service development. This underlying concept of Open Data is defined by the Open Knowledge organization and defined on their Open Definition website.

“Open data and content can be freely used, modified, and shared by anyone for any purpose” The Open Definition also states that is must have an open licence and be provided in a machine-readable form. (Open Knowledge International n.d.)

In addition to the term Open Data, there are also related terms that are used as synonyms in some contexts and overlap in meaning. Maria Sachinskaya, an Open Data researcher, outlines in her research the usages

of related terms: public sector data and government Open Data. Public sector data and its subset of government Open Data also can be used in Open Data contexts, but Open Data has a broader meaning. Sachinskaya offers the following example of public sector data or public sector information (PSI): if the government would collect traffic congestion data, it would be considered PSI because it would be information that is controlled by the public sector and paid for by the taxpayer. It would only become Open Data when it is published and opened so that it can be used for any purpose. Open Data is also not just government data, as private entities can also open data to be used by the public. Data should also be digitalized, be machine readable, and it can then be built upon to extend the data set options as well. There can be different types of Open Data. Examples could be geographical and location transportation data, which could include maps, public transport schedules, street camera images; demographic data, which could include inhabitant age and sex information; environmental data, which could include harmful emission information; and the list could continue with additional data possibilities with ever increasing potential options. (Sachinskaya 2015, p. 61–67)

With regards to charging for PSI, the general consensus has been that governments and cities should not be charging for PSI and it should be available across EU borders. (Sachinskaya 2015, p. 100–101) This is also in line with the general idea that government data and PSI has already been paid for by citizens through their taxes.

Sachinskaya outlines three motivations that researchers have found for government to develop Open Data strategies relating to democratic control and political participation, law enforcement and fostering of products and services. The Open Data motivations introduce relatively new concepts regarding potential citizen empowerment to be able to control products and services in new ways, Open Data enabling transparency of government, and any new business implications. (Sachinskaya 2015, 69-75) The EU has also listed the top 10 drivers of Open Data, which are summarized in the EU publication, The Openness of Government. The top 10 drivers include a variety of drivers from political leadership, regional initiatives, European legislation, citizen and market initiatives. (Huijboom Tijs & Van den Broek, 2011, p. 10–11)

There are a lot of datasets that are already opened, but a main challenge is identifying relevant data sources and making that data available for use. Using Open Data successfully, depends on the quality of that data, and there can be factors that can contribute to the lack of good quality data. Raw data is often error prone and full or mistakes, low information quality which doesn’t enable it to be directly processes. There can also be ownership issues, and the lack of cooperation between organizations and agencies and the willingness to share information is often a failure factor.

Governments and cities might find that data is at different levels of maturity. Tim Bernes Lee (2010), proposed a 5-star system for rating Open Data, which include 5 levels of Open Data maturity. These levels would vary from no stars where information is available online but is not re-usable under an open license; to five stars where information is available online under an open license, structured, unique URI, machine readable, interconnected and with the possibility to be linked to other data and the data is creating value. (Sachinskaya 2015, p. 69–70)

Capgemini Consulting also developed an Open Data maturity model (ODM model) that also deals with a country with regards to Open Data. Several indicators are taken into account to determine the maturity of a country and they can be classified as being either a Trend Setter, Follower, Advanced Beginner or Beginner. The characteristics of the classification can vary from having a solid portal with elaborate functionalities to no portal even existing. Analysing the EU28+ countries, using the ODM model, it was found that the evolution has been that 63% of countries initially were evaluated as a Beginner in 2005 - when not a single country classified as a Trend Setter - by comparison the forecast is that by 2020 88% of countries will become Trend Setters. (Carrara, Chan, Fischer & Steenbergen, 2015, p. 64, 70)

In 2019, European Commission published the Open Data Maturity (ODM) Report 2019 (Blank, 2019), which examines the status of Open Data maturity across Europe. In the ODM report various recommendations are listed based on what classification level the city is at. Some key points of those recommendations are summarized in the following:

- **Trend Setters** should maintain the ecosystem, experiment and share knowledge. They should enable data ecosystems around themes like mobility, with piloting activities. Monitoring should focus on high quality data publication and advancing reuse and impact. There should be a strategy to ensure sustainability of the portals with experimentation beyond state funding and the outcome should be shared with other countries. There should be metrics to measure impact and research to assess the economic impact at both micro and macro levels. Re-users should be enabled to upload their own data and showcases, with the possibility of commenting and rating of datasets. There should be incentives for real-time data publishers. There should be cooperation with other countries developing solutions to common solutions and re-use elements like open source software.
- **Fast trackers** should graduate from traction to impact. Assist and coordinate Open Data initiatives and teams at local and regional level. The activities should focus on targeting sustainable solutions and the trend should be to evolve beyond events like hackathons to formats that enable medium- to long-term engagement business

opportunities like data challenges. Winning ideas should have funding and sponsorship. The performance of developed product and services should be promoted and followed up on. Open Data portals should have better audience engagement with functionality that supports online interaction between data publishers and re-users. The re-use cases and relevant datasets, as well as potentially including the promotion of their developers, should be showcased on the Open Data portal. The Open Data portal usage and access should be monitored and developed around the portal's user profiles. Open Data portal's support for real-time data should be enhanced. Ensure sustainability in various forms including additional funding option.

- **Followers** should strengthen governance and boost engagement. Update the national strategy taking into account technical developments at EU level. Engage any potential re-users into the Open Data governance to enable common vision and buy-in. Develop a yearly plan for activities at the national level, with experimentation with creativity-leveraging events like hackathons to formats that enable medium to long-term engagement business opportunities like data challenges. Winning ideas should have funding and sponsorship. The performance of developed product and services should be promoted and followed up on. Re-users communities should be identified and focus on creating awareness activities. Activities such as meet-ups should be enabled between re-users and data publishers. Encouraging Open Data re-use by both public and private sector and encourage community to share their re-use cases and promote them on the Open Data portal. Include features that are based on user's needs such as feedback and interaction mechanism on the Open Data portal. Improve understanding of data by various mechanisms, including identifying data holders that have not published their data.
- **Beginners** should think big and act small. Gain support for Open Data from top-level government. Promote value of Open Data in various ways to show the economic value of Open Data. Develop and coordinate national strategies related to Open Data. Ensure there is a team to co-ordinate Open Data related activities. Engage both data publishers and re-users in a series of Open Data events. Identify the main data holders and remove any barriers to data publication. Make sure that the Open Data portal enables that the data is published and discovered. Follow European best practices, showcase Open Data re-use examples and ensure feedback channels are integrated. National strategy should incorporate management and funding of portal with resources to focus on awareness activities with publishers and re-users.

The progress can be seen in a visualized format also in an ODM dashboard on their website. The report identified four trends: 1) from acceleration to

consolidation 2) from quantity to quality 3) from publishing to creating impact, and 4) data sharing is the next frontier.

(Blank, 2019, p. 3, 75–79)

3.1.2 How does Big Data compare to Open Data?

The term Big Data usually refers to data sets with sizes beyond the ability of commonly used software tools. Big Data generally refers to unstructured, semi-structured and structured data, however, the focus is on unstructured data. Big Data generally refers to datasets that are large, from terabytes to exabytes. But size is only one part of Big Data, as Big Data generally referred to within three or more Vs: Volume, Velocity, Variety and additionally Value, Variability and Veracity. Big Data is generally complex sets of data, which can range from sensor to social media data that require advanced data storage to visualization technologies. Big Data and Open Data are closely related, yet they are not the same. “While Big Data is characterized by its size, Open Data is characterized by its free availability, although there is discussion about the level or volume that is necessary to make data big and the level of openness to deserve the name Open Data.” (Janssen, Matheus, & Zuiderwijk, 2015)

Open Data can be used with other data to expand the business opportunities. Linking and using Big Data and Open Data can bring broader insights and expand the business opportunities for smart cities. Big Open and Linked Data (BOLD), is an evolving field, but one that is critical for Smart City success.

The case studies by Janssen, Matheus & Zuiderwijk, show that BOLD can contribute to smart cities and effective data by linking and combining data sources and by employing data and predictive analytics. In both case studies, Open Data is linked to and mixed with closed data, which suggests that it is too narrow a view to just primarily focus on Open Data. In both of their cases, data analytics, in which big and Open Data plays a crucial role, is used to improve the resources in smart cities. The data analytics in those cases was not considered complex, as much can even be accomplished with simple techniques. The use of data analytics, linking and combining the data can result in improved decisions and better utilization of resources contributing to the smartness of cities. As technology continually develops, more advanced data and predictive analytics should make it possible for even better use of resources to make cities smarter.
(Janssen, et al., 2015)

3.1.3 How will personalization affect data, e.g. MyData

An increasing relevant and attractive concept to consumers of products and services is personalization of those services, as consumers are more willing to purchase products and services that have been customized for their needs.

In the “Open Data White Paper”, written by the UK government in 2012, it was noted that an interesting condition of a successful Open Data venture, is that opening data sets is not enough, that citizens have to actually use the data, and developers have to be able to use that data to develop added value and business solutions. While privacy and security concerns are seen as valid, the shift towards personalization was seen as needed. (Sachinskaya 2015, p. 124–125)

The control over one’s personal data in currently not very well managed, with consumers having little or no knowledge into how their data is being collected, processed or used. This is in the process of changing, for example, one such initiative or framework is MyData, a Nordic Model for human-centric personal data management and processing with the central idea that controlling one’s own data is a right while simultaneously encouraging innovative data-based business development aiming to ensure that it is accomplished in a trusted way for all parties. There are three main principles behind MyData: instead of being a passive participant, the individual would be empowered because of human-centric control and privacy 2) technically easy to use and access, i.e. MyData personal data would be re-usable across silos as it would have machine-readable access via standard APIs 3) open business environment with shared infrastructure and interoperability. (Poikola, Kuikkaniemi, & Honko, 2015, p. 2)

The term MyData is a new approach which shifts that focus from organizations to a more human-centric approach where one’s personal data can be accessed and controlled. If one’s own personal data cannot be controlled, then it cannot be referred to as MyData. So much like the easy usage with Open Data, MyData would have similar goals, but from an individual perspective, the individual would be able to e.g. access datasets with their personal information which could be everything from traffic data to online service-related data, and then control and benefit from the value of their personal data. The World Economic Forum sees personal data as a valuable resource and new economic asset class. There are individual privacy concerns which often conflict with the advantages of using personal data, and because it is a very relevant concern, MyData does have premise of human-centric control and privacy. Personal data could also have more usage potential and used in new services if there was better interoperability and portability. MyData approaches personal data from an infrastructure approach, is sector independent and with consent-

based management and control without the need to store all data in a centralized repository. (Poikola, et. al., 2015, p. 3)

Utilizing personalization options, Open Data re-users could more readily enhance their service offerings, by being able to provide e.g. personalized services, people discovery or recommendations.

3.1.4 Creating Open Data value and related economic re-use benefits

The EU has been active in promoting the benefits of re-use with the idea that it can contribute to the growth of the European economy. There is a new EU Directive, Directive 2019/1024, on Open Data and re-use of public sector information, which encourages the facilitation of re-use with minimal or no legal, technical and financial restraints (Blank, 2019, p. 37).

The European Commission initiated a study for the period 2016-2020 in order to determine economic benefits concerning the re-use of Open Data for all EU 28+ countries (which is all the 28 European Member States and European Free Trade Association or EFTA countries). According to that study and taking into consideration that each country might be on a different maturity level; the Open Data market size is expected to increase between 2016 and 2020, by about 37% to a value of about 76 bn EUR in 2020. The total market value of Open Data has an estimated projection in the mid 200 bn EUR range for 2020 with a cumulative total market size forecast around 1,200 bn EUR. In addition, the number of Open Data jobs created by 2020 is estimated to be around 100,000 with the total number of jobs in the 300,000s. (Carrara, et al., 2015, p. 8–9, 81)

The cost savings provided by Open Data is also cause for consideration in part for the large amount of savings it can bring. For example, for the EU28+ countries, cost savings from Open Data is expected to be 1.7 billion EUR. This can be brought about from different types of efficient behavior, for example, using Open Data in various different sectors, from first responders like fire-fighters that can get to the site faster to road safety and reducing road fatalities. Statistics and data analytics can provide information on trends and analysis to prevent e.g. death or injury. Reducing travel time, lower fuel use and reducing emissions, can be the efficiency benefits of using traffic jam and public transportation information. Efficiency related to parking is also another area, as the average motorist spends 2,549 hours trying to find a parking space, this could be reduced by more efficiently using real-time information, thereby reducing waiting time. Reducing the time on the road in these types of ways could be converted into savings in a monetary form, the European Commission study estimates those savings at around 27.9 bn EUR per year. (Carrara, et al., 2015, p. 4, 94–95)

3.1.5 Open Data roles and related business implications

The European Commission study refers to an Open Data Value Chain, (Carrara et al., 2015, 29) which would create value from Open Data as it would go through a series of steps from the data being created, processed, validated, aggregated and then released through a portal or purchased by a business. Analysis of the data could lead to the creation of products and services, and then further aggregation of the services is also possible. A study by the World Bank (Stott, 2014, p. 12–14) found that there are several archetypes in the value chain which are referred to as:

- **Suppliers** provide Open Data allowing others to use it free of charge, and there could be revenue gains from increased level of customer loyalty. The Supplier has the possibility to sell services where the value can originate from the supplier's deep knowledge of the data.
- **Aggregators** collect and aggregate Open Data and also other proprietary data and generating associated revenues with such things as data access services (APIs).
- **Developers** can be businesses or individuals that design and develop applications in order to sell them to customers.
- **Enrichers** use Open Data to gain insights which can be in services or products – and generally they are only available because Open Data is now available.
- **Enablers** provide e.g. platforms that other business and individuals use, and can generate associated revenues, but also cost-effective ways for others to access the data.

In order to ensure that benefits are derived from Open Data, from the government perspective there are also four roles, which aim to realize the benefits of Open Data. The roles are referred to as:

- **Supplier governments** which have to release the data and do so in regular, public manner, improving the quality and access continually.
- **Leader** has to provide related leadership activities for releasing data
- **Catalyst Government** enables the Open Data ecosystem and incubates data-driven businesses
- **User** ensures that the government also uses the Open Data for its own purposes and also that the government would be a customer for the private sector providing related products.
  (Stott, 2014, p. 12–15)

This is similar to the study by Lindeman, Kinnari, and Rossi who state that to create sustainable Open Data businesses, there is a need to understand

five roles that link raw data into valuable content. The five roles are listed here, and the business model implication is also included:

- **Open Data Publisher's** role is primarily to provide data for reuse and continuously improve the API for developers and provides cost savings
- **Data Extractor and Transformer** role is primarily to provide data for reuse by providing tools and has no associated revenue model
- **Data Analyzer** role is primarily to provide visualization and insights to the data and has income from project work
- **User Experience Provider** role is primarily to create user interfaces which have business models associated with advertising, product sales, licensing, etc.
- **Support Service Provider** role is to provide hosting or storage capacity and has income from project work.

From these five roles, one can see a chain of activity required in order to make data available and useful. And even some roles, e.g. the Data Extractor and Transformer role, has no associated revenue model, however the role is still needed in terms of the entire value chain.

(Lindeman, Kinnari & Rossi, 2016, p. 3–5)

The tasks that are done can range from creation of data to the creation of products and services, which could ultimately result in payment and a way to extract monetary value (Carrara et al., 2015, p. 29). All of these archetypes and roles are utilizing and supporting the value chain in different ways in order to extract value from Open Data.

3.1.6 Open Data portals to data marketplaces and sustainability

Generally, portals are set up in the early days of an Open Data initiative and funding issues are not necessarily one of the forefront issues. The European Data Portal set up in 2015 by the European Commission, has researched and provided sustainability recommendations for setting up sustainable data portals. Providing Open Data while sustaining the cost is important, as Open Data portals require ongoing financing for infrastructure and maintenance and the various support services for re-users of data. Especially for portals that operate on a zero-cost model, 71% of the EU 28 consider financial issues a barrier for Open Data portals. The second of two European Data Portal's sustainability reports focuses on two areas: monitoring the use and impact of portals and the financial environment in order to enable the sustainability of portals. (Fawcett, Whitworth, Chauvet & Ibanez, 2017, p. 8, 18)

The report provides several recommendations for portals in those two areas (Fawcett, et al., 2017):

- Ensuring impact: Some examples of the recommendations are such things as partnering with other organizations when doing user/business research and then publishing that data (as Open Data) in an ongoing way, encouraging reuse with such examples as use cases and showcases with links to relevant datasets, using relevant metrics and automated access of metrics such as page analytics, downloads and API logs.

- And for sustainable impact: Some examples of recommendations are using third-party hosted or open source solutions, ensuring sufficient technical knowledge of staff, using partnerships to share costs with other governments and portals, building awareness, engagement with innovation with such as things as hackathons, utilizing partnerships beyond government like universities, and looking at freemium model options for potential new datasets.

The freemium model option for new data sets would be providing basic functions for free and then some additional functionality with a price tag. The report noted that it would be more difficult to have the freemium model for static data, but could be more appropriate for transport data, where the data is provided by API and in real-time, but to avoid any issues with the whole data-for-free concept of Open Data, freemium models could be applied to new data sets that are seen as already have some sort of associated payment. The following are some of the examples of potential freemium models:

- By **volume or rate**, e.g. set the volume of data paying for higher amount or no limits.
- By **selective license**, e.g. paying to keep certain data closed
- By **level of service**, e.g. where additional technical support would be paid
- By **time period,** e.g. older or more recent data could be fee or paid
- By **geographic area**, e.g. where certain areas are free, but the larger areas would be paid
- By **data granularity**, e.g. aggregated data over time periods would be free, but more detailed granular data would be paid
- By the **frequency of update**, e.g. delayed access to the data would be free but real-time access paid
- By the **access method,** e.g. downloading data would be free but access via API would be paid
- Where a **subset** of the data would be free, but e.g. additional data fields or API methods would be paid

(Fawcett et al., 2017, p. 81, 82)

Cities providing Open Data as free or with marginal costs still does cause debate. There has been research done that show that cost-based pricing models are not cost effective while free or marginal cost models have more benefits. When governments try to recover costs for opening data it creates other barriers, potential re-users like start-ups and students, are not willing to using Open Data if a fee is associated with its use. More downloads or usage of the data is noted when governments authorities offer it as free or marginal cost. In addition, there is also the potential revenue from taxing products and services that are produced on top of Open Data. Some research indicating that higher economic growth results from providing data free or with marginal cost, Koski attributes 15% higher growth related to public sector geographic data, and even attributes the sales growth of small to medium businesses to the pricing of geospatial Open Data. (Carrara et al., 2015, p. 40)

As mentioned earlier, the underlying concept of Open Data is that it should be freely accessible, so that others could freely modify or share it for other purposes. While a certain portion of the data will be open and freely available, as Smart Cities develop with increasing amount of data from sensors etc. and with the developing ecosystems there could be a variety of different variations of proprietary solutions that use Open Data as well as a number of other data sources that might have different business models associated with that data.

For businesses that want to release some data with a price tag, there should be some way to easily make that data available to others. Windows Azure Data Market platform is an example of a potential business model around data usage that can be used in similar instances. Via that type of platform, data could be published free of charge, but there could be also subscription-based data charging or charging by the amount of data that has been consumed. These types of mechanisms would lead to data marketplaces, which would enable cross-platform opportunities like re-using of data and facilitation of billing of data. When Finnish IoT program participants were interviewed for a McKinsey and Company survey, the survey results indicated that sharing or selling data and/or applications, re-using data and reducing transaction costs when acquiring data/applications were the most important factors. (Mineraud, Mazhelis, Xiang, & Tarkoma, 2016, p. 8–9)

The development of a data marketplaces would have benefits, like data processing and sharing, support for developers, ecosystem formation including potentially new business model creation, market and billing mechanisms. Development of the data marketplace is ongoing, and this is further analysed in the case study two and Section 5.3.

3.1.7 What is a Smart City?

The Smart City has been defined in the EU publication, Mapping Smart Cities in the EU, as “a city seeking to address public issues via ICT-based solutions based on a multi-stakeholder, municipally based partnership.” A Smart City is defined as one with at least one initiative addressing one or more of the following six characteristics: Smart Governance, Smart People, Smart Living, Smart Mobility, Smart Economy and Smart Environment. In that publication, six of the most successful cities were analysed: Amsterdam, Barcelona, Copenhagen, Helsinki, Manchester, and Vienna; most of the solutions focus on transport, mobility and Smart Governance. There were several factors behind Smart City success: vision, people and process. The vision factor shows that inclusion and participation for both the urban elite and low-income areas is needed. The people factor shows that based on case studies; inspiring leaders are behind many successful initiatives. The process factor advocates the creation of a central office that acts as a mediator and coordinator for Smart City ideas and initiatives. Local level coordination is an important part of this as, e.g. information about public services should be provided as Open Data allowing individuals and businesses to create useful resources for the public by processing and recombining Open Data and other available data. (Manville, Cochrane, Cave, Millard, Pederson, Thaarup, Liebe, Wissner, Roel Massink, & Kotterink, 2014, p. 17, 28, 85–87)

Nam and Pardo examine the terminology used behind the word “smart” in Smart City, and one comparison is to the “intelligent” term, with the perception that smart is a more user-friendly term as a Smart City should be able to have customized interface and adapt to the user’s needs. A Smart City could also be indicated by intelligent products and services that are enabled factors, e.g. artificial intelligence, and the implication is that there would be automation, e.g. self-configuration and self-optimization. The entire ecosystem would entail everything from the smart individual space to the community to the larger city and be enabled by digital technologies from terminals, devices to sensors and actuators. It could be metaphorically compared to a large organic system and in effect, a linked system and system of systems. (Nam & Pardo, 2011, p. 283–284)

Nam and Pardo specified three components of a Smart City: technological factors, institutional factors, and human factors. The technological factors include such things like the physical and digital infrastructure, the institutional factors include governance, policy and regulation and the human factors include human infrastructure and social capital. (Nam & Pardo, 2011, p. 286)

Open Data and the ICT or technological aspect of the Smart City alone is not enough, without taking into account how human factors can enable urban innovations. Nam and Pardo also indicate the creative aspect as part

of human factors (Nam & Pardo, 2011, p. 287). Landry also refers to the Smart City as a creative city, where value can be added by creating innovations, so that creativity can be seen as a new currency (2008). Landry attributes the main aspect of a Smart City as one when technical factors also foster an entrepreneurial culture, which can be seen when cities provide opportunities for co-creation and experimentation. This type of cooperation can be seen in increasing businesses and government cooperation in 3P (Public Private Partnership) and 4P ecosystems (Public Private People Partnership). In addition to the benefits of user participation, which helps push innovation and the quality of existing services, PPP initiatives also include the possibility of external funding, investment and employment opportunities. (Sachinskaya 2015, p. 19–24)

But the underlying factor behind business and government involvement, is eliciting user participation in order to create user innovation. The focus should not only be on high profile projects and business needs, but actual innovations that improve the citizen's daily life and provide solutions to their problems. In order to achieve this goal, user's participation is necessary to improve the quality of services and help innovating new ideas. Improving the customer experience and customizing experiences for the citizen is really the heart of the Smart City and Smart Governance, as the operations and services ultimately should be citizen centric. (Sachinskaya, 2015, p. 22–25)

3.1.8 City as a platform

The platform term is used in various contexts, and it generally has been used with regards to technical software platforms, but it is important to note the evolution of the concept the Smart City as a platform.

Tim O'Reilly in his article on Government as a Platform, introduces some concepts related to seeing government as a platform, by taking into consideration some of the takeaways from the development of software platforms. Web 2.0 companies like Google, Amazon and Wikipedia, provide added value by co-creating functionalities with their users. So likewise, for government, instead of just expecting ready-made services supported by taxes, the government could be thought of more like a marketplace or a bazaar, where the community proactively exchanges goods and services. This concept is also being referred in similar contexts as Government 2.0. When O'Reilly refers to Government 2.0, he means using the collaborative nature of Web 2.0 technologies to collectively solve problems at city, state, national and international level. (O'Reilly, 2010, p. 13–15)

O'Reilly offers several lessons that can be learned from the Web 2.0 companies, one example is that open standards and interoperability are the basis for innovation and growth. Open standards and interoperability

limit the risk of one dominant player and enable others also to innovate and grow. When the barriers are low, innovation will be fostered and by contrast, if those barriers are raised, innovation will not stay. A lesson from Web 2.0 companies is that, a platform might be quite successful, but will not continue to be, if the platform vendor competes with the developer community. So likewise, in government scenarios, the government shouldn't be positioned to compete with the private sector in the platform economy. Even though O'Reilly establishes the importance of the government not competing with its developer ecosystem, he also indicates the advantages of government focused efforts e.g. beyond just providing APIs to the data resources, but also showing how the data can be used like a city showcasing both apps developed or funded by the city and those that are developed by third-party developers. In any case, the government's platform power should be checked so as not to extend government's control, but instead should be enabling the citizen experience and the related economy. (O'Reilly, 2010, p. 16–20, 37)

With regards to interoperability, the European Commission published the European Interoperability Framework (EIF) which gives recommendations and guidance on how to set up interoperable digital public services making way for the Digital Single Market. The EIF offers a conceptual model, four levels of interoperability (i.e. legal, organizational, semantic and technical), twelve underlying principles (e.g. openness, reusability and user-centricity, and 47 related recommendations. The conceptual model has the following ideas as foundation: 1) interoperability by design, meaning that services should be designed with interoperability and reusability in mind 2) reusability as a driver for interoperability, meaning that public services should reuse existing information and services as there could be information and services that already exist, and reusing even beyond organizational boundaries. (European Commission, 2017, p. 8, 34) In addition, there are already directives, e.g. the INSPIRE Directive (2007) where there is a focus on interoperability of data across EU borders.

It should be noted that, even if applications are being provided via a platform, each application might have a separate platform. This embedded nature of technology can also be seen in terms of layers (or systems and subsystems). Since there are various technical layers of platforms, there are various implications for interoperability or lack of interoperability.

In this city as a platform context, the city should and in many cases is an enabler of the distribution and exchange related to data, information, applications, solutions, services and ideas related to the citizen experience. A platform should provide a means or channel to enable interaction for all related parties or ecosystem. When referring to all related parties or stakeholders related to the platform it can also be referred to as an ecosystem. The ecosystem is an important concept as when we are discussing business implications, it is not necessarily apparent to every

stakeholder when an ecosystem player is relevant or who can benefit from evolving and new innovative business models.

3.1.9 What is Smart Mobility?

Open Data is applicable for all Smart City contexts, but one of the more prominent areas is Smart Mobility. Mobility involves the transport of people and goods, using both private and public transportation methods. Moving forward towards the future, the mobility ecosystem will be evolving and be impacted by different factors, for example, autonomous driving, the sharing economy and ICT will change the mobility ecosystem in a multitude of ways that might not be foreseeable today. The mobility area is continuously growing, and according to an article by the World Bank by Mohieldin & Vandycke (2017), passenger traffic will increase by 50% and freight will increase by 70% globally by 2030.

Sachinskaya outlines ICT and transport factors, which originate from research from the Vienna University of Technology, that can be used to measure Smart Mobility. These factors would be such things as local, national and international accessibility; sustainable, innovative and safe transport systems; and availability of transport infrastructure. In addition, Sachinskay points out, Smart Mobility should be seen in both layers, the real tangible one and the ICT or digital one. (Sachinskaya, 2015, p. 44–45)

In the Smart Mobility context, Sachinskaya indicates that the urban mobility forms would vary, i.e. from walking, bicycles, taxis, public transport, etc. Vuchic (1999) refers to the urban user experience as becoming a multimodal experience as users may take many different modes of transportation in the urban environment. The urban user might start with a personal car, use a taxi, bicycle and/or public transport. The use of a personal car in the urban environment, i.e. car free cities, might be cause of debate, however, Vuchic (1999) states that personal transport, is a fundamental element in modern society with unique advantages and eliminating the personal car completely would be a utopian concept. However, a city that is entirely dependent on the personal car would also have drawbacks. Car sharing can be seen as a solution to this dilemma, as it provides the user with personal transport but is a public option with advantages as well. City authorities would also be receptive to the nature of car sharing options as it does alleviate, issues such as traffic, pollution or parking availability. (Sachinskaya, 2015, p. 39–43) Cities are also doing their part in enabling public transportation to be as efficient as possible to eliminate any undue reasons to prefer personal transport. The benefits of real time geo-location data (waiting times for public transport, time, money, etc.) increases the reliability of public transport. Cities can also provide data related information in various forms: interactive maps, journey planners, construction on roads, etc. (Sachinskaya, 2015, p. 48)

An example of Smart Mobility from the EU perspective is that there are plans to develop an ITS (intelligent transportation system). It is part of the Digital Agenda for Europe EU initiative and the targets behind ITS are to make transport and mobility smarter, safer and greener by using digital technologies. One way this is realized, is the European Commission's e-call system, which in case of a traffic accident the vehicle would make an automatic call to the European emergency number 112 (Mobility, 2019). There is also EU support for enabling cross-border EU services (e.g. journey planners with information on train or other modes of transport). (Sachinskaya, 2015, p. 53)

In summary, the responsibility for urban mobility rests on each Smart City, and governments such as the EU is assisting in making standard solutions, guidelines, best practices and ensuring the integration of the European transport market. These initiatives ultimately should enable citizen-based products and services, by providing awareness and argumentation for issues such as a digital single market, interoperability, data free of charge, and personalization of services.

3.1.10 Value system modelling framework for the mobility ecosystem

Casey & Valovirta have applied a value system modelling framework of the mobility ecosystem, adapted from (Ali-Vehmas & Casey, 2012) to show how Smart Mobility services are changing from a closed system to a more open system. Although they have did not focus primarily on Open Data as significant factor in their study, a lot of their study's implications provides insights as well for the Open Data Smart Mobility ecosystem. In the value system mobility framework, there are four models: the Monopoly Model, the GSM model, the Fragmented Model and the Internet Model. (Casey & Valovirta, 2016, p. 8)

The Monopoly Model is a closed model, and a model that operates on a monopoly basis, where one actor controls it. The GSM model is an open one and is centralized, but there are multiple actors that cooperate and compete, so similar to the competition between large operators. The Internet Model is a decentralized and open model with many loosely coupled market actors and technical components, where services are used by all actors and aligns well with the sharing economy concept. The Fragmented Model is decentralized and closed with actors operating in isolation and who competing against each other with effective coordination.

When Casey & Valovirta analysed the current Smart Mobility services and transportation system using the framework above, they concluded that the markets are locked in a centralized and closed Monopoly Model where actors have tight control of the systems and a closed Fragmented Model where a small actor is operating and developing services that are

decentralized. Although the existing systems are still closed systems, there are indications of a more open model evolution, e.g. bus operation. Casey & Valovirta also indicated that some actors such as Helsinki Region Transport (HRT) have been active in opening their APIs for developers to develop new end-user services, but many of the services work in silos, open ICT technologies could help actors to move towards an Internet Model. (Casey & Valovirta, 2016, p. 13–14)

Casey & Valovirta suggest that an Internet Model could enable data exchange between services and the concept of data ownership and service interoperability by end users. There are already ride sharing applications or parking applications that utilize a two-sided platform, however it has historically been a closed platform, meaning the competing service providers are not interconnected and the end user cannot switch between them. In order to have the optimal Internet model, then those platforms would have to have interoperability within the platforms and the platforms would be interconnected using common interface and one client to access the platforms. The issue is that from the platform provider perspective there has been no incentive to interconnect the platforms and have interoperability which suggest the need for new collaboration models. (Casey & Valovirta, 2016, p. 19, 34, 40) Potential solutions to these issues are further examined in case study two and Section 5.3.

3.2 Relevant business model concepts

This section will focus on a brief history of business models, a basic definition of a business model, the Business Model Canvas, the nine building blocks of the business model which are outlined in a Business Model Canvas. Then there is an examination regarding patterns in business models and an evaluation on elements in successful the business models.

3.2.1 What is a business model?

A business model can be defined in simple terms “A business model describes the rationale of how an organization creates, delivers, and captures value”. (Osterwalder, Pigneur & Clark, 2010, p. 14)

According to Luchs, the origins of the use of the term business model, started with what-if financial models that came with personal computing, which helped develop business financials even before starting a business. If the financials of a business could be modelled it was thought, then why not other aspects of the business. In a 2002 article, Joan Magretta notes in “Why Business Models Matter” article, that business modelling is more than just the financial modelling, and proposed that business modelling is the combination of two elements, a logical story/narrative (who the customers are, what they value and how you will make money) as well as an economic model which are based on the assumptions of the narrative.

She concluded that a fault with either would be fatal to the business. This was the first time someone had proposed that business modelling went beyond financial modelling. (Luchs et al., p. 298n)

In 2008, Mark Johnson, Clay Christensen and Henning Kagermann defined the business model further in “Reinventing Your Business Model” and defined the business model as the sum of three elements: Value Proposition, Profit Formula and Key Resources and Processes. They showed that business model innovation can create new value and proposed a framework for creating a business model. Business model design value was that it could revolutionize a market or create new markets. All business model concepts have a guiding principle of optimizing the value to the customer as well as the organization. (Luchs et al., p. 298o)

Generally business model design starts with a new business or product or if the current business is under a threat. At that point, is also imperative to analyse how the business compares to the competition. As Michael Porter (1985) book Competitive Advantage, suggests that the main purpose of the business model is to create competitive advantage by creating superior value and improving your business model will depend on the strength and type of competition. (Luchs et al., p. 298q)

3.2.2 Business Model Design and the Business Model Canvas

Osterwalder and Pigneur address various concepts behind the business design process and also nine building blocks, which can be visually presented in the form of a business model canvas, presenting different areas within a business model or the way the business intends to make money. (Osterwalder & Pigneur, 2010, p. 15)

The nine building blocks, which are all part of the business model canvas, can be presented in a chart form, which is a one-page examination of all the nine building blocks in one view. There are various variants of the business model canvas, one example of the business model canvas showing Osterwalder and Pigneur’s nine building blocks, is shown in the following figure in a variant by Strategyzer.

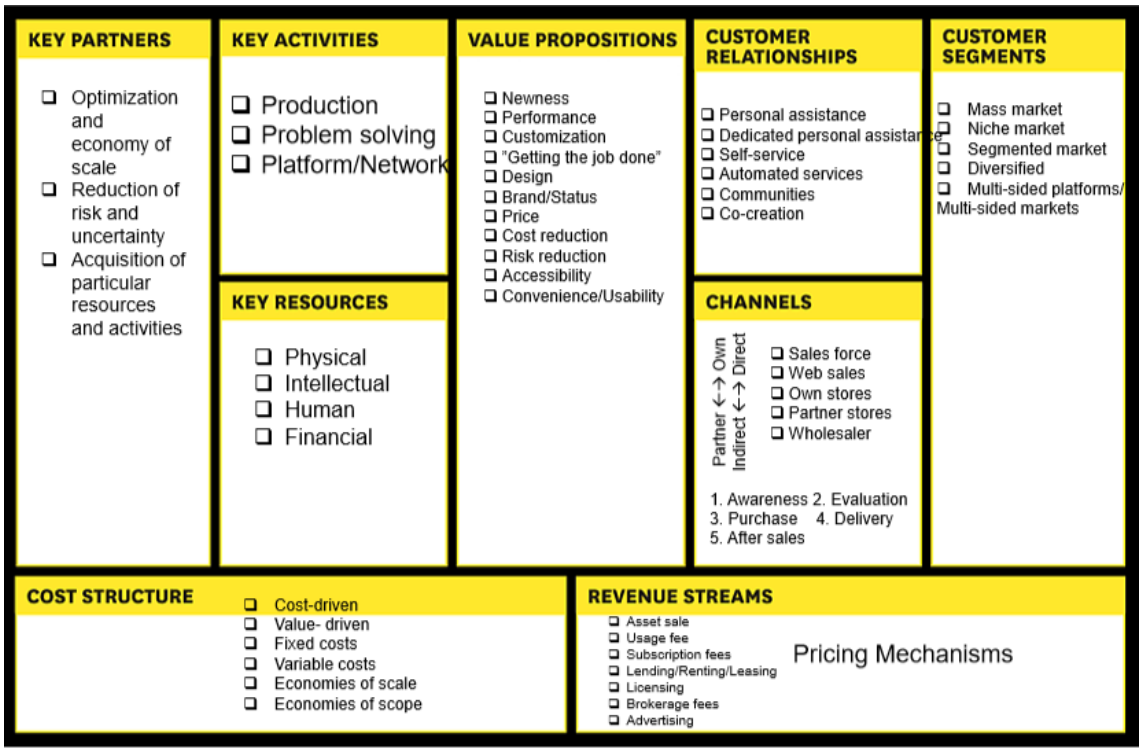

Figure 1 Example of Business Model Canvas by Strategyzer (n.d)

The nine building blocks are each detailed in the following table, which are all part of the business model canvas.

Customer Segments	In order to meet the needs of customers, a company can group them into different segments based on needs, common behaviors or other attributes. They can be grouped into different segments if they e.g. have a distinct offer or different type of relationship.
Value Proposition	The Value Propositions building block describes the bundle of benefits (in terms of products and services) that create value for each specific customer segment and is the differentiator on why customers prefer one company over another.
Channels	The Channels building block describes how the company communicates with and reaches customers to deliver value. Channel types can be partner, own, direct or indirect. Channels can have some of five different phases (awareness, evaluation, purchase, delivery).

Customer Relationship	The Customer Relationship building block describes the types of relationship the company establishes with customer segments. They can range from personal to automated and can have such motivations, e.g. customer acquisition to boosting sales.
Revenue Stream	The Revenue Stream building block represents the cash a company generates from each customer segment. The question to be asked is a customer segment willing to pay for what value? There could be one or more revenue streams for each customer segment. Each revenue stream can have different pricing mechanisms (e.g. market dependent) and there can be two different types of revenue streams: one-time payment or ongoing payments (e.g. for customer support) as well as two types of pricing mechanism (e.g. fixed and dynamics). Some examples: • Asset sale (e.g. physical product ownership) • Usage fee • Subscription fee • Lending/renting/leasing • Licensing • Brokerage fee/commission • Advertising
Key Resources	The Key Resources building block are the most important assets that require a business model to work: physical (e.g. buildings), financial (e.g. financial guarantees), intellectual (e.g. brands) or human and can be owned, leased or acquired.
Key Activities	The Key Activities building block are most important activities that require a business model to work and activities depend on the business model, e.g. software development for software companies. They can be classified, e.g. production, problem solving, and platform/network.

Key Partnership	The Key Partnerships building block describes the network (key suppliers, key buyers) that make the business model work, there are four different types 1) non-competitive, 2) cooperative with competitors 3) joint ventures 4) buyer and supplier. There are three motivations for partnerships 1) optimisation to reduce costs 2) reduction of risk/uncertainty 3) acquisition of product/resources like when a mobile phone producer licenses the OS instead of producing inhouse.
Cost structure	The Cost Structure building block describes all the costs that are acquired related to the business model. Since some business models are built around cost savings, some are cost-driven or value driven, with the following characteristics: fixed costs, variable costs, cost advantages due to scope or scale.

Table 1. The nine building blocks of the business model canvas (Osterwalder & Pigneur, 2010, p. 16–41)

Osterwalder and Pigneur also propose a business model design process which consists of five phases: Mobilize, Understand, Design, Implement and Manage. The phases do not necessarily happen linearly as some activities might happen simultaneously. The Mobilize phase, is setting the stage or preparation activities related to business design. The Understand phase is an immersive, research and analyse activity phase, collecting all sorts of relevant information and data. The Design phase is an inquiry into the viability of the business model, by generating, experimentation and testing of business model options. The Implement phase is and execution of the business model in the field. The last phase or managing the business model is a continuous process and even if a business model is a successful, it still might not have a long-life span. Each component of the business model might need to be managed and eventually the entire model rethought, so the model should be thought of as evolutionary. (Osterwalder & Pigneur, 2010, 248–249)

The Business Model Canvas has developed various adaptations and two such adaptations that are relevant for the Smart City Open Data context is the Smart City adaption of the Business Model Canvas and the Data Ecosystem Canvas, which are described below and also in the case study two.

The Smart City Business Model Canvas (referred to as SC-BMC) can be used by both private and public actors for the Smart City context. It examines the business model from a multiple actor perspective and asserts that a network of actors (in contrast to the view that the city or one business) all contribute to the creating, delivering and capturing value. It also takes into account the perspective of non-profit organizations such as governments or cities, where the primary goal is not to maximize profits but efficiently use the resources and manage the budget in a cost-effective way. The BMC has been adapted with following building blocks: 1) Network Beneficiaries 2) Value Proposition 3) Data 4) Deployment Channels 5) Actor Relationships, 6) Revenue Streams 7) Key Resources 8) Key Activities 9) Key Actors 10) Key Actors Offerings 11) Key Actors Co-Creation. SC-BMC aims at a holistic approach which examines BMC from the co-creation perspective where all the network actors contribute in generating value and can be used as framework for replicating solutions across various smart cities. The SC-BMC, to date, has not been tested thoroughly in practice but will be validated with the IRIS project. (Giourka, Sanders, Angelakoglou, Pramangioulis, Nikolopoulos, Rakopoulos, Athanasios, Tryferidis & Tzovaras, 2019, p. 5, 8, 15)

The Data Ecosystem Canvas, developed by Sitra as part of IHAN project, has developed a Data Ecosystem Canvas, which is based on the Business Model Canvas, and is a high-level summary focusing on the business design of the data network. The canvas focuses on such things as purpose and core needs, key stakeholders and their roles, ecosystem scope, rules and business models, data streams and value transfers, and governance and KPIs. (Sitra, 2020)

3.2.3 Open Innovation, Open Services Innovation business model

Openness within ecosystems enables innovation in new ways that were not necessarily thought of in the past. Chesbrough articulates the need for an Open Innovation business model. An important factor when innovating is generating innovative ideas. With idea generation, one entity might be the originator of the idea, but another might be the successful one that is able to monetize the value. In order to enable this sort of the innovation, the Open Innovation business model answers to this need by enabling the usage of ideas that originate externally or internal solutions that can be used externally. (Chesbrough, 2007, p. 22–27)

Chesbrough states that a business model performs two important functions: creating and capturing value. The creation of value results from a series of activities when creating a product or service. Capturing a portion of that value creates an output within those activities that has a competitive advantage. The Open Innovation business model helps create value by extending the scope of idea generation to include external

concepts and there is also greater value capture by extending operations to include also external entities. With shorter software cycles becoming the standard and increasing development costs, Open Innovation can enable savings in those areas as well enabling revenue from new areas. By using and taking advantage of decreasing costs as the result of taking advantage of opening development externally, revenue can also increase by benefiting from the external revenue opportunities that exist outside the traditional product domain, e.g. licensing, spinoffs, joint ventures. There should be a culture of experimentation concerning business models in order to explore various possibilities to gain benefits from Open Innovation. (Chesbrough, 2007, p. 22–27)

For Chesbrough a key concept for Open Service Innovation is co-creation. Instead of customers passively purchasing products and services, customers actively co-create products and services. And the services are not one-time purchases, but ongoing interactions or experiences. But providing services for customer experiences, requires tacit knowledge (or knowledge gained from experience) and customizing/personalizing the solution for the end customer. Co-creation is customer involvement on such a level that there is sharing of tacit knowledge to enable customization of the solution. (Chesbrough, 2010, p. 21–23)

Within Open Service Innovation, Chesbrough developed the concept of a services value web for creating the customer experience, which is not linear but is iterative in nature with various phases from customer engagement, service co-creation, eliciting tacit knowledge, designing experience points, service offering, with various points with interactions with customers throughout the iterative cycle. (Chesbrough, 2011, p. 87)

It is important to note that Chesbrough emphasizes that the focus for services is on the utility or what the product enables and refers to it as the utilization differential. Effectively using assets, as most assets are not continuously used, enables the creation of services using those assets which can be provided at optimized prices. Using a transportation/mobility example, personal utilization of a car would have an average of slightly under 5% utilization while a taxi would have a utilization of 90%, which would indicate that the taxi as a service provider, more efficiently uses the fixed costs of a car. In addition, taking into account any related hidden costs, like the cost of storing or parking of the car, can be used by the service provider as a new way to get additional revenue. Extracting value by increased utilization and rethinking transportation in terms of a service instead of a product, enables the possibility of getting more out of assets, and increasing profitability. (Chesbrough, 2010, p. 38–40)

Both Open Innovation and Open Service Innovation, extend the innovation paradigm from a closed system, which is centralized and inward looking, to open innovation which utilizes external benefits and then co-creates

solutions. Innovation networks would then be the next phase of innovation, which would be cross-organization and ecosystem centric. With the increasing importance of the ecosystem, the paradigm of Open Innovation 2.0 (OI2) has emerged with such principles as a basis, integrated multidisciplinary collaboration, co-created shared value and cultivated innovation ecosystems. The innovation ecosystems can be developed to deliver new innovations with active social network management and orchestration. (Curley, 2015, 9–11)

3.2.4 Business model archetypes and patterns

Neil Cabage defines seven Business Model Archetypes or seven high-level abstractions or fundamental business "personalities" upon which any business model can be developed to make sense of the vast amount and growing amount of derivatives of business models. In the case of businesses, there are three primary and four secondary archetypes that describe the fundamental interests and activities of every business. The primary archetypes are product, service, and trade; and the secondary archetypes are brokerage, subscription, marketplace, and ecosystem. The archetypes are visualized in the following figure. (Cabage n.d.)

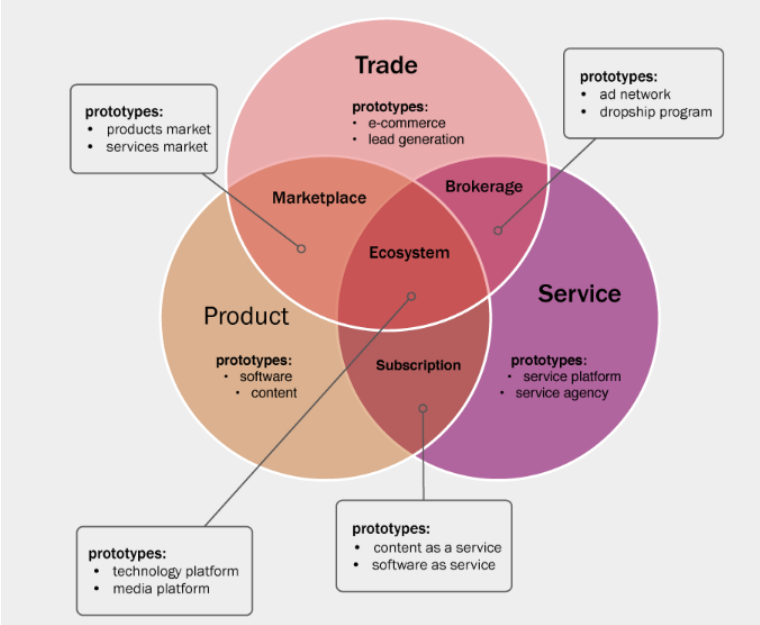

Figure 2 Seven Business Model Archetypes (Cabage n.d.)

Osterwalder also indicates that when comparing business models certain patterns can emerge, which are briefly described as follows:

- There are three different types of businesses, i.e. customer relationship, product innovation, and infrastructure. They should be

unbundled to avoid conflict, so internally a company should separate these three.

- The long tail business model focuses on selling a lot of niche products, whose aggregate sales can accumulate (compared to the traditional model where a low volume of best sellers are the revenue producers). Long tail needs low inventory costs and a strong platform to easily access buyers.

- Multi-sided platforms/markets bring together two or more different but interdependent groups which are mutually invested or gain benefits from the platform, the platform enables interactions between the two groups, and will gain in value as the amount of users increase. Sometimes the challenge might be to attract a customer segment as there might not be an initial advantage or they might not be too interested, but this can be solved by luring the segment by subsidizing or giving advantages (free offers or inexpensive value propositions).

- Free as a business model is where one customer segment benefits from the free offer and there can be different patterns to enable this, a non-paying customer is financed by another customer segment or by another part of the business model. Advertising has traditionally been seen as a free pattern as well as the freemium model, which provides basic services free of charge and the premium or advanced services have then a fee. In the digital age, there can be enablers for free, e.g. digital distribution has no or low cost on a wide scale that can enable business as long as there are other ways to make some income e.g. music industry. Another option is the “bait and hook” model where free or initial inexpensive offer will encourage customers for coming back for additional purchases.

- Open business models operate by taking advantage of outside partners, e.g. where either external ideas benefit the company or internal ideas benefit external parties. Open innovation and open business models are two terms coined by Henry Chesbrough. They refer to opening the research process, also opening the innovation process to the outside possibilities in terms of knowledge, intellectual property and products. These also could be monetized by enabling them to be accessible to outside parties, e.g. licensing.

(Osterwalder et al. 2010, p. 55–111)

Muurinen and Open Knowledge Finland workgroup as part of the 6Aika project, analysed 100 Open Data cases that were showcased on the DataBusiness.fi web. From those cases, the follow revenue streams were identified: freemium, paid advertising, sale of continuous goods and services, sales of unique or one-time services, licensing, cost savings and

then there were also no revenue. (Muurinen & Open Knowledge Finland workgroup, 2017)

Mobility business models are also evolving towards a sharing economy and service-based business models. In the mobility space, the trend is more towards not owning or buying products, but paying for it as a service, e.g. access or usage of the utility. Monetizing the mobility space can also include both the actual cost of the vehicle or transportation method and monetizing the time spent using the transportation. In the mobility space the business model opportunities also extend to related services. It is estimated that by 2030 the pricing of mobile media services and advertising for one minute of driving time globally can represent about 5 billion Euros globally in revenue per year. Since the trend is increasing and more and more media services and available, one minute could very realistically be increased to 5, 15, 50, etc. minutes. Because of the considerable revenue from time monetization, it is also a factor to be considered. (Dr. Comet, Dr. Mohr, Dr. Weig, Dr. Zerlin & Dr. Hein, 2012, p. 12–13)

Malone, Weill, Lai, D'Urso, Herman, Apel, and Woerner, classified business models based on asset rights into a business model analysis framework and then classified the business models of all publicly traded firms in the US economy during a specific time period. They analysed the firms' financial performance and found no model outperforms others on all dimensions. But some models did have better financial performance, and in their business model framework, these were referred to as "Physical Creator" or "Manufacturer" and "Physical Landlord." (Malone, Weill, Lai, D'Urso, Herman, Apel, & Woerner, 2006, p. i)

The "Physical Creator" aligns well with, e.g. creator or application/service development. Although their study was on a higher business model level, it does indicate that, e.g. developing/creating applications or services on top of Open Data, has the potential to be a profitable business model area.

3.3 Discovering business model viability

There are methodologies that can help when developing businesses and also a process to determine and discover the business model viability. The methodologies that will be examined further:

- Design Thinking
- Lean Startup
- Lean Product Process
- Agile

The following will also be examined briefly because they complement these processes:

- Co-creation for the citizen experience considering top down and bottom up approaches
- Examples of user experience (UX), service design tools/methods and ecosystem design

3.3.1 Design Thinking

Design Thinking is described as a creative problem-solving approach where one is approaching problem as a designer would. Design Thinking methodology is ideal when the problem is not well-defined such as when creating a new market or enabling significant market growth. Design Thinking has been used also in new venture creation, product development and business model design. (Luchs, Griffin & Scott, 2015, p. xxi – xxii) Design Thinking helps so that the focus is not on developing the final product but focuses using customer insights and possible solutions for hypothetical products in order discover, develop and test an idea.

Since Design Thinking has been around for quite a while there are many variations of Design Thinking frameworks, however, there seems to be common threads like the prototype framework which is done in an iterative way. Luchs, Griffin and Scott propose a specific framework, with two phases, identifying the problem and solving the problem in a systematic and collaborative way. Most focus on the second phase, but the key advantage of Design Thinking is focusing on the right problem in the first place (Luchs et al., p. xxiii).

There are four modes: Discover, Define, Create and Evaluate. Design Thinking should not be thought of as sequence of steps, that's why the phases are called modes, but it is an iterative approach to problem solving. The idea is to create solutions as fast as possible, even though knowledge might be incomplete or flawed, and use learning from those solutions to develop better solution and more refined insights. (Luchs et al., p. xxviii-xxix)

The Discover mode focuses on the customer in terms of customer insights. Existing solutions can provide a limited view and any customer or market information can end up being biased. It is therefore necessary that the customer needs or customer insights, which are undiscovered needs that can be difficult to specify, need to be explored. Gaining customer insights is described as an empathetic process, where there is understanding of users of e.g. context and behaviours. This is similar as what has been known as market research, but basically turning numerical data into customer insights. This can be done in a variety of ways, e.g. persona creation, empathy maps and journey maps which describe, e.g. customer's

ideal experience. And once a set of certain customer traits have been identified, then one can proceed to the next step. (Luchs et al., p. xxiii – xxv)

The Define mode is taking all of the information gained from the previous phase and then focusing or framing specific insights into problems that should be solved. The focus is trying to find the needs and insights that are the worthiest of following. These can be articulated as short statements that describe the customer type, the unaddressed need and the insight on why that specific problem should be addressed. (Luchs et al., p. xxv– xxvi)

The Create mode is about concept creation that can be shared with the target customers for feedback and iterated and improved upon. The two primary activities of this phase are generating ideas and creating prototypes in order to generate feedback. The prototypes at this stage are not fully functioning prototypes, they are generally ones that have with resolution, as the main idea is to explore an idea, so even a series of prototypes can be developed within the development group before one is chosen for getting feedback from users. (Luchs et al., p. xxv–xxvi)

In the Evaluate mode is about sharing the prototype to potential users and then collecting and analysing the data. The objective is to gain further insight on the solution or elements of the solution and depending on the conclusions gained from this, the team can decide the direction of the next phase, with the ultimate objective being to move beyond concept prototyping to full development of a product or service. This usually happens after multiple iterative rounds. (Luchs et al., p. xxvii-xxviii)

3.3.2 The Lean Startup

Originating in the early 2000s, Lean Startup became established as a methodology around 2010. It was developed by the key individuals Steve Blank and Eric Ries. The Lean Startup methodology seeks at an early phase of idea inception to eliminate waste so that a product can have a better chance of success. The conceptual basis of Lean Startup is a contradiction from the traditional way that products or business have been historically launched. Traditionally new businesses have been launched in a lengthy and somewhat secretive approach, with multi-year business plans with plans to raise money accordingly. The way that the Lean Startup differs it focuses on the business model and testing the ideas with the aim to gain earlier feedback and then adjusting ideas at an early phase. (Rouse, 2018)

Steve Blank states that from examining the processes behind startup processes, certain things can be learned. Traditionally after months or years of development, entrepreneurs finally realized that most of the product features were not wanted or needed by the customers, their business plans rarely survived the first contact with customers, and long

term planning like 5-year plans were not needed and planning that far ahead could be a waste of time. Startups also have unique issues compared to larger companies, the successful ones adapt and iterate going quickly from failure to failure, improving their ideas and learning from feedback from customers. One of the critical differences between large existing companies and startups is that the startup is still looking for a business model while large existing companies are existing in the process of executing one. Steve Blank highlights some key areas in Lean Startup: instead of having a detailed business plan, founders should summarize their ideas in a business model canvas, and should be focused on customer development, customer research and testing their hypotheses; the development should be done in an agile way, e.g. eliminate waste by developing product incrementally and iteratively. (Blank, 2013)

The details behind Lean Startup, are written in a book by Eric Ries, which gives a detailed analysis of the Lean Startup methodology. Ries defines the Lean Startup as “a set of practices for helping entrepreneurs increase their odds of building a successful startup” and a startup is defined as “human institution designed to create a new product or service under conditions of extreme uncertainty.” Since the inception of successful ideas can lead to the foundation of a business vision, the Lean Startup methodology can help entrepreneurs, individuals or independent developers formulate the product/service vision, even prior to the formation of a startup or company. The Lean Startup methodology lays down a way to measure productivity of new products and services by using validated learning. (Ries 2011, p. 27)

The Lean Startup focuses on the business model and human-centered design focuses on solving problems by answering four key questions: What is the business problem? Who has the problem? What is the value to the user in solving the problem and What are the attributes of the solution? There are other existing methodologies for sustaining innovation relative to existing products, and the Lean Startup differs in that it is ideal for disruptive cases, an entirely new value network that involves new consumers, and transformational innovation, which brings a significant improvement to the existing product line and often directs the company into new value networks. (Luchs et al., p. 299i)

A key concept of the Lean Startup is validated learning, which requires a change from the more traditional perspective. Instead of seeing business ideas and the building of products as a predictable process, a more experimentational perspective is needed. The Lean Startup methodology fulfils this experimentational perspective by encouraging the systematic breakdown and empirical testing of each of the component parts of a business plan. In effect, the Lean Startup is a scientific method, all the actions a startup does, for example, feature, product, marketing) can be analysed to achieve validated learning. (Ries 2011, p. 55)

The Lean Startup methodology also indicates that entrepreneurs should have two main assumptions in their vision: a value hypothesis which questions whether value has been created and a growth hypothesis which questions how customers will discover a product or service (Ries, 2011, p. 61.) The value hypothesis could then be tested by e.g. surveying or experimentation. The growth hypothesis could be tested by analysing how e.g. word or knowledge of the product/service is spread from person to person. The ultimate goal is to have sustainable growth which is formulated rule in the Lean Startup methodology "New customers come from the actions of past customers." The four primary ways to achieve growth is 1) word of mouth 2) product usage side effect 3) funded advertising and 4) repeat purchase/use. (Ries, 2011, p. 208)

The Lean Startup focuses on gaining insight from the early adopters' segment as those would be the ones that would realize the need, would be willing to give feedback and more forgiving of imperfections in the product. (Ries, 2011, p. 62)

An underlying goal of Lean Startup is building new products and services fast and without waste. Some activities create value while others are a form of waste, and the idea is to focus on activities that create value. If a business is built around a flawed product and or service, the longer the time to recognize the flaw increases the level of waste. The Lean Startup methodology creates a way to simply measure or steer the direction of a startup with the concept of Build-Measure-Learn feedback loop with the goal being to minimize the total time through the loop. (Ries, 2011, p. 75)

Once the Learn phase is completed, e.g. market research and identifying the hypothesis to test, the next phase is the Build phase or defining a minimal viable product (MVP) which is a version of the product, that is produced with minimal effort and development time, but still one that is able to do a full cycle through the loop. The MVP can be tested and then in the Measure phase, e.g. based on feedback and/or metrics, it could be decided to continue in the current direction or pivot. A pivot being a fundamental change regarding a testable hypothesis in the business model direction, product, or growth. Examples of pivots could be related to such things as a customer segment, customer need or an application to a platform pivot. (Ries, 2011, p. 172–173)

The ultimate goal being to reach a point where the customers realize the value and are willing to pay for it. The term product market fit is the point when the product has achieved this and appeals to large customer base or market. (Ries, 2011, p. 219) Product market fit is discussed in more detail in the Section 3.3.4 along with the Lean Product Process.

3.3.3 Lean Startup Challenges

It important to address the challenges and misconceptions that might arise when using the methodology. As potentially these same problems could be similar to the ones facing the Smart Mobility developers. Luchs et.al address some challenges (Luchs et al., 2015, p. 299t-u – 299u-v):

- Struggle to find the right problem. There is a struggle to accurately formulate the point of view of the user, i.e. the user, the user's need and the observation of the user.

- Confusing solution attributes with the solution. Solution attributes show how each competitor measures up on each attribute and importance of each attribute to the user. These attributes should then can be seen as independent from the solution.

- Focus on the wrong customers. Focusing on routine customers rather than lead users or early adopters, which only want a similar product/service they are currently using and don't see value in transformational or disruptive innovation.

- Envisioning the prototype as a finalized solution. Showing a rough prototype might bring feelings of embarrassment or offending their users, when their goal should primarily be soliciting feedback and dialogue.

- Incorrect assumptions about channels, cost structures and adoption rates. There are false assumptions regarding these three areas compared to other areas. There can be ingrained thinking and expectations for similar results for new products (even breakthrough innovations) as in other existing products. So even users have been studied extensively for other existing products, the same assumptions are kept on channels, cost structures and adoption rates for the new market.

Some misconceptions based on an interview with Ries

- Inadequate/cheap or not thinking big. As early iterations might not have all the ultimate functionality, they nevertheless save time and resources and is a rational way to test and gain valuable feedback before fine-tuning it further. Uber is an example of a unicorn startup that started with a lean MVP.

- Embracing failure. Since Lean Startup relies on a scientific method, the goal is the learning process. The goal is to get a successful outcome, by learning from the failures, e.g. trying new hypothesis, which should then accelerate the whole process. (Ferres, 2017)

3.3.4 The Lean Product Playbook and the Lean Product Process

The Lean Product Process is a methodology that is detailed in the Lean Product Playbook which introduces a step-by-step guide on how to create successful products. The Lean Product Process, by Dan Olson, is based on the concepts of Lean Startup by Eric Ries but gives concrete guidelines to build successful products. It first introduces certain important concepts: Product Market Fit and then Problem Space vs. Solution Space.

Olson's Product Market Fit concept is important because it is used as an indicator on why products succeed or fail. There are five key components: the target customer, their underserved needs, the value proposition, the feature set and user experience, each with a testable user hypothesis. The six steps of the Lean Product Process give a guideline through each layer starting from the bottom. The layers themselves can be divided into either part of the Problem Space or the Solution Space. Each step would have a hypothesis that could be tested. The Problem Space would contain 1) Determination of target customers 2) Identification of underserved customer needs 3) Definition of value proposition. The Solution Space would contain 4) Specification of the MVP feature set 5) Specification of the MVP prototype and 6) Creation of the MVP prototype. (Olson, 2015, p. xx)

An example given by Olson of the problem of going into the product/solution space too fast, without analysing the problem space, is from NASA: when asked to solve a problem for writing in space, a NASA contractor spent one million dollars to develop a gravity defying ball point pen, but by contrast the Russian counterparts, used a traditional pencil that solved the same problem, defying gravity without even implementing anything or going into the solution space. (Olson, 2015, p. 13) This shows that focusing and concentrating on the problem space is an essential part of product/service development and can ultimately reduce the most amount of waste.

In Step 1, and underlying the entire pyramid, is to determine the target customer, which is done by identifying the attributes of the customer. Defining subsets within a large set of customer traits is referred to as market segmentation, there are various examples, i.e. demographic, psychographic (psychological variables), behavioural, needs-based.

Olson also addressed such things like the technology adoption lifecycle that also breaks down users into five different customer segments: Innovators, Early Adopters, Early Majority, Late Majority, Laggards. This can help with targeting products, e.g. innovators for a new product which are willing to pay for it and more tolerant of shortcomings, but then if the target is to gain adoption, then certain aspects have to be modified (e.g. price or ease of use). (Olson, 2015, p. 29)

After determining underserved customer needs and benefits in Step 2, in Step 3 the research design has to be chosen by addressing the specific customer needs, but the product scope does not have to be too large, as the target it to create an MVP. In Step 4, you are specifying the MVP feature set which is the minimal functionality required to validate that it is headed in the right direction and at this point it is based on a hypothesis. For each benefit in the product value proposition, brainstorming follows focusing on how many feature ideas can be delivered regarding that benefit. At this point, there is a transition to the solution space. (Olson, 2015, p. 77)

In Step 5, an MVP is created and the basic goal is that the MVP should be a real, working product or at least an interactive prototype, as there will be tests to determine the hypothesis behind the MVP. The MVP should be a quality one that has enough functionality to be considered viable to the customer. In summary, the four hierarchical layers describe the product's attributes, functional, reliable, usable and delightful. Each layer should be addressed by the MVP. (Olson, 2015)

Step 6, or when the MVP is tested, the design and great UX design should be the target, as although innovators might be more tolerant of lower threshold of UX design, other customer segments will not be. When getting feedback, it is necessary to be able to differentiate between UX/usability issues and product-market fit. Usability feedback is how easy it is for customers to use the product, but by contrast product-market fit, has to do with how valuable they find the product. What should be avoided is getting feedback on how the MVP needs UX improvement, which impedes users from seeing the full value or potential of the product and instead will focus on bugs, etc. (Olson, 2015, p. 163)

The hypotheses should always be tested, and feedback gathered in an iterative way. As each hypothesis should correspond to a layer of the pyramid and the lower the layer it affects, the harder it will be to change, for example a slight change in UX would be an easy change, while if the benefit isn't there for the customer that would have be a larger change. (Olson, 2015, p. 176)

If the progress is not there as iteration happens, then it is important to look at the problems by mapping them to each corresponding layer. If a hypothesis of a target customer is wrong, iterating the UX design won't help the situation. If the hypothesis changes, then it's referred to as a pivot. A pivot is a larger change, which would be more than the normal changes that are encountered e.g. a UX design change, as it means a significant change in direction e.g. changing to a different target customer. (Olson, 2015, p. 176)

> Pivoting should be then done if product-market fit isn't achieved after several iterative rounds, or in other words, the customer feedback should indicate that there is some customer enthusiasm concerning the MVP concept. Sometimes the direction of the pivot would come clearer through the tests, e.g. a minor area might be the area that creates more customer enthusiasm. So, for example, after a first wave of testing there can be a pivot, improvements in the product, and then additional market opportunities targeted and improve the product-market fit. (Olson, 2015, p. 178)

3.3.5 Agile

Agile software development has been an underlying software development concept that has been relevant for a long time, but its importance has been ever increasing, as the software industry has sought to decrease the time to produce software. In the 1990's, the general estimated time to deliver software was about three years, with some industries taking even longer than that. Waterfall and other software processes at the time had overhead and a complexity that required having long time to markets. Waterfall methodology generally meant that teams would complete each step of the process before moving on to the next one, e.g. requirement definition and then on to functional design, and onwards. The emphasis was on planning and documentation instead of working software. Within the time it took to get software to market, everything could have changed in the business environment and the delivered solution might meet the initial requirements but might not meet the evolving and the recent/latest requirements. There was a seen a need to quickly build software so that end user could give feedback on the scope and direction, and rapid feedback and willingness to change were seen as the key features of agile. The trend to quickly deliver software keeps progressing with continuous delivery or DevOps being a central concept in the current day. (Varhol, 2019)

Alongside Agile there were other methodologies, like rapid application development (RAD) which aimed to get a working prototype within a short time window, like days or weeks; and also the Scrum software development process was conceived in 1990's and was based on the concept that the best results occur with small and self-organizing teams with freedom to achieve objectives within a specific time. (Varhol, 2019) On a more detailed level, Scrum can be comprised, e.g. of user stories, a work backlog, sprints or timeframe to complete work e.g. 2-4 weeks in length, and story points, which is a mechanism that translates work amounts into arbitrary amounts for the planning the user stories (Redmond, 2019). The Agile manifesto originated in 2001, and Agile was seen as an encompassing term for all the related frameworks that are based on the Manifesto for Agile Software Development and the underlying 12 principles, which were written by software developers and

a tester focusing on mainly software development issues, however, the agile mindset and certain takeaways can be adopted in other areas as well. (Agile alliance, n.d.)

3.3.6 Co-creation contexts for the citizen experience

The Smart City and Smart Mobility are ultimately about the citizen experience, the Open Data sets are inter-connected on a system and larger platform level, and likewise, the products and services have interconnections which have to be co-created with the citizen in mind. Co-creation, as earlier discussed in Section 3.2.3, is customer involvement on such a level that there is sharing of tacit or experience-based knowledge to enable customization of the solution (Chesbrough, 2010, p. 21–23).

Co-creation in the Smart City and Smart Mobility context depends on the various contexts of customer interactions. For independent developers the common creation method is to develop an application on top of an Open Data set, focusing on a somewhat focused customer interaction and not necessarily considering the multitude of customer interactions that might happen on a system level. By contrast, cities have the potential to steer creation on a system, ecosystem or higher-level strategical direction which would create robust applications and services which ultimately provide more added value to the citizen. So, there are two contrasting ways of approaching the customer context.

It is interesting to note that this duality in approaches can be referred to a as top-down approach or a bottom-up approach which is also addressed by Walravens, Breuer and Ballon. In a top-down approach, the city would take a direct role in steering the initiatives but could result in a “control room” scenario where the city finds itself in an authoritative urban monitoring role which could be influenced by commercial interests and would have privacy concerns. This approach could limit the citizen’s role with developing innovations related to products and services. So instead of the city having a focused role, in contrast, a bottom-up approach would take a more distributed role, which would ultimately accept some sort of chaotic approach, with the city not controlling every aspect. This bottom-up approach could conflict with the goals of city decision-makers and urban planners as core idea is that the ideal is not that everything is planned but focuses more on the people in the equation. The bottom-up approach can also result in extremes, for example, citizens not having respect for the common city guidelines such as established mobility paths. A bottom-up approach could also be problematic with regards to such things as scalability and interoperability. Both approaches have their own benefits but also have significant problematic issues a combined approach that incorporates benefits from both approaches seems to be the more optimal way forward. Combining both approaches would then be more of an ideal solution by working from a common local innovation platform that

incorporates the interests and advantages of all affected stakeholders, e.g. public and private sector as well as the citizen, in collaboration in order to generate new value including co-creation of product and services. (Walravens, Breuer & Ballon, 2014, p. 18–21)

3.3.7 Ecosystem design: UX and service design example tools/methods

Lean Startup and Lean Product Process have a specific focus on human-interaction based user experience (UX), and the focus of those methodologies is on individual interactions which is well-suited for product design. For example, Lean UX which is referred to related to Lean Startup, uses the concept of a customer archetype which can also be referred to in both UX (as well as in Service Design) as a persona. The persona is a tool, based on research of end user traits, that is used to personify the customer attributes within the internal development team. Lean UX also mentions "get out of the building" which really stresses the need to go where the customers or end users are and discuss with them, gain insights and get to know the customer firsthand. (Ries, 2011, p. 88–89)

One way to do this, would be to create and Empathy Map, or a customer profiler, which examines the customer on a deeper level giving a comprehensive view on details related to e.g. customer's behavior and environment. It can be used in such way as first brainstorming on the possible customer segments and then building a profile by asking questions like what the customer see, think or feel in their environments and their pains or gains. (Osterwalder et al., 2010, p. 131)

Although a lot of the UX principles and methods overlap with service design principles, service design is beneficial also for a larger end-to-end view that would be relevant for the Smart City and Smart Mobility. By examining Smart Mobility from a higher perspective, it would enable innovation and an improved user experience perhaps in ways that are not currently used or known. Although there are numerous tools that can be used in both UX and service design it is important to highlight a few service design examples, to illustrate the type of research that would be relevant for the end-to-end view in the Smart City context. Relevant service design tools that would be those that would also go beyond the individual interaction and could be used in a wider system view.

The following examples are examples of related service design tools:

- A service blueprint illustrates in a tabular form the steps in the customer journey (which are shown in columns) and then the aspects of the service's operation (which are shown in rows). In its complete form, it would have customer facing touchpoints as well as the background elements that enable the touchpoints. (Wilshere, 2018)

- Another example would be a user journey map which can be used as both a single touchpoint in UX design but would show the end-to-end journey in service design and can even be documented over extended periods of time e.g. decades. It also differentiates from the service blueprint in that it includes what the user is thinking, feeling and experience at each touchpoint. (Wilshere, 2018)

- Another example could be an ecosystem map or service ecology map which is a relationship diagram between all the service stakeholders and service actors. The diagram can also show the transactions facilitated by those relationships, value for the customer or the money exchanged for the service. (Wilshere, 2018) It should describe all the entities flows that characterize the ecosystem. (Service design tools, n.d.) Ecosystems would include such things as users, practices they perform, related information, other people, services, devices and channels. Designers can use inquiry methods to understand the ecosystem including any possible business possibilities. (Hussain, 2014) Similarly, a service ecosystem map can be visualized in a circular, ring format. It focuses on the phases of the service experience and within each of the phases it defines the user's needs, service interactions and touchpoints which take place. A service ecosystem map can be used prior to customer journey mapping and can be used to identify various additional parts of customer journeys, identify service opportunities as it visualises the interactions and lack of interactions, competitor analysis, and gives those that are designing services for a complex system an overall perspective. (Grimes, n.d.)

The ultimate aim of these types of tools/methods is to design the citizen experience beyond silos and broaden the citizen experience to enable the citizen to use products and services in a broader more innovative way. Designing beyond silos is an important concept as the products and services within the Smart City could be seen as part of an ecosystem so any application/service in that ecosystem should take into account ecosystem design considerations.

3.3.8 Summary, conclusions and hypothetical formulation

Based on researching the literature and key concepts related to Open Data, Smart Mobility and business model aspects, the following summary and conclusions can be drawn:

- From the concepts described in this section, there should be a basic understanding of the basic concepts of this domain, e.g. Open Data, Smart Cities, and Smart Mobility.

- Open Data value can be enhanced by such things as Big Data, linked data, personalization, city as a platform.

- Open Data and Smart Mobility products and services can be enhanced by incorporating multiple aspects, e.g. Business Model Design, Open Innovation and Open Service Innovation, Design Thinking, Lean Startup, Lean Product Process, Agile, User Experience, Service and Ecosystem Design and Co-creation.

Gartner has combined multiple frameworks (Lean Startup, Design Thinking, Agile) with the notion that innovation requires iterative and experimental processes which can be found in multiple frameworks to really understand the real customer need, as well as Agile to effectively build the products and services. (Blosch, Osmond & Norton, 2016) The following tables' adaptation summarizes some of the details related to this multiple framework combination and the details have also been further described in this section.

Problem space	Solution Space	
Business Model Design / User experience / Service and Ecosystem Design / Open Innovation / Co-creation		
Design Thinking: Important to empathize, define and ideate and Design Thinking has four modes: Discover (customer in terms of customer insights), Define (focus or frame specific insights into problems that should be solved), Create (concepts that can be shared with the target customers) and Evaluate (share prototypes to collect and analyse data)	**Lean Startup and Lean Product Process:** Business model canvas, validated learning and experimentation, Build, Measure and Learn loop with goal of minimising time through the loop, minimal viable product (MVP), testing hypothesis and gathering feedback in an iterative way, pivot to meet product market fit options (target customer, their underserved needs, value proposition, feature set and user experience)	**Agile:** Building software quickly for end user scope and direction, and rapid feedback and willingness to change, small self-organizing teams with freedom to achieve objectives within a specific time, Scrum a popular agile approach can be comprised of Agile development ways

Table 2. Multiple framework combination

Creating an application/service on top of Open Data, by itself, will not guarantee that it will be profitable and revenue generating so that it

can be sustainably developed. It is not enough for cities to release data and then expect product and services to be created. In order to enable citizens to create applications/services on top of Open Data, cities have to enable the ecosystem so that business ventures are revenue generating and profitable and provide incentives for citizens to create business ventures on top of Open Data. Products/applications/services should also create value for end users, which in turn, can be revenue generating and profitable for those that create and develop them

The hypothesis is that smart cities could enable revenue and growth of services and products in the ecosystem, i.e. specifically in this context Smart Mobility, by ensuring that startups, independent citizens, designers and developers have knowledge and expertise in wide variety of business model aspects, methodologies and tools. The aspects, processes and tools e.g. Design Thinking, Lean Startup, Agile, can provide insights on what factors are relevant for successful and profitable business ventures. In addition, open innovation and ecosystem factors, e.g. collaboration, interoperable solutions, design and co-creation can provide insights on what can be done to create an open ecosystem that will ultimately lead to improved revenue and growth for the service and products in the ecosystem.

The general survey/questionnaire brings out insights into these areas and practical usage scenarios, e.g. so what is working/profitable (in actuality) for individuals and/or businesses. The case studies also will bring insights from two complementary areas related to the Smart Mobility ecosystem that can provide best practice recommendations and examples for cities on how to ensure and improve the profitability and success of the products and services within the Smart City ecosystem.

4 RESEARCH APPROACH, PROCESS AND METHODS

The used research methodology is a mixed-method approach using both quantitative and qualitative methodologies. It is primarily descriptive, providing accurate representation by, for example, a questionnaire. It also is explanatory, since the data collection method will be a questionnaire and two case examples. The quantitative part is the online questionnaire which was sent via online channels in a structured format. The illustrative and descriptive case examples, focus on research question two, regarding the challenges and corresponding insights on how cities can enable the ecosystem a) Using Design Thinking methodology to improve digital wayfinding for Smart Mobility ecosystem, and b) Scaling interoperable mobility solutions across cities; both of these case examples are relevant

to providing solutions to the challenges related to the Smart Mobility Open Data ecosystem.

The research philosophy for this thesis is pragmatism, as the most important determinants are the research questions and objectives. There will be an element of deduction, that will be apparent when defining the research questions and specifying the way they will be answered. Deduction is a research approach that results in testing of the theory. There are five stages of deductive research which are summarized following: define research questions based on theory, specify the way they will be answered, searching for answers to the research questions, analysing the results, confirming or modifying the initial theory. (Saunders & Lewis, 2012, p. 108)

The research questions are then the following:

- Research question one - In the example of Smart Mobility, can certain business model aspects i.e. revenue and growth be improved by analysing and improving certain business aspects e.g. using Design Thinking, Lean Startup, Agile methodology?

- Research question two - What are some of the challenges and what should municipal cities do to enable the ecosystem e.g. residents/citizens (UX designers, developers, technical experts), start-ups, and small to large companies to benefit and profit from Open Data?

Study objective perspective	Research Question	Method + data gathering	Analysis Method
Developer perspective	RQ1, RQ2	Structured survey/questionnaire	Quantitative, Statistical Analysis, Descriptive Analysis
Smart City representative perspective	RQ1, RQ2	Structured survey/questionnaire	Quantitative, Statistical analysis, Descriptive Analysis
Smart City representative and developer perspective	RQ2	Case study and questions	Qualitative, Descriptive Analysis

Smart City representative and developer perspective	RQ2	Case study	Qualitative, Descriptive Analysis

Table 3. Research approach and methods

The research was conducted in three phases. The first phase was researching the topic in the form of literature and articles related to the central topics, theory, methodology etc. related to Open Data and business model aspects which have been described in Chapter 3. Based on the preliminary research, the important aspects related to Open Data and business models were outlined that substantiate the research questions and helped formulate the hypothesis, questions for questionnaires and targets for the case studies. The second phase was data collection which included surveys/questionnaires and research related to two case studies to give a comprehensive perspective. The third phase was the analysis of the data in order to summarize, formulate conclusions and provide a proposals and recommendations.

5 RESEARCH STUDIES

5.1 General survey

5.1.1 Introduction

As mentioned earlier, the hypothesis is that Smart Cities could enable revenue and growth of services and products in the ecosystem, i.e. specifically in this context Smart Mobility, by ensuring that startups, independent citizens, designers and developers have knowledge and expertise in wide variety of business model aspects, methodologies and tools. The aspects, processes and tools, e.g. Design Thinking, Lean Startup, Agile, can provide insights on what factors are relevant for successful and profitable business ventures. In addition, open innovation and ecosystem factors, e.g. collaboration, interoperable solutions, design and co-creation can provide insights on what can be done to create an open ecosystem that will ultimately lead to improved revenue and growth for the service and products in the ecosystem.

The target of the general survey questionnaire was to research from the local ecosystem what is the current situation with some of the Smart City representatives and Smart Mobility developers to see if certain business model aspects, and with a particular focus on revenue and growth, could be improved by analysing and improving certain business aspects, e.g. using Design Thinking, Lean Startup and Agile methodologies. In addition,

the target was also to find out what are the challenges and what can cities do to enable the ecosystem. Background for the business aspects are described in detail in Section 3.2 and 3.3. Section 3.3 addressed methodologies that are used to discover business model viability, in particular Design Thinking, Lean Startup and Agile, as these can provide insights on what factors are relevant for successful and profitable business ventures. In addition, open innovation and other ecosystem factors, e.g. UX/service and ecosystem design and co-creation can provide insights on what can be done to create optimal products in an open ecosystem that will ultimately lead to improved revenue and growth for the service and products in the ecosystem. The survey questionnaire should bring out insights into these areas and practical usage scenarios, e.g. so what is working/profitable (in actuality) for individuals and/or businesses.

So, in the general survey, the purpose is to find out more information related to the following question areas:

- If and how the applications/products/services are generating revenue, profit, and associated revenue? What is the business model?
- How clear are the target customers, customer segments, end user benefits/value and competitor products to application/product/service developers?
- Are the Smart Mobility representatives and developers familiar and using Design Thinking, Lean Startup and Agile methodologies?
- Related to Design Thinking and particularly Lean Startup: was a Minimal Viable Product created, tested and end user feedback collected? Based on that feedback, was there a pivot or change in the product and business model direction? Was the application/product/service able to achieve sustainable growth? If yes, how is/was sustainable growth gained?
- Related to the ecosystem: what type of help, related to the customer problem or customer solutions, developers would need from the Smart City ecosystem? Instead of a standalone application, are developers interested in developing an application or functionality as part of a larger platform?

5.1.2 General survey: data collection analysis

There were two online questionnaires created with the questions targeting the relatively the same issues, but one was targeting the Smart City/Mobility representative perspective, and the other questionnaire was targeting the developer perspective so those that have actually created Smart Mobility applications with Open Data.

The first part of the questionnaire included general questions that were asked, e.g. email address, where can the application be found, size of company and data set used. There were 8 people that filled out the questionnaire, 4 were developers and 3 were Smart City representatives. There was one developer who only created visualizations with sole purpose of visualization of data and had no business goals and so his responses were limited in the analysis. The questions and summarization of the responses, including graphical visualizations, follow (a full set of the questions can also be found in Appendix). The discussion, conclusions and recommendations are then drawn in the next sections.

Was the application/service revenue generating?

All the applications were able to generate revenue.

How did the application generate revenue?

There was a wide variety of business models indicated: subscription fee, licensing, advertising, usage fee, cost savings, a priced app in store (no adds). The subscription fee and licensing being the business model with the slightly more responses.

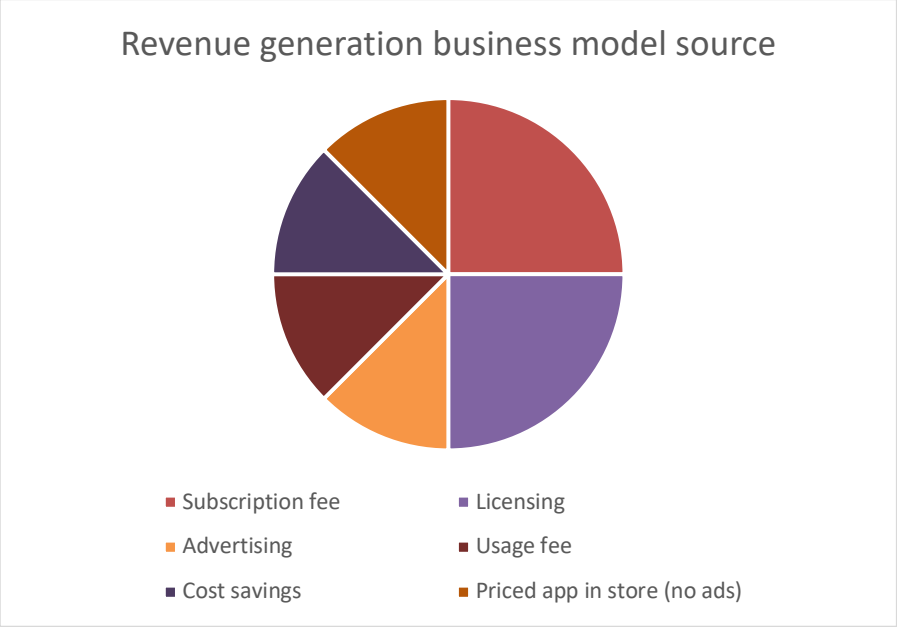

Figure 3 Business Model Source

After costs, was your application able to generate profit?

50% indicated that application was able to generate profit after costs.

Figure 4 Profit after costs

Were there any associated revenues, e.g. with the data produced?

Only one respondent indicated that there were associated revenues with the data produced.

Were the target customers and/or customer segment clear?

Most of the respondents indicated that the target customers and/or customer segment were clear. One indicated that it was only somewhat clear.

End user benefits/value

All of the respondents indicated that the benefits/value to the end/users and/or were clear.

Competitor products

All the developers indicated that there were competitor products.

Have/did you use Design Thinking, Lean Startup and Agile methodologies when developing your product?

Developers: 75% indicated Lean Startup, 50% Agile, 25% Design Thinking methodologies were used when developing products.
Smart City Representatives: 70% indicated all the methodologies all the methodologies were used when developing products.

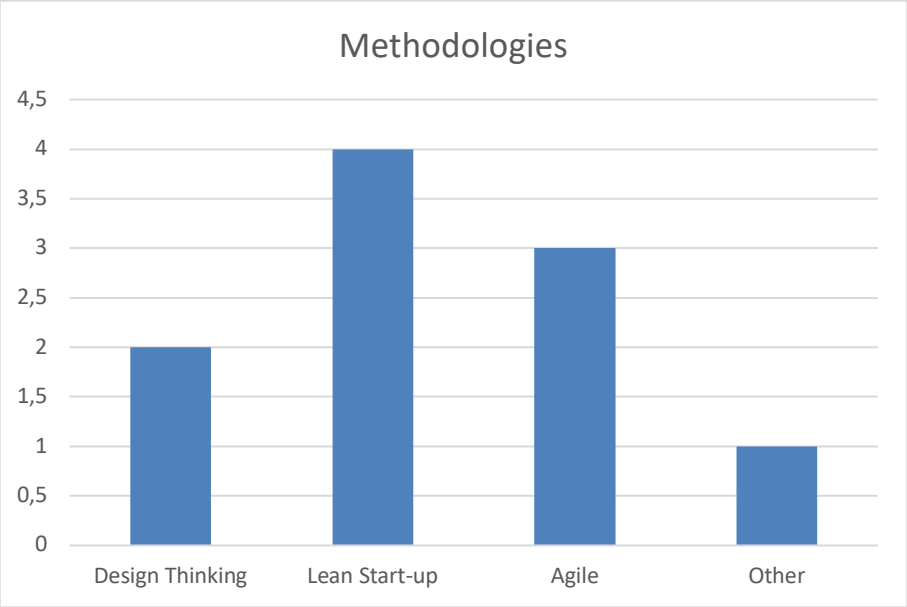

Figure 5. Methodologies

Was a minimal viable product created?

Developers: 50% indicated MVP created.
Smart City Representatives: 100% indicated MVP created.

One respondent indicated, that the first iteration of the product could be called a Minimal Viable Product, but nobody liked it, and that specific app required quite a few many features to be useful.

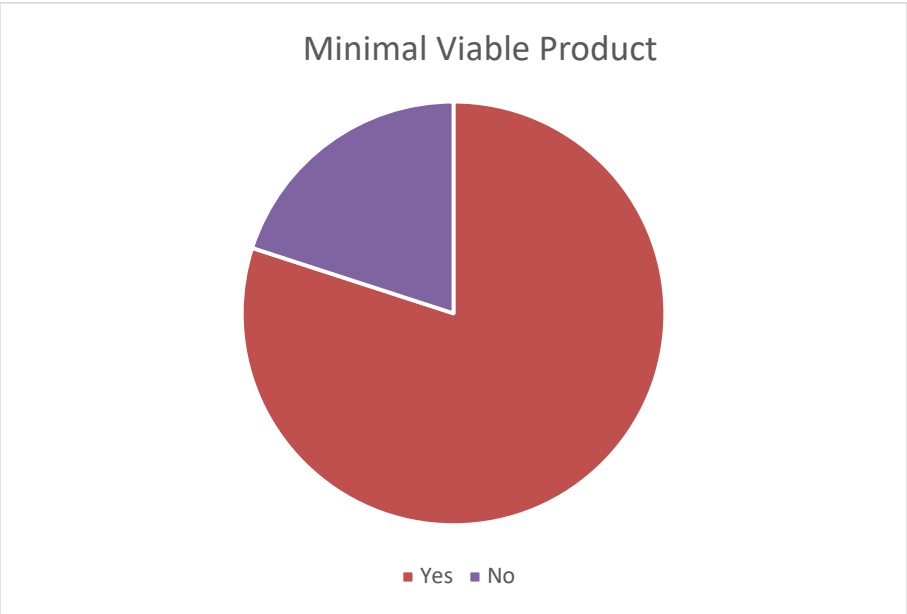

Figure 6. Minimal Viable Product

Once a product or minimal viable product was created did you test it and collect end user feedback.

Most tested and collected the end user feedback on the MVP. One indicated that the MVP was showed to friends.

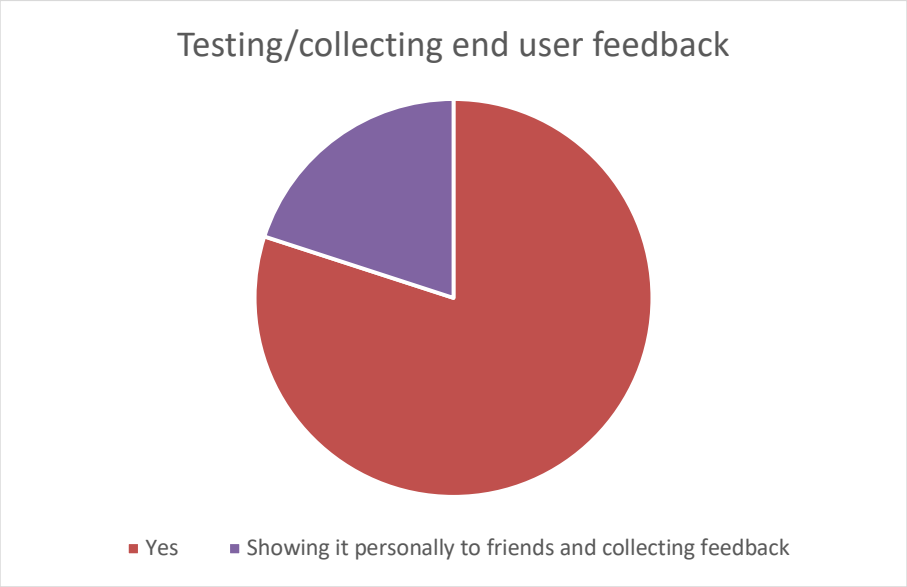

Figure 7. Testing and collecting end user feedback on MVP

Based on feedback received on the products/services, was there a pivot or change in the product or any part of the business model direction?

Most of the respondents indicated that there was a pivot or change in the product or any part of the business model direction.

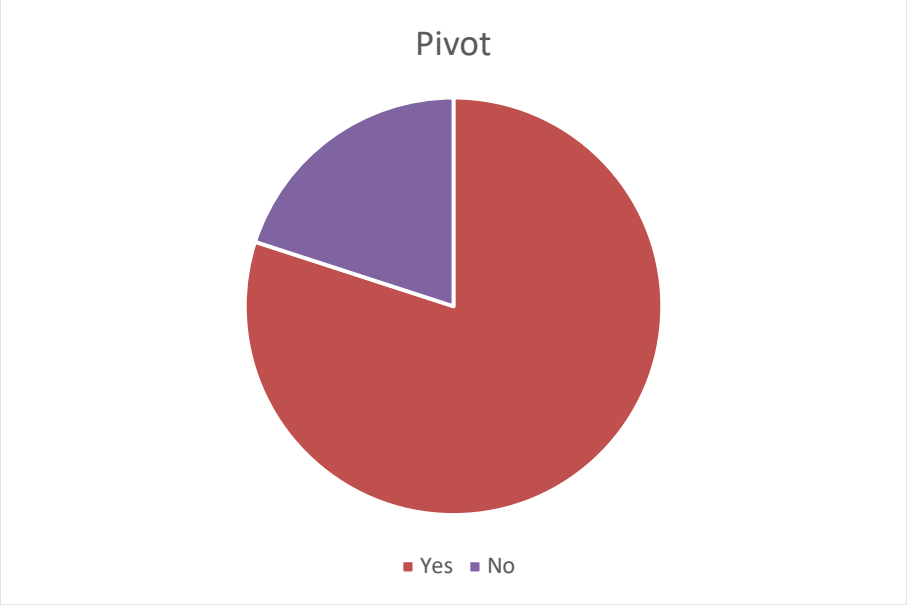

Figure 8. Pivot

Was your product/service able to achieve sustainable growth?
If yes, how was sustainable growth gained?

All respondents indicated that sustainable growth was gained with word of mouth being the largest factor in growth.

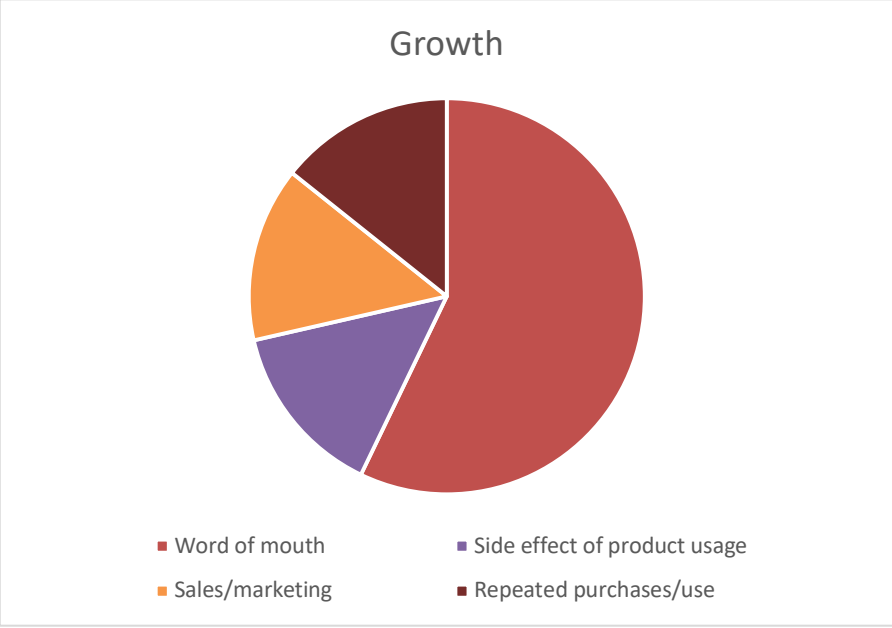

Figure 9. Sustainable growth method

Do you feel the Smart City ecosystem could help you in with the customer problem or customer solution?

The city could help in business model help or mentoring, marketing or advertising support, collaboration with other coders, open source data and facilitate co-creation, with marketing and advertising support slightly higher than the rest.

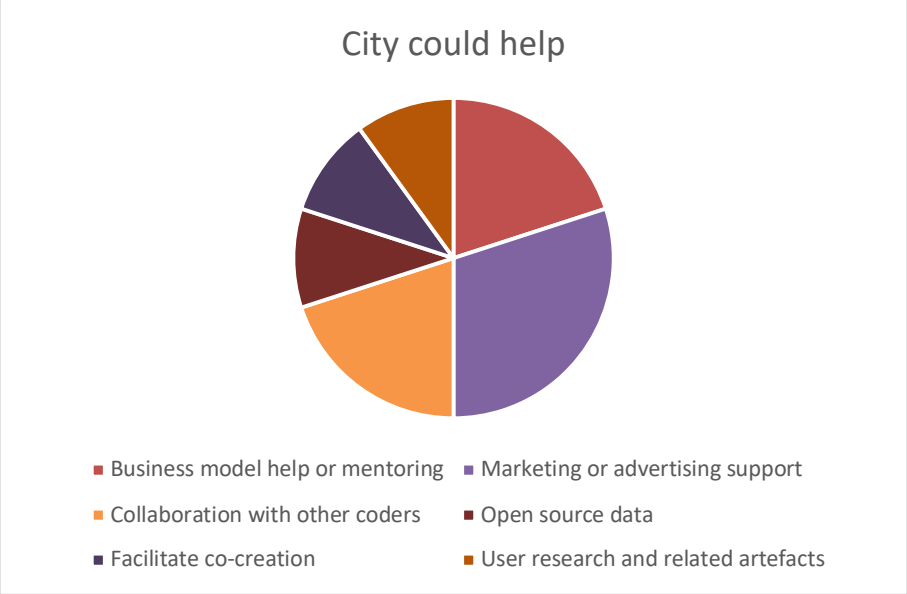

Figure 10. Ways Smart City Ecosystem Could Help

Instead of a standalone application, would you be interested in developing an application or functionality as part of a larger platform?

50% of the developers indicated they would be interested in developing application or functionality as part of a larger platform.
70% of the Smart City representative indicated interest with one indicating maybe in developing an application or functionality as part of larger platform.

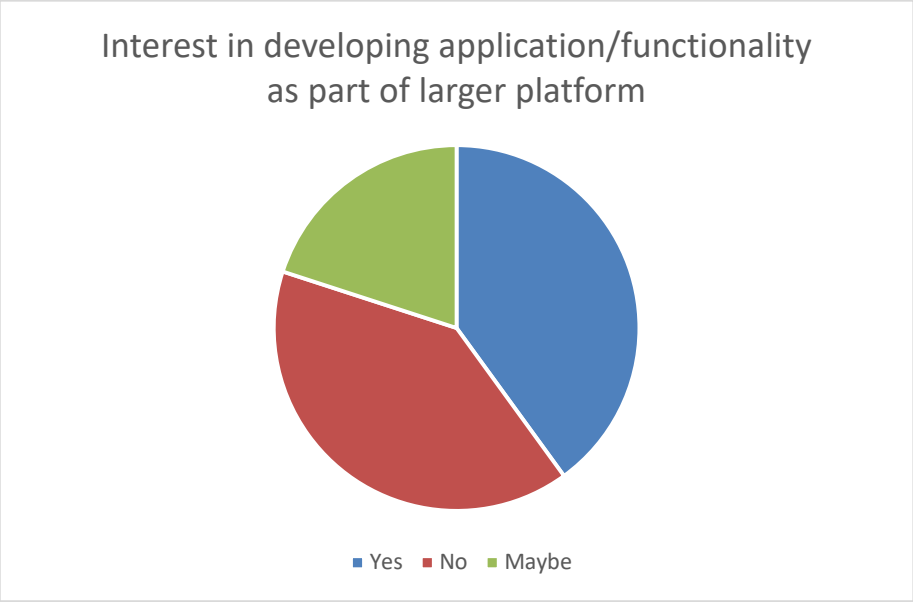

Figure 11. Interest in developing application/functionality as part of larger platform

Is it or do you see it possible if some software functionality or applications would be purchased or subsidized by the city?

30% of the Smart City representatives indicated interest.

Free form comments

Developer: Today it is very difficult to make any meaningful revenue with mobile apps. There is lots of competition (there are more than 10 journey planner apps for iOS), people don't want to pay for apps (don't seem to care about ads and tracking, selling of location data etc.), getting yourself heard in the information flow is close to impossible without a big marketing budget. Cities could really help by more prominently advertising, free or very low-cost apps and services, developed by individuals, hobbyists and small teams.

5.1.3 General survey: summary of data collection analysis

The following table summarizes the key takeaways.

Summary of key takeaways	
Revenue generating	All of the applications are revenue generating.
Business model	Subscription fee* Licensing* Advertising

	Usage fee Cost savings Priced App in store, no ads *With subscription fee and licensing being the highest
Profit after costs	50% indicated that application was able to generate profit after costs.
Associated revenues	One respondent indicated that there was associated revenues with the data.
Target customers and/or customer segment clear	Most of the respondents indicated that the target customer and/or customer segment were clear, only one indicated that it is was somewhat clear.
End user / customer benefits / value	All of the respondents indicated that the end user / customer benefits / value were clear.
Competitor product	All the developers indicated that there were competitor products.
Used methodologies, Design Thinking, Lean Startup	Developers: 75% indicated Lean Startup, 50% Agile, 25% Design Thinking Smart City Representatives: 70% indicated all the methodologies
Minimal viable product	Developers: 50% indicated MVP created Smart City Representatives: 100% indicated MVP created One respondent indicated, that the first iteration of the product could be called a minimal viable product, but nobody liked it, and that specific app required quite a few many features to be useful.
Testing minimal viable product	Most tested and collected the end user feedback on the MVP. One indicated that the MVP was showed to friends.

Pivot / Change in business model direction	Most of the respondents indicated that there was a pivot or change in the product or any part of the business model direction.
Growth	Growth was achieved primarily/mostly by word of mouth but also sales/marketing, side effect of product usage and repeated usage/purchase.
Can the city help in customer problem or solution	The city can help in business model help or mentoring, marketing or advertising support, collaboration with other coders, open source data and facilitate co-creation, with marketing and advertising support slightly higher than the rest.
Instead of a standalone application, would you be interested if developers would provide dedicated functionality or an application as part of a larger platform?	50% of the developers indicated they would be interested. 70% of the Smart City representative indicated interest with one indicating maybe.
Is it or do you see it possible if some software functionality or applications would be purchased or subsidized by the city?	30% of the Smart City representatives indicated interest.

Table 4. Summary of key takeaways

5.1.4 General survey: discussion, conclusions and recommendations

Since the hypothesis was that Smart Cities could enable revenue and growth and products in the Smart Mobility ecosystem by ensuring that the data re-users have access to the knowledge and expertise behind business model aspects, methodologies and tools. The questions from the survey/questionnaire targeted a lot of the Lean Startup concepts, as Lean Startup has an underlying theory that it can be used as a scientific method and the actions related to business ventures actions can be analysed to achieve validated learning (Ries, 2011, 55).

The responses related to the questionnaire indicated that the applications/products were generating revenue with about half being able

to generate profit. There was a variation of the business models used, with advertising, usage fee, priced app in store with no ads and cost savings being the same and subscription fee and licensing being the highest. One indicated that there was associated revenues with the data.

In Section 3.3.8, it was also mentioned that creating innovative products requires iterative and experimental processes which can be achieved by combining multiple frameworks (Lean Startup, Design Thinking, Agile) in order to really understand the real customer need, as well as Agile to effectively build the products and services (Blosch, Osmond, & Norton, 2016). The respondents indicated that Lean Startup was the most popular or well-known methodology, but also Agile and Design Thinking also were also used.

As mentioned earlier in Section 3.3.2, the Lean Startup focuses on concepts around the business model and has a human centered focus; it examines, for example, whether value has been created as well as how growth is realized and a key area within Lean Startup is the MVP, testing the MVP, collecting user feedback and pivoting if and when necessary (Ries, 2011) Most of the responses indicated that the target customers were clear and/or customer segment were clear, only one indicated that it was only somewhat clear. All of the respondents indicated that the end user, customer benefits and value were clear. All the developers indicated that there was a competitor product. Most respondents indicated that an MVP was created and that testing on it was done, and feedback collected. Most respondents indicated that a pivot or change in the business model was done. Growth was achieved primarily/mostly by word of mouth but also sales/marketing, as a side effect of product usage and also through repeated usage/purchase.

In terms of what the Smart City ecosystem could do to help, the responses indicated that mentoring, marketing or advertising support, enabling collaboration with other coders, facilitate co-creation with users would all be beneficial; with marketing or advertising support slightly higher than the others. One respondent indicated that it is very difficult to make meaningful revenue with mobile apps. The respondent indicated that users do not want to pay for apps, but they do not seem to mind about ads, tracking, selling location data; and in order for an app to stand out with so much information everywhere, a big marketing budget would be needed. The respondent indicated that cities could help by prominently advertising free or very low-cost apps and services. 50% of the developer respondents indicated that they would be interested in providing dedicated functionality or an application as part of a larger platform. 70% of the Smart City representative indicated interest with one indicating maybe. 30% of the Smart City representatives could see possible if some software functionality or applications would be purchased or subsidized by the city.

In summary and in response to the research question one and two, the survey responses indicated that the applications/products were generating revenue with about 50% being able to generate profit. Most respondents indicated that they are using the Lean Startup methodology, with Agile second and Design Thinking third. However, the Smart City representatives indicated that 70% using all three methodologies. It would seem that both from the Smart City perspective and the developer perspective there has been a business benefit of using the methodologies, however, there is a gap between the top-level and bottom-up awareness of methodologies, with potential benefits of exposing the developer community to ways that the methodologies could be used to help drive business, e.g. revenue and growth. In terms of developing the ecosystem, the application developers indicated that they would be interested in marketing and advertising support, mentoring, collaboration with other coders and facilitation co-creation with users. There is some interest from developers in not necessarily developing their own application but providing code or functionality for a larger platform. This would indicate that there could be ways to have code exchange or open source code marketplaces in conjunction with Open Data portals and data marketplaces. By developing the exchange of services, i.e. marketing or software code, there could be ways the ecosystem could enable cost savings in the development of the applications that could reduce the costs significantly and thereby increasing profit.

As can be seen from the survey data, the following conclusions and recommendations for cities can be the following:

- Design thinking, Lean Startup, and Agile are well in use and should continue to be, but especially the developer community could benefit from mentoring with potential benefits of exposing the developer community to ways that the methodologies could be used to help drive business
- Smart City representatives or leaders could facilitate activities within the ecosystem, e.g. facilitation co-creation with users.
- Developing ecosystem marketplaces for exchange of services would be beneficial, e.g. marketing, software code, which would enable cost savings in the production of products and services and thereby increasing profit.

5.2 Case study: Using Design Thinking to improve digital wayfinding

5.2.1 Introduction

The first case example that will be examined provides an analysis some basic concepts for designing a digital application in the Smart Mobility and

Open Data context. One of the basic ideas behind city mobility is wayfinding. Wayfinding from its initial roots, means how to navigate throughout the city using traditional means, e.g. signposts. The navigational means in the digital age have a parallel dimension, e.g. digital signposts or digital navigational aids. Incorporating wayfinding design concepts for the Smart Mobility context can also provide digital design benefits for application and service providers. In addition, because different applications are produced by independent application and service providers, one of the underlying issues is: will those applications seen as separate entities produced from different silos? And if that is not the desired effect, how to make the applications have the same look and feel even if they are created by different application service providers on different platforms? One way to improve this is using Design Thinking and developing an online design system for a city. And just as Open Data is available to all citizens, the design system and related design artefacts should be available to all citizens.

5.2.2 Aims, method and background information

This case study then gives background information, collects answers from Helsinki city's design expert, and helps to answer research question two, relating to a case example on what municipal cities do to enable the ecosystem.

So, in this case example, the purpose is to find out more information related to the following questions:

- What is wayfinding and how is it related to mobility?
- What is a design system and how can that be used to improve digital products and services?
- Perceptions of how Design Thinking, and design systems will help develop Smart Mobility Open Data applications.
- A series of related questions were then asked by then to a Helsinki city design professional.

5.2.3 Descriptive research and investigative results

What is wayfinding?

Wayfinding could be considered the basis of mobility as it is an underlying means on how people navigate to destinations. The Society for Experiential Graphic Design (SEGD) refers to wayfinding as the information systems that provide guidance through a physical environment and enhance understanding and experience of the space. Wayfinding is an important aspect in a complicated and especially in built environments as it enables navigation to guide people to destinations by providing visual

cues like maps or symbols. Wayfinding includes signage and information systems for pedestrians and motorists. (SEGD, n.d.)

The focus of wayfinding has generally been on the external environments as positioning information has been readily available, but with ongoing developments, wayfinding in internal environments are and could also becoming more reliable then has been traditionally possible with the emergence and development of modern technologies e.g. beacons or sensors. In addition, wearable devices such as smart watches and glasses, or virtual/augmented reality as well as wearable (including haptic or vibrating) devices will also extend the potential product and service opportunities.

The visual cues and creating navigation solutions requires that cities take into account design into the basis of designing navigational solutions. One such project in the UK is the concept of the legible city**,** which is part of the Legible Cities Movement. It began in the 1990's with the initial case of Bristol, where the city worked with designers to create innovative navigational solutions. The result was that it was a consistent network including such things as new directional signs and any related street information from printed maps, plaques and informational panels**,** which together constituted a wayfinding solution. Mike Rawlinson, a Bristol town planner who now runs his own company called City ID, conceived the idea and plans to extend the practice worldwide. Mike Rawlinson states "The crucial thing is to build any sign system as a system: it's a network, and you have to plan the routes. You do a lot of modelling – there is a science to this. You have to model new buildings or places through scenarios, data, flow data, trying to predict the needs of the user at any point in their journey. If you get that right, job done." (Poole, 2014)

In the physical or static dimension, there are elements of design that can be considered when determining the wayfinding system. Some examples:

- Signage relating to identification direction, information, regulatory including considerations of material, technology and symbols (Peate, 2018)
- Mental map navigational models around the environmental image such as paths, edges (e.g. boundaries), districts (e.g. areas with common characteristics), nodes (e.g. focus points like a town square) and landmarks. (Jeffrey, 2017, p. 513)
- Navigation types such as the strider and stroller, where a strider navigation type was seen as getting quickly to their destination and with the goal of getting near and then using environmental and informational cues to find their destination. On the other hand, the stroller navigation type, was more spontaneous like drifting and wandering, and not focusing on the information, but the environmental cues. (Jeffrey, 2017, p. 517–518)

In Sections 3.3.7, it was mentioned that user journey maps are an important part of service design, and journey maps also can be used in wayfinding. Jeffrey notes that Miller and Lewis, elaborate on the journey stages and relevant information needs when travelling to a new destination and they differentiate between physical/static and digital needs. The four journey stages are the pre-travel, en route, on site and destination. In the pre-travel stage, the static information would include such things as printed map and written directions, while in the digital dimension that could be a digital map and an internet search. In the en-route stage, the static information would include road signs while in the digital dimension that could be a smartphone map and digital road signs. In the on-site stage, the static information might include a directory and site map while in the digital dimension that would be a digital directory and site map. And finally, in the destination stage, the static information might be location sign and in the digital dimension it might be informational displays and site-specific app. With the evolvement of the interaction between the physical and virtual/digital environment, the information design boundaries are blurring and establishing information planning and design also as an integral part of digital wayfinding. (Jeffrey, 2017, 511, 521)

Legible London aimed at creating a seamless journey for both digital and static platforms for transport and wayfinding. The journey would include examples from bus shelters providing not only the bus routes but also the walking routes, to providing traditional walking maps, other digital solutions such as interactive apps with real-time travel information and mobile applications and also arrival signs providing orientation. (Jeffrey, 2017, 518, 519)

Navigational frameworks and outlines of journey stages are useful but also such design details as typography can help designers with wayfinding solutions. Rawlinson's worked on one project, the Moscow's legible transport network, which started with the transit system in Moscow and included typographic specialists (A2Type) that worked on a new design for the Cyrillic alphabet. Another wayfinding project for New York City which aimed at reduction of times people were getting lost, also used typographical elements, Rawlinson worked with the Monotype company, which has an award-winning font library and specializes in customizing fonts for various uses. In the New York City project, they used a Helvetica font that was adjusted. (Poole, 2014) Also, in the Legible London project, the original font was replaced to New Johnston (de Graaf, 2011).

With all the design improvements, there are tangible results that can be drawn from these types of wayfinding improvements. This can be seen in an evaluation of the Legible London case in 2007, where an independent evaluation showed such improvements such as 33% reduction in

pedestrian journey time to destinations, “lost” users from overseas were reduced from 17% to 8%, as well as numerous other improvements. Some lessons that could be drawn from the Legible London case: evaluate user behaviour, encourage use of the same information elements everywhere e.g. map, naming. In addition, and probably the most important in the context of the Legible London case, was to consider the trends in the relationship between mobile information and the physical infrastructure. (de Graaf, 2011)

What is a design system?

When entering the digital dimension, and especially the software environment, companies/enterprises with different designers and/or developers may produce software applications with different look and feel which might not be an optimal output. For example, if a company or enterprise has a brand, they ideally might want all the applications that they produce to have the same look and feel and/or branding. One of the challenges when developing a software product, is that there are different styles and/or design directions that a UI/UX designer and/or a software developer might have to consider. And when developing software for a large company/enterprise, there might be various different software applications, so the variance in UI development will be a considerable concern. Generally, UI designers/developers will need a framework that will help them develop consistent UIs. How to ensure that all designers/developers create applications accordingly? A concept to enable this is to create a Design System. So, what exactly is a Design System?

The UX collective, in the medium article defines a Design System as the “single source of truth which groups all the elements that will allow the teams to design, realize and develop a product.” Some of the deliverables of a Design System are a Style Guide, which shows usage guidelines for such things as colours and fonts, as well as a Pattern Library, which will show the functional usage of UI components. The terms, components and patterns, are somewhat different as the components are the elements used by designers and developers to construct the UI, but patterns are similar to instructions or recommendations on how to use the components in a consistent way across all products. (Hacq, 2018)

A lot of companies have or are going public with their Design Systems, they can be browsed in various types of online repositories. Adele is one such example (Adele, n.d.). The online display of design systems for cities are not as readily available in 2020 as much as in the private sector, however it does seem to be a growing area as well. Jukka Tuominen the Chief Experience Officer (CXO) of the city of Helsinki mentions some benefits of creating a Design System for a city. He mentions that creating coherent and consistent look and feel by using software components and guidelines, manages software in large scale and makes technology transitions

controlled and flexible. It also reduces redundant work, as there can also be parallel but separate style definitions, e.g. city branding. Jukka Tuominen states that there is cooperation within Helsinki and with other cities and stakeholders as well. (Tuominen, 2019)

Some cities might not have a full-blown Design System, but some level of design artifacts online. Transport for London has a digital toolkit where they have various standards and guidelines for use by staff and suppliers when working on digital services (Transport for London, n.d.). The digital toolkit is a comprehensive site, with various downloadable standards and guidelines. It has also artifacts about users, e.g. personas, user testing and research information. It also has downloadable documents for design and content, e.g. that show the standard icon usage, informational architectural principles and a style guide. Although the site is currently very extensive and useful, it fits more into a traditional style format with guidelines in PDF format, but what seems to be missing in January 2020 is the latest incorporation of Design System ideas, i.e. code examples integrated with modern pattern and component usage guidelines.

Investigative results

The following questions were asked of Jukka Tuominen the Chief Experience Officer (CXO) of Helsinki (email interview 4 February 2020). The questions are listed on the left and his responses are listed on the right.

Question	Jukka Tuominen's response
How do you display or document the design requirements, style, typography etc. Is it on your website?	The overall Helsinki brand guidelines are visible in public brand.hel.fi website. Adaptation to user interface design is under work at the moment. Once it reaches a mature state, it will be made public, as well. That will likely happen later this year, probably in autumn.
Would you think it a good idea for cities to publish their design systems alongside Open Data i.e. in Open Data portals?	Yes, I do. Public organizations' have no reason to keep them secret and sharing them could be beneficial to others (say, consistent accessibility conventions).
If citizens or independent developers would have access to the design system what are your thoughts?	Helsinki is actively trying to support third-party developers, so that they can contribute to ecosystem around Helsinki services. There is no reason to deny this from individual developers either, be it professional or otherwise.

Have you used wayfinding design elements in the physical dimension? If so, what were they?	So far, we haven't had such use case to my knowledge. This doesn't mean, there hasn't been such somewhere in the city, but there is no such content in the current design system. We add content based on the actual needs from various projects rather than potential need, so based on the product cycles, content contributions vary in time. Additionally, some of the city departments haven't yet transitioned to use the new design system. The whole of Helsinki is planned to use the same design system, eventually.
Are you using some of the same design elements in the physical dimension (like typography) as in the digital dimension? If so, what were they?	All design elements, such as typography, colours, and icons are planned to be used coherently and consistently. The domain they are used in, may need some adaption, but in the end, they should appear as part of the common look and feel.

Table 5. Questions and answers regarding wayfinding and design

5.2.4 Discussion, results and recommendations

When designing digital solutions, wayfinding concepts are an underlying consideration for facilitating navigation in the digital dimension. Designing mobility solutions would benefit from considering wayfinding and design elements, such as, navigational models, navigation types, user journey maps and typography. Utilising the same underlying design principles from the physical dimension can facilitate and bridge the physical and digital dimension.

As an emerging trend, businesses and cities are producing online design guidelines and Design Systems. Online design guidelines and Design Systems provide a framework to help designers/developers develop consistent look and feel for digital products and solutions, even across various application platforms.

As can be seen from the Jukka Tuominen's interview, in the Helsinki case, there are already design guidelines available on their pages and ongoing work to make user interface guidelines available to the public. As a public organization, there would be no reason to keep those proprietary and there could be various benefits to the public, as it would provide consistency in such things as accessibility conventions. In addition, it is in Helsinki's interest to support third-party developers and enable their

contribution to the ecosystem. Currently in Helsinki's case, there wasn't any knowledge that they have coordinated with wayfinding design elements from the physical dimension, but there could be and there are plans that the entire Helsinki would eventually use the same Design System. All design elements are planned to be used consistently.

From the descriptive research, Legible London does seem to be an example of a city leading the way in creating a seamless journey for both the digital and physical dimensions and specifically for transport and wayfinding. Legible London takes into consideration various transport mediums from walking to bus routes and their corresponding mapping needs, from traditional walking maps to other digital solutions such as interactive apps. Legible London was also able to show that the wayfinding design improvements had actual results, for example, reducing the pedestrian journey times and reducing the number of lost users. The lessons from the Legible London case also illustrate the importance of evaluation of user behavior as well as using the same information elements everywhere. In addition, the correlation between the mobile information and the physical infrastructure was deemed important.

As can be seen from the research in this case study, the following conclusions and recommendations for cities can be the following:

- For Smart Mobility solutions, it would be beneficial to coordinate design elements, i.e. especially wayfinding design elements, from the physical and digital dimension.
- Creating and ensuring the development of a Design System is a way to enable independent developers that are creating different applications on different platforms to have applications with the same look and feel, this can help develop the UX or user experience and enhance the business case and attractiveness for independent developers.
- Cities have to ensure design artefacts are also easily accessible online and from Open Data portals.

5.3 Case study: OASC and Synchronicity - scaling interoperable mobility solutions across cities

5.3.1 Introduction

The second case example that will be examined provides an analysis of solution that addresses the Smart Mobility problem area of interoperability. One of the problems as was mentioned in Section 3.1.8, City as a platform, is interoperability. So, the second case study that will be examined is related to finding solutions to the interoperability challenges that cities face and at the same time enabling various monetization

strategies. How are cities finding solutions to interoperability challenges? If cities adopt solutions that are fragmented and not interoperable it will significantly increase the costs, so decreasing costs with standardized solutions that focus on re-use and replication will be advantageous for smart cities. This case study will examine the case of OASC and Synchronicity, which is one interoperable solution that can be deployed in various cities and enables the concept of data marketplaces and the monetization of data. One way to improve this solution is by examining successful factors and related solutions which will result in recommendations for improving the current challenges that cities face.

5.3.2 Aims, method and background information

This case study then gives background information on OASC and Synchronicity and offers comparison ecosystems which draw insights which helps to answer research question two, relating to a case example on what municipal cities do to enable the ecosystem.

So, in this case example the purpose is to find out more information related to the following questions:

- What is OASC and Synchronicity and how does it improve interoperability?
- How can this solution and the data marketplace concept be improved and extended taking into account related solutions and ecosystem factors?
- By taking ecosystem factors into account, how can it improve the business aspects and profitability of Open Data re-use?

5.3.3 Descriptive research and investigative results

OASC and SynchroniCity

One solution is to ensure the creation of Smart City market with interoperable mechanisms. This is currently being done by Open and Agile Smart Cities (OASC), founded in 2015, which is a coalition of 100+ cites from various countries. OASC is creating a Smart City market and adopting MIMs (Minimal Interoperability Mechanisms) such as shared data models, real-time APIs for marketplace/ecosystem transaction management and context information (context information is data from various sources relevant to what is happening in the city at any given moment). (OASC, 2019, Annex 1) MIMs are considered the tools for achieving interoperability in systems, data and services between cities and global suppliers. (Tomas, 2019) One of the underlying concepts is that MIMs open

up the global market by enabling cities to develop once and potentially deploy many times.

OASC's focus is on implementation and the results can be seen and validated in the SynchroniCity project. SynchroniCity was initiated to create global collaborative IoT digital services, some of the related goals are to achieve standards-based innovative solutions that are able to demonstrate such things as interoperability and reusability. Standardization is also playing a part, a related example is FIWARE, which is an open source initiative that aims at building a set of standards related to e.g. smart cities, and collecting, managing and publishing context information. FIWARE also offers solutions so that applications and solutions could be ported from one customer on to another as well as providing solutions to multiprotocol communication/multisensor networks, translating information gathered from sensors to a common language. (TMForum, 2019)

One such example of this, is CEDUS or City Enabler for Digital Urban Services, which enables cities to use urban data using an open platform. A related project using CEDUS, Select for Cities, enables large-scale co-creation of urban IoE (Internet of Everything) applications and services with the idea of having a single solution and scaling it for use in different contexts, e.g. mobility in Antwerp and health in Helsinki. The CEDUS solution gathers data from different sources and displays it in a single application. Standard APIs enable openness to other platforms and there are no lock-ins which enable full access to the ecosystem. CEDUS already has pilots in different cities and plans to extend that to other cities. (EIT Digital, 2017)

Besides the CEDUS' open platform solution, SychroniCity has also solutions for various contexts and they are being deployed in more than one city, the following are some Smart Mobility examples:

- Autonomous Hub for Cyclist is a sustainable mobility solution, that offers a safe way to store your bike. The app-based solution provides a safe place to park bikes and provides video surveillance which is technological intelligent and connected. The cities involved in this project are Santander and La Nucia. (Synchronicity Autonomous Hub for Cyclist, n.d.)

- BlueAlpaca is an open challenge solution, that can be used in mobility solutions as well as other types of solutions. It consists of nine chatbot applications addressing citizen needs and connected to IoT data streams. Available from different pages, all chatbot applications having the same U-Hopper Chatbot Framework. The cities involved in this project are Antwerp, Helsinki, Milan and Santander. (Synchronicity, n.d. a)

- Kimap-city is a sustainable mobility solution, which provides accessibility maps for public transport. It can be used by individuals that have disabilities or the elderly and helps them navigate through the city and use the public transportation that fits their needs. The collected data will enable creation of maps related to the accessibility information concerning points of interest and the main public transport lines. The cities involved in this project are Porto, Santander and Milan. (Synchronicity, n.d. b)

- KissmyBike, is a sustainable mobility solution, which is an IoT tracking solution for bicycles and small vehicles designed for theft protection and will track the location until it is successfully recovered. It will alert the owner, tracks in real-time and the position of the stolen bicycle or vehicle can be seen in an app.
  Any data that is collected, can be used and analysed by cities to develop insights related to e.g. to cycling routes and urban security. The cities involved in this project are Milan, Santander and Antwerp. (Synchronicity, n.d. c)

- See.Sense Smart Cycling is a sustainable mobility solution that looks to encourage non-motorized travel. The project will collect data from citizens, e.g. journey information and road surface quality. With that data it aims to work on an International Standard for cycling data. The cities involved in this project are Manchester, Dublin and Antwerp. (Synchronicity, n.d. d)

SynchroniCity also has the concept of an IoT data marketplace which then allows data providers to expose, exchange and trade IoT data. The concept is being developed and the core aspects of the digital marketplace include such things as a having a data catalog and monetization for transactions. The marketplace is being developed using FIWARE but also using TM Forum's Business API Ecosystem which is a set of standard APIs that facilitate selling and the lifecycle and monetization of assets which includes such things as charging and revenue. There are various APIs, e.g. Catalog Management, Customer Management and Billing Management. It is operational in the city of Santandar, Spain with various other cities already deploying it or planning to deploy the solution. (Hibberd, 2019)

TM Forum has also released a Smart City Operation Map, which provides a business operation framework which allows other technology partners from other areas, e.g. telcos to integrate and benefit from the interoperability of city data. It helps smart cities avoid repetitive business processes, provides a systematic view of smart cities operations, and enables a cooperative framework and digital ecosystem which can solve challenges for both buyers and sellers. There are 10 cities in China that

have already implemented TM Forum's Smart City Operation Map. (Mobile Europe, 2020)

Comparison ecosystems

The next areas will list some comparison ecosystems, that can be used as inspiration on how to evolve the OASC and Synchronicity as an example of a Smart City ecosystem. There will be further analysis and summarization in the following section.

Other comparison ecosystem: City:One Challenge

Since OASC and Synchronicity is focused currently on European cities, a related concept but with a different focus will be analysed next. OASC and Synchronicity seems to be missing the visible enterprise and company collaboration, by contrast, North-American-based City:One challenge, which gives a slightly different perspective, focusing on mobility and it also has more enterprise/company collaboration with such companies as Ford Mobility, AT&T, Dell Technologies and Microsoft collaborating in the project. City:One Challenge incorporates community engagement is a core part of their process. There are five phases (explore, propose, refine, select, and pilot) that are directed at community engagement, firstly their objective is to explore the questions around existing problems in transportation needs and options, secondly to propose ideas, thirdly refine those ideas developing full pilot proposal for their communities, fourthly selecting the top applicants which will receive up to $100K for piloting, and then the challenge winner(s) receive contract awards. There are several cities involved, e.g. Austin and Indianapolis. (City:OneChallenge, n.d.) Their website is transparent and interactive, with the city stating the problem and then following up each phase. Each participant from the community can have their own page where they can contribute with their proposals which: describe their solution, the stage of development, list insights from previous testing, describe the team or organization, funding request and budget, describe a plan to pilot and contact details. The proposals can be commented on freely from other members of the community.

Other comparison ecosystem example: Using open-source software for service creation

Within the ever-developing ecosystem of open source software, open-source has become the industry standard as software developers can use the source code from existing applications and use that code for their own projects which can cut considerable development time. Open source software is developed in a collaborative way, from tech company employees to unpaid volunteers. The code is written and developed freely, and in the present day, most software businesses rely and even lead

projects dealing with open source code, and that includes such companies as Intel, Google, Amazon, etc. In modern programming, there generally is just too much software to be written, so it doesn't pay not to take advantage of open source, as companies working only internally generally cannot compete or not take advantage of the millions of open source developers collaborating in repositories like GitHub, which hosts the majority of open source software. Since open source software is free, open source companies' monetization options focus on such things as support services. As a considerable amount of open source developers are volunteers, there has been an issue on how developers would receive payment for their work. There seem to be evolving solutions to that, with concepts like GitHub Sponsors which is a funding model to offer donations to developers which theoretically could make it possible for developers to even fully support themselves just writing open source code. (Brigham, 2019)

GitHub Sponsors is similar to Patreon which has a proven their business model for, e.g. artists or developers. There can be various funding levels and will be able to accept recurring payments from their support network directly in GitHub. Microsoft, which owns GitHub, will also be supporting the venture in the early stages, by matching sponsorship payments up to a certain level. Other facilitation mechanisms, like linking to other funding pages, are also encouraged. (Kastrenakes, 2019)

Other ecosystem examples: replication projects like STARDUST and IRIS

Stardust is an EU Horizon 2020 Smart Cities project which works with advanced model cities which are grouped together. The project has three lighthouse cities and then four follower cities which will have innovative solutions for energy, mobility and ICT which include the following targets: creating the innovation islands or urban incubators that can demonstrate e.g. scalable and cost-effective solutions, creating a smart ecosystem, creating an open city information platform within the cities, and transferring and replicating the lighthouse cities' solutions. They will replicate and validate energy, mobility and ICT solutions, taking into consideration innovative business models, which can then act as blueprints for other cities. (Build up, 2018)

The IRIS project is similar to the Stardust concept and has both lighthouse cities and followers. It commits to six action clusters which are set by the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) which include such things as citizen focus, business models, finance and procurement, urban mobility, integrated infrastructures and processes (which includes Open Data). IRIS also published the paper that was discussed in Section 3.2.2, adapting the Business Model Canvas to the Smart City ecosystem. (IRIS Smart Cities, n.d.)

Other ecosystem examples: Freelance platforms, e.g. Fiverr

In the present day, there are more and more independent workers that can practice the skill of their trade via freelance platforms, e.g. Fiverr. Freelance platforms generally offer contractors the opportunity to create their own profiles that lists their work experience and qualifications, bid on projects, facilitate monetization and payment options. Freelance platforms offer a flexible and convenient medium for both contractors and businesses/employers to meet and trade services. (Gilbert, n.d.)

Some findings from Upworks study included: 57 million Americans are now freelancing, freelancing income is exceeding the GDP of many industries at nearly 1 trillion dollars, full-time freelancing increasing, flexibility, and ever-increasing freelancing among younger generations, with 53% of Gen Z workers (18-22-year olds) now freelancing. (Upwork, 2019)

Sitra IHAN project, Fair Data Economy and Rulebook

Sitra, the Finnish Innovation Fund, has an IHAN project which is aiming to build the basic foundation for data economy that is fair and functioning targeting creation of a method for data exchange as well as European level guidelines and rules (Sitra, n.d.). The fair data economy is a Finnish led European initiative which aims to have better trust-based usage of personal data, so that it enables individuals to have control of their data and increase the data pool, and at the same time enabling new possibilities for services to emerge and also enable data exchange between service providers (Sitra, n.d. a). In 2020, Sitra as part of IHAN project, is developing a rulebook, with tools and templates, which offers a framework for how data can be shared in order that it can enable data network building. It is also working on enabling operational data ecosystems with MVPs and data ecosystem pilots. The Rulebook encompasses business, legal, technology, ethical issues and, as part of the Rulebook's Business Annex there is a Data Ecosystem Canvas, which is based on the Business Model Canvas, and is a high-level summary focusing on the business design of the data network. The canvas focuses on such things as purpose and core needs, key stakeholders and their roles, ecosystem scope, rules and business models, data streams and value transfers, and governance and KPIs. (Sitra, 2020)

Data sharing and Support Centre for Data Sharing (SCDS)

Support Centre for Data Sharing (SCDS) is an initiative funded by the European Commission in order to support development of the Digital Single Market with the objective to enable data sharing, for free or with payment or other reward, where data from either public or private sector is available to other organization for use/re-use. (Support Centre for Data Sharing, n.d.)

A data sharing example for Smart Mobility is Mobility as a Service Madrid (MaaS Madrid). In the MaaS Madrid case, overall lack of public awareness of the public transportation options is seen to be a usage barrier, and can result in increased private car usage, road congestion and poor air quality. In the MaaS Madrid example, there are various mobility operators both public and private and they are working together to create a multi-modal and single integrated platform. The goal is to create an initial version that integrates all the mobility data from the different data providers. Sharing the mobility data increases the potential of a successful business models, as if all the data providers share their data, then the users of the transport services will have better access to quality services, and a private car will be less convenient. MaaS Madrid aims to have the best travel options to get from point A to B and will be based on user's preference, purchase history and payment options. A key aim of the app is to be more interactive and provide incentives to use mobility services over private cars. An example of an incentive would be if that a user could accumulate reward points by using a shared bike and then a bus, that could then be exchanged for a free coffee at the public transport station. (Support Centre for Data Sharing, n.d. a)

Another example related to data sharing is the Data Sharing Toolkit, that collects e.g. recommendations and resources from data sharing projects in creating sustainable businesses and was collected as a result of Data Pitch which is an EU H2020-funded open innovation programme. A significant challenge found when data sharing was that data holders, e.g. private organisations, have to change the way they have been working in order to facilitate open innovation and share data with others. (Support Centre for Data Sharing, n.d. b)

In addition to Open Data, the Data Sharing Toolkit lists established data sharing forms for various contexts: 1) Data commons are where resources are held in common and accessible to all within a group 2) Data collaboratives are where private data is shared for social good 3) Data marketplaces are where data is bought or sold through an intermediary platform 4) Data trusts are where they work within the law for trustworthy data processing. The financing behind data sharing can come from various means, for example, financing can come from marketplaces that sell licences directly or then working within various mechanism behind funding in the ecosystem and cost reduction mechanisms. (Thuermer, Walker, & Simperi, n.d., p. 6, 28)

The Data Sharing Toolkit states that the benefit of data sharing is primarily economic but provides benefits to various actors within the ecosystem: data holders, innovators, intermediaries and society:

- Data holders, or the organizations where the data is controlled, could have various reasons to benefit from sharing data for

example, they might not be able to solve an issue in house and external skills could be beneficial, and by sharing data there could be efficiency savings and they could explore or develop new or improve existing products/services.

- Innovators/data users can use the data to develop new insights and new products/services and can do this in innovative ways by extending the data sets to provide more value, e.g. mutual pooling of data or supplementing data with own data. Data users can also have a business relationship with the data holder as well as have insights to new markets.

- Intermediaries enable to scale the data sharing process in various way and act as a go-between for data holders and users. There is various type of intermediaries, but are generally seen as a third-party organization or platform that enable data sharing between organization, institutions, individuals etc. Data trusts could act as an intermediary by pooling data from individuals and on their behalf negotiates terms of use for the data. Intermediaries reduce complexity by managing the relationship with the data holders and could bundle data holders, data subjects, data itself and then determine the accessibility terms, rules and obligations (e.g. legal requirements like GDPR) on how to access data. In addition, intermediaries can do matchmaking, like provide marketplace functions between data holders and users; provide infrastructure for sharing data; creating trust in e.g. various negotiations related to data sharing; provide various support services; and advise and develop best practices.

- Society can benefit from data sharing in many ways, in various innovation contexts and products and services that are created.

(Thuermer, et al., n.d., p. 7–12)

5.3.4 Discussion, results and recommendations

The following tables summarizes the benefits and key points with OASC and Synchronicity being the primary case and the others being the comparison cases.

Summary of Key Ecosystem Benefits	
OASC and Synchronicity	• Coalition of 100+ cities • Interoperability and reusability as key concept • MIMs (Minimal Interoperability Mechanisms) • Standardization (e.g. FIWARE for collecting, managing and publishing context information) • Actual implementation examples are shown in Synchronicity project, with solutions that are existing in multiple cities so utilising the benefits of the global market by developing once and deploying many times. • IoT Data Marketplace which uses TM Forum's Business API Ecosystem which is a set of standard APIs that facilitate selling and the lifecycle and monetization of assets which includes such things as charging and revenue.

Table 6. Summary of Key Ecosystem Benefits

Examples of Comparison Projects and Benefits for Contrast	
City:One Challenge	• Enterprise and company collaboration, e.g. Ford Mobility, AT&T • Community engagement (5 phases, explore, propose, refine, select and pilot) • Incentive to winner with 100K for piloting + contract award • Transparent and interactive website • Community participation encouraged with option for participants to create own page outlining proposal with interactive commenting possible
Open Source Software, e.g. GitHub, Patreon	• Re-use open source code • Cost savings • Open source monetisation strategies: services and funding models with donations to e.g. developers
Freelancing platforms, e.g. Fiverr	• Increasingly popular, especially among younger generation • Flexibility and convenience • Facilitate monetization and payment options
Replication project: STARDUST, IRIS	• Concept of lighthouse (leader) and follower cities to ease replication of solutions to other cities.

	• Takes into account business model innovation including the entire Smart City ecosystem (i.e. Business Model Canvas – Smart City)
Sitra IHAN project	• Rulebooks with tools and templates to facilitate data sharing • Addresses business, technological, legal, ethical issues • Pilots and MVPs to enable operational data ecosystems • Takes into account business model innovation including the entire data ecosystem (i.e. Data Ecosystem Canvas)
Data sharing, SMSC, MaaS Madrid, Data Pitch and Data Sharing Toolkit	• SMSC objective to enable data sharing, for free or with payment or other reward, where data from either public or private sector is available to other organization for use/re-use. • MaaS Madrid example of working together to create a multi-modal and single integrated platform for sharing data • MaaS Madrid plans to use user's preference, purchase history and payment options as well as incentives, like reward points that can be exchanged • Data Sharing Toolkit provides recommendations and resources for data sharing based on learned experience from Data Pitch • Data Sharing Toolkit and data sharing recommendations work with the underlying principle of Open Innovation

Table 7. Ecosystem comparison

OASC and SynchroniCity framework and initiatives address and provide solutions to a lot of the basic interoperability challenges that cities face: it has developed a coalition of 100+ cities, mechanisms to ensure interoperability, reusability and standardization with actual implementation projects realized within the Synchronicity project. It also is developing the concept of an IoT data marketplace and uses standard APIs, facilitating selling.

Similarly, there are the comparison projects that can also offer different perspectives, that can provide insights in order to enhance the OASC and Synchronicity ecosystem. By taking the best practices and innovative ideas from comparison examples, the Open Data ecosystem can develop in similar and optimal ways. It should be noted that there could be numerous

other comparison projects, but the ones that are highlighted here are included to just give some examples and recommendations of how the ecosystem could be developed:

- Ecosystem engagement within the portal ecosystem encouraging product/service providers to create their own pages detailing their solutions with more active interaction within the local ecosystem
- Utilizing the synergies between cities, create/develop once and deploy many times, more transparency.
- Utilizing tools for business model innovation: Business Model Canvas – Smart City, Data Ecosystem Canvas
- Private/enterprise/company collaboration that provide funding and incentives
- Open source software creation and re-use within the local ecosystem with funding mechanisms
- Access to freelance exchange platforms with the local ecosystems, for IT/software/marketing/designs services
- Enable data sharing, for free or with payment or other reward, where data from either public or private sector is available to other organization for use/re-use.
- City enabled incentives/rewards offered as part of the applications/services.

Metrics should measure the success of the product and solutions as well as the ecosystem factors. If the related metrics only measure Open Data then the ecosystem factors will be ignored: business factors related to the re-use solutions, trade marketplaces i.e. data sharing and the data marketplace, code exchange, service exchange.

These ecosystem recommendations can be further visualized in terms of how to monetize the ecosystem, so a subset of the factors behind the recommendations are illustrated in the following diagram.

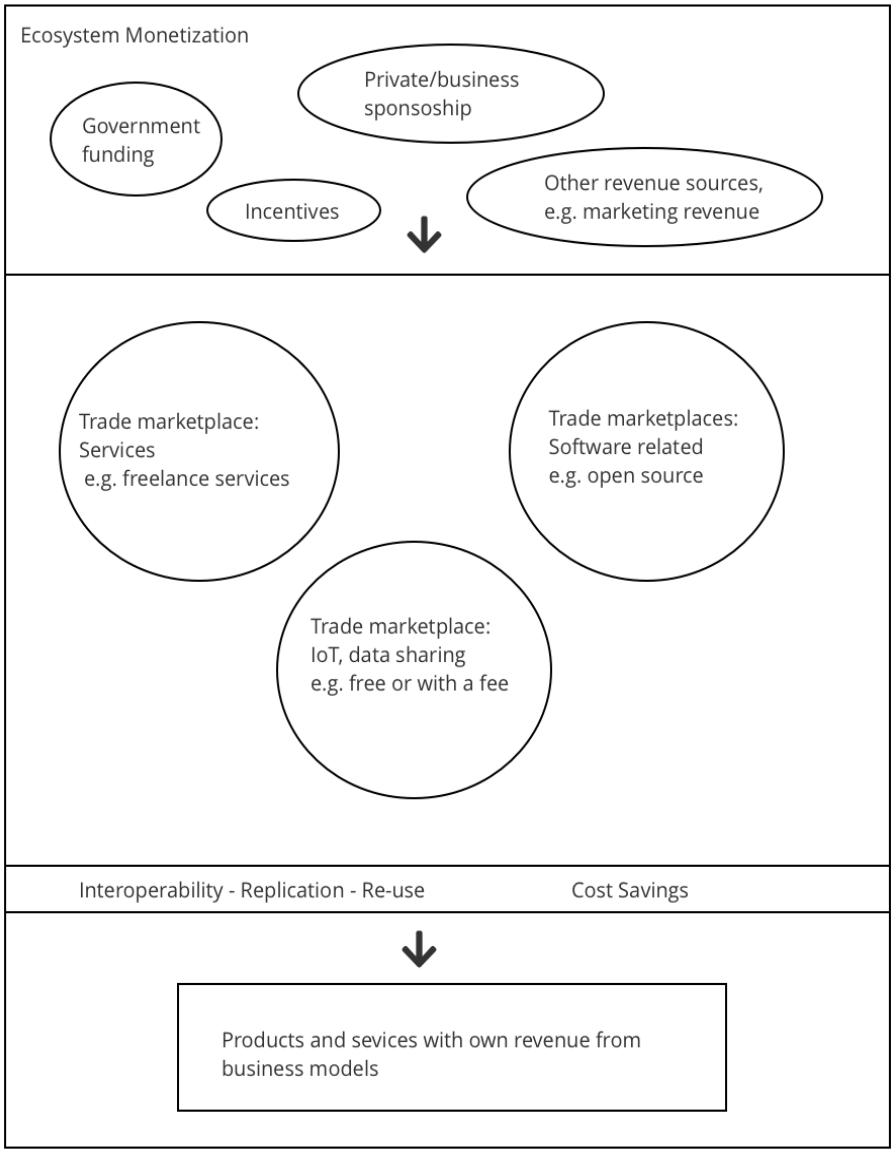

Figure 12 Ecosystem monetization factors

6 OVERALL SUMMARY AND CONCLUSIONS

The Open Data situation has evolved in the last decades and Open Data maturity has evolved from acceleration to consolidation. A lot of countries no longer have the sole focus of only publishing data but also extracting benefits from the data and looking forward to the re-use benefits of sharing data in the public and private sector.

The research objective was to determine the business aspects needed to make Open Data product/service development successful and profitable for citizens and businesses in the Smart Mobility context. The general survey focused on research question one and two, which brought out

insights on what business aspects are actually working and profitable for individuals and businesses. The case examples focused on research question two, regarding what municipal cities could do to enable the ecosystem and addressed the challenges within the ecosystem, using Design Thinking to improve digital wayfinding and scaling interoperable mobility solutions across cities.

As can be seen from the results from the general survey questionnaire, revenue is being generated from Open Data applications using a variety of business models; but focusing on increasing profit would be an area to improved. Multiple methodologies and frameworks, e.g. Design Thinking, Lean Startup and Agile are in use to some extent and will continue to be, but the re-users and developer community could benefit from more mentoring and exposure to the details regarding the methodologies and frameworks and there could be ways that the Smart City ecosystem could facilitate that, e.g. enabling co-creation with users. Developing the ecosystem could facilitate cost savings, which could be generated by developing and utilizing the ecosystem benefits such as exchange of services, i.e. marketing and open source software code exchange, which could cut the development costs and thereby increase profits.

The first case study examined design solutions for the Smart Mobility context. There would be benefits to coordinate wayfinding design elements from the physical and digital dimensions. Independent developers are producing various applications on different platforms. Currently a lot of Open Data portals focus on Open Data but they should be extending portals to also publishing design artefacts, e.g. online design guidelines and a Design System as well as other artefacts, UX research, customer journeys and service ecosystem maps, which would help independent developers develop the business case and create applications with the same look and feel regardless if the application is on a different platform.

The second case study examined the case of OASC and Synchronicity, which is one interoperable solution that can be deployed in various cities and enables the concept of data marketplaces and the monetization of data. Comparing OASC Synchronicity with comparable ecosystems examples brought out insights such as advantages in private/enterprise/company collaboration that could provide funding and incentives, city enabled incentives as part of application/services, enabling more active interaction and engagement within the ecosystem, achieving cost savings by utilizing freelance exchange platforms for exchanging services and enabling open source software creation and reuse. There are also evolving open innovation business aspects like data sharing from public and private sector for free or with payment, and emerging tools that are encouraging open innovation by extending business model possibilities i.e., the Business Model Canvas – Smart City and the Data Ecosystem

Canvas. Scaling solutions across cities with interoperability, replication and re-use, can enable the creation of an open ecosystem, which can result in more successful business ventures.

The shift going forward will be going from Open Data maturity to Open Data Ecosystem maturity with the focus on data sharing and validating the solutions in the field. This is currently following the trend setter's perspective and in actuality is already being seen in emerging solutions as can be seen in the case study OASC and Synchronicity. As the ecosystem matures, so too will the business benefits and efficient ecosystem monetization. Business model analysis and extending ecosystems with concepts from similar ecosystems will result in data sharers and re-users having viable business models with increased areas of revenue and growth, and product and services could be produced with efficient costs savings and then replication could be done across ecosystems for further efficiency and re-use.

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Appendix 1

SURVEY QUESTIONS

Survey question targeting business professionals	**Survey questions**
Do you have an interest to develop the Smart Mobility applications/services (e.g. journey planner, transport, parking etc.) on top of Open Data? Yes No	Have you created/developed a Smart Mobility application/service (e.g. journey planner, transport, parking etc.) on top of Open Data? Yes No
What is your name and email address? (this is optional, but helps with ensuring the validity of the research data, all data will be kept anonymous)	What is your name and email address? (this is optional, but helps with ensuring the validity of the research data, all data will be kept anonymous)
Have you been involved with developing a specific Smart Mobility application or service on top of Open Data? If so, where can the application/service be found, for example, what is the web address, the data set and can you describe the application (if more than one, you can focus on the most prominent one)?	Where can the application/service be found, for example, what is the web address, and can you describe your application? What was the Open Data set used?
What role or title do you have?	I work: • as an independent product/service developer • in small company < 50 people • in a medium sized company > 50 but < 250 people • in a large company > 250 people • Other If you aren't a software developer what role do you have?

Has/or have the application/service provider (s) been able to generate revenue? • Yes • No	Was/is your application able to generate revenue? • Yes • No
How did the application/service provider receive revenue? • Usage fee • Subscription fee • Licensing • Brokerage fee/commission • Advertising • Cost savings • I don't know	How did you receive revenue from your product? • Usage fee • Subscription fee • Licensing • Brokerage fee/commission • Advertising • Cost savings • I don't know
Were there any other associated revenues, e.g. with the data produced?	Were there any other associated revenues, e.g. with the data produced?
Are the benefits/value of the Smart Mobility application/services to end users / customers clear?	Was/is your target customer and/or customer segment clear?
Are there competitor products that deal with the same Smart Mobility area?	Are there competitor products for your product and, if so, how did you differentiate from competitors?
The following picture illustrates Design Thinking, Lean Startup and Agile methodologies. Have/did you seen any of these methodologies used when developing products/services? • Design Thinking, or researching about the user base, researching/ideating the customer/user problem • Lean startup: build - measure - learn, experimentation, creating a proof of concept or minimal viable product and collecting feedback for validated learning • Agile • I am not aware of any methodologies, just interested in developing applications and services. • Other…	The following picture illustrates Design Thinking, Lean Startup and Agile methodologies. Have/did you use any of these methodologies when developing your product? • Design Thinking, or researching about the user base, researching/ideating the customer/user problem • Lean startup: build - measure - learn, experimentation, creating a proof of concept or minimal viable product and collecting feedback to validate learning • Agile • I didn't use the methodologies, I just developed an application. • Other…

The following figure illustrates the concept of a minimal viable product or most basic proof of concept product possible. Was a minimal viable product created in any product/service?	The following figure illustrates the concept of a minimal viable product or most basic proof of concept of a product possible. Did you create a minimal viable product?
Once the product or minimal viable product was created, was it tested and collect end user feedback on the product?	Once you produced the product or minimal viable product, did you test it and collect end user feedback on the product?
Based on feedback received on the products/services, was there a pivot or change in the product or any part of the business model direction?	Based on feedback received on your product, did you pivot or change the product or any part of the business model direction?
Was the product/service able to achieve sustainable growth?	Was your product/service able to achieve sustainable growth? If yes, how was sustainable growth gained? Word of mouth Side effect of product usage Advertising Repeated purchases/use Other…
Do you feel the Smart City ecosystem could help developers with the customer problem or customer solution? • The city could help by providing business model help and/or mentoring • The city could help by providing marketing and advertising support. • The city could help by providing collaboration with other coders. • The city could help by providing research related to the customer problems, e.g. user data, personas, market research, customer journeys or touchpoints • The city could help providing collaboration with UI/UX design services.	Do you feel the Smart City ecosystem could help you in with the customer problem or customer solution? • The city could help by providing business model help and/or mentoring • The city could help by providing marketing and advertising support. • The city could help by providing collaboration with other coders. • The city could help by providing research related to the customer problems, e.g. user data, personas, market research, customer journeys or touchpoints. • The city could help providing collaboration with UI/UX design services. • Other

• The city could help with facilitating co-creation workshops • Other…	
	Instead of a standalone application, would you be interested in developing an application or functionality as part of a larger platform? Yes No Maybe Other:
Are you familiar with service design techniques and methods, e.g. personas, storyboards, customer journeys?	
Instead of a standalone application, would you be interested if developers would provide dedicated functionality or an application as part of a larger platform?	Instead of a standalone application, would you be interested in developing an application or functionality as part of a larger platform? Yes No Maybe Other:
Is it or do you see it possible if some software functionality or applications would be purchased or subsidized by the city?	