IRIS

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Smart City User Innovation and Business Incubation Program Handbook for Implementation in IRIS cities and beyond

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Authors

Surname	First Name	Beneficiary	e-mail address
Sanders	Mark	UU	m.sanders@maastrichtuniversity.nl
Zanders	Loek	UU	l.zanders@uu.nl
Polzin	Friedemann	UU	f.h.j.polzin@uu.nl

Reviewers

Surname	First Name	Beneficiary	e-mail address
Kiseleva	Anastasiya	VUB	anastasiya.kiseleva@vub.be
Norrman	Jonas	IMCG	jonas.norrman@imcginternational.com

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Executive Summary

The aim of this deliverable is to report on the activities undertaken in Task 3.2: Developing and testing of new business models. More specifically, we have analysed the problem of developing new smart city business models and based on this research, have concluded early on that developing a dedicated incubation program is not the most fitting approach. Instead, our efforts were aimed at adjusting the business incubation programs at UtrechtInc to serve a more diverse inflow of new business models and feed that program with a series of dedicated smart city ideation tools. The combination of clearly focused ideation with a broad, high quality incubation program is, according to our research and pilot project, an effective way to support new business model creation in smart cities.

The report consists of three parts. First, we present the more academic research based on which we have developed our practical approach. Next is a description of the reforms in the UtrechtInc incubation programs. We conclude with a 'cookbook' type description of recipes for the smart city ideation activities we have (co)organised. Readers who are interested in developing more effective smart city incubation programs are advised to jump ahead to Part II, whereas readers interested in directly replicable smart city ideation activities can jump directly to the recipes in Part III.

Based on extensive academic literature reviews, we develop and propose two indices that can be used to identify smart city and user projects based on short descriptions. Our Smart City Index (SCI) and User Innovation Index (UII) can be used to identify ex-ante but also monitor the impact of interventions ex-post.

Our recommendation to academic readers is to use these tools to study user and smart city innovation in different contexts. It that way our tools can be tested and validated in other contexts and build a knowledge base on a comparable, literature based empirical definition of smart city and user innovations.

For smart city planners, developers, and policy makers our report has more practical recommendations.

From the research in Part I we conclude that the most effective way to support smart city business model development is to NOT create or support smart city specific incubation programs. Our research (and the literature) shows that business incubation programs do have a positive impact on performance criteria such as firm survival, investability, growth, or turnover. Smart city start-ups and projects, however, do not differ significantly on these criteria, so the data does not justify a dedicated, exclusive smart city incubation program. Instead, incubators should try to open their programs for a broader group of incubates in different stages of development.

The focus on users or incumbents as alternative sources of incubatable ideas has also proven to be ineffective. The reason is that incumbent ideas, so-called spinout innovations, are very hard to identify and track in practice. Ideas in incumbent firms are either too premature to incubate or too advanced and already under development in the incumbent firms themselves. User innovations face other challenges. We have found they are underrepresented in incubation programs, but the reason is that it is very difficult to compensate in incubation for the lack of a motivated team. User innovators not only lack the resources and expertise but importantly also the incentives to develop their idea into a business.

In Part II we show that the pivot in the incubation programs of UtrechtInc has been successful in attracting a broader range of business ideas from a broader set of sources and in a wider range of stages of

development. Our main recommendation from this pilot is to aim to broaden the inflow, especially on the dimension of accepting ideas from different sources and in different stages of development and structuring the program to support these.

The recipes presented in Part III show that different recipes have had different levels of success. Across all recipes, we conclude that business ideation can be focused on smart city development by creating clear challenges and provide clear information to participants. The key take-away from our different recipes is that the number and level of development of the ideas harvested, depends on the combination of specificity of the challenge and size of the prize. People are willing to brainstorm and generate many very immature ideas for relatively low incentives, but generating more developed ideas by more motivated teams that can flow into an incubation program, requires more specific challenges and higher incentives. However, such more specific events also generate fewer benefits in terms of citizen engagement, awareness building, and communication.

When IRIS lighthouse and follower cities take our recommendations to heart, a vibrant entrepreneurial ecosystem around smart city challenges can be developed. Of course, these ecosystems will be unique in every specific context and will focus on different subsets of problems and challenges. The program and recipes described in this report, however, can easily be adapted to local pre-conditions. Of course, it is much easier to implement a smart city business incubation program in places that already have business incubation programs and incubators in place. Also, the presence of universities and higher education institutions can provide a high-quality knowledge infrastructure that can support such programs and supply potential incubates. Access to networks of potential problem solvers is essential for the success of business ideation activities. Therefore, it pays for smart city planners and policy makers to invest in building up and maintaining communication channels to such networks.

The report has received valuable input from the other tasks in work package 3, notably tasks 3.1 and 3.3 and provides input for tasks 3.3, 3.4 and 3.5. Moreover, the presented recipes for smart city business ideation will be disseminated for replication in IRIS follower cities and beyond, serving as an input to the replication tasks in work package 8. The proposed reforms in the UtrechtINC incubation programs are directly relevant for the incubators PACA-Est in Nice and Chalmers' Ventures, in Goteborg, as well as for any other incubator interested in widening their scope. The work presented in Part I has relevance in the IRIS project but also contributes to the broader academic literature on smart city development and business incubation.

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List of Abbreviations and Acronyms

Abbreviation	Definition
EU	European Union
HKU	Hogeschool voor de Kunsten Utrecht
LH	Lighthouse
SCI	Smart City Index
SCUIBI	Smart City User Innovation Business Incubation
TT	Transition Track
UI	User Innovation
UU	Utrecht University
WP	Work Package

1. Introduction

The purpose of the lighthouse projects in general and IRIS specifically among them is to promote smart city innovation in European Cities. The underlying idea in work package 3 (WP3) is that to do so, we need to not only develop and demonstrate the technical feasibility of integrated solutions, but also work on developing and diffusing the corresponding business models. New technologies have impact and change urban living, only if they are adopted and taken up by users. Developing viable and profitable business based on these new technologies and integrated solutions is an effective, efficient, and sustainable way of doing so. The WP is divided into six tasks (T), in which nine deliverables (D) are developed. All tasks and deliverables in the WP build on each other.

Important to mention here is that the work in WP3 starts from the assumption that innovation and new business development does not take place in a vacuum. The WP is structured in such a way that the different tasks address this context along the stages one can identify in the typical journey from rough first idea to validated and bankable business models. To position the work presented in this report, it is useful to briefly describe the other tasks in WP3.

Task 3.1 zooms in on the characteristics of the local, regional, and national **ecosystem or technology innovation system** in which new business models, including the novel, integrated solutions that IRIS demonstrates and develops. In that task, deliverable D3.2 zooms in on strengths and weaknesses in the technical innovation systems of our lighthouse and follower cities, while D3.3 puts this analysis in a broader context and develops an evidence based diagnostic toolkit for the ability of regional ecosystems to promote innovation and business development in general and smart city innovations on IRIS' five transition tracks specifically.

Task 3.2 focuses on **development and testing of new business models**, to come up with and strengthen viable IRIS solutions at district scale. To be comprehensive, T3.2 contains activities devoted to different stages of business model development. More specifically T3.2 aims to **bring user innovation and design thinking** to the stage of business incubation; to take existing emergent business models in LH-city Utrecht to the next level of business incubation; and to match business model developers to the resources they need. Lessons learned are delivered in this well-documented **step-by-step guide/cookbook**, through which IRIS lighthouse and follower cities can implement a Smart City User Innovation Business Incubation (SCUIBI)-program. The proposed SCUIBI-program can best be described as a set of activities and facilities specifically designed to develop and validate ideas, generated by users, and turn them into new, scalable business models addressing smart city challenges.

In this report (D3.4) we therefore zoom in on the role of incubators and incubation techniques in smart city development. But over the course of the project intermediate results and experiences drove us to pivot and change the originally envisioned approach. Our original idea was to develop a dedicated incubation program for smart city user innovations in the three lighthouse cities' incubators. This Smart City User Innovation Business Incubation (SCUIBI)-program was supposed to have been designed and piloted in year one in Utrecht and then improved in two iterations in Nice and Goteborg before being disseminated to the follower cities and beyond. Our first analyses, however, presented below in detail in Part 1 (Chapters 2 to 5), quickly revealed that business incubation programs need not be targeted on smart city innovation to be effective and typically will not attract a lot of user innovations and/or spinouts

from incumbents. Analysis of the historical records of UtrechtInc, later confirmed also in PACA-Est in Nice and Chalmers Ventures in Goteborg, revealed that both spinout innovation and user innovations are rare animals in incubators and the same incubation programs and techniques promote smart city innovation as well as they promote other innovation and business development. Consequently, the way to promote smart city (user) innovation in a regional ecosystem is not to target incubation programs, but rather ensure that incubation programs are optimally organized, and smart city (user) innovation ideas are being generated and find their way into the generic programs that already exist. It is not in the stages of incubation and scale-up that smart city (user) innovations are different and need special attention and there is no need for a SCUIBI-program. So, we advised the incubators in Utrecht, Nice and Goteborg not to develop a specific smart city (user) incubation program, but instead optimize their existing programs to receive smart city (user) innovations. UtrechtInc in lighthouse city Utrecht has reformed its incubation program to broaden the scope of ideas and teams flowing into the incubation programs, tailoring these programs to the specific needs of academics, students and entrepreneurs while extending its scale-up program. We describe the antecedents and preliminary experiences with this new program set-up in Part 2 (Chapter 6). This pivot in the business incubation program can be interpreted as our recipe for creating a supportive business incubation program for smart city innovation. The COVID pandemic was an unexpected natural experiment in the incubation program, as all activities had to be moved online. We also reflect on the impact of this natural experiment on the inflow and effectiveness of business incubation for smart city development.

Then we shift our attention to the stage of ideation in Part 3 (Chapter 7 and 8). We shifted focus and resources to investigating a range of ideation tools that were either already being used or could be (co-) organized and guided by the WP3 team to ensure that the IRIS transition tracks would be in focus. We first investigated what ideation tools would be available and suitable in what conditions to obtain what goals and report on this in Chapter 7. We then describe a range of actual experiments, some more successful than others, that we undertook to test what ideation tools would work successfully towards developing incubateable new ventures. Chapter 8 therefore takes the form of a list of step-by-step recipes for (smart city) ideation tools that in themselves have been written in such a way that they can be replicated in follower and other cities. The key ingredients for a successful venture, smart city or otherwise, is a team and an idea. To find that golden combination is a rare event, and one typically needs many failed attempts and dedicated coaching before a successful venture emerges. Our gross list of recipes identifies what business incubation methods worked better under what circumstances. The ideation activities we (co)organised and monitored for this, resulted in several start-ups and we describe the case of a single start-up venture that has moved from one of our ideation events to the UtrechtInc incubation program.

Task 3.3 then brings the work in T3.1 and T3.2 together. It shows how the lighthouse, follower and potential replication cities could assess and strengthen their local ecosystems, while it also presents tools and techniques adapted from business incubation that have been helpful for the innovators in the IRIS project (the smart city business model canvass), seeking to fit their integrated replicable solutions to new local, regional, and national contexts. Tasks 3.4 and 3.5 then present how this work can be extended beyond IRIS in time and space. Together, the tasks in WP3 thus present research and develop toolkits and strategies that both innovators and ecosystem managers in lighthouse cities, follower cities and urban developers inside and outside of Europe can apply to accelerate smart city development, whether they

seek to adopt and replicate the integrated IRIS solutions of our project or develop new smart city business altogether.

1.1. Scope, objectives and expected impact

This deliverable aims to provide an overview of the activities organized in the IRIS project, specifically lighthouse city Utrecht, around business incubation and ideation to support smart city development. The importance of new business models in smart city development cannot be overstated. But it is far from clear how new business formation can be supported in this context.

In this deliverable, we aim to find out what is the best way to test and develop new and innovative business models in a smart city context. The main objective resulting from this quest, is to develop a guide which especially policy makers, but also other stakeholders, can use in their respective cities to stimulate innovation and business development in the process of becoming a smart city. Next to policy makers, the target audience of this deliverable are different stakeholders in the business incubation process, who we identify as investors, (aspiring) entrepreneurs, incubators, and researchers on topics related to entrepreneurship and smart city development.

Our first objective is to figure out what type of innovation or business development can be qualified as relevant in the smart city context. Then, we need to find out to what extent business incubation programs are beneficial to develop ideas into validated and investable businesses. And what happens when we combine the two? Do business incubation programs have a different – more positive or negative – impacts on smart city ideas? At the start of the project, there was little academic research or information that we could build upon, so we set out to research these questions ourselves. Using the knowledge thus acquired, we proceed to our next step: describing the ideal business incubation program for smart city ideas. However, while drafting such a program, we also realised that participants in an incubation program do not magically appear and asked ourselves, which activities do we need to organize to stimulate ideation and business development in the first place? In this report we thus move from more academic research-based analysis of the problem at hand towards more practical approaches to shaping a more vibrant smart city business development ecosystem.

Different parts of the deliverable are therefore also expected to have a different impact on different stakeholders. An explanation of the concepts (Chapters 2 to 4) is relevant to policy makers and researchers, whereas the analyses of the impacts and effectiveness of incubation programs on (smart city) start-ups (Chapter 5) may also be relevant for the stakeholders in the business incubation process. An overview of ideation tools, ideation activities, and the business incubation program (Chapters 6 to 8) we propose and describe is certainly more directly relevant to incubators and smart city developers interested in building up an ecosystem in their own context.

Both the lessons from the business incubation program pivot and the ideation events can be useful for replication (after adaptation) in follower cities in IRIS as well as cities aiming for smart city development beyond IRIS. We advise readers interested in the justification and motivation for choosing this approach to creating a smart city business incubation program (in deviation from the originally envisioned SCUIBI-program) to also read Part I of the report. Parts II and III are more relevant for more practically oriented incubator managers, wanting to learn how to pivot their programs to broaden the inflow of ideas (Part II),

and smart city developers and policy makers interested in generating more business ideation on smart city challenges (Part III).

1.2. Contributions of partners

The work underlying this report has been done by a broad range of partners, both inside and outside of the IRIS-consortium. Of course, especially in the work discussed this deliverable we have worked intensively with our academic IRIS partners at Chalmers University of Technology and University of Nice Sophia Antipolis as well as our incubator IRIS third party beneficiary, UtrechtInc, and the incubation programs Chalmers' Ventures in Goteborg, Sweden and PACA-EST in Nice, France, providing data and access to experts in the respective incubation programs. For the first part, we thank Aleksander Tase, Daniel van Hemert, Elsa Weiszflog, Simon Rombouts, Fernanda Ardiles Morgado, Inge Scholman, Thomas Achtereeke and Elisa de Weerd for excellent research assistance at UU. Carolin Eckinger, David Mooij, Estela Meraza Farfan, Imke Nijland, Maaike Hermse, Katherina Valkova, Martina Picari, Romain Morin, lenne Omlo, Maurits Vogels, Britt Kuipers, and Kaj Steenhouwer for contributing their Bachelor and Master Thesis research at UU, Eva Werkman, Francine Burema, Guolle Quintana, Niek Takken, Urbanus Kiio, Boris Lumumba, Georgia Zafeiri, Nestory Makendi and Wieger de Vries for their participation in the Lean Startup Research Project IRIS challenges and Leendert de Bell for supervising these projects and giving us valuable feedback, Alexander Boisseau, Ibrahim Nijad, and Sjoerd Piersma for doing IRIS related qualitative research under the supervision of Friedemann Polzin and Max Schmal, Lu Ting An, Gloria Carta, Anik Metzger, and Felina Lapp at the UtrechtInc Students Board for their support in the student challenges we describe in part 3. Furthermore, we are grateful for contributions from HKU, Rianne Bakker and the team for WP5 in Utrecht, Labyrinth Research who contributed much more that what they were contracted for and a host of partners in the various events and activities described below, especially in part 3 of this report. We thank them all for their kind cooperation in executing and granting interviews, collecting, cleaning, and analyzing data, giving feedback, and providing context and background information. All possible remaining errors are of course ours alone.

1.3.Relation to other activities

This deliverable and the activities underlying it is naturally closely related to the work done in Tasks 3.1 and Task 3.3. The first task aims to analyse and map out the innovation ecosystem of partner cities and developed tools and methods to do so. The new business development in a city is of course a vital and fundamental part of this ecosystem and as such Task 3.2 zooms in on that aspect of the entrepreneurial ecosystem and technology innovation system that is represented by the incubation programs in the three lighthouse cities. In part 1 of this report, we present and discuss the strengths and weaknesses of these respective incubation environments in generating smart city (user) innovation for new business model creation. The work on business incubation also inspired some of the work that was done for and presented in Task 3.3, D3.6. That is, in this report we already present results on a comparison between new business incubation and innovation in incumbent firms and in (Giourka et al., 2019) we have taken this one step further in developing the smart city business model canvass as a tool to assess business model viability for developing bankable business models in the smart city context.

1.4. Structure of the deliverable and reading guide

The remainder of this report is structured as follows: In part one (Chapters 2 to 5) we describe the research done to investigate the potential of spinout- and user innovation for incubation, using a mix of qualitative and quantitative research methods and using the data collected from incubators in the three lighthouse cities. In part two (Chapter 6) we describe how UtrechtInc implemented a reorganization of its programs to better accommodate (smart city user) business incubation. In part three (Chapters 7 and 8), we describe the importance of ideation for promoting smart city innovation specifically, list a range of recipes for supporting the creation and development of ideas into viable business propositions and describe a case of a start-up that is currently enrolled in the UtrechtInc incubation program as a direct result of IRIS business ideation activity. Part four (Chapter 9) explains how the deliverables in Tasks 3.3, 3.4 and 3.5 follow up on this work by providing a framework for assessing and improving such business propositions and matching the resulting business models to different local conditions and/or identify how such conditions might be altered to increase the chances of successful replication within and beyond IRIS and Europe.

We advise those readers interested in the more academic background and research that motivates our choice to not develop a smart city (user) innovation specific incubation program, to read Part I entirely. There we outline the most relevant concepts: business incubation, smart cities, spinouts, and user innovations from the academic literature in chapter 2. In chapter 3 we present the results of our research showing that the potential for spinout innovations as a source of ideas for business incubation was limited in the Utrecht context. We also concluded from our survey of the relevant literatures, that very practical methods for classifying start-ups as smart city (user) innovators are lacking and propose methods to fill that gap in chapter 4. Chapter 5 then presents the results of our empirical analyses of the impact of business incubation on (smart city user) innovations, showing why it does not make sense to develop a very targeted smart city (user) innovation business incubation program, but rather split this into targeted ideation activities combined with a more open, but generic business incubation program.

More practically oriented readers, who are willing to accept the above conclusion without having seen the evidence and arguments, are advised to skip directly to Parts II and III where chapter 6 describes the pivot in the UtrechtInc incubation programs, chapter 7 offers guidance on selecting the fitting type of ideation event and chapter 8 offers a list of “recipes” for business ideation activities that can be geared towards specific smart city challenges and local contexts.

2. General overview of literatures on Business Incubation, Smart Cities, Spinouts and User Innovations

The purpose in WP3, T3.2 is to identify and help develop new, bankable business models that support the transition tracks that have been identified in the IRIS project. Utrecht University, in close collaboration with UtrechtInc, is responsible for setting up a business incubation program in which we aim to develop such new business models. An incubation program is a process. By matching resources and coaching to a team with an idea, it aims to develop these ideas into bankable business models (**Fout! Verwijzingsbron niet gevonden.**).

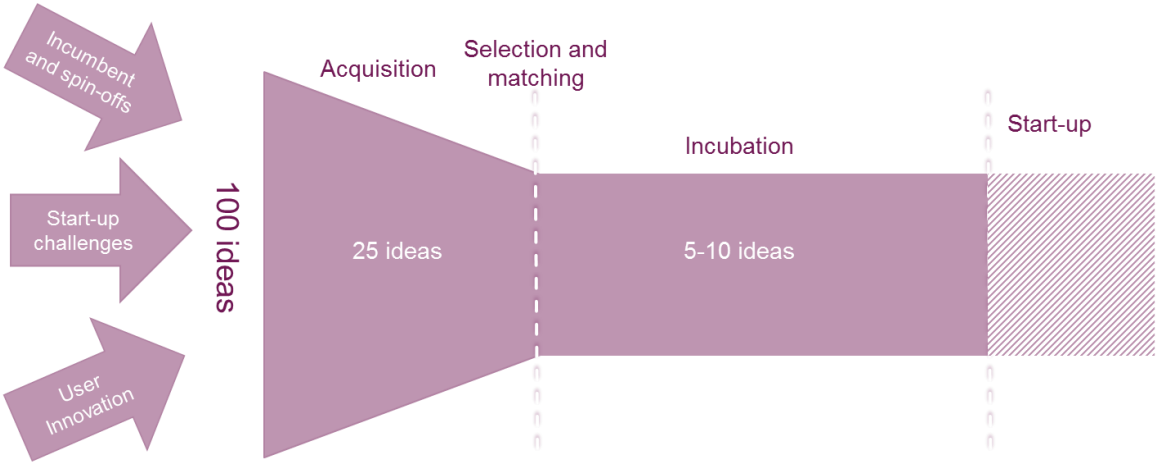

Figure 1: Schematic Overview of Business Incubation Process

Strictly speaking a "start-up" is a new organisation that may emerge towards the end of the incubation process to exploit the developed business model, but for the purposes of this report we will use this term lightly to refer to a team that has organised itself around developing a new idea into a venture (Cockayne, 2019). Generating and collecting ideas, with capable teams to implement and develop them into a viable business, is the key challenge in any business incubation program (Hansen et al., 2000). In IRIS this challenge is even larger as we want to focus our efforts on business models in the five predefined transition tracks and search for teams and firms in the three lighthouse cities primarily.

From the literature we can derive that there are broadly speaking three sources of new business ideas that we can look at (see e.g. Alexy et al., 2012; Coyne et al., 2007; Dahlander & Piezunka, 2014): New business models can come from existing companies, active in the transition tracks already; from new entrants that look for new application of technologies and solutions they have available; and finally from

citizens and users that experience problems along the way, for which solutions may have been developed non-commercially representing viable new business ideas.

All three sources have their specific incubation challenges. With spinouts from incumbents the team is often strong and capable, but the new business may not be in the strategic interest of the incumbent and the new venture competes with ongoing business concerns for attention, energy, and resources. For new entrants there is little strategic disagreement, but resource constraints are often much tighter and novel ideas are often technology driven, supply push and market demand is doubtful. Whereas for user innovators, the demand is obviously there, but the team is often weak or even absent, resource constraints are tight and often incentives are misaligned (Riggs & Von Hippel, 1994; Henkel & Von Hippel, 2004). The numbers in Figure 1 are there to give an idea of the rate of attrition between the typical stages of business incubation. In order to develop a single successful (Smart City) start-up, one needs a development funnel of approximately 100 ideas, resulting from e.g. Spinouts, Start-up Challenges and User Innovation. These might result in 25 matched teams to ideas. During a careful selection process, 5 to 10 ideas might have right qualities to join a Business Incubation program. And in the end, after a few months or years, it is possible that one of these can survive and grow into a thriving business venture. A well-designed incubation program might alleviate the bottlenecks and thereby promote smart city business development by attracting (more) ideas from spinout and user innovation specifically. The work in task 3.2 thus centres around four key concepts: Business Incubation, Smart Cities, Spinouts and User Innovation. To set the stage and provide the background for the report, this chapter first surveys and summarizes the academic literature on these concepts.

2.1. Business Incubation[1]

Business incubation has been studied quite intensively by academics, interested in innovation dynamics and entrepreneurship and a rather extensive literature has developed. Since the earliest accounts of incubators in 1959 in the Batavia Industrial Centre in New York (Leblebici & Shah, 2004), the phenomenon has become widespread.[2] Also in lighthouse cities Utrecht, Goteborg and Nice, several incubators and incubation programs are active. There have been different generations and types of business incubators (Bruneel et al., 2012; Dee et al., 2015; Grimaldi & Grandi, 2005; Leblebici & Shah, 2004). Most of the variety of incubation models, in more conceptual terms, lies in three dimensions. First, incubation models vary in terms of their intervention system, resources, and services provided (Bruneel et al., 2012; Grimaldi & Grandi, 2005; van Weele et al., 2018; von Zedtwitz & Grimaldi, 2006). Second, incubators focus on different stages of the start-up development (Dee et al., 2015; Madaleno et al., 2018; Mian et al., 2016). Third, incubators vary in terms of their funding or sponsorship (Baraldi & Ingemansson Havenvid, 2016; Bergek & Norrman, 2008). Despite this variety, the common thread has always been to support innovative

[1] This chapter is based on work published earlier as Eveleens (2019). Large parts of this paragraph are (sometimes verbatim) quotes from earlier publications of IRIS work.
[2] As of November 2018, the website 6fs listed no less than 8.591 accelerators/programs worldwide

entrepreneurship. What unites the different models is the underlying logic that it is possible, desirable, and effective to interfere with the development of start-ups.

Academic research on the topic has focused on such questions as how incubation performs and what distinguishes successful from less successful incubators and incubation practices. As is common in academic research, the first papers in the field relied more on qualitative research methods (small-n case studies and interviews) and focused on scoping out the emerging field. But these efforts were quickly followed by more quantitative assessments of incubator impacts and incubates' performance (Albort-Morant & Ribeiro-Soriano, 2016; Mian et al., 2016). The publication of a systematic review by Hackett and Dilts (2004a) and a special issue in the Journal of Business Venturing (Phan et al., 2005) directed research along three main lines of inquiry. The first concentrates on the definition, configuration, and taxonomies of business incubators; in other words: what is incubation? The second focusses on the evaluation of the performance and impact of incubators, in other words: are they helping? The third area of inquiry concerns the theoretical mechanisms which explain how incubators influence start-up performance; in other words, how and why would they work?

The first question can be debated at length, but for our purposes here a simple definition can suffice. A business incubator can be defined as "an organisational entity which performs a set of activities or services for incubated firms, such as facility renting, coaching, training, and networking" (Baraldi & Ingemansson Havenvid, 2016, p. 53). The precise services and resources depend on the goals of the incubator (Bergek & Norrman, 2008), but they are provided through interactions between start-ups, mentors, coaches, investors, etc, accentuating a network-based understanding of incubation (Hansen et al., 2000; McAdam & Marlow, 2008).

For our purposes the second line of inquiry is most relevant. This line of research was based on data collection efforts and more quantitative analyses (e.g. Aernoudt, 2004; AMEZCUA et al., 2013; Barbero et al., 2012; Colombo & Delmastro, 2002; Ensley & Hmieleski, 2005; Lindelöf & Löfsten, 2003; Van Rijnsoever, Frank J. et al., 2017; Vásquez-Urriago et al., 2016; S. Yu, 2020).

A methodological challenge in this literature has always been to handle the strong selection biases in the population of incubated firms. Incubators have a stake in the success of their incubates. Sometimes very directly when they take an ownership share in the incubated companies, but more often indirectly in terms of reputation and reporting to their funders and supporters and attracting investors and coaches for their incubates. They therefore select among the already self-selected applicants, such that those start-ups that eventually end up being incubated, are not a random draw from the universe of start-ups. Consequently, it is hard to separate the effect of the pre-conditions they self-select and are selected on from the effects of incubation on the observable outcomes (J. Yu & Nijkamp, 2009). Comparing incubated and non-incubated firms on outcomes is simply insufficient and one must try and control for the factors that drove selection and potentially affected the outcomes. A suitable control group is simply missing (Hallen et al., 2016). The location of the incubator also influences its impact, and this further complicates arriving at generalisable results from impact assessment (AMEZCUA et al., 2013; Chakma et al., 2010) on a range of relevant outcome variables (Dvouletý et al., 2018). Finally, the type and aim of the incubator also affects the impact (AMEZCUA, 2010; Barbero et al., 2012).

Consequently, earlier generations of incubator studies were not always able to show positive impact (Lukeš et al., 2019; Schwartz, 2013; Udell, 1990). More recent studies, based on better data and methods, but also studying more mature incubators, generally do show a significant and positive effect on the most common dependent variables such as survival, investments raised, and start-up growth in turnover or employment (Hallen et al., 2016; Stokan et al., 2015; Van Rijnsoever, Frank J. et al., 2017). For our purposes, the relevant conclusion from this literature is that there are ways to identify the impact of business incubation and the evidence now suggest that such effects are generally positive even if they remain highly context dependent. If we dig a little deeper into the nature of business incubation, this should not come as a big surprise.

Business incubation itself is not a one-size-fit-all treatment that is implemented in the same way in all incubators for all incubates. In fact, every incubator has its own practices and methods, typically linking coaches with always a unique set of experiences, networks, and skills to incubates in response to their individual needs. In other words, business incubation is very much tailored to the needs of the incubate at the time of incubation. This makes incubation (success) highly context dependent, even if it is limited to some extent by the skills and resources of the incubator. This limits the usefulness of statistical analysis, as that assumes a degree of generalizability that is simply absent. But even though the match between incubate and incubator is always unique, the literature suggests that the contemporary incubation model increases the employment (Madaleno et al., 2018; Stokan et al., 2015), growth (Hallen et al., 2016; Stokan et al., 2015), investments (Hallen et al., 2016; Madaleno et al., 2018; Smith & Hannigan, 2015), and exits (Smith & Hannigan, 2015; S. Yu, 2020) of start-ups that are drawn to incubation. From these studies, it also has become clear that the effect of incubation depends on the characteristics of incubation. Namely, the more experienced, assertive, and high-pressured incubators contribute more to start-up performance (Lukeš et al., 2019; Madaleno et al., 2018; van Weele et al., 2018). As a result, while previous research emphasised the broad variety of incubation approaches (Aernoudt, 2004; Hackett & Dilts, 2004a), the accelerator model begins to emerge as a dominant model of incubation (S. L. Cohen et al., 2019; Madaleno et al., 2018) Nonetheless, Eveleens (2019) concludes, based on his elaborate survey of the literature, that five problems remain:

4. There is a paucity of studies that systematically review, organize, and analyze the extant incubation literature. This leads to fragmentation instead of consolidation of the field of research.
5. There is a lack of incubation impact studies in north-western Europe to complement the prevalence of studies in the American context. This hampers generalizability.
6. It remains unclear if some start-ups are more suitable for incubation than others. This could account for unexplained variance in the impact of incubation.
7. There is a need for more convincing explanatory mechanisms that relate incubation services and activities to start-up performance.
8. There is a lack of studies that explicitly compare cases of incubation with non-incubation. This has led to research that is susceptible to an overly positive view of incubation.

Source: Eveleens (2019) Table 1.

For our purposes in IRIS, question 3 proved particularly relevant as we need to know how business incubation (programs) would have to be tweaked to support smart city and user innovations specifically. Unfortunately, the literature could give us only limited guidance on that. To date, the question of whether

the positive effects of incubation depend on the characteristics of the start-ups is largely ignored in the literature. Because incubation was originally targeted at a quite specific group of start-ups in the ICT domain (S. Cohen, 2013), their characteristics were rather similar. Today incubation also targets other types of start-ups, including clean tech (Malek et al., 2014), life sciences (Van Rijnsoever, Frank J. et al., 2017), sustainability (Bank et al., 2017) and media (Schwartz & Hornych, 2008). Before we can consider building a program that will target and support smart city and user innovations specifically, we need to establish how the standard accelerator model performs in attracting and affecting start-ups in this domain. With the methods and approaches developed in the literature surveyed above, we can do so. The literature above gives us guidance in selecting the relevant outcome and performance variables and the methods by which we may hope to tackle the important selection bias issues. But to be able to identify the impact of incubation programs on smart city and user innovation-based start-ups specifically, we also need an empirically workable definition of what constitutes such a start-up. We turn to those challenges in Chapters 4 and 5, but first survey the academic literature on Smart City Innovation in general.

2.2. Smart Cities[3]

Smart city development is high on the policy agenda of urban planners around the world (de Lima et al., 2020). Research has shown that smart cities are part of a new and rapidly changing reality that will affect the efficiency, equity, sustainability, and quality of life in cities (Batty et al., 2012). Consequently, the concept is increasingly being researched, also in the academic literature (e.g. Adiyarta et al., 2020; Fietkiewicz et al., 2017; Ismagilova et al., 2019; Sproull & Patterson, 2004; Sun & Poole, 2010; Sussman, 2001; Tan, 1999). However, the literature is currently developing without a clear and unambiguous definition of the concept.

In some research, modern cities are referred to as for example intelligent city, digital city, innovative city, or knowledge city (Adiyarta et al., 2020; Fietkiewicz et al., 2017; Ismagilova et al., 2019; Sproull & Patterson, 2004; Sun & Poole, 2010; Sussman, 2001; Tan, 1999).These studies all provide building blocks for our understanding of the phenomenon. But when authors collect data, often for a limited number of case-studies, based on their own definitions, this limits the comparability across studies, generalisability of results and the usefulness of these definitions for empirical research. Moreover, “smart cities” represent something more than these more limited concepts (Samarakkody et al., 2019; Yigitcanlar et al., 2018). Definitions of “smart cities”, however, also emphasise different themes, elements, or dimensions (e.g. Giffinger et al., 2007; Silva et al., 2018; Winkowska et al., 2019).

A highly cited definition of smart city that incorporates many of these elements is “a city is smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and high quality of life, with a wise management of natural resources, through participatory governance” (Caragliu et al., 2011, p. 70). However, other definitions emphasize other dimensions. For example, according to Zhuhadar et al. (2017, p. 274) “smart cities are those cities that have the greatest quality of life and economic wellbeing for their citizens”. This

[3] This section was published as Hermse et al. (2020)

definition emphasizes the citizens in a city and their quality of life. Whereas e.g. Neirotti et al. (2014, p. 25) focus on the Information and Communication Technologies (ICT) aspect of smart cities, stating: "smart cities are characterized by the pervasive use of ICT, which, in various urban domains, help cities make better use of their resources". Governance and institutional components are also often emphasized in definitions. According to for example Nam & Pardo (2011, p. 284) "smart cities are an organic connection among technological, human and institutional components. The usage of 'smart' captures innovative and transformative changes driven by new technologies". Most scholars emphasize the quality of life, citizen wellbeing, technology, or governance. But other topics are also frequently incorporated, such as innovation, collaboration, and infrastructures. None of the definitions incorporates all the themes identified in the definitions of smart city.

What all definitions do seem to have in common is the idea that a smart city challenges the old way of doing things in the urban environment. This puts entrepreneurs and start-ups in focus as they are considered the agents of change (Lombardi et al., 2012). However, as there is no readily available definition of smart city, it is even harder to define a smart city start-up. The empirical literature on smart city start-ups is therefore limited to date. Building on the definitions that have been proposed in the literature, in chapter 3, we propose a definition and develop a coding scheme for smart city start-ups to help researchers collect data and do empirical research on smart city development.

2.3. Spinout Innovations[4]

Many of today's largest firms are spinouts from parents we often do not even remember. The literature on these spinouts was initiated by Garvin (1983) and pushed by the late Steve Klepper and co-authors (Klepper, 2009; Klepper & Sleeper, 2005; Thompson & Klepper, 2005). Several researchers have analysed the factors that lead to spinoffs and spinouts. A common theme in many prior studies is that of strategic disagreement, or even conflict, between the parent firm and the employee. For example, large firms can be bureaucratic and inert, developing inflexible but valuable internal organisational 'routines' which discourage radical change and intrapreneurship (R. Henderson, 1993; R. M. Henderson & Clark, 1990; Winter, 1984). Employees who discover radical new opportunities within these firms are not permitted to develop them intrapreneurially or through assisted spinouts because that would disrupt the firm's routines (Freeman & Engel, 2007). On other occasions, a new business idea might fall so far outside the firm's core line of business that the firm does best by sticking to its core competencies. Employees, prevented from seeing their ideas developed, can thus become frustrated and come into conflict with their employer (Garvin, 1983; Klepper, 2007). Research has shown that this commercialization route is of particular importance in the early stages of new industries, when dominant designs have not yet been established and a lot of experimentation characterizes the dynamics in the sector. Under those circumstances, there is a lot of potential strategic conflicts that may cause spinouts. Ultimately, employees might have to leave and start up on their own if they are ever to commercialise their ideas. This logic can

[4] The literature uses the terms spinout and spinoff interchangeably. We will refer to spinouts in the remainder of the report. Parts of this section have been published earlier as an IRIS report in Zanders, Polzin and Sanders (2019) and Valkova (2020).

explain why, even though large bureaucratic firms generate plentiful ideas, they can also be associated with numerous independent breakaways (Klepper & Sleeper, 2005). Sometimes these are accompanied by vigorous litigation by the firm alleging breach of trade secrets (Jackson, 1998; Agarwal et al., 2009).

Organisational limitations are not the only reason why employees sometimes leave firms to develop new innovations. Another is asymmetric information. For example, Klepper (2007) develops a theory in which an incumbent firm's managers agree about the firm's current course until one manager comes into possession of a new piece of information about a valuable opportunity for the firm. This manager tries to persuade the other managers of the value of pursuing the opportunity. If this effort fails and the managers disagree, and if the opportunity's expected value exceeds the cost of starting a new firm, then the well-informed manager quits and starts his own venture. The same outcome also arises from several models based on agency theory. When property rights are weak, and firms cannot credibly commit to reward employees for co-operating on product development in a joint venture, employees are likely to leave the firm and start up an independent venture (Anton and Yao, 1995; Wiggins, 1995).

For the purposes of the IRIS-project, we need not delve deeper into the theoretical and largely US based empirical literatures here. The relevance of the spinout literature for our purposes is that smart city development also presents a dynamic and fluid environment in which employees in existing firms may have ideas that are not being developed in the firms in which they are employed.

In Valkova (2020) we have therefore developed a more elaborate comparison of the literatures and models that have been developed to describe the processes of business incubation and corporate entrepreneurship. The extant literature does not offer a common framework that encompasses both these forms of innovation. Valkova (2020) provides a literature review of existing process models (her Table 1, reproduced below) and she ends with a synthesis and comparison of the existing models that served as guideline for her qualitative, empirical analysis.

Process	Authors	Outcome
Business Incubation	(Campbell et al., 1985)	A process model of business incubation
	(Smilor, 1987)	A process model of business incubation; Success factors
	(Hackett & Dilts, 2004a)	A real options driven theory of business incubation
	(Phan et al., 2005)	Science parks and incubators; Observations, Synthesis and
	(Ayatse et al., 2017)	The business incubation process and firm performance
Corporate Entrepreneurship	(Burgelman, 1983a)	A process model of internal corporate venturing in diversified large firm
	(Edison et al., 2018)	Conceptual framework of lean startup; Lean internal startups for software product innovation
	(Fecher et al., 2020)	Innovation labs from a participant's perspective
	(Heikkinen et al., 2018)	Managing radical innovations in established companies

Table 1: Table 1 reproduced from Valkova (2020)

2.3.1. Business Incubation

Valkova (2020), like Eveleens (2019), emphasise the idiosyncrasies of the various forms of business incubation and related terms, such as incubators, accelerators, science parks, technology parks, innovation centers etc., when considering them in their geographic, economic, cultural, political and social contexts (Phan et al., 2005). Still, across these very different contexts, at a higher abstraction level, the business incubation process can be described as a process with distinct stages. An early process model for business incubation was introduced by Campbell et al. (1985). This model includes four basic "services" (value addition activities) by which an incubator might contribute to the performance of incubated start-ups: diagnosis of needs, selection and monitoring, capital investment, and access to expert networks. Ayatse, Kwahar, & Iyortsuun (2017) pointed out limitations to this framework: the model does not account for entrepreneurial capability, the strengths and shortcomings of the ecosystem, and the adopted selection criteria. A model by Smilor (1987) was built on the framework proposed by Campbell et al. (1985) and was extended by putting more emphasis on the external environment (incubator affiliation and support systems) relative to the internal activities of an incubator. This framework describes the process as a combination of internal support services and external networks that allow for the formation of new ventures to reach higher objectives of technology development. Nevertheless, unlike Campbell et al.'s (1985) framework, this model merely describes the internal support systems, failing to address the actual processes occurring within the incubator.

More complete process models were defined by Hackett and Dilts (2004a, 2004b) based on their systematic review of business incubation research. Drawing on the Campbell et al.'s (1985) focus on value adding activities, their models acknowledge the same elements of the incubation process: new venture selection, monitoring and assistance, and resource infusion but add a 'black box' principle for describing the internal process of business incubation.

2.3.2. Corporate Entrepreneurship

Like business incubation, the process of corporate entrepreneurship has been studied intensively in recent decades. Arguably, there are subcategories of corporate entrepreneurship to be studied as individual processes (Sharma & Chrisman, 1999), however, as will be shown below, these approaches exhibit similar steps when it comes to process modelling and often fail to account for specific resources and practitioners' methodologies. According to a study of internal corporate venturing in diversified major firms (Burgelman, 1983a), there are two core processes of internal corporate venturing: definition (articulation of the technical-economic aspects) and impetus (attaining and preserving support in the organization). Burgelman (1983a) emphasized that internal venturing takes shape in the strategic and structural contexts within the corporation. In other words, the new venture is influenced by various organizational and administrative mechanisms that support the current corporate strategy on the operational and middle managerial level. The current corporate strategy often needs to be extended or adjusted to accommodate the new business activities of an internal venture that has fallen outside its scope.

The model accounts for different stages of the process, from a process of linking solutions with problems and needs, to project championing, and to the impetus process which is composed of strategic forcing and strategic building. However, there has been a shift in the approach to corporate innovation over the

last few decades. In the recent years, the Lean Startup methodology by Ries (2011) has become popular not only in the start-up scene, but also in the corporate innovation context. In its essence, it is a hypothesis-driven approach that aims at achieving a product-market fit.

Edison (2015) proposed a conceptual framework for the lean internal start-up and tested it empirically (Edison et al., 2018). His framework uncovered three main phases: envisioning, steering, and accelerating. In the first stage, a vision of the future venture is created using necessary support systems from the corporate management – authorization and coaching. In the steering process, otherwise also called impetus process, the idea is (in)validated in an iterative process based on the build-measure-learn cycle (Ries, 2011). The corporate management monitors the progress of the innovation team during each cycle. In the last stage, steering, the intrapreneurs aim to scale their project to a viable product or service, while aligning their goals with the corporate strategy. Sometimes the intrapreneurs must convince the corporate management to change their strategy to accommodate the new business. Incumbents often use similar procedures without linking them very explicitly to The Lean Startup methodology. An example of this is presented in a study of the innovation process in established companies by Heikkinen et al.(2018). There, the process is described as a sequence of idea generation, proposal preparation and idea verification with an optional trial at the end. This "Product/market fit means being in a good market with a product that can satisfy that market" (Andreesen, 2007) approach is like the above-mentioned framework in many ways, although it does not mention the iterative process when validating an idea. Innovation labs are a recent popular phenomenon in the corporate innovation area. However, the current literature does not provide a process model for this novel concept. A study by Fecher et al. (2020), while not providing a process model to follow, does propose three distinct phases: a pre-lab phase (1), in which organizations make decisions on time, talent, and tasks, a lab phase (2), where research, ideation, and prototyping take place, and a post-lab phase (3), where the innovative project is abandoned or prepared for transfer reintegration to the business line. According to Memon & Meyer (2017), an innovation lab, not much unlike an incubator, commonly comprises three components: a physical space, resources, and facilitation.

2.3.3. The Common Process Model

A synthesis of the existing models suggests that there are many similarities between the two processes in terms of their chronological phases. This suggests that a comparative study can be performed when it comes to resources and methodologies used by practitioners. Both the corporate entrepreneurship and business incubation processes begin with a form of envisioning, when a new innovative idea is born through processes such as linking a solution to a need or problem and keeping an idea backlog. For business incubation, envisioning is present in an independent venture or carried out by an entrepreneur. In corporate settings, it is usually the presence of entrepreneurial orientation that fosters intrapreneurial behaviour. In some cases, the external environment of an incumbent firm (market, governmental policy or similar) requires a new corporate strategy that leads to a top-down decision to innovate (Blank, 2013; Burgelman, 1983b; Edison, 2015; Edison et al., 2018; Lumpkin & Dess, 1996; Ries, 2011).

Next, product championing takes place. This involves pitching the idea to either the incubator representatives or to the corporate management or in the case of top-down innovation, selecting and

appointing the project manager (Burgelman, 1983a, 1983b; Campbell et al., 1985; Edison et al., 2018; Hackett & Dilts, 2004a; Heikkinen et al., 2018). After delivering a successful pitch, the idea is transformed into a project or new venture and the steering process of new business development begins. Here, the independent venture enters the incubation program, and the nascent corporate innovation unit begins the so-called impetus process. In both cases, the embryotic business unit is monitored, gains access to coaching, external network and other non-financial and financial resources (Burgelman, 1983a; Campbell et al., 1985; Edison et al., 2018; Hackett & Dilts, 2004a). The steering phase is over once the new venture starts concentrating on growing and scaling, as well as attracting venture capital. For the independent venture, this stage usually begins after exiting the business incubation program. Some start-ups then enter an acceleration program which guides them in their growth phase and connects them to investors. In a corporation, the innovative project becomes a multifunctional business unit that is part of the overall corporate strategy (Burgelman, 1983a; Campbell et al., 1985; Edison, 2015; Edison et al., 2018; Smilor, 1987).

Figure 2:

Figure 2: Common Framework for Business Incubation and Corporate Entrepreneurship

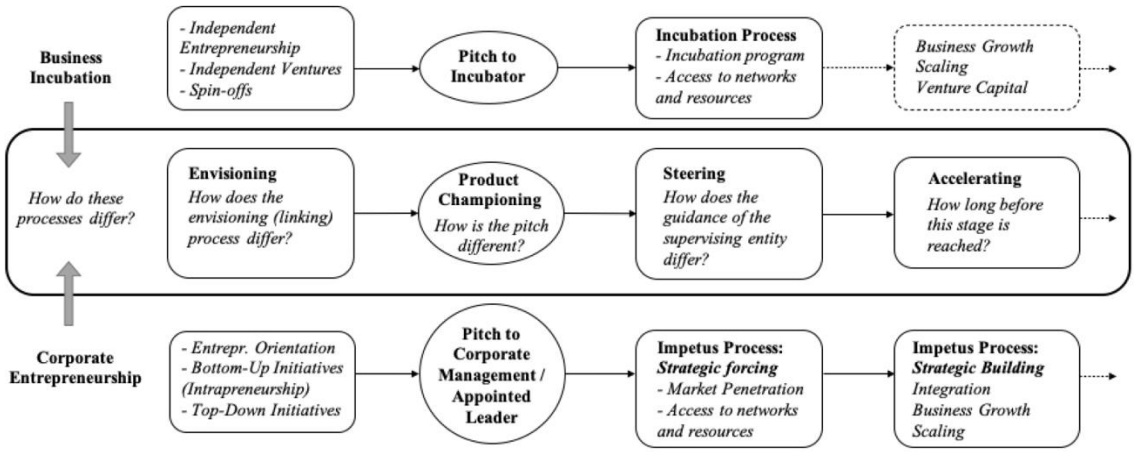

Figure 2: reproduced from Valkova (2020) - Common Framework for Business Incubation and Corporate Entrepreneurship

As demonstrated in Figure 3, both processes follow similar steps that can be described as four phases: envisioning, product championing, steering, and accelerating. In Valkova (2020) we found and described the differences between the two processes, using the four phases as common guiding criteria for the comparison. For this chapter we can suffice to say that the similarities in business incubation and corporate entrepreneurship were sufficient reason to consider spinoffs and corporate entrepreneurship a relevant channel for business incubators to tap into if the aim is to develop bankable smart city business models. The quality of the ideas developed inside existing organisations is typically high, as the ideas come from people engaged intensively with the new technologies and challenges that the smart city transition entails. Moreover, although it may be beyond the resources or strategic interests of the incumbent firm to develop these ideas, they might be willing to allow their employees to develop them outside the firm,

as these ideas may well be complementary to the firms' own strategic interests. In chapter 2 we therefore explore this channel and its potential for business incubation in the context of the IRIS project.

2.4. User Innovations[5]

Users can also be an important source of innovation (Urban & Von Hippel, 1988). User innovations are developed for personal use and as such satisfy needs not yet detected by manufacturers. The innovations developed can thus be used to detect latent consumer demand (von Hippel et al. 2011). Additionally, user innovations help to resolve inefficiencies in the market such as reducing information asymmetry, reducing business stealing and filling high-need niche markets (Henkel & Von Hippel, 2004). We find successful user innovations in form of modifications or improvements of equipment for kayaking, mountain biking, kite surfing or canoeing (Franke et al., 2006; Franke & Shah, 2003; Hienerth, 2006; Lüthje et al., 2002). Other examples are found in open software development (i.e. Linux), scientific instruments, improvements to librarian information systems or computer assistance systems (Morrison et al., 2000; Urban & Von Hippel, 1988). Eventually incumbent manufacturing firms pick up many of these innovations, but several modern household names like Dyson and Dropbox can indeed be traced to user innovations. User innovations sometimes linger in obscurity for quite some time. Only a few user innovators built successful firms and became famous with their innovations. Many more user innovators can simply not be traced. These inventors lacked the skill, capacities, or incentives to develop their innovations into a business themselves and others have picked up on their ideas.

While researchers and industrialists are starting to recognize the importance of user innovation, users as a source of innovation are still being underestimated by policy makers (Bradonjic et al., 2019). The cases described in the literature all show that user innovations justify further attention and could be promoted more openly to encourage users to innovate and increase the number of user innovations. Incumbent firms are increasingly interested in mining this hidden treasure (e.g. Kraft, 2012) and developed design thinking and open innovation to tap into the user resource for their own benefit. But these processes are designed to promote the interests of the company, not society at large. Therefore, truly transformative ideas that could disrupt, cannibalize, or creatively destroy exiting activities, will receive insufficient support from incumbent firms and in fact may be actively discouraged. The same market failures that justify public support for new ventures can therefore also justify the support for the disclosure and incubation of user innovations. Business incubation programs could thus play an important role as providers of skills, facilities, and finance, as they are for would-be entrepreneurs. Especially in the Smart City context, user innovations have the marked advantage of an automatic alignment between user-need and innovator solution. As an important element in the definition of a Smart City is the role of citizen engagement and involvement in the selection and implementation of solutions, this makes User innovation an interesting concept for Smart City (business) developers.

To target public support for user innovation, however, it is essential that decision makers can identify them unambiguously and early on. The academic literature on user innovations to date is very case-based

[5] Parts of this section have been published as part of Eckinger and Sanders (2019)

and academics and innovation managers still use their own definitions. There is some theory development, but rigorous empirical testing, especially in the context of the effectiveness of business incubation programs for Smart City User Innovations is absent, limited by a lack of data and an established, unambiguous definition of the concepts that are essential to investigate this. We return to this in Chapter 3 where we develop workable definitions and classification schemes.

2.5. Summary and Conclusions

In this chapter we present the academic literature related to the key concepts in his report. Of course, the review of these different literatures is necessarily incomplete and leaves many open questions. The most important conclusion from this review is that there is still a gap in the literature when it comes to assessing the impact of business incubation programs on different types of start-ups and innovative firms. Specifically, the potential for smart city spinout and user innovation-based projects is not clear. Designing a program to support smart city innovation requires that we scope the potential for spinout innovations and develop clear and empirically operationalizable definitions of “smart city” and “user” innovations. Then we can proceed to investigate how the incubators in the Light House cities perform in supporting such ventures in the past and present. Such an analysis can identify what elements in these programs that are most relevant to smart city and spinout and user innovations and could be strengthened as part of an urban transition strategy.

3. The Scope for Spinout Innovation in the Smart City Context

Our first step in scoping the potential for spinout innovation in smart city incubation was to scan the existing local ecosystem in Utrecht for opportunities and ideas. As this exercise also generates relevant information for other parties in the consortium, we published this chapter also as an intermediate report (Zanders et al., 2019). In this chapter, we present the results of interviews that were held in the period November 2017-April 2018 in Utrecht. We contacted 37 and interviewed 17 businesses in and around Utrecht to generate data and collect information into the inner workings of their innovation processes (Taylor Buck & While, 2017). The targeted interviewees were found in the consortium and local entrepreneurial ecosystem and were selected to be active in the five transition tracks targeted in IRIS: 1) Smart renewables and closed loop energy positive districts, 2) Smart energy management solutions, 3) Smart e-mobility, 4) City Innovation Platforms and 5) Citizen engagement and co-creation. As there are no commercial firms active in the latter transition track and our user innovation focus in chapters 3 and 10 will cover citizen engagement, the latter transition track was left out of scope. The following questions were discussed with innovation managers, business developers or strategy representatives in these firms.

1. How does your company act in the IRIS transition pathways?
2. What kind of problems do the clients of your company face in these areas?
3. What would be potential solutions, and could they be commercially exploited?
4. Is your company actively pursuing these ideas (for example through the creation of spin-offs or through or forms of 'start-up support')?
5. Which barriers prevent the commercialization of (your) smart city ideas?

Not all firms were able or willing to provide detailed answers to all these questions and our interviews did not uncover any readily incubatable ideas. Responses on questions 3 and 4 were thus usually limited. This was perhaps to be expected. We managed to interview 17 people in as many firms, and it would indeed be a rare coincidence if one of these people would have detailed information about a potential business idea in the exact right stage for it to enter incubation. Still our interviews, together and individually, do give a good overview of the current state of things in the Utrecht ecosystem and we thought it useful to report on our findings. The structure of our interview guide implies we carefully mapped the current business models on a well-established business model canvas and the discussions with our interviewees were revealing on opportunities and barriers they perceive in the Utrecht ecosystem for Smart City innovation as defined in the IRIS transition tracks. In addition to the results of our interviews, we also draw conclusions on our own process and discuss how we have pivoted the incubation program to address the challenge of identifying viable business models in the future.

The remainder of this report first briefly presents the research context and methodology in section 3.1. Then section 3.2 discusses the data we have collected and describes the business models that our interviewees currently operate in the different IRIS-transition tracks. Our interviewees, short of offering detailed future business models they want to develop, did give us a lot of information on the trends and opportunities they see in their respective markets. Section 3.3 presents the results on these outlooks for the IRIS transition paths. Section 3.4 then presents the major barriers our interviewees identified for their

firms to address challenges and engage with new opportunities. Section 3.5 concludes and reflects on the results as well as the next iteration of the IRIS-incubation program for Utrecht.

3.1. Research context

In this research, a qualitative research approach (M. Q. Patton, 2002) was used. A team of research assistants[6] contacted businesses of various sizes and asked to discuss business ideas with innovation managers, business developers or strategy representatives (see e.g. Alexy et al., 2012). To build a relevant database of interviewees, our research assistants conducted several interviews with multiplier parties. We kept doing multiplier interviews until saturation was achieved. That is, new multipliers would not mention new target interviewees. We started by contacting the IRIS Project partners, and then continued to contact other companies using snowball sampling, the multiplier interviews and the researchers' professional networks (Bryman, 2016). In total, 37 organisations were identified as relevant and approached for an interview. Out of these organisations, 17 organisations (46%) agreed to have an interview representing typical cases from a Smart City eco-system.

The interview guide is reproduced in the Annex. To allow for a comprehensive assessment of new business ideas we mainly based our questions on the established business model canvas that is used in the lean start-up method process (Osterwalder et al., 2005). After a brief introduction of the research process, interviewees were asked to elicit their current and prospective involvement in the Smart City ecosystem. The interviewers then turned towards (most promising) business ideas as well as its origin (one of the contributions of this research). The remainder of the interview revolved around properties of this potential new idea, including the customer value proposition, key resources and process to implement that idea (value delivery) and the profit formula (value capture) (see also Bocken et al., 2014). In a final part we discussed future developments of the business models (with respect to the transition track) as well as barriers with the company representatives.

The interviews were conducted in the period November 2017 to April 2018. The interviews had an average length of 41 minutes, the shortest lasting 23 minutes, and the longest lasting 78 minutes. During the interviews, the interview guide ensured our research assistants consistently asked about the way the organisation acts in the IRIS transition pathways, what problems companies face in these areas, and what potential solutions they think would be feasible and could potentially be commercially exploited. There was a strong focus on (potential) new business models. The coding strategy started from a top-down analysis by using the business model canvas (Johnson et al., 2008). In addition, during the coding process, codes that arose from the interview data were added (M. Q. Patton, 2002; Yin, 2014). All interviews were coded independently by at least two researchers and the senior researcher checked consistency in blind samples.

[6] We are grateful to Elisa de Weerd, Inge Scholman, Fernanda Ardiles Morgado, Thomas Achtereekte and Aleksander Tase for their excellent research assistance.

3.2. Interviewed organisations

The interviewed organisations consist of partners of the IRIS consortium (Utrecht) such as Bo-Ex, Civity, LomboXnet, Qbuzz as well as other parties active in the smart-city ecosystem of Utrecht. Further companies that took part in the study were Solease, Suez, Elaad, Wocozon, van Scherpenzeel, Viriciti, Senfal, Qwiksense, Sundata, Veolia, Strukton and Antea Group as well as intermediary organisations (TNO). An overview about the consulted organisations can be found in Table 2.

Name of the company	Sectoral focus	IRIS consortium	Transition Track
Antea Group	Engineering & Consultancy	No	3
Bo-Ex	Housing corporation	Yes	1, 5
Civity	Data management	Yes	4
Elaad	(Smart) charging infrastructure	No	3
LomboXnet	(Smart) charging infrastructure	Yes	2, 3
Qbuzz	Public transportation	No	2, 3
QwikSense[7]	Energy data management	No	2
Senfal	Energy data management	No	2
Solease	Solar energy	No	1
Strukton	Rail infrastructure	No	3
Suez	Waste processing	No	1
Sundata	Solar energy	No	1
TNO	Research institute	No	1, 2, 3
van Scherpenzeel	Waste processing	No	1
Veolia	Resource management	Yes	2, 3
ViriCiti	(Smart) charging infrastructure	No	3
Wocozon	Solar energy	No	1

Table 2: Interviewed organizations

Bo-Ex, Solease, Suez, Sundata, TNO and van Scherpenzeel are all active in transition track 1, Smart renewables and closed loop energy positive districts. Both **Suez** and **van Scherpenzeel** are trying to turn waste into energy, closing the loop. **Bo-Ex**, as a housing corporation, is looking to make their portfolio energy neutral. Both **Wocozon** and **Solease** are providers of renewable energy, marketing solar panels as a service, targeting renters and private homeowners respectively. **TNO** is a research institute working on research questions in this transition track, as well as transition tracks 2 and 3.

In transition track 2, Smart energy management and solutions, active organizations are LomboXnet, Qbuzz, Qwiksense, Senfal, TNO and Veolia. IRIS-partner **Qbuzz** puts the organization of storage of energy at the core of their business model development activities. They aim at storage and sell electricity with their busses and provide enhanced load-management to the grid operator. **LomboXnet** also targets storage and control, by providing solutions to storage in cars but also stationary storage. **Qwiksense** uses data to improve the indoor climate in i.e. schools and offices. **Senfal** uses artificial intelligence to manage energy use and production. **Veolia** is a French transnational company with activities in four main service

[7] QwikSense was declared bankrupt in February 2018 and has since continued activities as Unicornify Labs.

and utility areas traditionally managed by public authorities – water management, waste management, transport and energy services, extending its activities to both transition tracks 2 and 3.

Antea Group, Elaad, LomboXnet, Qbuzz, Strukton, TNO, Veolia and Viriciti are active in transition track 3, Smart e-mobility. **Antea Group** is an internationally active engineering and consultancy agency, specialized in the infrastructure of (e-) mobility, a specialization they share with construction company **Strukton**. **LomboXnet** and **Qbuzz** both work on mobility solutions (vehicle to grid) including cars solutions, as well as electric busses. **Elaad** is a knowledge centre for electric mobility and **ViriCiti** provides monitoring systems for electric trucks and busses.

Civity is a main provider of City Innovation Platforms, transition track 4, whereas **Bo-Ex**' core business is social renting of houses, putting citizen engagement – transition track 5 – very close to their core business, because Dutch law and regulations largely protect renters from changes to their housing situation and prior consultation and consent is usually required.

3.3. Trends and Scenarios for Transition Tracks

During the interviews, interviewees were asked to reflect on the most relevant trends for the future. These outlooks can be clustered according to the transition tracks identified above and give us an overview of the future the active players in each transition path are currently planning on. Taking the most common elements from these outlooks together we can build scenarios that organisations active in these tracks feel they are likely to face when it comes to developments in Smart City innovation.

Transition Tracks (TT)	Likely scenarios
TT1: Smart renewables and closed loop energy positive districts	• Data protocols will be put in place, so available data can be easily linked • Increase in need for connecting organisations (i.e. municipality, incubators, etc.), who link smaller organisations together to generate co-created ideas and business models • The B2B and B2C markets will change from a purchasing market to a service market, changing underlying business models. Where currently as much products as possible need to be sold to make profit, future products need to last to make a profit; • Product production will become increasingly circular, more often using recycled raw materials;
TT2: Smart energy management and solutions	• Housing and offices will become energy-neutral and use of renewable energy will be substantial • Consumers will increasingly enter the energy market as producers; • Innovation will become increasingly data-driven, as historic data can be used to predict future developments; • A clear link will emerge and develop between smart mobility and smart energy, in terms of generation and storage of energy

TT3: Smart e-mobility	• An increase in number of smaller organisations with very specific knowledge (data, expertise, etc.) • An increase in size of object printing possibilities is expected, making it possible to print i.e. houses, bridges, etc. • Time-to-market of innovations exponentially decreases; • Increase in drones as a means of transport (people, packaging) • Decline in (ownership of) cars • Self-driving cars and public transport (buses, trains, etc.) • Increase in use of public transport • Transport will become electric
TT4: City Innovations Platforms	No future scenarios are mentioned in the interviews with organizations active in Transition Track 4. This is not necessarily strange, since this track is horizontal overlapping Transition Tracks 1 to 3, largely covering the same activities.
TT5: Citizen engagement and co-creation	No future scenarios are mentioned in the interviews with organizations active in Transition Track 5. This is not necessarily strange, since this track is horizontal overlapping Transition Tracks 1 to 3, largely covering the same activities.

Table 3: Trends and scenarios for Transition Tracks

Taking the most common elements from these outlooks, we conclude from Table 3 that the interviewees in Transition Track 1 foresee a need for so-called orchestrators. A lot of activity is happening concerning smart city developments, increasing the need for connecting existing organizations and streams of data, to bundle resources in moving towards these future scenarios. This expected scenario is shared by organizations active in Transition Track 3. Interviewees for example said:

"We're now constructing a part of the puzzle that touches upon other parts of the puzzle. I think the biggest opportunity is how to, in a smart and efficient way, combine all these pieces of the puzzle together. [..] the role of the incubator can also be the role of an integrator of all these different pieces of the puzzle." - Renewable energy producer

"One of the main challenges is going to be linking all available data. Gathering all the data from public transport companies, car and bike sharing businesses, et cetera, and putting them in one place." - Mobility consultant

In terms of business modelling, we can conclude that players in the energy service market see the trend where the need for more sustainable products represents a clear opportunity for business, as a shift from

a product to a service-market is expected. If businesses have the incentive to sell as many goods as possible, the sustainability level of the respective goods will not be optimal.

> *"When making long-lasting sustainable products - which do not easily break down, that are easy to repair, and in the end of the life cycle are easy to recycle - you'll only have the financial benefit of the product in a service business model." - Renewable energy producer*

In terms of smart energy management (TT2), interviewees expect a large impact from the transition from fossil fuels to renewable energy when it comes to production and consumption of energy, increasing the need for balanced grid-use. Finding this balance requires an increasing need for energy storage and large quantities of data to predict flows of energy.

> *"We have had the situation in Germany, where during a very sunny day, there was not enough demand for energy. This resulted in a negative price for energy (consumers received money for using energy, red.). Now it must be possible to switch off solar parks, which is absurd." - Mobility infrastructure producer*
>
> *"Using data, we can predict and look at historic patterns." - Energy manager*

A conclusion we can derive from interviews with organizations active in smart e-mobility (TT3), the transition to electric cars and busses, accompanied with the transition from product to a service market, will largely impact (inner) cities. Decreasing ownership of cars and more frequent and efficient use of public transport will also change the use of public space. Or as an interviewee put it:

> *"Public transport use will increase, and we will see more use of car services instead of ownership. [..] You're going to need less parking spots, opening up the possibilities of rethinking public space." - Mobility consultant*

No future scenarios are mentioned in the interviews with organizations active in Transition Tracks 4 and 5. This is not necessarily strange, since both tracks are horizontal tracks overlapping Transition Tracks 1 to 3, largely covering the same activities.

3.4. Barriers to smart-city business model development

Throughout the research several barriers to business model development and implementation were mentioned. In the process of open coding, we coded these into commercial, communication and

partnership, legal/taxation, societal and technical barriers. In the axial coding phase we linked these to existing literature (Bocken et al., 2014; Ceschin, 2013; Rauter et al., 2017). Technical, commercial and communication barriers mainly link to the customer value proposition, value delivery and value capture part of the business model (Bocken et al., 2014). Legal, tax barriers and partnership barriers as well as societal barriers more explicitly are part of the wider socio-technical environment that influences the development and implementation of business models (Ceschin, 2013; Rauter et al., 2017).

Our coding scheme is thus not exhaustive perhaps, but it allows us to discuss the barriers identified in rather general terms. For an overview see Table 4. We will refer to "an interviewee" if only one mentioned it, "some interviewees" if it were at least two and "all interviewees" when in a transition track all interviewees mentioned and described similar barriers (see also Polzin et al., 2018).

Barrier Type	Experienced Barrier	Transition Track
Commercial	Knowledge at customer's organization	2
Commercial	Long term planning (electrical cables, grits, etc.) make short term innovation hard	3
Commercial	New product innovations (much) more expensive than current products (electrical cars)	3
Commercial	Small financial margin in energy market	2
Commercial	Tax regulation doesn't promote enough the use energy during non-peak hours	2
Commercial	High storage costs	1
Commercial	Intelligent products often a lot more expensive than non-intelligent versions, not possible to earn difference back	2
Commercial	Finding developers	1
Commercial	Cost of infrastructure is very high	2, 3
Communication	Lack of skilled workforce within organization	3
Communication	Decision-making in organizations very cumbersome	3
Communication	Education level in city neighborhoods very different, need for different ways to communicate	5
Communication	Innovation also means educating customers	3
Legal and tax	Concerns about use of data in terms of privacy legislation	4
Legal and tax	Flying drones within 25 meters of the road is not allowed	3
Legal and tax	Need for more favorable regulations concerning energy (use of batteries, nudge people to use electricity in non-peak hours)	2
Legal and tax	Energy neutral buildings mean wind and sun energy collection in the neighborhood, not necessarily an energy neutral building itself	3
Legal and tax	Paying taxes when charging and using a battery, double	3
Legal and tax	Subsidies for fossil fuels doesn't help the development of renewable energy	3
Legal and tax	No regulation for taxes on the ocean	3

Legal and tax	Currently not possible to be an incidental heath supplier	1
Legal and tax	Rental laws don't help housing corporations to make homes more sustainable, because the individual renter doesn't always have the same interest as the collective	5
Limited Time	Lack of innovation capacity within the organization	3
Limited Time	Processes with governments take a lot of time, some which innovative small organizations (i.e. startups) don't have	1, 2, 3
Partnership	Governments should act as examples, for example regarding their procurement policies	1
Partnership	Organizations keep data to themselves, while seeming useless data could be useful for other organizations	3
Partnership	Bigger organizations often afraid to work with startups	1
Societal	Lack of people/organizations taking responsibility for tackling climate problems	3
Societal	High percentage of unemployment and crime in some city neighborhoods	5
Societal	Change of mindset needed for people when to use energy, cars, etc.	5
Societal	Sustainable alternative needs big upfront investment, with ROI in 30 years – no individual consumer thinks this far ahead	1
Societal	Hard to get people involved in societal challenges	1, 2, 3
Technical	Really hard to get the right data, and quality data, especially since it's almost impossible to get historical data	4
Technical	Problems for grid operators can be very, very local	2
Technical	Too few batteries, too few electrical cars, not enough capacity to store energy	2

Table 4: Categories, barriers, and corresponding transition track

Commercial barriers mainly referred to customer value proposition, value delivery and value capture (costs and revenues) of the business model and relate to transition tracks 1-3 which concern the main markets (energy production, energy efficiency and mobility). Some interviewees highlighted limited knowledge of wishes of potential customers and the challenge of creating (additional) value in the existing energy market. In addition, the long-term planning (electrical cables, grids, etc.) makes short term innovation hard for the companies in our sample. A second set of obstacles relate to the value delivery. Limited budget allocated to innovation per year and for finding technical developers on the job market makes it hard to commercialize new smart city ideas as value delivery is jeopardized. Overly long processes involving governments prove especially hindering for innovative small organizations (i.e. start-ups) that do not possess the endurance.

The biggest part of the perceived issues revolves around profitability of new business models (value capture). General commercial barriers such as small financial margins in energy market and the fact that new (smart) product innovations are (much) more expensive than current products (electrical cars) imply that

"It is hard or impossible to earn investments back" - Mobility consultant

In specific smart city innovations such commercial barriers, such as high cost of energy storage and infrastructure as well as high switching costs (for example for individuals to change heat system), make it hard or impossible to recover investments. Companies also emphasize the fact that tax regulation doesn't promote enough the use energy during non-peak hours, which

"Makes it hard to create a business case for technologies that help people manage their energy use" - Energy manager

Communication and partnership barriers indirectly relate to the individual business model as it mainly affects the ability of companies to integrate into a present and future (smart) city ecosystem. We found links to transition tracks 1, 3 and 5 that focus on the energy on the district level, integrated mobility systems and citizen engagement.

"The energy transition only works if all organizations change at the same time." - Research consultant

Governments should act as examples, for example regarding their procurement policies. Interviewees referred to internal struggles in the organisations such as a lack of skilled workforce and distributed knowledge which makes decision making and entering a partnership difficult. Larger and more mature organizations often refrain from working with start-ups. Interestingly organisations keep most of the data they produce to themselves although seemingly useless data could be useful for other organizations.

Furthermore, the education level in city neighbourhoods is very different, which necessitates educating customers and governments as well as businesses communicating the challenges in different ways. Both activities do not happen to a sufficient degree according to the interviewees.

A large cluster of barriers revolves around *legal and taxation aspects* of new business models based on ICT technologies for smart cities that can be found in all the transition tracks as they touch upon a variety of boundary conditions. The interviewees feel that

"The regulatory environment is not ready for digital / smart society and city." - Several interviewees

This concerns use of data in terms of privacy legislation and the use of new technologies such as drones. However, they also realize that future-proofing laws and regulation takes a lot of time in comparison to developing innovative business models.

The energy sector is one of the most regulated business environments. The interview participants stress the need for more favourable regulations concerning energy (use of batteries, nudge people to use electricity in non-peak hours). Also, the concept of energy neutral buildings means that wind and sun energy collection in the neighbourhood, not necessarily an energy neutral building itself. However:

"Rental laws don't help housing corporations to make homes more sustainable, because the individual renter doesn't always have the same interest as the collective." - Housing manager

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In the energy literature this is referred to as 'split incentives' (Sorrell, 2015). On a more general note, subsidies for fossil fuels do not help the development of renewable energy.

In a deep transition, such as the current Smart City and sustainability transition, *societal barriers* play an important role. We mainly see overlap with 'system-focused' transition tracks 1, 3 and 5 (district energy, mobility and citizen engagement). The interviewees mention the struggle to involve people in addressing societal challenges, reflected in the fact that few people and organisations take responsibility for tackling climate problems. Most potential customers are preoccupied with a high percentage of unemployment and crime in some city neighbourhoods and think about their role in a Smart City as a secondary problem.

"It requires a change of mindset when to use energy, cars, etc." - Research consultant

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On the business side that means a change from product market to service market. In the current transition towards a Smart City people willing to move first in energy transition are not rewarded or advantaged hence there is no incentive to use new products or services. In addition, they require large upfront investments.

"With an ROI in 30 years – no individual consumer thinks this far ahead". - Renewable energy producer

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Challenges that are mentioned in relation to *technical barriers* are the quality and suitability of data and missing technical infrastructure and equipment e.g. on the side of the grid operator or properties of technology. These understandably link to the more 'technology-oriented' transition tracks 2 and 4 (energy management and city innovation platform).

3.5. Conclusions and next steps

In this chapter, we have described the findings derived from interviews with employees of seventeen organizations active in five different transition tracks. The interviewees have described different scenarios they foresee regarding these transition tracks. According to the interviewees on transition track 1, the main changes and developments will occur in business modelling – shifting from a product market to a service market. Also, a clear need for orchestrators of activities in this transition track is described. Interviewees in transition track 2, smart energy management, expect many more players on the market and therefor emphasize the need of a balanced energy-grid and the need for large quantities of data to for prediction purposes. The third track, smart e-mobility, expects mobility will become more of a service, compared to the current ownership of vehicles, foreseeing changes in demand of public transport and use of public spaces.

In terms of barriers, a few exist for multiple transition tracks. Friction is mentioned between long-term planning of infrastructure and wishes for short- and medium-term innovation. Both commercially and regarding communication, organizations highlight the lack of knowledge inside and outside their organization. Regarding legal and tax barriers, interviewees promote more favourable regulations for smart city innovations and stress the need for clarity on privacy regulation. Looking at limited time barrier, we can conclude the lengthy processes in the smart city domain do not benefit start-ups with short-term horizons. The main conclusion we can derive looking at the partnership barrier, is that to reach the in section 4 described futures, organisations need to be more open and collaborate more with other organizations in the same domain. In a deep transition, such as the current smart city and sustainability transition, societal barriers play an important role. The interviewees mention the struggle to involve people in addressing societal challenges, reflected in the fact that few people and organisations take responsibility for tackling climate problems. The quality and suitability of data is a technological barrier which organizations currently face.

Regarding the first iteration of our smart city incubation program, we can conclude that the approach we have designed and implemented to track and find incubatable ideas in the Utrecht ecosystem did not deliver the readily incubatable ideas for active incubation. We have deployed resources to interview incumbents (project partners) to look for incubatable spinout ideas and snowballed through the Utrecht ecosystem to identify incubatable spinouts and spin-out ideas. These efforts have resulted in interesting data and information that is useful also in the ecosystem assessment, but it did not yield ideas in the right stage of development or teams willing to develop them. Still, our search for needles in the haystack did deliver some relevant information that may be useful for other partners working in the IRIS-project. Moreover, we identified several barriers to innovation for incumbents. It is not to be expected that incumbents have solutions to these barriers readily available but not yet implemented. These barriers are opportunities for new business development, but it is not clear what teams would work on what ideas to overcome them. We conclude that, although spinout innovation can sometimes be revealed (ex post), it is near impossible to track these ideas (ex ante) in a stage and with a team that would make them benefit from enrolment in a business incubation program. Therefore, we have decided to abandon the search for spin-out incubates and pivot our approach for the second iteration of the incubation program in Utrecht in the following way:

1. UtrechtInc developed a program to engage students and academics (see Chapter 6 of this report) more intensively. To attract smart city innovations more effectively into these programs we need to approach them with clear challenges, for which we have designed and field-tested several recipes (see Part III of this report).
2. Information gathered in the interviews has been disseminated and can be used as blueprint for similar analysis and to take stock of the development of the business ecosystem in other cities. The forecasted scenarios have been used in the search for related ideas and guiding incubatable ideas.
3. The research team committed to keeping close track of the demonstration projects being developed in IRIS with a special focus on potentially incubatable business models.

The main lesson we must draw from our first iteration of the SCUIBI-project is that the chosen strategies of interviewing existing firms and gatekeepers in the ecosystem yields very few useful leads and ideas for incubation. Ideas are either in a very early stage and not yet ready for incubation or have already been implemented and are currently in development, beyond the stage of incubation. There simply are not that many ideas around in the right stage of maturity, let alone ideas with motivated and capable teams. This, however, is a general problem for incubators worldwide and there is no easy solution.

Later in the project, as IRIS demonstrator projects and solutions were implemented, we have scanned the baseline reports of the three lighthouse cities for spinout and spinoff business models. That is, we have listed the 18 novel business models we identified could benefit from business incubation methods to validate them. Table 5 below lists these products and services.

Product / Service	Company	Short Description	Location	Transition Track
Solar Panels	Bo-Ex	A business model will be set up for each of the 644 households, with their own set of PV-panels (collectively placed on the building roofs by Bo-Ex), to exchange solar power. This business model has been set up by Bo-Ex.	Utrecht	TT1
Overcome Split Incentive	Bo-Ex	The housing cooperation Bo-Ex will develop a novel business model to overcome the split incentive for the additional investment required to deliver nearly zero energy buildings. Split incentives occur when those responsible for paying energy bills (the tenants) are not the same entity as those making the capital investment decisions (the building owner). In this model, the benefits associated with the resulting energy savings accrue to the tenant.	Utrecht	TT1
Second-Life Batteries	Stedin	The project will develop business models whereby second-life (former automotive) batteries may profitably be used for static energy storage in a building or district. The project will also examine depreciation against longevity of these specific batteries and potential extended use of stationary battery storage.	Utrecht	TT2

TOON Smart Meter	Eneco	Usually the Eneco Toon is sold to users through purchase channels. With these earnings, the costs for developing and producing the Eneco Toon are covered. IRIS sponsors the purchase of the Toon including installation works which is worth about € 325 per household. Besides, the (optional) subscriptions from clients and relevant information obtained from the users to develop (new) products and improve existing products e.g. Warmtewinner, compatible software applications and/or other concepts Eneco wants to develop in the future.	Utrecht	TT1
Innovative home EMS (Energy Management System)	Stedin	The project will investigate business models whereby stationary batteries may profitably be used for static energy storage in a building or district. Such business models will be coupled to the exploitation of the smart grid and Smart RenewableV2G Charging systems. Extra sources of flexibility emerge from the static storage, the V2G cars, from smart charging of these cars and from the PV-panels and hybrid heat pumps.	Utrecht	TT2
V2G e-cars	We Drive Solar MaaS	At this point, the business model of the shared e-cars is in a demonstration phase. Participants in the sharing scheme pay a fixed amount per month for the possibility to use a car for a certain number of days per month; there are several tiers. On top of that fixed amount, an amount is charged per km driven, which includes charging costs.	Utrecht	TT3
Smart Renewable V2G Charging	Stedin & Gemeente Utrecht	By using the EV Batteries in the energy system an extra business model may be added to the cars, in the form of price bonuses compared to classic EV charging tariffs. At this moment, this business model is in its pilot phase; several aspects are under investigation.	Utrecht	TT3
City Innovation Platform	Civity	The CIP brings together city data in a structure that facilitates development of services of all sorts, like services improving the city mobility system.	Utrecht	TT4
Virtual reality platform	Bo-Ex	A virtual reality platform, extending existing Oculus Rift® VR experiences for apartment buildings to other new buildings so households can experience their future 'new' home, including infotainment and interactive training about the new smart energy and mobility services they may expect.	Utrecht	TT5
Optimization of heating load curve	COFELY	As part of the renovation of existing buildings, the aim [..] is to integrate a smart control system within the district heating distribution, giving the possibility to adjust heat supply to the individual demand in each apartment according to their sun/wind exposures but also considering accurate indoor temperature.	Nice	TT1
Local Energy Management Dashboard	EDF	The dashboard will provide real time or near to real time information of the energy and environmental performance of the system to the community by mapping energy fluxes related to the district. Thanks to IRIS, the dashboard will be enhanced in its functionalities concerning its capabilities of monitoring the energy fluxes, potentially integrate forecasting services for optimal demand-supply balance and	Nice	TT1

		the information quality made accessible to the end user or provided via push notifications.		
EC2B	Trivector	EC2B offers customers an attractive alternative to owning their own car, allowing easy access to a variety of transport modes in connection to where customers live or work and make their everyday choices for transport. The EC2B service integrates several different mobility solutions within one app. To start with, the following are included: e-cars, e-bikes (normal bikes as well as cargo bikes), light e-vehicles and public transport. Further on, taxi, rental cars and municipal bike sharing might be added.	Gothenburg	TT3
Energy Cloud	SME Metry	Partner SME Metry will develop and implement an "Energy Cloud" on the Chalmers Campus. Near real-time data from energy (electricity, heat, water) consumption will be collected, integrated and made available for further analysis, thereby opening up for new applications to optimise energy supply and management on campus.	Gothenburg	TT4
Fighting Energy Poverty	Bo-Ex & Gemeente Utrecht	Early warning to Housing Corporation when households' energy costs are rising: the CIP brings together data of housing corporations, the Municipality, and energy grid operators on energy consumption of citizens. The housing corporation wants to use this data as an early warning system in case their tenants have an extremely high or irregular energy consumption pattern.	Utrecht	TT4
Free floating scheme		The added value of these innovative mobility services, lies on the consideration of the impact of the technological evolutions on users' daily practices on a territory, by examining what are the links between technical aspects (number of charging stations, level of connectivity, improvement of online offering, increasing of EV's autonomy…) and behaviors?. In return, what are the practice's impacts on technological evolutions (including EV's geographical distribution, energy management, dynamic pricing…).	Nice	TT3
Smart Lighting	Gemeente Utrecht / HKU	"Slimme straatverlichting benutten: bewoners denken mee over invulling en apps om de wijk te verbeteren"	Utrecht	TT5
"Model a Better City"		The main activity will be the organisation of a spatial planning design contest using the Minecraft® city model aimed at young people ("Model a Better City"). In the creation of forthcoming electrified bus stops, with related services for passengers, security aspects and availability issues, students for a Greenhack will be involved. Individuals, classes and several schools will build the new attractive society which will	Gothenburg	TT5

		eventually be expanded in the building game Minecraft, with 2021 as the target.		

Table 5: Novel Business Models identified from Baseline Reports Lighthouse Cities

Several of these have then been evaluated using the smart city business model canvas that was developed in Giourka et al. (2019) for the purpose of Task 3.3 and published these as Omlo (2020) and Kuiper (2020) on the IRIS website. Results of that exercise are reported there.

4. Classifying Start-ups as Smart City and User Innovations

In this chapter we develop empirically workable definitions for the key concepts in our report. For both User innovations and Smart City Innovations we have developed an index, following the same literature-based methodology to get to such an index. This chapter explains how these indices have been constructed. In chapter 4 we then present the research these indices allowed us to do. The sections in this chapter have been published in two working papers as Eckinger and Sanders (2019) and Hermse et al. (2021) (and are sometimes reproduced verbatim here).

4.1. The User Innovation (UI-)Index

Eric von Hippel is one of the pioneers in researching user innovation and has defined user innovation as 'firms or individual consumers that benefit from using a product or a service they develop' (Von Hippel, 1988; von Hippel, 2005). Key elements in this early definition are therefore: (1) firms or individual consumers, (2) development of a service or product, (3) personal usage, and a (4) received benefit. This definition has been used (papers cited 1459 and 9228 times respectively) and extended by many other researchers. For instance, Baldwin et al. (2006) further specified the type of user innovators into single user innovators as either a single firm or individual, or collaborative user innovations. Collaborative user innovations or communities of users have been additionally identified by Baldwin et al. (2006) by introducing a model that illustrates the transformation of a user innovation through a user community into a commercialized product. This concept was validated in case studies of the rodeo and kayak industry (Hienerth, 2006). Hence, 'user community' can be added as an element to the user innovation definition.

A user innovation is first and foremost, an innovation. That is, it is classified as a 'modification' or 'new creation'. This criterion can be especially found in empirical research, identifying user innovations within broad samples. De Jong and von Hippel (2008) distinguished 'user creation' and 'user modification' and defined firm user creation 'as developing an entirely new technique, equipment or software' whereas firm user modifications are 'any modification the firm may do to an existing technique, software or equipment'. Other empirical studies have applied the same criteria to identify firm user innovators within samples of UK firms, high-tech SME's in the Netherlands and Canadian manufacturing plants (De Jong & von Hippel, 2009; Flowers et al., 2010; Gault & Von Hippel, 2009).

Next to firm user innovations, the elements 'user creation' and 'user modification' have also been applied to distinguish among consumer innovators. For instance, Flowers et al. (2010) adjusted the definition of these two elements for individual consumers to 'modification or creation from scratch of an existing product or service' and used these as selection criteria within a sample of UK consumers.

A final element of user innovation is the development of an innovation for 'personal use' by individual consumers or 'in-house use' by firms. De Jong and von Hippel (2009) added this element to their criteria of user innovations in a sample of Dutch high-tech SME's, as did Flowers et al. (2010) in their sample of

firms and consumers based in the UK and De Jong et al. (2015) in a random sample of the Finnish population.

This gives us three elements of user innovations identified within the literature build the key characteristics of a user innovation: (1) firm user, individual consumer user or user community, (2) modification or new creation of products, processes, techniques, or software, and (3) development for personal or in-house use.

Other elements were mentioned rather briefly or only mentioned by a limited number of researchers. Nevertheless, these elements still need to be taken into consideration to create a specific understanding of innovations that qualify as a user innovation. As Von Hippel stated in his first papers, user innovations create a benefit for the user (Von Hippel, 1988; von Hippel, 2005). This realization has been supported by other researchers as well (e.g. Franke et al., 2006; Henkel & Von Hippel, 2004; Morrison et al., 2000). Further characteristics identified are (1) new to market and novelty, (2) satisfaction and better suit of own needs, and the (3) development of tailor-made and customized innovations (e.g. Baldwin et al., 2006, 2006; Gault & Von Hippel, 2009; Morrison et al., 2000).

We will not use characteristics such as “high product-related knowledge” and “high-use experience” (Lüthje, 2004; Lüthje et al., 2002; von Hippel, 2005), “low production cost” (Lüthje et al., 2002; Morrison et al., 2000) and “low market demand for the innovation” (Henkel & Von Hippel, 2004) in our definition as they do not appear consistently in the literature. Table 6 provides an overview of all user innovation characteristics identified in the literature base (see **Interview Guide Spinout Innovations Chapter 3**

- **Introduction**
    - Introduction of the researchers
    - Explanation of the IRIS project and SCUIBI (the business incubation process)
    - Assurance of confidentiality!
- **Company’s engagement in smart city innovation / background**
    - How does your company act in these five transition pathways (mobility, energy, …)?
    - Person of the entrepreneur/team/business: experience, motivation, etc.
    - Where does your company see NEW (business) opportunities/ideas regarding the transition tracks?
- **The business idea *(focus on most promising business idea?)***
    - (What’s the name of the business idea?)
    - Please describe the product/service (as it currently stands)
    - (Can you give a brief description/summary (‘30 second pitch’) about the idea?)
    - Has it been tried out already (pilot), or is it a wild guess? Or is it emerging?
- **Origin of the idea**

- Where does the idea originate: Incumbent/spin-off interview, challenge, user-source, other?
- Can you please explain the origin of the idea?

- **Customer value proposition/value proposition canvas (required!)**
  - What kind of customer demand do you see arising in the future?
  - What core value would you deliver to the customer? Which customer needs would you satisfy?
  - What kind of problems do the clients of your company face in these areas and how do they solve these problems today?
  - What would be potential solutions and could they be commercially exploited?
  - What kind of customers do you intend to serve? Who is your most important customer?
  - What bundles of products and services are we offering to each Customer Segment?

- **Key resources (optional)**
  - What key resources does your value proposition require?
  - **What resources are important the most in distribution channels, customer relationships, revenue stream…?**
  - Who are your key partners/suppliers? What are the motivations for the partnerships?
  - Which Key Resources are we acquiring from partners?

- **Key processes (optional)**
  - What key activities does your value proposition require?
  - What activities are important the most in distribution channels?
  - And in customer relationships?
  - And in production/manufacturing?
  - Which Key Activities do partners perform?

- **Profit formula (optional)**
  - How will you make money with this idea?
  - What kind of revenue model do you foresee?
  - What does the cost structure look like?

- **Business idea development**
  - Is your company actively pursuing these ideas (for example through the creation of spin-offs or through or forms of 'start-up support')?
  - Which barriers prevent the commercialisation of (your) smart city ideas?
- **End of the interview**
  - Any comments, remarks, feedback from the interviewee?
  - Can be contacted for clarifications/additional information?
  - Who else would you suggest we could speak to with these questions? (You can always email it to us)

Potential follow-up questions for individual business model elements

Questions for developing new products

(if there are insufficient ideas coming from the interviewee)

De-average buyers and users

Which customers use or purchase our product in the most unusual way?

Do any customers need vastly more or less sales and service attention than most?

For which customers are the support costs (order entry, tracking, customerspecific design) either unusually high or unusually low?

Could we still meet the needs of a significant subset of customers if we stripped 25% of the hard or soft costs out of our product?

Who spends at least 50% of what our product costs to adapt it to their specific needs?

Examine binding constraints

What is the biggest hassle of purchasing or using our product?

What are some examples of ad hoc modifications that customers have made to our product?

For which current customers is our product least suited?

For what particular usage occasions is our product least suited?

Which customers does the industry prefer not to serve, and why?

Which customers could be major users, if only we could remove one specific barrier we've never previously considered?

Explore unexpected successes

Who uses our product in ways we never expected or intended?

Who uses our product in surprisingly large quantities?

Imagine perfection

How would we do things differently if we had perfect information about our buyers, usage, distribution channels, and so on?

How would our product change if it were tailored for every customer?

Look beyond the boundaries of our business

Who else is dealing with the same generic problem as we are but for an entirely different reason? How have they addressed it?

What major breakthroughs in efficiency or effectiveness have we made in our business that could be applied in another industry?

What information about customers and product use is created as a by-product of our business that could be the key to radically improving the economics of another business?

Revisit the premises underlying our processes and products

Which technologies embedded in our product have changed the most since the product was last redesigned?

Which technologies underlying our production processes have changed the most since we last rebuilt our manufacturing and distribution systems?

Which customers' needs are shifting most rapidly? What will they be in five years?

Explanations

Value Proposition

Describes the bundle of products and services that create value for a specific Customer Segment.

The Value Proposition is the reason why customers turn to one company over another. It solves a customer problem or satisfies a customer need. Each Value Proposition consists of a selected bundle of products and/or services that caters to the requirements of a specific Customer Segment. In this sense, the Value Proposition is an aggregation, or bundle, of benefits that a company offers customers. Some Value Propositions may be innovative and represent a new or disruptive offer. Others may be similar to existing market offers, but with added features and attributes.

Customer Segments

Defines the different groups of people or organizations an enterprise aims to reach and serve.

Customers comprise the heart of any business model. Without (profitable) customers, no company can survive for long.

In order to better satisfy customers, a company may group them into distinct segments with common needs, common behaviors, or other attributes. A business model may define one or several large or small Customer Segments. An organization must make a conscious decision about which segments to serve and which segments to ignore. Once this decision is made, a business model can be carefully designed around a strong understanding of specific customer needs.

Customer groups represent separate segments if:

- Their needs require and justify a distinct offer
- They are reached through different Distribution Channels
- They require different types of relationships
- They have substantially different profitabilities
- They are willing to pay for different aspects of the offer

Channels

Describes how a company communicates with and reaches its Customer Segments to deliver a Value Proposition.

Communication, distribution, and sales Channels comprise a company's interface with customers. Channels are customer touch points that play an important role in the customer experience.

Channels serve several functions, including:

- Raising awareness among customers about a company's
- products and services
- Helping customers evaluate a company's Value Proposition
- Allowing customers to purchase specific products and services
- Delivering a Value Proposition to customers
- Providing post-purchase customer support

Customer Relationships

Describes the types of relationships a company establishes with specific Customer Segments.

A company should clarify the type of relationship it wants to establish with each Customer Segment. Relationships can range from personal to automated.

Customer relationships may be driven by the following motivations:

- Customer acquisition
- Customer retention

Boosting sales (upselling)

Key Resources

Describes the most important assets required to make a business model work.

Every business model requires Key Resources. These resources allow an enterprise to create and offer a Value Proposition, reach markets, maintain relationships with Customer Segments, and earn revenues.

Different Key Resources are needed depending on the type of business model. A microchip manufacturer requires capital-intensive production facilities, whereas a microchip designer focuses more on human resources. Key resources can be physical, financial, intellectual, or human. Key resources can be owned or leased by the company or acquired from key partners.

Key Activities

Describes the most important things a company must do to make its business model work.

Every business model calls for a number of Key Activities. These are the most important actions a company must take to operate successfully. Like Key Resources, they are required to create and offer a Value Proposition, reach markets, maintain Customer Relationships, and earn revenues. And like Key Resources,

Key Activities differ depending on business model type. For software maker Microsoft, Key Activities include software development. For PC manufacturer Dell, Key Activities include supply chain management. For consultancy McKinsey, Key Activities include problem solving.

Key Partnerships

Describes the network of suppliers and partners that make the business model work.

Companies forge partnerships for many reasons, and partnerships are becoming a cornerstone of many business models. Companies create alliances to optimize their business models, reduce risk, or acquire resources.

We can distinguish between four different types of partnerships:

- Strategic alliances between non-competitors
- Competition: strategic partnerships between competitors

Joint ventures to develop new businesses

Cost Structure

Describes all costs incurred to operate a business model.

This building block describes the most important costs incurred while operating under a particular business model. Creating and delivering value, maintaining Customer Relationships, and generating revenue all incur costs. Such costs can be calculated relatively easily after defining Key Resources, Key Activities, and Key Partnerships. Some business models, though, are more cost-driven than others. So-called “no frills” airlines, for instance, have built business models entirely around low Cost Structures.

Revenue Streams

Represents the cash a company generates from each Customer Segment (costs must be subtracted from revenues to create earnings).

If customers comprise the heart of a business model, Revenue Streams are its arteries. A company must ask itself, For what value is each Customer Segment truly willing to pay? Successfully answering that question allows the firm to generate one or more Revenue Streams from each Customer Segment. Each Revenue Stream may have different pricing mechanisms, such as fixed list prices, bargaining, auctioning, market dependent, volume dependent, or yield management.

A business model can involve two different types of Revenue Streams:

- Transaction revenues resulting from one-time customer payments
- Recurring revenues resulting from ongoing payments to either deliver a Value Proposition to customers or provide post-purchase customer support

Table 30 in the Annex) and ranks these according to the number of times they have appeared.

Rank	UI characteristic	Number of appearances
1	Individual consumer innovator	**18**
2	Firm user innovator	**17**
3	User community innovator	**17**
4	Modification / improvement / elements added	**15**
5	New creation	**11**
6	For personal / in-house use	**11**
7	High expected benefit / value	**9**
8	New to market (novelty)	**8**
9	Satisfies / better suits own needs	**5**
10	Tailor-made / customized	**5**
11	High product-related knowledge	**3**
12	High use experience	**3**
13	Low cost	**2**
14	Low market demand	**1**

Table 6: User innovation characteristics and their numerical appearance

In Table 7 we group the individual user innovation characteristics into different categories and assigning them a position based on the number of appearances in Table 6. The first three most highly ranked characteristics fall in the category 'user type'.

Rank	Category	UI characteristic	Position N°
Type of user innovator			
1		Individual consumer	**1**
2		Firm user innovator	**2**
3		User community innovator	**3**
Type of innovation			
4		Modification	**4**
5		New creation	**5**
Type of innovation characteristic			
6		For personal / in-house use	**6**
10		Tailor-made / customized	**7**
Type of motivation			
7		High expected benefit / value	**8**
9		Satisfies / better suits own needs	**9**
Type of market characteristic			
8		New to market (novelty)	**10**
14		Low market demand	**(11)**
Type of user characteristic			
11		High-product-related knowledge	**(12)**
12		High use experience	**(13)**
Type of production characteristic			
13		Low cost	**(14)**

Table 7: Categorical grouping of user innovation characteristics

Additional categories are innovation type, innovation characteristic, type of motivation, market characteristic, user characteristic, and production characteristic. We now construct our own definition by using the most relevant characteristics with a minimum numerical appearance of 5 (see Table 6) and limited the number of characteristics to be included in the measure to 10.

It is of course possible to score actual ventures, firms, innovations, and ideas on the criteria identified above. Each characteristic (item) can then take on a value of zero (false) or one (true). But for a meaningful and consistent measure of the degree to which a specific activity classifies as a user innovation, we need to develop an index. The index we are looking for must exclude those activities that are not innovations and those that do not come from users, while it should give higher values to activities that tick more of the boxes. We, admittedly somewhat arbitrarily, used the innovation characteristics with position number 1 to 10 (see Table 6). The first three characteristics (with position number 1 to 3 and a numerical appearance higher than 10) were used as "user innovation identifying" characteristics. The remaining four characteristics were added as "supplementary criteria", that intensify an identified user innovation. The results are shown in Table 8.

Item		Symbol	Value
User innovation identification			
4.	**Individual consumer/firm/community user innovator**	I	0|1
5.	**Modification/ new creation**	M	0|1
6.	**For personal/in house use**	P	0|1
User innovation intensification			
a.	**Tailor-made/customized**	TM	0|1
b.	**High expected benefit/value**	BE	0|1
c.	**Satisfies/ better suits personal needs**	SA	0|1
d.	**New to market/ novelty**	NE	0|1

Table 8: Value assignment to user innovation characteristics

Note: 0 = false | 1 = true

We then apply equation (1) to calculate an ordinal index measure ranging from 1 to 5 that captures the degree to which a venture conforms with the criteria used most often in the literature:

$$UI\text{-}Index = (I*M*P)\ (1 + TM + BE + SA + NE) \quad (1)$$

If the first three items of the user innovation identification outlined in Table 8 are not satisfied and, hence, take on a value of zero, the outcome of the formula will be zero and the innovation is not a user innovation. If the value is 1 for the first three criteria, the user innovation can be classified as a very weak (1) up to a very strong (5) user innovation based on its index number (see Figure 3).

0	1	2	3	4	5
Non-UI	*Very weak*	*Weak*	*Moderate*	*Strong*	*Very strong*

Figure 3: User Innovation Index

With this index in hand, we can investigate the effect of business incubation on User Innovations that end up in business incubation programs.

4.2. The Smart City Innovation (SCI-)Index

The aim of this section is to develop a clear classification scheme to identify "smart city" projects and start-ups. To do so, we follow the method proposed above (Eckinger & Sanders, 2019), using a variety of definitions found in the existing literature. Based on these definitions, we develop our index using on the one hand necessary conditions for "smart city", and on the other hand, some non-necessary variables to measure the intensity. We call this the Smart City Index (SCI).

First, we systematically collected papers regarding smart cities and their definitions in the literature via Google Scholar. The search terms used were "smart city", "smart-city", "smart city" AND "literature review", "smart city" AND "definition", and "definition smart city". In total, we came up with 165 articles, including multiples of the same reference and twenty literature review articles from which we took articles and definitions to supplement our reference list. After deleting the recurring papers, we were left with a list of 92 unique peer-reviewed papers, including 20 literature reviews (see Table 31 in the Annex). These references were collected in an Excel file with a column for the author, publication date, title, and journal (Table 32 in the Annex). Next, these articles were ranked by the number of citations per paper. We took citations in Google Scholar on the 1st of April 2020 and added this to the spreadsheet in a separate column. To be more accurate, two extra columns were added; one with citations per year, thus taking the total citations per article and dividing it by the years the article had been in circulation, and another for the rounded-up number of these citations per year. We deleted articles below 3 citations per year, however keeping the articles of 2019 and 2020 regardless, plus the definitions of(Manville et al., 2014). Finally, we ended up with 78 different references.

Next, we divided the 78 articles amongst ourselves (excluding the literature reviews) and looked in each one for a definition using "smart city", "define" and/or "definition", later adding this to the Excel file in a new column. Some definitions were quoted multiple times by different authors. These were deleted, after which we ended up with a total of 73 unique definitions of a smart city in our Excel sheet (see Table 32 in the Annex). We then listed the main keywords per definition. To come to an idea on what keywords appeared most, we did an initial search of the recurrence per word. Based on this, we were able to code the most recurring keywords and chose the following themes, coded 0 if the definition did not include the theme, coded 1 if it did. The themes were "technology", "ICT", "quality of life", "city", "sustainability", "innovation", "collaboration", "citizen", "integration", "economic", "human capital", "social capital", "business", "resource management", "infrastructure", "efficiency", "safety/security", "transportation", "network", "energy", "growth", and "creativity". Next, we calculated the percentage of appearances in the 73 definitions by making a sum of all the codes and ordered them in descending order.

#	Themes	% of appearances in total number of definitions
1.	Technology (data, sensors, activators, internet, ICT, IT, database, algorithm, grid, digital, solar panels, smart meters, WIFI, software, hardware, smart devices)	80.9%
2.	City/ urban challenges (territory, place, geographical area)	75.6%
3.	Sustainability (green, environmental, ecological)	50.2%
4.	ICT (if 1, also add 1 to technology)	49.6%

5.	Social capital (social, social wealth, inclusion, community)	48.4%
6.	Economic (economy)	38.6%
7.	Quality of life (liveability, prosperity, habitable, well-being)	38.1%
8.	Human capital (intelligence, skilled workers/ jobs, (high) education, knowledge)	35.4%
9.	Resource management	34.8%
10.	Infrastructure	32.2%
11.	Citizen (inhabitants, people)	29.2%
12.	Transportation (mobility, transport)	23.4%
13.	Innovation	17.8%
14.	Growth	17.5%
15.	Efficiency (efficient)	14.3%
16.	Safety (security)	14.1%
17.	Energy	10.9%
18.	Business (entrepreneurship)	10.5%
19.	Integration	10.5%
20.	Collaboration (participation, partnership, relational capital, coordination, stakeholder)	9.5%
21.	Network (interconnected)	8.6%
22.	Creativity	5.8%

Table 9: Smart City Innovation characteristics and their appearance

Additionally, we also calculated the percentage of appearances based on the total amount of citations per year (see Table 33 in the Annex). Based on these percentages, we identified the themes and keywords in Table 9. In this table, we present the keywords that are included in the theme.

Conditions	Themes	Symbol	Keywords included
Necessary conditions	Technology	T	Technology, data, sensors, activators, internet, ICT, IT, database, algorithm, grid, digital, solar panels, smart meters, WIFI, software, hardware, smart devices)
	City	C	City, urban, urban challenges, territory, place, geographical area
Intensity conditions	ICT	IC	ICT
	Citizen	CI	Citizen, inhabitants, people
	Environmental Sustainability	ES	Sustainability, green, environmental, ecological
	Quality of Life	QL	Quality of life, liveability, prosperity, habitable, well-being
	Social Capital	SC	Social capital, social, social wealth, inclusion, community
	Economic	EC	Economic
	Human Capital	HC	Human capital, intelligence, skilled workers/jobs, (high) education, knowledge

Table 10: The SCI-Index

There are two criteria that clearly stand out as most important – Technology and City. As we think it is also rather fundamental that smart city projects address urban problems and do so with smart, new

technology, we labelled these the two necessary conditions and dubbed the next seven – ICT (IC), citizen (CI), environmental sustainability (ES), quality of life (QL), social capital (SC), economic (EC) and human capital (HC) - intensity conditions. The overall SCI-index is then defined analogous to the UI-index defined above in equation (1):

$$SCI\text{-}Index = (T^*C)\ (1 + IC + CI + ES + QL + SC + EC + HC) \quad (2)$$

To test our coding scheme, we coded several datasets independently and iterated the coding scheme accordingly. We applied the above coding scheme to a dataset of start-ups that have applied for incubation at UtrechtInc between 2014 and 2017. For each start-up, we coded all start-ups, with three people independently, using the descriptions of the start-ups provided by Eveleens et al. (2019). These rather elaborate descriptions were composed from information collected online, using LinkedIn and the incubator files (see Eveleens et al. (2019) for details on the data collection). In the discussion of individual results, small irregularities were found. We therefore decided to make a few minor adjustments.

After making these adjustments, we tested our adapted coding scheme in a second dataset. This time, we used a dataset of start-ups in Gothenburg. These start-ups are incubated at Chalmers Ventures between 2015 and 2020. Three authors coded ten companies independently. Again, we coded them on seven variables - two necessary conditions and five intensity conditions. The descriptions of the companies on the Chalmers Ventures website, however, are short and basic. This made the coding of the start-ups more challenging, but we managed to get quite similar results. In our discussion, we decided to code the variable "quality of life" 1 only when the start-up has a direct effect on the quality of life of people. Incorporating the indirect effects on the quality of life in this variable would introduce a lot of ambiguity and subjectivity, which would make it hard for others to replicate the coding. Additionally, it became clear in the discussion that the definition of "technology" should be considered a lot broader than some may have in mind. Therefore, before coding, it is important that one has a good and common understanding of what "technology" entails. This allows for a more accurate replication when using the algorithm. We then coded a second set of start-ups in Gothenburg. We used twelve start-ups to check our adapted coding scheme. The results we individually obtained were very similar, with only a few discrepancies. This meant that the coding scheme is replicable, and the definitions were no longer ambiguous. When discussing the results, we agreed that to be able to code the variable "technology" as 1, new academic knowledge or R&D should be put into practice by the start-up. We acknowledge that this makes technology time dependent, which may introduce some ambiguity. However, we feel it is the most reliable way of coding technology since it is closest to the definition. It also proved challenging to code the variable ICT. We agreed that a start-up should be able to collect, store, use and send or share data electronically to be coded 1 on this variable.

After having coded another 12 start-ups independently on "economy", we also agreed that "economics" should entail both the direct effect on the start-up itself, for example cost reduction, but also the indirect effects on the customers of the start-up. These customers can be businesses or consumers, so it is valid for both B2B and B2C start-ups. In contrast, we decided to code the variable "quality of life" as 1 only when the effect of the start-up on the quality of life is direct. The indirect effect on the quality of life is more prone to interpretation, which would limit the replicability of our coding scheme. Finally, we agreed that the variable "citizens" should be coded a 1 when we could code the variable "city" as 1 also, as these

two variables are connected to each other (the "citizens" referred to in the definitions, live in a city by definition).

With these iterations, we were able to proceed and code the full datasets for the Netherlands (a further 194 start-ups various Dutch cities; see Hermse (2020) for details on the data) in Gothenburg (157 start-ups in Chalmers Ventures; see Nijland (2020) for details on the data) and Nice (295 start-ups in incubator PACA-EST; see Morin (2019) and Picari (2020) for details on the data). The results of our coding are presented and described in the next chapter.

4.3. Summary and conclusions

In this chapter we presented the two indices we have developed in the IRIS project to classify projects, start-ups and incubates on the degree to which they match the rather diffuse definition of these concepts as can be found in the academic literature. Both indices were constructed based on an elaborate text analysis of definitions proposed in the academic literature. We cannot claim to have been exhaustive in our approach, but we do believe our indices capture the most salient features of these definitions and probably overlap to a large extent with definitions used in papers we have missed. Moreover, should future research reveal additional dimensions, than these can easily be added to our indices. For now, we conclude that these indices capture the state of the art in both literatures. Moreover, by distinguishing between necessary conditions and intensifying aspects, we have built indices that not only classify a venture, project or innovation as User Innovation or Smart City Innovation in a 1/0 form but give a value that refers to how much overlap there is between the venture and aspects of the concept as deemed important in the academic literature. Both indices were tested for consistency across coders by coding datasets of start-ups that contain a short description of the start-up's main activities, products, and services. The indices and definitions of the component parts have been discussed until convergence was achieved and thus, we have ensured consistent coding of the data we had available for the project. We turn to the resulting data, coding and first results in the next chapter.

Both policy makers and researchers can use our indices to identify and distinguish between activities focussing on providing solutions for rapid changes in the (smart) city. A clear and unambiguous way to identify smart city and user innovations is an important tool in targeting policies as well as monitoring their impact. Using a Business Incubation program, as will be described in Chapter 6, can help these projects or companies in becoming successful quicker or more often.

5. Smart City Business Incubation in Utrecht, Gothenburg and Nice

In Chapter 3 we have already established that spinout innovations is not a very likely source of incubatable ideas in smart city development in Utrecht. The ideas that (people in) incumbent firms might be either too green or too developed and it is hard to near impossible to speak to the right people at the right time to hope to generate significant numbers of spinout incubates. In Chapter 4 we developed our methods for identifying the remaining projects as smart city and user innovations, where we, importantly, developed an index that allows us to also differentiate between projects that are only marginally and very much aligned with the definitions of these concepts in the academic literatures. In this chapter we present the results of our data collection efforts in the IRIS project. To analyse what business incubation practices and programs are most congenial to smart city and user innovations, we collected data on incubated start-ups in incubators in the three lighthouse cities in the IRIS project, Utrecht, Gothenburg and Nice. We collected historical and contemporary data (before and during the IRIS project) to track the incidence of smart city and user innovation-based start-ups in these incubators prior to and during the IRIS project. In a first study, based on data from Utrecht, we investigate if the knowledge base underlying a venture influences the impact of business incubation. Using by now standard techniques we then analyse also how specifically smart city and user innovation-based start-ups fare relative to their non- or less-smart city and non- or less-user innovation-based colleagues in the incubators. Unfortunately, data on start-up performance is not easy to come by. Incubators do not systematically keep track of this data and reconstructing it from public sources is very labour intensive. In this chapter we describe the data collection process and present the results for Utrecht, Gothenburg and Nice, respectively.

5.1. Characteristics of a Venture and the Impact of Business Incubation[8]

Before we can propose an effective business incubation program to support user innovations in a smart city context, we would need to establish that the underlying characteristics of the venture have an impact on the effectiveness of business incubation practices. If business incubation programs already cater to the needs of smart city and non-smart city or user and non-user innovations alike, then there would be no need to adapt the programs and/or target these ventures specifically. More generally, it is relevant to investigate what underlying mechanism would drive such differential impacts. The work of Eveleens (2019) proves highly relevant here. Eveleens (2019) views start-ups as bundles of knowledge with which they exploit an entrepreneurial opportunity to achieve their growth ambitions (Fleming & Sorenson, 2001; Grant, 1996). Eveleens (2019) distinguishes two rather generic characteristics of the start-up. The originality and diversity of the knowledge base underlying the venture. If these characteristics can be

[8] This chapter is based on work published earlier as Eveleens (2019). Large parts of this paragraph are (sometimes verbatim) quotes from earlier publications of IRIS work.

shown to affect the outcomes of business incubation, it is likely that characteristics of incubates in general should be considered when designing targeted incubation programs.

The originality of the knowledge base refers to the extent to which the knowledge base is different from the knowledge base of other start-ups (Amason et al., 2006; Koellinger, 2008). While a high level of originality can result in the introduction of important and radical innovations, sometimes even sparking completely new industries (Hannan & Freeman, 1989), it is also associated with low survival rates of businesses (Hyytinen et al., 2015). Business incubation has been proposed as a tool to overcome this low survival rate by creating a support network around these startups that may otherwise remain misunderstood, undervalued, or even actively opposed (AMEZCUA et al., 2013; Bøllingtoft & Ulhøi, 2005; Hallen et al., 2016). This embedding in a network may be particularly helpful for the start-ups with the most original knowledge base.

The diversity of their knowledge base refers to how they combine different types of knowledge (Aharonson & Schilling, 2016; W. M. Cohen & Levinthal, 1990). Due to their limited size, start-ups often have a quite narrow knowledge base (Freeman et al., 1983; van Weele et al., 2018), which limits their ability to search, identify, and integrate new knowledge (Macpherson & Holt, 2007; Zahra & George, 2002). Incubation has been suggested to complement the knowledge base of start-ups and thus increase their absorptive capacity (D. Patton, 2014). This would imply that incubation is especially helpful for start-ups that have a low level of knowledge base diversity.

Together, the increased variety of start-ups could mean that the dominant model of incubation is more suitable for some start-ups than others. Indeed, this would provide support to the idea that incubation becomes more standardised, and that one size does not fit all (S. L. Cohen et al., 2019). Unveiling this would have important practical implications for the incubator selection process (Aerts et al., 2007) or for the design of incubation programs (S. L. Cohen et al., 2019), specifically also for the design of smart city incubation programs.

Eveleens (2019) focused on start-ups that apply to incubators, because this is the relevant population to study the effect of incubation. The conceptualisation of start-ups as a unique mix of knowledge types enables us to measure them as a multidimensional vector representing their knowledge base. This knowledge base determines their location in a knowledge space (Fleming & Sorenson, 2001; Frenken et al., 2007; Krafft & Quatraro, 2011). We determine this location of the start-up using elaborate text descriptions of the start-ups which we assessed using a topic modelling algorithm (Blei et al., 2003). From their location in the knowledge space, we derive proxies for originality (Jaffe, 1986) and diversity (Rafols & Meyer, 2010). Drawing on the incubation literature and using a knowledge-based perspective, Eveleens (2019) first hypothesises that because incubation helps the start-up to navigate the knowledge space more efficiently, incubation experience leads to higher start-up performance. Second, he hypothesises a moderating effect of the originality and diversity of the start-up's knowledge base on the impact of incubation. Eveleens (2019) then tested these hypotheses on an original dataset of 269 start-ups that applied for two publicly sponsored incubation programmes in Utrecht, the Netherlands, of which 158 were accepted. See Eveleens (2019) for a more detailed description of the theoretical background, data collection process and data. Importantly, Eveleens (2019) used the pre-incubation quality and analysis of sub-samples to control for non-random selection by the incubator.

The main results of the analysis are presented in Eveleens (2019) Table 9, reproduced in Table 11:

Dependent Var	Survival			Size			Growth			Investments		
Method	Logistic			Zero inflated count data			Ordinary Least Squares			Logistic		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
INCUB	1.422***	2.460*	1.946†	0.636**	-0.318	0.405	3.048***	1030	0.745	1.568**	-0.098	0.083
	(0.316)	(1.131)	(1067)	(0.206)	(0.910)	(0.673)	(0.728)	(2.610)	(2.514)	(0.587)	(1.907)	(2.020)
DIVERSITY		1.115†			-0.555			-0.477			-0.814	
		(0.659)			(0.562)			(1.442)			(1.268)	
INCUB*DIVERSITY		-0.684			0.627			1.395			1.284	
		(0.734)			(0.557)			(1.716)			(1.234)	
ORIGIN			0.584			-0.141			-1.062			-0.858
			(0.729)			(0.488)			(1.753)			(1.714)
INCUB*ORIGIN			-0.452			0.256			2.281			1.421
			(0.915)			(0.556)			(2.171)			(1.830)
QUALITY	-0.034	-0.026	-0.040	0.023	-0.027	-0.029	0.078	0.081	0.071	-0.159	-0.162	-0.253
	(0.163)	(0.164)	(0.162)	(0.100)	(0.102)	(0.098)	(0.376)	(0.378)	(0.366)	(0.302)	(0.299)	(0.241)
AGE AT APPL	0.705***	0.719***	0.692***	-0.023	-0.033	-0.028	0.093	0.126	0.105	0.071	0.084	0.077
	(0.177)	(0.178)	(0.176)	(0.054)	(0.055)	(0.054)	(0.239)	(0.241)	(0.240)	(0.150)	(0.151)	(0.150)
YEARS SINCE	-0.249	-0.253	-0.248	0.147	0.132	0.129	0.292	0.346	0.303	0.415†	0.429†	0.425†
	(0.155)	(0.157)	(0.155)	(0.095)	(0.099)	(0.099)	(0.360)	(0.364)	(0.361)	(0.234)	(0.236)	(0.235)
MARKET B2C	-0.508†	-0.524	-0.511†	-0.174	-0.180	-0.114	-0.579	-0.921	-0.618	0.083	0.097	0.093
	(0.298)	(0.317)	(0.302)	(0.192)	(0.197)	(0.182)	(0.695)	(0.753)	(0.697)	(0.444)	(0.441)	(0.440)
HARDWARE	-0.713*	-0.356	-0.657†	-0.197	-0.239	-0.176	-1.655*	-1.101	-1.435†	-0.227	-0.318	-0.192
	(0.326)	(0.411)	(0.341)	(0.181)	(0.236)	(0.209)	(0.755)	(0.926)	(0.803)	(0.453)	(0.554)	(0.468)
Constant	0.803	-1.284	0.134	0.742	1.297	1.082	-1.001	-0.249	0.066	-4.26**	-2.197	-3.058
	(0.826)	(1.285)	(1.143)	(0.488)	(1.103)	(0.795)	(1.879)	(2.974)	(2.681)	(1.397)	(2.011)	(2.200)
Observations	269	269	269	269	269	269	269	269	269	269	269	269
McFadden R2	0.169	0.178	0.170	0.054	0.058	0.054	0.014	0.014	0.015	0.085	0.091	0.090
Log Likelihood	-145.7	-144.0	-145.6	-601.7	-599.1	-601.4	-840.1	-839.7	-839.5	-80.2	-79.7	-79.8
LR-test		1.577	0.352		-0.243	-0.162		-0.243	-0.162		0.397	0.298

Note †P<0.10; *p<0.05; **p<0.01; ***p<0.001; Z = zero data, CD = count data, INCUB = incubation, ORIGIN = originality

Table 11: Empirical Results Eveleens (2019) Table 9: Regression models testing the interaction effect of diversity and originality

Eveleens (2019) finds that while incubation positively affects all measures of performance, the originality and diversity of the start-up do not moderate this effect. In other words, such characteristics of a start-up do not significantly affect the impact of incubation on start-up performance.

With this insight, we can draw two important conclusions. First, we find **a positive effect of incubation on start-up performance**.[9] Second, we show that **start-ups with knowledge of varying originality and diversity similarly benefit from incubation**.

These results suggest that, regardless of their location in the knowledge space, start-ups benefit from incubation equally. Of course, this suggests there is no need to tailor the incubation program to target incubates' knowledge base, including that specific to smart city and user innovations. But before we turn to these implications, we need to confirm this using the indices we developed and that allow us to go into more detail on the (potentially differential) effect of business incubation on smart city and user innovations.

5.2. User Innovation Based Business Incubation in Utrecht[10]

The main role of business incubators is to support innovative and entrepreneurial start-ups and new ventures with services geared towards their performance and success. Adegbite (2001) has created an overview of these services which include incubator space, professional management, strict admission and exit rules. Furthermore, common services such as counselling, training, secretarial support, start- up financing, as well as assistance with product development and marketing, support ventures in their growth process (Adegbite, 2001, p. 157). In broader terms, services of business incubators address needs regarding the overall infrastructure of the start-up, coaching and networking (Peters et al., 2004, p. 86). Entrepreneurs and starting enterprises benefit from incubation programs since these often lack these specific success factors. Limited access to funding is one of the main challenges start-ups face due to high-risk evaluations by financial institutions based on their failure rate (Kirsty, 2010, p. 3). Additionally, start-ups are lacking skills regarding market opportunity recognition and industry expertise, have limited access to technologies needed and have only limited social and business network connections for further expansion (Kirsty, 2010, pp. 3–5). Due to these limitations, start-ups are motivated to apply to business incubation programs which provide the services required to grow and succeed (Lose & Tengeh, 2016). The performance of start-ups can be observed by certain indicators such as survival, growth, or increased R&D activity (Barbero et al., 2012). A lot of empirical research has tested the effect of incubation on start-up performance which has led to the identification of a positive relationship between incubation programs and the success rate of start-ups and their innovations (Arlotto et al., 2011; Eveleens, 2019; D. Patton, 2014; Sedita et al., 2017). To validate our data, we will retest this effect and compare our findings to the positive relationship found in the literature. Based on this we formulate a first hypothesis:

H1: Business incubation positively influences the performance of start-ups.

If we can support hypothesis 1, we can show that incubation positively affects the performance of start-ups, implying that start-ups benefit from incubation. If the effect is positive and significant, we have found

9 Confirming earlier findings in for example Hallen et al. (2016); Madaleno et al. (2018); Van Rijnsoever et al. (2017)
10 Parts of this section have been published as part of Eckinger and Sanders (2019)

the same outcome as previous research and can use this as a validation of our data to test our hypotheses specific to user-innovations.

Start-ups and new ventures develop innovations for different reasons. These can be profit-related, aimed at increasing social welfare or developed for the own personal benefit. If the latter applies, the innovation developed could classify as a user innovation. User innovations differ from non-user innovations, also called producer or manufacturing innovations, in the sense that the latter are developed to create a financial profit from selling it (De Jong & von Hippel, 2009; Gambardella et al., 2017; von Hippel, 2005). This stands in contrast to user innovations. Another distinguishing feature is that producer innovations are specifically developed to satisfy consumer needs and to attract a large share of the market (Henkel & Von Hippel, 2004) instead of being developed for personal use or value (Gambardella et al., 2017). But even though differences regarding the motivation of the innovations' development exist, similarities can still be observed. Firstly, some user innovations are developed due to recognition of new market opportunities as well (Baldwin et al., 2006; Franke & Shah, 2003), though not necessarily for a large share of the market. Secondly, both lead to a benefit for the developer, either in terms of financial profitability or personal use, though regarding user innovation this is not the initial motivation. Third, user innovations as well as non-user innovations imply the development of new products or addition to existing products or services (Gault & Von Hippel, 2009; Hienerth, 2006), though new product development derives from an individual need, looking at user innovations. Since both innovation types show underlying similarities and since business incubators can be considered profitable for start-ups by providing the necessary skills, we hypothesize that business incubators will be beneficial also for user innovations:

H2: Business incubation positively influences the performance of user innovation-based startups.

If we can support hypothesis 2, we can show that incubation positively affects the performance of user innovations, implying that user innovations benefit from incubation as well. Regarding the acquisition process of start-ups, business incubators use specific selection criteria to evaluate start-ups and estimate their incubation success. Common screening factors include characteristics of the management team, financial ratios, and market factors (Aerts et al., 2007). Since the success of an incubator depends on the performance of the start-up that has been accepted to the program, incubators try to select only the most suitable candidates with lowest potential failure rates (Aerts et al., 2007). As a result, strict screening practices are applied by the business incubators. We hypothesized that business incubators can be beneficial for the performance of user innovations. However, when it comes to the selection of suitable start-ups for the incubation program, user innovations might have a disadvantage compared to other candidates. Since user innovations are developed for personal use due to the detection of a problem or need, the founding team of user innovations usually consists of the user himself (Shah & Tripsas, 2007) and therefore, tends to be small. Even a user innovation community or group doesn't match the selection criteria because most user innovators are specialized in their field and have strong experience with the product or service they develop (Lüthje, 2004; Lüthje et al., 2002), hence the overall diversity as well as technical, management, financial and marketing skills of the innovation team (Aerts et al., 2007) being rather low. In terms of their financial strength user innovations might also experience barriers regarding their selection to incubation programs. Most user innovations are developed at low cost and therefore do

not require much capital and investment from the user side (Lüthje et al., 2002; Morrison et al., 2000). Taking this into consideration, financial ratios regarding the start-up's liquidity, profitability or debt are likely to have a negative effect on the selection of the user innovations to incubation programs (Aerts et al., 2007). From this, we hypothesize that a selection bias of business incubator selection criteria against user innovations exists, meaning that incubators are not likely to select many user innovations to their programs based on the selection criteria applied.

Moreover, user innovations are not primarily developed to achieve financial profitability and to become commercially successful, but rather to satisfy the users own personal needs (Shah & Tripsas, 2007). We therefore further hypothesize that user innovations show a negative self-selection bias towards business incubators themselves. This would imply that not many user innovations are attracted by incubation programs nor apply for their support in the first place. But despite these selection biases, incubation programs could strongly benefit user innovations because of their small size and lack of financial profitability. Therefore, we would like to test whether the benefit of incubation, if hypothesis 2 can be supported, differs for user innovations and non-user innovations. By looking for a moderation effect of user innovations on incubation in comparison to other start-ups, we can formulate our third hypothesis:

H3: USER INNOVATION POSITIVELY MODERATES THE INFLUENCE OF INCUBATION ON PERFORMANCE.

If we find support for hypothesis 3, we can show that incubation indeed influences the performance of user innovations more positively compared to non-user innovations. To study these hypotheses, we used the same data as Eveleens (2019) above, amended with our indicator for user innovations described above. For a more detailed description of the data selection and collection, we refer to the original reports Eckinger and Sanders (2019) and Eveleens (2019). In these reports, the reader can also find more elaborate positioning in the academic literature. For the purposes of this report, we fast forward to the results. First, we found that only 7% of all 269 start-ups in the Utrecht incubators' dataset were coded as user innovations. Compared to percentages of user innovations in broader datasets (e.g., De Jong, von Hippel, Gault, Kuusisto and Raasch (2015) find 176 verified user innovations out of 624 innovations (28%) reported by of 2048 respondents in Finland), we therefore find an indication for a negative self-selection bias of user innovations towards incubation programs. Only 6 out of the 19 user innovations, so about 32%, were eventually admitted to the incubation programs. This is 58% in the total dataset and the relatively low acceptance rate for user innovations could indicate a further selection bias of business incubators against user innovations.

Figure 4, reproduced from Eckinger and Sanders (2019), shows that of the user innovations we did find, most (5.1 percent point) could be classified as moderately user innovation, whereas we did not find a single user innovation that would tick all the boxes in our dataset. We conclude from these results that

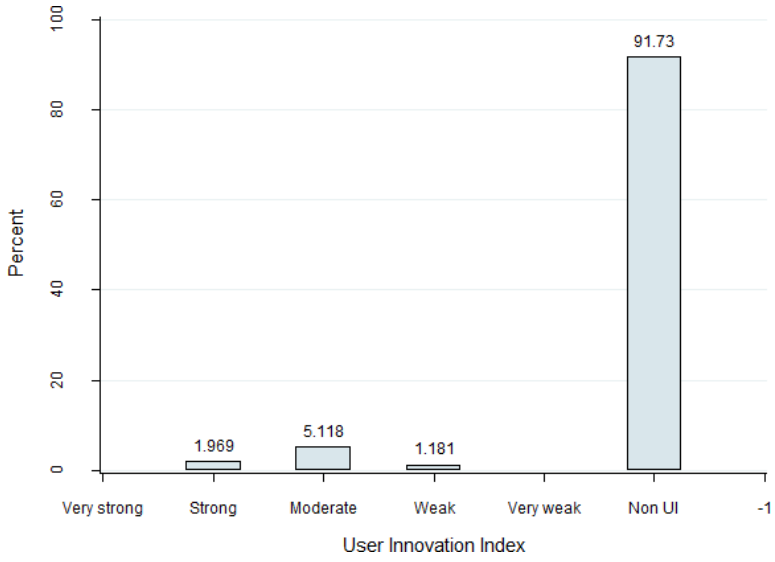

Figure 4: Categorical Representation of User Innovation Variable (in percentages) reproduced from Eckinger and Sanders (2019) Figure 2

user innovations, like spinout innovations, are a rare animal in our data and unlikely to be attracted to and admitted in existing incubator programs. The results on the hypotheses follow from the reproduced Table 8 from Eckinger and Sanders (2019) in Table 12:

Dependent Var		**SURVIVAL**			**GROWTH**			**INVESTMENT**		
Method		***Logistic***			***Ordinary Least Squares***			***Logistic***		
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
INC	1.132***	1.093***	0.990**	2.981***	2.663***	2.623***	1.891**	1.718**	1.567*
	(0.381)	(0.388)	(0.399)	(0.852)	(0.845)	(0.897)	(0.803)	(0.806)	(0.817)
UI		-0.317	-1.165		-1.675	-1.969		0.280	-12.993
		(0.739)	(1.207)		(0.990)	(1.160)		(1.205)	(1501.427)
INC*UI			1.700			0.577			13.644
			(1.715)			(1.590)			(1501.428)
QUAL	-0.047	-0.069	-0.071	-0.056	0.050	0.051	-0.364	-0.223	-0.225
	(0.181)	(0.185)	(0.186)	(0.341)	(0.335)	(0.335)	(0.305)	(0.316)	(0.323)
SAA	-0.106	-0.083	-0.070	-0.903***	-0.824***	-0.819***	-0.255	-0.210	-0.195
	(0.130)	(0.132)	(0.133)	(0.227)	(0.226)	(0.229)	(0.213)	(0.209)	(0.209)
AAA	0.629***	0.653***	0.643***	0.082	0.073	0.070	0.156	0.162	0.152
	(0.199)	(0.204)	(0.203)	(0.160)	(0.160)	(0.161)	(0.177)	(0.177)	(0.177)
YSA	-0.159	-0.164	-0.126	0.326	0.415	0.425	0.601*	0.567*	0.595*
	(0.194)	(0.197)	(0.202)	(0.523)	(0.523)	(0.528)	(0.311)	(0.317)	(0.323)
EXP	-0.159	-0.220	-0.233	-0.081	-0.195	-0.198	0.460	0.291	0.280
	(0.215)	(0.220)	(0.220)	(0.522)	(0.523)	(0.524)	(0.315)	(0.332)	(0.332)
B2C	-0.596*	-0.674*	-0.694*	-0.939	-0.933	-0.939	0.148	0.099	0.058
	(0.352)	(0.363)	(0.364)	(0.906)	(0.957)	(0.959)	(0.543)	(0.578)	(0.585)
HDW	-0.653*	-0.677*	-0.705*	-1.520*	-1.577*	-1.577*	-0.207	-0.154	-0.163
	(0.388)	(0.395)	(0.400)	(1.159)	(1.172)	(1.175)	(0.539)	(0.569)	(0.570)
Const.	1.355	1.529	1.488	1.841	1.435	1.424	-4.697***	-4.866***	-4.816***
	(1.097)	(1.123)	(1.128)	(1.819)	(1.782)	(1.789)	(1.777)	(1.866)	(1.768)
Obs	186	180	180	186	180	180	186	180	180
Pseudo R-squared	0.137	0.146	0.151	0.110	0.110	0.110	0.130	0.110	0.130

Note: Robust standard errors and normal R-squared for Growth *** p<0.01, ** p<0.05, * p<0.1

Table 12: Results Eckinger and Sanders (2019) Table 8: Regression models testing hypotheses 2&3

Models 1, 4 and 7 include incubation experience and all control variables and provide the results on hypothesis 1. These confirm earlier findings, amongst others by Eveleens (2019), that incubation positively impacts the outcome variables under consideration. Models 2, 5 and 8 add user innovation as an independent variable to the incubation model. Finally, models 3, 6 and 9 add the interaction term between UI and INC to the model. We can observe that adding UI as well as adding the interaction term between INC and UI does not impact the significance of the results of the incubation model. The estimates stay almost the same within all three models for each performance measure. Only the estimates of INC with SURV and INV are reduced in their confidence percentage when adding the interaction term. However, we cannot find any significant or positive estimates of user innovation when adding the UI variable to our incubation model. **From this, we can conclude that the performance of user innovations in terms of survival, growth and investments is not affected by the user innovation being incubated or not.**

Of course, we must be cautious in interpreting these results. We have identified only a small number of incubates that classify as user innovation and the number of observations is too small to even attempt to estimate the effect of scoring more on the user-innovation index. The power in our statistical analysis is weak, potentially explaining the absence of significant results that might still be there and could be revealed in larger datasets. Nevertheless, the results as presented here, give us no reason to change incubation practices for the benefit of user innovations specifically. The absence of significant coefficients for the user innovation dummy in our regressions, implies that user innovations, to the extent that they self-select and are accepted into incubation programs, benefit from the incubation program in the same, positive, way as non-user innovations. The implication of this analysis is that we should rather focus on getting more user innovations to apply for incubation and perhaps make incubators more sensitive to the specific strengths and weaknesses of such innovations. Business incubation is, to date, very much geared towards the specific needs of the incubates, such that user innovations, even if they enter with somewhat weaker teams and financial resources, benefit from incubation in strengthening these weaknesses and leveraging their strengths.

5.3. User Innovation Based Business Incubation in Nice[11]

We also replicated the analysis that was conducted by Eveleens et al. (2019) and Eckinger and Sanders (2019) for Utrecht in a French dataset on 308 incubates in the incubator PACA-Est in Nice. Exact replication is unfortunately not possible, as very little data was collected for non-incubated firms. In fact, for the latter, we only have survival up to 2019 and some information from the application. However, to assess the impact of incubation itself, we would need information on quality for a significant number of non-incubated firms in the sample. Therefore, the study on PACA-Est, published earlier as Morin (2019), investigated the impact of incubation on the survival expectancy of start-ups by using survival analysis with a Cox proportional hazard model. This analysis is followed by the study of three different types of resources and their impact on incubated firm's success indicators with a multilinear regression model.

[11] Parts of this section have been published as part of Morin (2019)

The extensive data collected over eighteen years enabled Morin (2019) to contribute to the assessment of incubation impact and the role of knowledge capital, human capital, and financial resources in the success of start-ups. Moreover, we focused on specific dimensions such as user innovation, using the above UI-index and smart-city transition tracks.[12]

In his thesis, Morin (2019) first explores the existing theoretical framework of incubation and start-up growth. Particularly, the study conducted by Hausberg & Korreck (2018) offers a comprehensive literature review about incubators. Second, Morin (2019) detailed the data collection process. His data section also contains a precise description of all variables used in the analysis. We refer to the full report in Morin (2019) for a detailed presentation of the theoretical background, data collection and methods applied in the analysis. For this report, we skip right to the results and their interpretation considering our main purpose here.

First, Morin (2019) found, as Eckinger and Sanders (2019) did for Utrecht, a low number of user innovations in the PACA-Est incubator. This should not come as a surprise. The criteria for application in the PACA-Est incubator include a requirement to involve a scientist from the university, such that the incubator targets academic start-ups primarily. This reduces the scope for user innovations, especially in the smart city domain, significantly. Consequently, it did not come as a surprise that only 9 out of 308 incubated firms could be classified as user innovations. These rare user innovations did score very high on our index (4.3 out of 5), but the number is simply too small to make any statistically relevant conclusions on the impact of business incubation on user innovations, specifically.

Morin (2019) then investigated the role of resources that the Resource-Based View of the firm would predict an incubator can effectively mobilize for start-ups. He concluded that having a diverse team, specifically, having non-academics on a relatively highly educated team, significantly increases survival and performance. He also finds that incubation of hardware producers (as opposed to software and service providers) tends to increase growth but decrease survival probabilities, whereas a match on the IRIS transition tracks as identified in the project has no significant impact on survival (neither positive nor negative) but does show a positive and significant effect on growth (in employment). As Morin (2019) could not yet benefit from the work published in Hermse et al. (2020), the matching on transition tracks was done by first scoring a subset of incubates and then verifying these classifications with transition track coordinators in the project (in Utrecht). The results gave us a first indication that perhaps smart city innovations would fare differently in incubation programs and therefore, one might design an incubation program specifically for smart city innovation. However, the results for user innovations in Morin (2019) confirmed that that type of innovation rarely applies for and/or gets selected into incubation programs. More importantly, the results also suggested that those that do, benefit in the same way from business incubation as non-user innovation-based start-ups. Therefore, redesigning incubation programs specifically for these types of innovations did not seem to be needed or effective. To develop more user

[12] Note, this is not using the smart city index described above that was developed later in time, but rather classified the start-ups on the IRIS-specific transition tracks. A venture was therefore only classified as Smart City if it fitted the IRIS transition tracks. We developed the SCI later because we felt this was a too restrictive definition.

innovations in an incubator, one would instead have to look at the factors that drive the (self)-selection of such innovators in the incubation program. We now turn our attention to first classifying and then researching if smart city innovation-based start-ups benefit from incubation differently and require a different approach.

5.4. Smart City Innovation Based Business Incubation in Utrecht, Gothenburg and Nice[13]

Table 133 and Table 14 shows the descriptive statistics for our coded data for the samples from incubators (UtrechtInc, Climate-KIC, Chalmers Ventures, and PACA-Est) and Dutch cities, respectively. The samples show that smart city innovation is not uncommon in our datasets.

	City	Technology	Quality of Life	Citizen	Sustainability	ICT	Economic	#Smart city	Average SCORE	Obs.
UtrechtInc, Utrecht, NL	6 (13.33%)	43 (95.56%)	8 (17.78%)	4 (8.89%)	7 (15.56%)	38 (84.44%)	20 (44.44%)	6 (13.33%)	3.67	45
Climate-KIC, Utrecht, NL	19 (27.94%)	68 (100%)	20 (29.41%)	9 (13.24%)	60 (88.24%)	19 (27.94%)	55 (80.88%)	19 (27.94%)	3.84	68
Chalmers Ventures, Gothenburg, SE	14 (8.92%)	149 (94.90%)	34 (21.66%)	5 (3.18%)	33 (21.02%)	97 (61.78%)	41 (26.11%)	14 (8.92%)	3.29	157
PACA-Est, Nice, FR	29 (9.8%)	294 (99.6%)	68 (23.1%)	10 (3.4%)	86 (29.2%)	103 (34.9%)	74 (25.1%)	28 (9.4%)	3.21	295
Total	68 (12.0%)	554 (98.0%)	130 (23.0%)	28 (4.9%)	186 (32.9%)	257 (45.5%)	190 (33.6%)	67 (11.8%)	3.34	565

Table 13: Descriptives for Incubators

Over all incubators, the percentage of start-ups that we could classify as "smart city" is 11.8%, ranging between some 9% in Gothenburg and 27% in Climate KIC, an incubator dedicated to sustainable innovation. It should also be noted that the most restrictive necessary condition is "city", not "technology", as the latter scores 1 for over 90% in all samples. That is, incubators tend to be focused on tech start-ups. That tech start-ups in incubators address urban challenges is rarer. Of the "intensity" factors, the scores on "citizen" are clearly lowest at on average 5%. In comparison, the use of ICT

[13] Parts of this section have been published earlier as parts of Nijland (2020), Picari (2020), Hermse et al. (2020) and Kolassa (2021).

technology is common to some 50% of the sample. All this makes sense intuitively and corresponds with what we would expect, given the profiles and nature of the incubators.

	City	Technology	Quality of Life	Citizen	Sustainability	ICT	Economic	#Smart city	Observations
Amsterdam	10 (9.2%)	109 (100%)	10 (9.2%)	5 (5.0%)	16 (14.7%)	99 (90.8%)	38 (34.9%)	10 (9.2%)	109 (56.2%)
Rotterdam	6 (20.0%)	30 (100%)	8 (26.7%)	12 (40%)	6 (20%)	21 (70.0%)	9 (30.0%)	6 (20.0%)	30 (15.5%)
Den Haag	0 (0.0%)	13 (100%)	0 (0.0%)	0 (0.0%)	2 (15.4%)	10 (76.9%)	1 (7.7%)	0 (0.0%)	13 (6.7%)
Utrecht	3 (45.8%)	19 (100%)	3 (15.8%)	1 (5.5%)	4 (21.1%)	17 (89.5%)	4 (21.1%)	3 (15.8%)	19 (9.8%)
Eindhoven	2 (33.3%)	6 (100%)	1 (16.7%)	1 (16.7%)	1 (16.7%)	3 (50.0%)	2 (33.3%)	2 (33.3%)	6 (3.1%)
Delft	2 (11.8%)	17 (100%)	4 (23.5%)	2 (11.8%)	6 (35.3%)	12 (70.6%)	6 (35.3%)	2 (11.8%)	17 (8.8%)
Total	23 (11.9%)	194 (100%)	26 (13.4%)	21 (10.8%)	35 (18.0%)	162 (83.5%)	60 (30.9%)	23 (11.9%)	194 (100%)

Table 14: Descriptives for Dutch Cities

In Table 13, we observe that the patterns are quite similar in a sample of start-ups in different Dutch cities. Some 11% of the start-ups are classified as “smart city” and once more technology is not a very discriminating factor. For this smaller sample it is remarkable that the start-ups coded “1” on citizen do seem to be more common (at about 10% on average with rates as high as 40% in Rotterdam), but the sample sizes differ quite a bit across the cities, with most start-ups concentrated in Amsterdam. For Amsterdam, the pattern is roughly comparable to the sample in UtrechtInc. As that incubator has rather general programs for business incubation, this suggests the smart city index works reasonably well in and outside incubators and that incubators attract and select a representative sample of start-ups on the smart city index dimensions. To *promote* smart city development, incubators should thus aim to increase the share of smart city innovations that apply to their programs. But before we can conclude this might be a good idea, we should first establish that smart city innovations benefit at least as much from business incubation services as the non-smart city (tech) start-ups.

To investigate this question, we ran similar analyses on survival, growth as presented above. In Nijland (2020) we presented the results for a comparison between the combined UtrechtInc-Climate KIC dataset collected by Eveleens (2019) and data collected from Chalmers’ Ventures in Gothenburg, Sweden. The dataset for this analysis consisted of 157 start-ups from Chalmers Ventures, 45 of UtrechtInc and 68 of Climate-KIC. The descriptive statistics for the full sample are presented in Table 13.

The total sample size consists of 270 start-ups. One of the most significant differences between the data of Utrecht and Gothenburg is the mean of “investment”. This is a binary variable indicating if the start-up had received an external investment up to the date of data collection (spring of 2019). The mean of

investment is 0.757 for Gothenburg, whereas it was only 0.133 for Utrecht. This could be because Chalmers Ventures itself, also provides funding for some of the start-ups that they are incubating.

For the analysis, Nijland (2020) presents a set of general linear regression models. As we have three performance measures, we follow Eveleens (2019) and estimate three different models. A logistic regression model is estimated for the performance measures of investments and survival. The performance measure of employment growth is estimated with a negative binomial regression. This model was applicable since the variable consists of a count variable. Additionally, Nijland (2020) tested for overdispersion by looking at the histogram of the employment growth, and the goodness of fit of the Poisson model. Also, the variance was larger than the mean of the employment growth. Based on these tests, it was clear that there was overdispersion, and the negative binomial regression is most applicable (Lawless, 1987). Additionally, Nijland (2020) performed a likelihood-ratio test (LR-test). This test shows whether adding the independent variable, "smart city score", enhances the model fit. The appropriate assumptions of each of the analyses are verified (see Nijland (2020), Appendix C). Nijland (2020) tested for multicollinearity using Spearman's correlations and variational inflation factors (VIF). All the VIF scores were below 2, implying there is no issue with multicollinearity in the model (Field et al., 2012). Additionally, based on the scatterplots, Nijland (2020) removed three outliers from the model. We reproduce Nijland's (2020) results in her tables 6 and 7 below in Table 15:

Dependent Var		**SURVIVAL**			**INVESTMENTS**			**EMPLOYMENT GROWTH**	
Method		**Logistic**			**Logistic**			**Negative Binomial**	
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Smart City		0.288	0.972		0.028	0.083		0.093*	0.356*
		(0.206)	(0.743)		(0.157)	(0.584)		(0.055)	(0.208)
UtrechtInc	2.907***	2.958***	2.955***	-3.367***	-3.366***	-3364	0.321	0.326	0.330
	(1.053)	(1.060)	(1.069)	(0.680)	(0.680)	(0.680)	(0.207)	(0.206)	(0.206)
Climate-KIC	1.167**	1.065*	1.082*	-2.782***	-2.796***	-2792	-0.117	-0.172	-0.165
	(0.551)	(0.562)	(0.560)	(0.473)	(0.480)	(0.478)	(0.188)	(0.190)	(0.189)
Founding team size	-0.115	-0.172	-0.170	0.418*	0.416*	0.416	0.170*	0.164*	0.161*
	(0.251)	(0.254)	(-0.254)	(0.242)	(0.242)	(0.242)	(0.094)	(0.093)	(0.093)
Percentage males	5.048*	5.520*	5.538*	-2.012	-2.026	-2.018	1.518	1.456	1.502
	(2.770)	(2.843)	(2.837)	(3.115)	(3.113)	(3.113)	(1.330)	(1.322)	(1.321)
Percentage males squared	-3381	-3.884	-3.893	2.289	2.291	2.284	-0.849	-0.835	-0.880
	(2.477)	(2.562)	(2.555)	(2.686)	(2.681)	(2.682)	(1.099)	(1.092)	(1.092)
Age startup	0.437***	0.454***	0.450***	0.057	0.057	0.057	-0.019	-0.019	-0.019
	(0.105)	(0.108)	(0.108)	(0.056)	(0.056)	(0.056)	(0.023)	(0.023)	(0.023)
Market type B2C	-0.176	-0.286	-0.253	-0.490	-0.498	-0.492	-0.008	-0.061	-0.043
	(0.439)	(0.448)	(0.445)	(0.480)	(0.481)	(0.479)	(0.178)	(0.179)	(0.178)
Constant	-2.062**	-2.064**	-2.071**	-0.014	-0.010	-0.011	-0.457	-0.435	-0.443
	(0.813)	(0.814)	(0.814)	(0.897)	(0.900)	(0.897)	(0.397)	(0.394)	(0.394)
Obs.	222	222	222	182	182	182	211	211	211
Log Likelihood	-77.240	-76.090	-76.275	-83.533	-83.518	-83.524	-351.110	-349.700	-349.652

Chi2	60.88***	63.18***	62.81***	84.45***	84.48***	84.47***	13.41*	16.23**	16.33**
McFadden R2	0.283	0.293	0.292	0.336	0.336	0.336	0.019	0.023	0.023
LR-test		2.30	1.93		0.03	0.02		2.82*	2.92*
Note: *p<0.10, **p<0.05: ***p<0.01;									

Table 15: Regression results reproduced from Nijland (2020) Table 6

The models (1), (4), and (7) in Nijland's (2020) Table 15 only contain control variables. Model (2), (5), and (8) contain the independent variable of smart-city, whereas model (3), (6), and (9) contain the independent variable of smart-city as a binary variable. All the models created are found to be significant (1%, 5% and 10% levels). However, the McFadden R2 are low for the negative binomial regressions. In the marginal effects of the logistic regressions are shown in Table 16. Nijland's (2020) Tables 6 and 7 show some interesting significant estimators.

Dependent Variable	**SURVIVAL**			**INVESTMENT**		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Smart City		0.021	0.056*		0.007	0.020
		(0.015)	(0.033)		(0.039)	(0.145)
UtrechtInc	0.121***	0.115***	0.116***	-0.545***	-0.545***	-0.545***
	(0.034)	(0.033)	(0.033)	(0.058)	(0.058)	(0.058)
Climate-KIC	0.074**	0.065*	0.066**	-0.540***	-0.542***	-0.542***
	(0.034)	(0.033)	(0.034)	(0.066)	(0.067)	(0.067)
Founding team size	-0.009	-0.013	-0.013	0.103*	0.102*	0.102*
	(0.020)	(0.019)	(0.019)	(0.060)	(0.060)	(0.060)
Percentage males	0.400*	0.411*	0.417*	-0.495	-0.499	-0.497
	(0.226)	(0.217)	(0.219)	(0.766)	(0.766)	(0.766)
Percentage males squared	-0.268	-0.289	-0.293	0.563	0.564	0.562
	(0.198)	(0.192)	(0.193)	(0.661)	(0.660)	(0.660)
Age start-up	0.035***	0.033***	0.034***	0.014	0.014	0.014
	(0.007)	(0.007)	(0.007)	(0.014)	(0.014)	(0.014)
Market type B2C	-0.014	-0.023	-0.020	-0.118	-0.120	-0.118
	(0.037)	(0.037)	(0.037)	(0.112)	(0.112)	(0.111)

Table 16: Marginal effects reproduced from Nijland (2020) Table 7

On Average chances of survival increase when a start-up is incubated at UtrechtInc in comparison to Chalmers Ventures, which is significant at a 1% level. This is also true for Climate-KIC, even though the difference is small. Moreover, chances of survival increase when the age of the start-up increases, which is significant at a 1% level. This is in line with previous research (Soetanto & Jack, 2013).

Additionally, for the dependent variable investment, results are somewhat different. On average changes of investment decrease when the start-up was incubated at UtrechtInc or Climate-KIC in comparison to Chalmers Ventures. These relationships are significant at a 1% level. But this may simply reflect the fact that Chalmers Ventures also offers funding for some of their incubated start-ups. A larger founding team also significantly (10% level) increases chances of receiving investment for the start-up.

For the negative binomial model with a dependent variable of employment growth, a bigger founding team also significantly increases employment growth (10% level). Therefore, the results are in line with previous studies (Klepper, 2001; Leonard & Sensiper, 1998; Soetanto & Jack, 2013).

In addition to the significant effects of the control variables, Nijland (2020) also finds a positive association between the SCI score and the dependent variables. This relationship is significant for the negative binomial models for the normal smart city and the binary smart city scores. This means that being a "smart city start-up" increases the employment growth significantly (10% level). Based on the LR-test, Nijland (2020) concludes that adding smart city as an independent variable for these two models substantially improves the model fit (10% level). The relationship between the binary smart city score variable and the dependent variable survival is also significant (10% level). This means that when the start-up is defined as a "smart city start-up" chances of survival increase.

In a parallel study, Picari (2020) coded the data we collected on the incubator PACA-Est in Nice discussed above and in Morin (2019) on the SCI-index in Hermse et al. (2021). In a similar exercise as Nijland (2020) did for Chalmers' ventures, she then compared outcomes for smart city and non-smart city incubates between Utrecht and Nice. The descriptive statistics of the chosen control variables for the PACA-EST incubator are shown in Table 17.

Variable	Obs	Mean	Std. Dev.	Min	Max
Age start-up	160	7.95625	4.653188	1	18
Male percentage	269	0.8608028	0.2518105	0	1
Male percentage^2	269	0 .8041543	0.3194621	0	1
Experience	212	1.613208	0.7977546	0	3
Exited	297	0.5858586	0.4934045	0	1
Incubated	297	0.0707071	0.2567675	0	1
hw	297	0.4309764	0.4960486	0	1
Turnover	243	0.7201646	0.4498448	0	1
Founders team	291	2.766323	1.571415	1	10
Smart City	297	0.0942761	0.2927056	0	1

Table 17: Descriptives PACA-Est, reproduced from Picari (2020) Table 7

The smart city index is here a binary variable that corresponds to the interaction between the characteristics of a start-up to be defined as "smart city". Picari's (2020) Table 19, reproduced in Table 18, shows the results adopting the Logistic and the Negative Binomial procedures. Unlike Nijland (2020), Picari (2020) ran the regression models separately for the Utrecht and Nice data. Regressions 1, 2, 5, 6, 7 and 8 refer to the Nice dataset, while regressions 3, 4, 9, 10, 11 and 12 to the Utrecht dataset. As before, her dependent variables are survival and growth.

For the first model, Picari (2020) developed two regressions for each dataset to analyse the difference between smart city and non-smart city start-ups. The same procedure was followed for the second set of negative binomial models on growth, including incidence rate ratios (irr) regressions (models 6, 8, 10 and 12). Model 1 and 2 are statistically insignificant. Models 3 and 4, where Picari (2020) added the dummy

for market type, in contrast, are significant. Results on the Smart City index remain insignificant, also when we look at employment growth. This contrast to the results in Nijland (2020) can be explained when we consider the effect of running the regression models for the two datasets separately. In that case the number of observations and degrees of freedom drops significantly. And with it the estimation of not so clear and strong effects becomes imprecise. The results for Utrecht in Picari (2020) show that Nijland (2020) needs the variation across Utrecht and Gothenburg to identify the effect, whereas in Picari (2020) no such significant impacts can be found. In addition, it should be noted that the number of smart city incubees in the French incubator was low (only 28 observations or 9%) to begin with. This probably has a lot to do with the way the incubator attracts and selects incubates for its programs. PACA-Est is an incubator that is much more affiliated with the University and requires the involvement of academics in the incubates. Moreover, it seems to be specialized in incubating firms that offer digital security and encryption solutions. Such firms will occasionally offer relevant solutions for smart city development, especially in the data management sphere, but they can rarely be exclusively and unambiguously classified as smart city innovations.

Dependent Variable			**SURVIVAL**				**GROWTH**					
Method			**Logit**				**Negative Binomial**					
Model:	(1)	(2)	(3)	(4)	(5)	(6-irr)	(7)	(8-irr)	(9)	(10-irr)	(11)	(12-irr)
Smart City	-0.593		-0.147		0.113	1.120			0.149	1.161		
	(0.536)		(0.374)		(0.362)	(0.406)			(0.282)	(0.327)		
Founders team	0.078	0.093	0.107	0.114								
	(0.128)	(0.128)	(0.113)	(0.111)								
Male Percentage	0.182	0.269	0.626	0.046	6.728**	835.499**	6.719**	828.422**	-0.208	0.811	0.494	1.638
	(3.618)	(3.589)	(2.420)	(2.345)	(3.375)	(2820.621)	(3.373)	(2794.4)	(2.169)	(0.118)	(1.996)	(3.271)
Male Percentage Squared	-0.583	-0.623	-0.001	0.457	-4.418**	0.012**	-4.395**	0.012**	0.353	1.424	-0.181	0.834
	(2.751)	(2.729)	(2.094)	(2.045)	(2.285)	(0.027)	(2.283)	(0.028)	(1.796)	(2.559)	(1.662)	(1.138)
Age start-up					0.016	1.016	0.015	1.015	-0.130	0.878	-0.188*	0.828*
					(0.028)	(0.029)	(0.028)	(0.028)	(0.134)	(0.118)	(0.123)	(0.102)
Market Type B2C			0.519*	0.515*					0.116	1.123	0.125	1.133
			(0.365)	(0.357)					(0.302)	(0.339)	(0.288)	(0.326)
Entrepreneurial Experience	-0.154	-0.158	-0.164	-0.120	-0.379**	0.684**	-0.378**	0.685**	0.063	1.065	0.033	1.033
	(0.231)	(0.230)	(0.200)	(0.196)	(0.171)	(0.117)	(0.171)	(0.117)	(0.141)	(0.151)	(0.134)	(0.139)
Hardware	-0.161	-0.133	-0.708**	-0.679**	-0.241	0.785	-0.250	0.778	-0.362*	0.695*	-0.273	0.760
	(0.374)	(0.371)	(0.336)	(0.329)	(0.233)	(0.183)	(0.231)	(0.180)	(0.277)	(0.192)	(0.258)	(0.196)
Incubated	0.406	0.308	0.920***	1.034***	0.132	1.141	0.127	1.135	0.893***	2.443***	0.924***	2.519***
	(0.675)	(0.662)	(0.325)	(0.318)	(0.420)	(0.480)	(0.420)	(0.477)	(0.249)	(0.610)	(0.237)	(0.597)
Constant	1.874*	1.715*	-0.152	-0.216	-1.768*	0.170*	-1.75*	0.172*	0.275	1.317	0.332	1.394
	(1.202)	(1.179)	(0.727)	(0.720)	(1.220)	(0.208)	(1.219)	(0.210)	(0.690)	(0.909)	(0.660)	(0.920)
Obs.	190	190	206	206	147	147	147	147	142	142	150	150
Log-Likelihood	-92.047	-92.623	-177.926	-122.533	-201.904	-201.904	-201.95	-201.95	-262.40	-262.40	-279.95	-279.95
Chi2	3.25	2.10	19.44	20.83	10.88	10.88	10.78	10.78	15.97	15.97	18.51	18.51

Prob > chi2	0.860	0.910	0.012	0.004	0.144	0.144	0.09	0.09	0.042	0.042	0.009	0.009

*Note: standard errors in parentheses, * p<0.1, **p<0.05, ***p<0.001*

Table 18: Regression results reproduced from Picari (2020) Table 19

This interpretation of the Picari (2020) results was confirmed in a follow-up study by Kolassa (2021) on incubates in UtrechtInc since the start of the IRIS project in 2017. The data collected in Kolassa (2021) has information about start-up survival, their smart-city categorization, and the number of employees. Financial information such as revenue or investments has proven difficult to obtain. The data was complemented with more information gathered by web search (browsing, LinkedIn), but is necessarily less complete than the data that was collected in Eveleens (2019) and from the historical archives at Chalmers Ventures. The companies and mostly the founders, the founding year and if the start-up survived, were found up on LinkedIn. Furthermore, LinkedIn displayed a specific year the start-up stopped operating. Information about the number of employees was gathered via LinkedIn as well as the company's websites. Lastly, Kolassa (2021) reached out to the ventures via their official e-mail address and asked about the number of employees they are employing at the time of data collection.

The sample contains 168 start-ups and depicts applications from the beginning of 2017 till September 2020. This dataset covers both approved and unselected start-ups for the incubation program. Kolassa (2021) looked at incubated start-ups only. The descriptive statistics for this sample are reproduced in Kolassa's (2021) Table 2 in Table 19:

Variable	Obs	Mean	Std. Dev.	Min	Max
Survival	168	0.554	0.497	0	1
Size	168	1.875	3.163	0	15
Smart city start-up	168	0.214	0.411	0	1
Smart city score	168	1.000	1.741	0	6
Online/Offline	168	0.512	0.501	0	1
Entrepreneurial experience	168	0.208	0.407	0	1
Founding team	168	1.827	0.841	1	5
Gender	167	0.835	0.313	0	1
Market type	157	0.325	0.470	0	1
Age start-up	168	19.351	28.791	0	216

Table 19: Descriptive Statistics reproduced from Kolassa (2021) Table 2

Survival shows that 93 out of 168 start-ups survived, which results in a survival rate of 55.4%. The second variable *size* indicates that the average number of employees within our data sheet is 4 people. Out of the 168 coded start-ups, Kolassa (2021) concluded that about a quarter of them can be categorized as smart city start-ups. This is significantly more than the 13.3% reported for the dataset collected by Eveleens (2019) and used in all previously discussed studies. From Table 19, it can also be seen that the average score on the index has dropped to 1.7 from 3.6. This suggests that more of the UtrechtInc incubates address urban challenges in recent years, but this higher number on average scores lower on the intensity factors in the SCI.

The outbreak of COVID-19 and the ensuing lockdowns imply that this sample can be split between ventures incubated on site and those incubated online. We see that here the split is about 50-50, and although we will use this variable as a control variable below, it should be noted that it confounds the effects of being incubated online with those of being incubated during rather exceptional economic circumstances. This dummy variable correlates perfectly with COVID-19 restrictions in the Netherlands. Although the impact of these restrictions on employment growth and firm survival is likely to be important, we do not see any strong reasons for these effects to impact smart city start-ups differently.

Dependent Variable *Method*	**SURVIVAL** *Logistic*			**SIZE** *Negative Binomial*			**SURVIVAL** *Penalized ML*
	1	2	3	4	5	6	7
SC (1/0)		Omitted			1.119***		4.057***
					(0.286)		(1.454)
SC(score)			1.142***			0.292***	
			(0.358)			(0.078)	
Online/Offline	0.792*	0.510	0.335	0.172	0.021	-0.145	0.455
	(0.417)	(0.463)	(0.476)	(0.281)	(0.268)	(0.279)	(0.444)
Entrepreneurial Experience	1.420**	1.268*	1.302*	0.311	0.392	0.297	1.140
	(0.694)	(0.736)	(0.754)	(0.331)	(0.312)	(0.314)	(0.689)
Founding Team	-0.137	-0.156	-0.134	0.209	0.236	0.218	-0.134
	(0.230)	(0.258)	(0.261)	(0.186)	(0.183)	(0.184)	(0.246)
Gender	-0.827	-1.179*	-1.190	-0.307	-0.514	-0.546	-1.082
	(0.646)	(0.710)	(0.724)	(0.444)	(0.421)	(0.425)	(0.676)
Market	0.010	-0.381	-0.388	-0.238	-0.436	-0.456	-0.349
	(0.418)	(0.491)	(0.505)	(0.295)	(0.286)	(0.290)	(0.470)
Age	0.065*	0.052***	0.045***	0.037***	0.032***	0.032***	0.0474***
	(0.015)	(0.016)	(0.016)	(0.009)	(0.008)	(0.008)	(0.015)
Constant	-0.264	0.063	0.073	-0.534	-0.581	-0.473	0.036
	(0.881)	(0.0975)	(0.994)	(0.651)	(0.612)	(0.612)	(0.929)
Obs.	156	120	156	156	156	156	156
Log Likelihood	-79.282	-64.469	-64.297	-268.326	-260.291	-260.676	-55.838
Chi2	51.89***	37.12***	81.86***	31.14***	47.21***	46.44***	26.23***
McFadden R2	0.2466	0.2235	0.3890	0.055	0.083	0.082	
LR-test			29.97***	238.66***	210.61***	216.29***	

Table 20: Regression results reproduced from Kolassa (2021) Tables 7 and 8

The results of the analysis in Kolassa (2021) are reproduced in

Dependent Variable *Method*	**SURVIVAL** *Logistic*			**SIZE** *Negative Binomial*			**SURVIVAL** *Penalized ML*
	1	2	3	4	5	6	7
SC (1/0)		Omitted			1.119***		4.057***
					(0.286)		(1.454)
SC(score)			1.142***			0.292***	
			(0.358)			(0.078)	
Online/Offline	0.792*	0.510	0.335	0.172	0.021	-0.145	0.455
	(0.417)	(0.463)	(0.476)	(0.281)	(0.268)	(0.279)	(0.444)
Entrepreneurial Experience	1.420**	1.268*	1.302*	0.311	0.392	0.297	1.140
	(0.694)	(0.736)	(0.754)	(0.331)	(0.312)	(0.314)	(0.689)
Founding Team	-0.137	-0.156	-0.134	0.209	0.236	0.218	-0.134
	(0.230)	(0.258)	(0.261)	(0.186)	(0.183)	(0.184)	(0.246)
Gender	-0.827	-1.179*	-1.190	-0.307	-0.514	-0.546	-1.082
	(0.646)	(0.710)	(0.724)	(0.444)	(0.421)	(0.425)	(0.676)
Market	0.010	-0.381	-0.388	-0.238	-0.436	-0.456	-0.349
	(0.418)	(0.491)	(0.505)	(0.295)	(0.286)	(0.290)	(0.470)
Age	0.065*	0.052***	0.045***	0.037***	0.032***	0.032***	0.0474***
	(0.015)	(0.016)	(0.016)	(0.009)	(0.008)	(0.008)	(0.015)
Constant	-0.264	0.063	0.073	-0.534	-0.581	-0.473	0.036
	(0.881)	(0.0975)	(0.994)	(0.651)	(0.612)	(0.612)	(0.929)
Obs.	156	120	156	156	156	156	156
Log Likelihood	-79.282	-64.469	-64.297	-268.326	-260.291	-260.676	-55.838
Chi2	51.89***	37.12***	81.86***	31.14***	47.21***	46.44***	26.23***
McFadden R2	0.2466	0.2235	0.3890	0.055	0.083	0.082	
LR-test			29.97***	238.66***	210.61***	216.29***	

Table 20. Models (1) and (4) are only including control variables. Instead, models (2) and (5) have been run with the independent variable *smart city start-up*, and models (3) and (6) with the second independent variable *smart city score*. The LR-test indicates that adding "smart city score" as an independent variable to the model, is substantially improving the model fit (1% level).

The first interesting finding in the logistic regressions is the control variable *entrepreneurial experience*, which was significant at all three models (5% and 10% level). More entrepreneurial experienced founders survive longer. With a 10% level of significance, *gender* harms the survival within the full binary model of

the logistic regression. And we need to control for *age* in our regression (1% and 5% level) as predicted by previous research by Soetanto and Jack (2013). The highest McFadden R2 value for *survival* has been obtained by the model (3), pointing to the model's best fit with the independent variable *smart city score*. Nonetheless, all models have a McFadden value between 0.2 and 0.4 and thus constitute a good model fit (McFadden, 1973).

The independent variable of the model (2) is perfectly correlating with the dependent variable *survival*, which is why it is omitted in the second model. Because determining the coefficient and standard error for such a covariate in a regular logistic regression is theoretically impossible, the covariate is omitted, along with the perfectly correlated observations (36) from the model. Kolassa (2021) proposed a solution to overcome this (quasi) “complete” separation in our logistic regression model. To decrease bias in generalized linear models, Firth (1993) proposed modifying the score equations. In logistic regression, Heinze and Schemper (2002) proposed utilizing Firth's technique to address the problem of "separation", a situation in which maximum likelihood estimates trend to infinity (become inestimable). Kolassa (2021) was then able to include the SCI as an independent variable into the regression and obtained statistically significant results for the whole model (1 % level) and the variables *smart city start-up* (1% level) and *age* (1 % level) using all observations (156) in model (7) in Table 20.

The binary variable *smart city start-up* and the control variable *age* were thus found to affect the survival rate of a start-up positively. All models of the negative binomial regression regarding the *size* of the start-ups were statistically significant (1% level). The LR-test indicates that the first model has the best fit, which was only run with control variables (4). In these regressions, Kolassa (2021) also obtained some significant results for our coefficients. The independent variable *smart city start-up* is significant at a 1% level. Smart city start-ups compared to “regular” start-ups are expected to have a 1.119 times greater number of employees, while holding the other variables constant in the model. The same applies to the *smart city score*, which is likewise statistically significant at a 1% level and positively impacts the size of start-ups.

5.5. Summary and Conclusions

Using the indicators we developed for identifying smart city (user) innovations empirically, in this chapter we have reported on the various studies that have been conducted with these indices to establish if and in what way business incubation programs need to be adapted to facilitate and promote smart city (user) innovations. Eveleens (2019) has first shown that business incubation has a positive impact on incubates survival rates, investment, and employment growth and that such performance enhancement is NOT related to the knowledge base a venture is founded upon. This is good news for developing a smart city user innovation program, as it implies that we need not redesign the business incubation program from the ground up to serve this purpose. However, the results in Morin (2019) and Eckinger and Sanders (2019) show that business incubation programs attract only very few user innovations and indeed seem to discriminate against them in their selection procedures. On the other hand, these studies also showed that user innovations, like any other venture, do benefit from incubation programs. Hence, the challenge will be to attract and select more user innovations into incubator programs, but there seems to be no need to change these programs themselves. Studies by Picari (2020), Nijland (2020) and Kolassa (2021) showed that smart city innovations benefit from business incubation. In Picari (2020) the effect was

insignificant in Nice, implying smart city innovations do not survive or grow more or less than non-smart city incubates in incubation programs, while Nijland (2020) and Kolassa (2021) show positive and significant effects for Utrecht and Goteborg.

Interestingly, Kolassa (2021) also showed that smart city business incubation has become more prevalent over the past years at UtrechtInc, even if the smart city incubation seems to tick fewer boxes in our SCI-index. We can conclude from these results that business incubation benefits smart city innovation, even if it does not always benefit it more than non-smart city incubates. This implies that our program can remain generic and open to non-smart city innovations. To promote smart city development through business incubation, not the incubation program but the ideation stage of business creation needs to be targeted. We return to this in Part 3. Part 2 will now describe how UtrechtInc used our early results to improve the structure of their incubation program to support smart city incubates.

6. A Business Incubation Program to Support Smart City Development: The UtrechtInc Business Incubation Programs

UtrechtInc is a start-up incubator located in Utrecht, with a focus on start-ups with tech aspects. Currently, UtrechtInc runs a new program, in which around 40 start-ups participate yearly, with an inflow moment twice a year. Before IRIS and up to 2018, UtrechtInc had had three programs: one validation, one acceleration, and one scaleup program. The validation program was focused on turning an idea into a product. The acceleration program focused on finding the right market for the product and generating initial revenue. The scaleup program focused on growing the revenue of the young venture. After a careful internal review, and partly because of IRIS, UtrechtInc drastically overhauled its programs to facilitate (user) smart-city innovation. From our analyses above, however, it was clear that smart city (user) innovations do not really need targeted incubation programs. Therefore, the reforms were not geared towards changing the contents of the programs but rather to better fit them to the different target groups for recruiting (user smart city) business ideas. Specifically, the scaleup program was discontinued, the acceleration program overhauled, and the validation program has been split into three different programs, focusing on academics-based, students-based, and tech-focused teams, respectively. What was the basis for this change? Did it succeed? This chapter presents some evidence from a series of in-depth interviews, briefly explaining the design of their old and new programs, and UtrechtInc's justification for the pivot. We then identify the most significant benefits and pitfalls of the new programs.

Furthermore, we explore how the characteristics of the program are related to smart city start-ups. We already concluded above that smart city start-ups have become more prevalent in the UtrechtInc population of incubates. It is too early and rather complicated to link this directly and exclusively to the changes made to the program, but we can conclude that the implemented pivot has not hurt UtrechtInc's ability to support smart city innovation. The lessons drawn from the above research and discussions with the executives at UtrechtInc and their stakeholders resulted in a list of starting points for the pivot in the UtrechtInc program that are summarised in Table 21.

On the design of an Incubator	On Incubators and smart city start-ups
Team needs (with regards to training) are dependent on the team skill-set, not the product Partitioning on the team skill-set/background seems productive Validation programs need to focus on very early stages of product development	Smart city start-ups require similar incubation programs to normal start-ups. Demands may vary, but not significant enough to warrant a separate program

The informal community and network created plays a very significant role in the success of an incubator	Current programs can produce and have produced a plethora of successful smart city start-ups Spinout and user innovation are not very promising sources for incubateable smart city innovations

Table 21: Starting Points for Designing the New Incubation Program(s)

6.1. The incubation methods

Globally, over 7,000 incubation programs aim to aid startups and ideas into full-fletched businesses (Mulolli et al., 2017). UtrechtInc is one of these incubators, based in Utrecht. To participate, ideas of potential startups require a tech-aspect; non-tech startups are not considered for participation. Originally founded in 2009, UtrechtInc is and has been the starting ground for over 200 businesses, of which 64% remains active today. The original founding partners of UtrechtInc are Utrecht University, University Medical Center Utrecht, Utrecht University of Applied Sciences, the municipality of Utrecht, the Province of Utrecht, and Rabobank. Being linked to major educational institutes of Utrecht, UtrechtInc focuses on helping startups originating from academics and students and local tech practitioners. Overall, UtrechtInc is a reputable incubator, spawning successful businesses such as FAQRA, GitLab, and SnappCar. Originally, UtrechtInc aligned its incubation program to the stages identified in business incubation process models and ran an incubation, validation, and acceleration program. Over the course of 2018, they worked on a pivot towards three different incubation programs and a single validation program. These programs were executed over the course of 2019 for the first time – with influx moments at the start of the year as well as over summer. In total, 98 startups applied, out of which 38 eventually were accepted into the programs. As UtrechtInc specialises in incubating tech-based start-ups and has an additional focus on smart-city solutions, the weaknesses and strengths of their old and new programs and their motivations for adaptation provide valuable lessons.

In general, incubators require a significant amount of time before major payoffs can be expected. Most incubators adopt a business model in which they foster ideas with great potential, and the success of only one or a few of these ideas can fund the incubator, at times generating a profit. UtrechtInc, in contrast to many incubators, has a business model that requires incubates to pay minor fees for participation (as commitment) and renting office space (albeit below market price). UtrechtInc, has a participation fee of €1,500 for the tech and science-based programs, and €750 for the student-based programs. Prices for office spaces differ but start with desk space costing €150 per month. Additionally, upon breaking €150,000 turnover after 3, 4, or 5 years after completion of the program, start-ups must pay a set fee between €3,600 and €18,000, depending on how high their turnover is. UtrechtInc is – by design – making a loss, and local governments and sponsors partially fund the gap. This choice is made from the belief that this model provides more breathing space for start-ups, as providing a suitable infrastructure is deemed more important than making a profit.

In contrast, there are many different common practices for other incubators. These often either a) require a stake (e.g. 5%) in the start-up, b) charge program fee's, c) charge percentages of future financing rounds, and/or d) charge royalties over future turnover for a set period of time.

In a smart city development context, it seems appropriate that the incubator does not charge the incubates for full costs of the incubation. Subsidies and sponsoring can be justified by the fact that smart city innovation typically generates positive spillovers and external effects that are hard for the startups to monetize. Non-smart city incubates also generate such positive externalities and as the incubation activity is similar both on the costs, risks, and benefits side, it is not advisable to try and distinguish between incubates. Furthermore, making such distinctions might interfere with the community building and knowledge exchanges that are sometimes of crucial importance in an incubator. Our research presented in Part I, as well as, these more practical and operational considerations led to the conclusion that incubation programs should not differentiate between smart city and non-smart city incubates in the selection into or the contents of the programs. Instead, promoting smart city innovation requires targeted activities in the ideation stage that precedes incubation and to which we return in Part 3.

6.2. The old incubation method

Before 2019, UtrechtInc organized three yearly incubation programs: validation, acceleration, and scale-up. To apply to such a program, a team would contact UtrechtInc with a one-paged idea description, mainly focusing on the idea at hand and how the team expects this to be both a valid and scalable idea in the future. The incubator thus assumes that both the team and idea have been formed before the incubation process can start. If the one-pager is both of sufficient quality and meaningfully developed, the team is invited for a pitch. In this pitch, the feasibility of the idea and the motivation, quality, diversity, and versatility of the team are assessed. This assessment is done by employees of UtrechtInc and an industry expert (often one of the current start-ups) and contains no set checklist of criteria. This jury is asked to assess the quality of the idea presented and the quality of the team in rather general terms. The final decision to incubate a start-up is up to this jury – after which a start-up can join the incubation program (or not).

"Yes, we operated under the assumption that we would bring the incubates to the next stage. In fact, that is what we still do, but we have redefined what that next stage is. In the past, we selected incubates at the door and looked for startups that had a product to develop into a successful start-up. But we have found that the main problem for the market, our customers, the potential startups, is in the validation stage. So, one step before the incubation stage. So, the researching of an idea. An entrepreneur with an idea or a scientist with an idea. Not yet a team with an idea, but people that say: "I have to develop this", "I want to develop this" and: "Give me tools to make it work"." – Jorg Kop, General Manager at UtrechtInc

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Upon entering the program, the teams behind the start-ups can rent a workplace (ranging from simple desks to small offices), join workshops given by former participants or industry experts aiming to help the business advance, and join informal events. This has the final aim of the start-up outgrowing the incubation program, after which it can join first the validation then the acceleration program. After the acceleration program, which primarily focuses on scale-up, the start-up should have grown into a full-fletched business and thus have completed all programs.

The pre-IRIS incubation program lasted around 4 months, with regards to the work-shops participants were asked to attend. On average, participation took 3 to 4 workdays a week for the first two weeks and half a workday per 2 weeks after that: next to the management of the start-up itself.

Specifically, the 4-month programs aimed to:

- Learn about entrepreneurship
- Develop your entrepreneurial skills
- Create a blueprint for your (academic) start-up
- Validate to a successful business model
- Explore the market potential for your venture
- Work on a founder team
- Develop a road map for the next months
- Find the right follow-up (network, finance)

Offering the following activities in the incubator:

- 2 day lean start-up training
- Business model canvas
- Masterclass Customer Discovery
- Legal Basics
- Masterclass: Team setup/composition/skills
- Masterclass: Design thinking
- Masterclass: Accounting & Financials
- Masterclass: Funding (Subsidies & Investors)
- Masterclass: Pitching
- biweekly progress session with an expert (entrepreneur) en UtrechtInc. An important part of this session is giving and receiving peer feedback from other start-ups in the program
- Mentor sessions during the program
- Access to monthly consultation hours with experts (legal/financial etc.)

A start-up was deemed to have completed the program when it generated (significant) turnover. Participants came mainly from academia (both students and scientists) and practitioners aiming to build their own idea into a company – which is also represented in the pivot. The number of applications ranged between 30 and 40 per round, with around half of that number in accepted participants.

But UtrechtInc realized, as we did in the research presented above, that a program is vulnerable if it focuses very specifically on start-ups and ideas that are exactly at the start of their incubation stage.

"There are simply too few start-ups in that stage, too few quality start-ups in that stage." – Jorg Kop, General Manager at UtrechtInc

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The pivot in UtrechtInc aimed to broaden the inflow of participants by widening the funnel of ideas to include less developed business ideas in earlier stages of development. As the pivot brings incubation programs closer to the ideation stage, smart city ideation can easily feed into the programs.

6.3. The pivot: old versus new program

After an extensive process of critical reflection, the team concluded that a new program was required.

> *"We have listened to our customers and what they wanted. It turned out that that has changed gradually over the past few years and drifted away from what we thought at the start of UI. And by listening to what your customer wants, you come to programs that differ from each other." – Jorg Kop, General Manager at UtrechtInc*

First, the old program worked well in many aspects, which thus could be the same; with regards to application, for example, little changed. The same goes for the fostering of informal support and interaction between the participating start-ups. This has been recognized as one of the most important factors to success – and will thus be more of a focus – but the system will remain relatively similar. On other aspects, it was noted that improvements were needed.

Second, UtrechtInc noted that, upon entering, most start-ups were in a less advanced stage than initially expected. Additionally, they found that their focus on the complete route from validation to scale-up required a too diverse set of skills and resources. Third, they found that the workshops provided were not always as helpful as hoped. This was not a quality issue, but different start-ups seemed to have vastly different support needs because of the difference in the stage. Differences in needs seemed to be mostly decided by the type of team supporting the product and said phase, rather than the type of product. Last, as noted before, the positive informal atmosphere seemed to play a large role in the success of start-ups and thus became a larger priority.

And although this pivot was broader and had more antecedents than the IRIS program, there was a clear link between the need to develop more smart city innovation in the incubator and the pivot of 2019.

> *"I think IRIS has also contributed to the changes that we have now made. We have spent a lot of time and energy in trying to promote start-ups in the IRIS transition tracks but had to conclude that this was more difficult than originally envisioned. Then you have to look if there are perhaps other ways to achieve the same objectives." – Jorg Kop, General Manager at UtrechtInc*

6.4. New program

The new system builds on the observations mentioned above. The first decisions were to discontinue the scale-up program and to shift focus within the validation programs. The validation programs currently

focus on an earlier stage of product development. Just as before, UtrechtInc aims to guide start-ups from their first nascent phase to the next phase, but in a sense, both phases have been redefined. Then, to overcome the vastly different needs of start-ups, they split their validation programs into three programs: science-based start-ups, student start-ups, and tech-focused start-ups. Last, to improve further positive spillovers between start-ups, UtrechtInc increased the number of informal events.

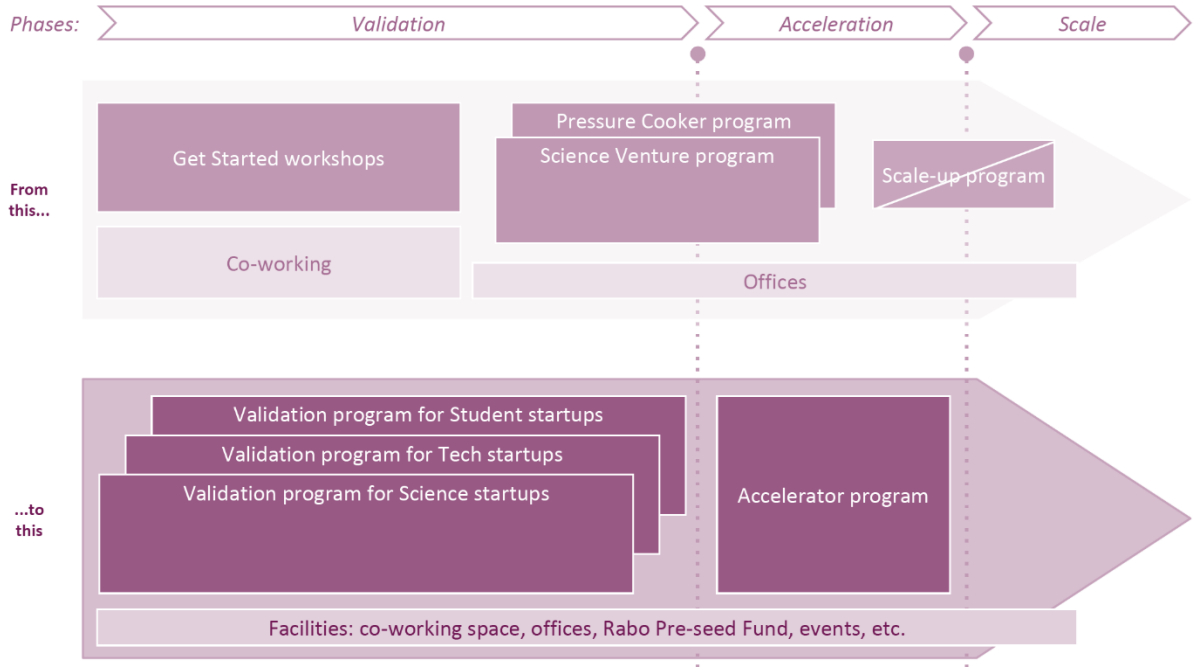

Figure 5: Incubation Programmes at UtrechtInc - old vs new

The new incubation programs lasts 3 months for student-based start-ups, 10 months for science-based start-ups, and 3 months for tech-based start-ups. They take up 8-24 hours per week for both the student- and science-based programs and over 32 for the tech-based programs. These programs are all pre-revenue, and a start-up is a successful participant if they reach the revenue phase, at which point they can continue in the acceleration program.

Program	Validation for Student startups	Validation for Science startups	Validation for Tech startups	Acceleration
Focus	Interviews & experiments	Business development	Interviews & experiments	Introductions, investors & customers
How?	Workshops & coaching	Workshops & coaching	Workshops & coaching	Masterclasses & mentoring
Commitment	Parttime (8 – 24 hpw)	Parttime (8 – 24 hpw)	Fulltime (> 32 hpw)	Fulltime (> 40 hpw)
Duration	4 months	10 months	3 months	4 months
Iterations per year	2x	1x	3x	2x
Stage	Pre revenue	Pre revenue	Pre revenue	Post revenue
Customer	UU, UMCU or HU students	UU or UMCU scientists	UU, UMCU, HU alumni and others	All
Trainers	Internal & graduates	Internal & external & graduates	Internal & external & graduates	External & graduates

Progress sessions & coaching	Bi-weekly	Monthly	Bi-weekly	Bi-weekly
Coaches	Internal	External	External	External
Mentor No Yes Yes Yes (at least 2)	No	Yes	Yes	Yes (at least 2)
Expert consults monthly	No	Yes (legal, accounting, etc.)	Yes (legal, accounting, etc.)	Yes (legal, accounting, etc.)
Online startup library	Yes	Yes	Yes	Yes
Rabo Pre Seed Fund	No	Yes, 18K after completion	Yes, 18K after completion	Yes, 50K during or after completion
Price	Commitment fee (249 Euro)	Commitment fee (399 Euro)	899 Euro	1.499 Euro
Success fee	Double	Normal	Normal	Half
Max / ideal # per batch	20/10	10 / 5	20 / 10	10 / 5
Topics	1. Lean startup methodology	1. Business development	1. Lean startup methodology	1. Funding (early stage & VC)
	2. Customer discovery	2. Customer discovery	2. Customer discovery	2. Grow the team
	3. Experiments & MVP	3. MVP & IP	3. Experiments & MVP	3. Marketing
	4. BMC	4. BMC	4. BMC	4. Sales
	5. Pitching	5. Pitching	5. Pitching	5. Networking
	6. Funding (basics)	6. Funding (basics) & Grants	6. Funding (basics)	6. Media & PR
	7. Founding team	7. Founding team	7. Founding team	
		8. Sales (basics)		
Hours of online self study	33	33	35	33
Hours with U.I. graduates	3	4	3	4
Hours with trainers	23	31	33	34
Hours with coaches	7	7	3	6

Table 22: Overview of New UtrechtInc Programs

The student program requires a participation fee of €249 (with an increased fee upon success). Training and coaching sessions are bi-weekly and provided by graduates and internal experts, focusing on the basics such as pitching and funding. The Science program has a fee of €399. It consists of monthly workshops, additionally provided by external experts, who also offer individual consultation focusing on more complex matters such as legal or accounting aid. Topics additionally include slightly more complex topics such as sales. Finally, the tech program is like the science program, albeit a bit more intense. The fee is €899, and the workshops are bi-weekly. The maximum numbers of participants are 20, 10, and 20, respectively, with the ideal number being at half capacity for each.

This three-way split represents three different types of teams; the student start-up program aims to bridge the gap from the classroom to practice. Being aimed towards students means it is the cheapest program for the participants and focuses much on practicality. The science-based program aims to facilitate researchers in bridging the gap from academic and theoretical work to practical applications. The tech program allows current (tech) practitioners to develop their own start-up, being a shorter program and focusing more on the details. In this manner, UtrechtInc can now better target the individual

needs of teams. Long masterclasses on how to file taxes, for example, may not be relevant to experienced academics or practitioners but may be highly valuable to students. Alternatively, masterclasses that focus mainly on steering theory into practical solutions may help academics but are hardly relevant for those already working as practitioners.

To engage the participants more and tailor the sessions to their needs, the didactical approach was also adjusted. The workshops and sessions are more interactive, more engaging, and more focused on skills than knowledge. The newly hired program and event coordinator:

"I give the example of the workshop on funding. In the old program that was a two-hour session of lecture and knowledge transfer on that topic by one of our trainers who knows a lot about that topic. Now we start with a 30-minute session in which the participants meet and greet a graduate. They explain who they are, and then questions and discussion emerge from the group that is there. After that, there is a 2-hour interactive workshop or masterclass in which the trainer has given some homework and material to be prepared in advance, so the participants are already up to speed on the basics. The start-ups do this homework conscientiously and in the session, the group can go into the details very fast. In special cases, we then add several one-on-one consultation hours if needed. So, where this was first a one-size-fits-all session to transfer knowledge, it is now a half-day filled with content around a specific theme. That is a big difference, and they get a very diverse offer on different themes, meeting various people." – Robin Lechner, Program and Event Coordinator at UtrechtInc

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This approach also implies that the participants must take a bit more responsibility but get a lot more out of the sessions, as they can tailor the contents to their individual needs. Such, more open validation and incubation programs are more fitting for start-ups in a broader range of developmental stages and, importantly, can accommodate ideas on a wider range between initial first ideas and a fully developed business model. This implies the incubator can make the same resources available to more incubates and, by playing this numbers game, incubate more and more successful start-ups with the given resources. The approach to let start-ups take more responsibility in shaping their own incubation program allowed the incubator to provide more tailored support and was consistently implemented.

"What we did well is that we stimulated the start-ups at the right time to go into action themselves. Mentoring Day for example, we have shaped very differently. In the old program, we were trying to match the mentors and the start-ups. Now we organized an evening in which the start-ups pitched their ideas to the mentors and then had informal drinks. The start-ups did get the mentors' profiles in advance but had to pitch and approach them themselves. That worked very well." – Robin Lechner, Program and Event Coordinator at UtrechtInc

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Note that there no differences in the program are introduced based on the sector or product of the start-up. As mentioned before, all start-ups at UtrechtInc must have a tech-based concept, but the needs per concept do not differ significantly enough to separate programs on the bases of product-type or sector. Indeed, not every workshop is always equally relevant, but separation by stage and background of the team seems much more suitable than doing so by sector or technology. Although to truly measure outcomes quite some time is needed as start-ups require time to grow, the staff and participants already indicate they are much more satisfied with the new programs.

"Yes, I feel good about this. I have recently executed the program evaluation and in it the program participants indicated they are very satisfied. We get a lot of good feedback and when someone misses something, or a workshop missed depth, then we can offer it again. So, it was pretty easy to keep the participants happy as we can target our resources on what the start-ups need at that moment. They also very much appreciate the community here. That is something that we have worked hard to achieve. To make sure that the community grows larger and closer and really works for the start-ups." – Robin Lechner, Program and Event Coordinator at UtrechtInc

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Furthermore, this is reflected in the significant growth of applications that UtrechtInc has seen over the past year, illustrating that the programs have been attracting more attention due to word-to-mouth communication.

The UtrechtInc team notes that some improvements may still be possible – though typically trade-offs are involved. At times, the usefulness of masterclasses could be improved – not every masterclass is yet relevant for everyone, and some topics which may be relevant for a few could currently be missed. Yet, this is a trade-off between masterclass quality and costs. More classes would mean higher costs, and at this point the gains seem insufficient to warrant making the program less affordable. The program and events coordinator:

"Absolutely. I have several trainers I would like to engage but who are too expensive. I could also make the program much nicer if there would be more financial resources, also when it comes to coaching. But we need to make trade-offs between what we would like, how we can optimize our program and how we can remain responsible towards our sponsors and financial partners. I do not know exactly how things are organized, but the money comes from somewhere and we cannot throw it around to make the program perfect. With more financial resources we can push the program from an 8 to a 10. But that is about it. I would not change the fundamental approach or the themes. I would expand on the coaching and try to motivate the start-ups to work even more in the incubator to build the community." – Robin Lechner, Program and Event Coordinator at UtrechtInc

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Alternatively, more online integration of the program could also prove convenient for participating start-ups. UtrechtInc is a founding partner in StartupMe, an online platform for start-ups in the Netherlands and was active in online business incubation before the COVID-19 lockdowns. That forced UtrechtInc to fully develop online incubation programs. But although online can complement the offline incubation program, going 100% online may reduce the benefits from informal contacts with other start-ups, an intangible factor of which the benefits are very often highlighted and cannot be underestimated.

In general, many different choices on program design, business model, and program partitioning are possible. Most important, however seems to be an affordable program that caters sufficiently to the individual team's needs. That is best "organised" by putting the star-ups in the driver seat and stimulating them to take the initiative and shape their own incubation program while continuously fostering informal community forming. The participants appreciated the combination of feeling autonomy and support in the first waves of the new program, even if it is too early to tell if the new program is more successful than the old on the more traditional measures of incubation success and failure.

6.5. COVID-19 and digitalization

Besides the previously mentioned programs, UtrechtInc has been in the process of rolling out a digital program. This allows participants from all geographic regions and is less time consuming than the original programs. In addition, there are communal workshops and meetings. Part of this process has been implemented on the traditional program as well, due to COVID-19. COVID-19 made physical meetings in larger groups impossible, and UtrechtInc was forced to move parts of its program online entirely.

UtrechtInc identifies its digital program as an opportunity to share knowledge more efficiently with a broader audience. This may be useful to start-ups inconveniently located or those having a hard time attending physical meetings. Whilst participants are generally satisfied, the team does note one crucial difference; a digital environment does not allow for a similar community creation as the physical program – while this is identified as one of the most beneficial aspects to participants. This is partially overcome by providing similar informal events digitally. Those events have been more successful than previously imagined, but the difference in community building still is noticeable, and something UtrechtInc aims to improve upon.

6.6. Additional conclusions for smart city start-ups

All start-ups in the programs of UtrechtInc have a technological aspect at their core. Many of these start-ups could also be classified as providing smart city solutions (see Kolassa, 2021). As we have reported above, the new programs attracted some 40 incubates of which about half were accepted over the various waves since the pivot in 2019. To tentatively compare the results of the new versus the old programs at UtrechtInc, we can compare the descriptive statistics for Kolassa's (2021) 168 incubates in the period 2017-2020, that includes the new program (reproduced from Table 2 in Kolassa (2021) below) to the 259 start-ups that enrolled in the programs studied by Eveleens (2019) between 2014 and 2017 (reproduced from Table 6 in Eveleens (2019), below). In both samples, about half survived for a year after the last

program.[14] Also, on size, measured as employment at the data collection date, the averages for the Eveleens' data are higher and feature a very high standard deviation, implying the difference is not likely to be significant. As Kolassa (2021) could not obtain data on investments and growth, the comparison on these incubation outcome measures is not yet possible.

Moreover, these numbers cannot be compared in any meaningful way with similar statistics on the old program as especially the years 2020 and 2021 were exceptional because of the COVID lockdowns. We therefore tentatively conclude that inflow of start-ups at UtrechtInc has unambiguously increased, the prevalence of smart city start-ups in their programs has increased (cf. the descriptive statistics in Nijland (2020), Picari (2020) and Hermse et al. (2020) who coded the Utrecht data collected by Eveleens (2019) using the SCI) and their survival and size have not suffered visibly and significantly despite the COVID-19 restrictions put on the new program in the last iterations. Without further data collection and analysis, it is impossible to say anything about whether these effects are caused by the pivots in the program. It is possible that these changes would have occurred also under the old programs. To conclude causality, we would need to compare to a representative control group that has not been given access to the new program. Such a design, however, was not feasible and outside the scope of the IRIS project.

Variable	Obs	Mean	Std. Dev.	Min	Max
Survival	269	0.654	0.476	0	1
Size	269	3.734	5.755	0	38
Growth	269	1.054	5.732	-8	36
Investments	269	0.100	0.301	0	1

Table 23: Descriptives reproduced from Eveleens (2019) Table 6

Variable	Obs	Mean	Std. Dev.	Min	Max
Survival	168	0.554	0.497	0	1
Size	168	1.875	3.163	0	15
Smart City (1/0)	168	0.214	0.411	0	1
SCI-score	168	1.000	1.741	0	6

Table 24: Descriptives reproduced from Kolassa (2021) Table 2

Therefore, the above is not a formal quantitative evaluation of the differential impact the new incubation program at UtrechtInc had on smart city business model development in Lighthouse City Utrecht. But the data do give a first indication. In Part 1 of this report, our research concluded that smart city business incubation was unlikely to require different incubation programs and approaches. This is not surprising when we consider that business incubation, in general, is very much tailored to the needs of the incubate and the fact that many smart city innovations find themselves facing the same challenges other (tech) start-ups typically face. We also found that, despite our efforts, innovative (employees at) incumbent firms and users, for different reasons, are hard to draw into business incubation programs. This has led UtrechtInc to decide against more drastic interventions, like for example, providing a validation program

[14] It should be noted that in the Eveleens' (2019) dataset this can be survival up to 4 years, whereas in Kolassa (2021) it was restricted to 1 year. Also, the Kolassa (2021) dataset contains all start-ups that were incubated online, due to COVID-19 lockdowns.

specifically aimed at smart-city start-ups or user innovations. The benefits of being able to cater better to their specific needs would be trumped by the loss of important economies of scale and access to common networks and communities for the start-ups. Instead, we shifted our focus to organising events that would help feed more smart city (user) innovations into the incubator. The pivoted program could then help these innovations to the next stage in their development exactly because they could network them with start-ups and support infrastructures that also non-smart city innovators benefit from and help shape. Therefore, we concluded with UtrechtInc that the needs of teams should be the focus of the program reform and the same infrastructure supporting tech start-ups, in general, will allow smart city start-ups to flourish. Having more inclusive incubators that are able to tailor their services and support to the needs of the incubates will thus benefit smart city development and innovation alike.

"We have chosen for an approach which is certainly also applicable to smart city [start-ups]'' – Jorg Kop, General Manager at UtrechtInc

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What smart city managers (and incubators) can do to promote more smart city (user) innovation in their respective cities specifically, is organise events and activities that challenge would-be entrepreneurs to think about and formulate solutions for smart city challenges. We believe smart city developers can team up with incubators to promote new business model development during this pre-incubation stage of ideation. To stay faithful to our original task of providing tools and recipes to promote smart city business model development, we report on the ideation activities we have (co)organised and monitored. We believe, even if this caused us to deviate from the originally planned activities under Task 3.4 that using the results of scientific research to make improvements to, in this case, incubation practices is a more fruitful and cost-effective way to spend our resources.

7. Taking stock of ideation tools available from the literature and selecting the right recipe.[15]

In smart city development, as in IRIS, city planners and business developers alike face the challenge to involve citizens. The most interesting and useful stage for citizens to be involved in is when their involvement can still significantly impact the outcomes. Therefore, before we go into ideation for smart city development, we want to discuss the use of citizen engagement in these ideation tools first. Different ideation tools have been implemented throughout European smart city projects, but to date this has attracted little academic attention, especially for the non-financial benefits that can be obtained through different ideation tools. This chapter is based on a research project that contributed to filling this gap by contrasting civic hackathons, innovation crowdsourcing and civic crowdfunding in terms of the potential benefits obtained and type of knowledge produced. To examine this topic, 8 interviews with ideation event initiators and platforms were conducted and coded. The findings indicate that smart city planners should select the most suitable ideation tools depending on which potential non-financial benefit they wish to pursue: community building, citizen-oriented decision-making, continuous citizen involvement or image improvement. In our research, we analysed and contrasted three ideation tools increasingly used in different European Smart City projects: civic hackathons, innovation crowdsourcing, and civic crowdfunding. These three tools were selected based on the frequency of use and will be explained in the following sections. We then conducted interviews with the organisers of such activities to hear their experiences. Data collected through these interviews were analysed using a three-cycle coding method focusing on a better understanding of the benefits obtained through civic ideation initiatives.

7.1. Interviews and Findings

Eight interviews were conducted with people who have experienced a civic ideation tool's planning and implementation phases. Table 1, reproduced from (Meraza Farfan, 2018), briefly describes the interviewees.

Interviewee	Civic Ideation Tool	EU City	Country	Initiative/Organisation	Role	Specific role	Date	Duration	Channel
1	Civic Hackathon	Utrecht	NL	UtrechtInc	Platform	Organisation Leader	16/05/2018	01:24	F2F
2	Civic Hackathon	Utrecht	NL	Avicenna hackathon	Initiator	Board executive	29/05/2018	01:16	F2F
3	Innovation Crowdsourcing	Amsterdam	NL	Agru	Platform	Founder	02/05/2018	01:31	F2F
4	Innovation Crowdsourcing	Brussels	BE	Citizen Lab	Platform	Founder	30/04/2018	00:36	TEL
5	Innovation Crowdsourcing	Rotterdam	NL	City Lab 010	Initiator	Municipality Leader	07/05/2018	00:32	TEL

[15] This chapter is a reworked version of the MSc. thesis published as (Meraza Farfan, 2018) and contains (verbatim) quotes from that source.

6	Civic Crowdfunding	London	UK	Crowdfunding London	Initiator	Municipality Leader	30/04/2018	00:41	TEL
7	Civic Crowdfunding	Utrecht	NL	Voor je buurt	Platform	Manager	07/05/2018	00:38	TEL
8	Civic Crowdfunding	North-Holland	NL	1% Club	Initiator	Municipality Leader	02/05/2018	01:40	F2F

Table 25: Interviewees reproduced from Meraza-Farfan (2018) Table B1

Of course, the number of interviews limits the generalisability of our results. As there is very little data and research out there to answer our specific research questions, our results can be considered a first attempt at systematically collecting evidence on what ideation tools might create what type of benefits for smart city development. To be able to at least cross-validate the information from the interviews somewhat, at least two interviews per civic ideation tool were conducted. Interview transcripts were then analysed, organised, and compared. For the analysis of this research, a three-cycle coding process was applied. During the first cycle, two interview transcripts were coded in themes based on literature. Afterwards, the rest of the transcripts were coded in the second cycle, taking the first cycle codes as a basis. However, since first cycle themes were insufficient, other themes were added to ensure that no critical information was lost. Finally, the third cycle consisted in finding patterns and relationships regarding the research question and sub-questions.

After several iterations of revising and reorder codes, the final themes were defined. Themes were contrasted to avoid redundancy on references and concepts. The code hierarchy was analysed with special attention to making a comparison between the three civic ideation tools. According to the three sub-questions of this chapter, the tools were compared on three aspects: non-financial benefits, knowledge produced, and challenges faced. Finally, we compared between the literature and our empirical results.

Tables 25 and 26 below summarize the results on non-financial benefits and knowledge produced respectively:

Coded Quotes and Sample Quotes		Innovation Crowdsourcing	Civic hackathon	Civic crowdfunding	Total Coded Quotes
Non-financial benefits	Community building	67 (31,9%) [25,8%] "[…] It really helps to build your [Smart City] platform using this viral effect "	62 (29,5%) [40,5%] "[…] the goal was to make people [citizens] enthusiastic about meeting others."	81 (38,6%) [56,6%] "These were people [citizens] that never worked together before toward a common goal."	210 (100%) [37,8%]
	Continuous citizen involvement	105 (61,7%) [40,4%] ¨ […] give feedback and also enough possibility for citizens to give you input more than once."	46 (27,0%) [30,3%] "We [initiators] kept track of the people who won the prices via email and LinkedIn […]"	19 (11,1%) [13,3%] " […] apart from posting results, they can post an update of the impact the projects are having."	170 (100%) [30,6%]
	Image improvement	32 (34,4%) [12,3%]	35 (37,6%) [22,9%]	26 (27,9%) [18,2%]	93 (100%) [16,7%]

			"So only through the acquisition of participant you [municipalities] get a lot of exposure […]"	"the benefit is more about the impact, the visibility, the story telling they can do with those projects […]"	
	Citizen oriented decision-making	56 (67,5%) [21,5%] "The interface designed dashboard of the discussion is valid and useful as a report of the discussion […]"	10 (12,0%) [6,5%]	17 (20,5%) [11,9%]	83 (100%) [14,9%]
	Total Coded Quotes	260 (46,8%) [100%]	153 (27,5%) [100%]	143 (25,7%) [100%]	556 (100%) [100%]

Table 26: Summary of the results on non-financial benefits

Considering the "non-financial benefits", four main themes were coded. The most frequently mentioned was community building (37,8%), which refers to the ability to create and nurture relationships between initiator, citizens, and other stakeholders. The next most relevant theme relates to the facility for initiators to go back to citizens and ideas as needed over time, which we will refer to as "continuous citizen involvement" (30,6%). The third theme found is referred to as "citizen-oriented decision making" (14,9%), which points out the increased attention to citizens from their municipality. The fourth and last main theme identified the "image improvement" (16,7%) of the city in becoming smarter and more citizen-oriented.

Coded Quotes and Sample Quotes		Innovation Crowdsourcing	Civic hackathon	Civic crowdfunding	Total Coded Quotes
Knowledge produced	Early stage ideas	8 (47,0%) [57,1%] "[...] promotes civic discussions and solution-oriented discussions."	5 (29,4%) [25,0%]	4 (23,5%) [25,0%]	17 (100%) [34,0%]
	Prototype	1 (6,7%) [7,1%]	11 (73,3%) [55,0%] "It could either be an app, prototype […]"	3 (20,0%) [18,8%]	15 (100%) [30,0%]
	Ready-to-implement	5 (27,7%) [35,7%]	4 (22,2%) [20,0%]	9 (50,0%) [56,3%] "[…] project proofs if they get to achieve the initial promise."	18 (100%) [36,0%]
	Total Coded Quotes	14 (28,0%) [100%]	20 (40,0%) [100%]	16 (32,0%) [100%]	50 (100%) [100%]

Challenges		Relevant problem Resources for continuity Marketing strategy	Coaches & experts Resources: promotion Data access Outcome ownership	Skepticism Inclusiveness	
Literature		Theme related solution Structure process Continuity	Validates prototype On-going communication Innovative branding	Transparent process Community support Project strategic planning	

Table 27: Summary of the results on knowledge produced

A lot less was commented on the "knowledge produced" aspect of ideation activities (50 versus 556 on non-financial benefits), possibly reflecting that the initiators and platform providers we interviewed were less interested in the outcomes than the process. Still, we can identify three main themes reflecting how readily useable the input collected from the ideation tools was. The first theme indicates that more conceptual input is generated by citizens, which is referred to as "early-stage ideas" (34%). The next theme considers "prototypes" as the knowledge produced (30%), which indicates a more developed and validated solution. Finally, the theme of "ready-to-use solutions" (36%) emerged from the input that is closer to an implementation phase.

The challenges mentioned in our interviews, as well as the strengths and weaknesses mentioned in the literature, obviously differ by ideation activity. In addition, there are some remarkable differences across the three ideation tools we have covered. We discuss these tools in a bit more detail below.

7.2. Innovation Crowdsourcing

Innovation crowdsourcing taps into the wisdom of the crowd to develop innovative ideas on how to address a well-specified challenge. Continuous citizen involvement seems to be the most significant aspect for innovation crowdsourcing (105 quotes out of 260). Innovation crowdsourcing can take place in a digital or physical environment depending on the strategy developed by the initiator. To implement this ideation tool, initiators can either use an existing platform or build their own from scratch. According to our interviews, the initiators preferred to join an existing platform as a tailor-made solution that gave them a defined process with clear steps to follow. Moreover, the existing platform gave the initiator access to the best practices of smart city development applied in previous ideation initiatives. Relying on platform expertise on effective civic ideation processes is perceived as an important benefit that our interviewees repeatedly mentioned:

> *"we [platform] developed a methodology to help cities on different ideation processes. We provide them with all support. For the cities [innovation crowdsourcing] is still very new, so we help them design each process depending on their purpose" (Interviewee 3)*

Both innovation crowdsourcing platforms studied developed their own methodology to achieve citizens participation. The continuity of the ideation initiative is a key element for innovation crowdsourcing success due to the difficulty of keeping track of citizens' ideas. Therefore, it is relevant to achieve the purpose of continuous citizen participation in public initiatives (Schuurman et al., 2012). When citizens participate in a crowdsourcing initiative, they are interested in receiving follow-up regarding the ideation process. Therefore, founders from both platforms always recommend initiators to give constant feedback to idea contributors during and after the ideation process.

> *"[…] is important to give continuity, what I mean by that is that you [initiator] need to make sure you give feedback and also enough possibility for citizens to give you input more than once." (Interviewee 4)*

In addition to scoring high on continuous citizen involvement (61,7%), innovation crowdsourcing initiatives also received the most references to citizen-oriented decision making (67,5%). Most of the respondents from this civic ideation tool considered that getting information facilitates their decision-making process within the municipality. Gathering information from citizens through digital platforms enables initiators to translate this information into discussion material for internal meetings.

> *"The interface designed dashboard of the discussion is valid and useful as a report of the discussion. So, it provides an overview of the problem, the solutions and the pros and cons [comments]. And of course, how many people voted [in favor of] each of them." (Interviewee 3)*

Through innovation crowdsourcing, initiators get both quantitative and qualitative data. In most cases, respondents 3 and 4 identified a tendency of initiators to rely more on the quantitative data, such as the number of votes or arguments against the ideas. This can help them make faster decisions. However, the drawback is leaving out the interesting arguments and thoughts presented by citizens as qualitative data. As interviewee 3 mentioned, the quantitative approach might be a natural preference for municipalities due to its similarity to a democratic decision, in which most votes are what matters.

> *"[…] all that time I was really hoping to for this government to look at the arguments, look at the discussion. […] And the question is how municipalities deal with this kind of input and I am afraid that they overly rely on like the processes input. And they focus more on the quantitative input, and I think qualitative input is way more valuable." (Interviewee 3)*

Finally, citizen-oriented decision-making is possible after a crowdsourcing initiative due to understanding citizen priorities and interests. Understanding their real needs is considered by interviewees the first step to achieve the desired orientation in decision-making:

> *"For instance, our policymakers are mainly concern about bike lanes in their cities, while most of the people [citizens] are more concerned about not having enough parking space to go the butcher." (Interviewee 4)*

Community building is essential across all three types of ideation activity. As expected from the literature, smart city planners seek to build or improve a relationship with citizens and identify or develop new communities that enhance the implementation of initiatives (Certoma et al., 2015). For our interview respondents, community building plays a vital role during the planning phase of the ideation. Respondents from crowdsourcing initiatives acknowledge the community-building benefits between the initiator and participants. In the three initiatives we discussed, an open dialogue was created within the ideation process, where the initiator takes an active role in communication and feedback. Interviewees repeatedly mentioned Co-creation as a practice to strengthen the relationship between municipality and citizens:

> *"Also, the idea of co-creating enables citizens and the city to work together and achieve something new. This is also a new way of government". (Interviewee 5)*

Co-creation leads to a better acceptance of public decisions and gain support from citizens (Schaffers et al., 2011). This element is considered in the ideation process planning when initiators decide how to interact with participants during the smart city development. In innovation crowdsourcing challenges, co-creation is a crucial element where citizens interact directly with initiators. This personal approach was considered by respondents a strong benefit for building a community with citizens due to the support element and face-to-face interaction on top of the digital communication. For crowdsourcing initiatives, the co-creation element needs to be planned to make sure municipality staff and citizens have an interaction element throughout the process.

Also, citizens should not encounter barriers to share their ideas on a platform. The aim is to get as many participants as possible to gain more knowledge, better solutions, and bigger communities. Thus, respondents emphasized the need to avoid complicated and unnecessary steps to access the forums. Moreover, municipalities should select problems that are both relevant and clear for citizens. Since the description of the problem or task asked by the initiator might pose a barrier for the crowd to participate (Brabham, 2008), initiators should prevent such barriers for citizens to get involved.

According to respondents, problems presented should focus on specific and local problems easy to relate to for citizens. Furthermore, citizens should understand what is expected of them, not only in terms of the ideas provided but also in the interaction that crowdsourcing requires. For instance, it should be

communicated from the beginning that it is important to interact with municipality staff, comment on others' ideas or vote for an idea different than their own.

Finally, community building among citizens emerged as important during the interviews. As mentioned before, open call platforms focus in seeking for local solutions to specific problems pinpointed by the municipality. Consequently, most of the citizens are motivated to participate due to the direct impact that this solution will make in their neighbourhood. This implies that citizens living in the same area are going to be participating in the same platform by posting their ideas and commenting on each other´s proposals. This creates the possibility for offline interaction that may emerge, allowing citizens from the same neighbourhood to communicate directly and co-create. In addition, outside the platform, citizens´ communities can be built and strengthened because of the crowdsourcing initiative:

"And when people [citizens] started to post ideas, they started to activate friends and family through Facebook or through their social networks. That also helped for the sake of discussion. That is really a big interaction that causes a lot of additional users [citizens]. It really helps to build your [Smart City] platform using this viral effect."
(Interviewee 3)

Innovation crowdsourcing as an ideation tool produces a variety of ideas depending on factors such as problem specification, type of participation and rewards. Problem specification refers to the extent in which initiators present the call for ideas to citizens in terms of specific requirements. For all the initiatives, this characteristic is key to determine the level of detail and development of the ideas obtained from the ideation tool. Interviewee respondents consider that the more specific the problem is, more readily implementable the solutions obtained are. Nonetheless, through crowdsourcing platforms, knowledge produced is usually an early-stage idea. Therefore, problem specification in an innovation contest is a priority for initiators. Establishing themes or topics is consequently helpful for initiators to narrow the scope of knowledge produced. This strategy was implemented in CityLab 010 and incentivized with the possibility to get funds from the municipality budget. According to interviewee 5, if this incentive would not exist the knowledge produced would not be feasible for implementation.

"If you [municipality] are looking for ideas and you really want them [citizens] to put effort and time into creating a great idea, make sure that there is a reward"
(Interviewee 3)

In short, the innovation crowdsourcing initiatives and platforms we discussed were quite strong in generating continued citizen involvement and citizen-oriented decision making. In contrast, the events scored comparably to the other ideation tools on community building and image improvement. An innovation crowdsourcing campaign, however, does put significant strains on the smart city planners. The contest needs to be incentivized and quite a bit of time, effort and energy needs to be spent on identifying,

developing, and clearly communicating the challenges. Nevertheless, the innovation crowdfunding tool should be part of smart city planners' standard toolkit that cares about citizen engagement and is willing to involve citizens in the early stages of smart city planning.

7.3. Civic Hackathons

Civic hackathons are comparable to innovation crowdsourcing but typically smaller scale and more focused in scope and time. Where a crowdsourcing campaign can run online, for large groups and over extended periods of time, the hackathon is typically more focused on a specific problem and takes place on-site in a short period of time. The civic hackathons initiatives studied in this chapter took place in the Netherlands, where according to our respondents, these events are gaining attention from companies and citizens. Citizen participation was higher than expected in most of the hackathons organized by interviewees. There typically is a marketing strategy behind this ideation tool to acquire participants. This, perhaps, explains their relatively high score on community building and image improvement.

Depending on the nature and topic of the hackathon, promotion can make use of different channels. Partnerships with organizations in the field and the business sector are highly relevant to get a higher spread and scope. For instance, in a hackathon related to e-health solutions, partnerships with health research institutes, universities and pharmaceutical companies will make a big difference in terms of quantity and quality of participants. This also implies that one typically applies more selective criteria for participants in this civic ideation tool.

Because of the marketing strategy to acquire the right participants, the branding and image of the initiator are enhanced (if it is done well). Interview respondents underlined the image effect associated with hackathons:

> *"So only through the acquisition of participant you [municipalities] get a lot of exposure, and also during the event you also have a press release after the final. It is a new, positive, innovative news. A lot of media channels or partners are willing to share that kind of news. It also involves like the Netherlands as a society, with a message of innovation can be for everyone." (Interviewee 1)*

The development of smart cities is strongly related to the technological element as an enabler to improve services for citizens. Therefore, using an ideation tool that has an innovation and technology concept closely interrelated helps build a consistent image in the eyes of citizens.

By initiating a hackathon, the municipality can brand itself as innovative and technologically inclined, which fits the smart city concept and therefore generate benefits beyond the hackathon itself in recruiting and mobilizing citizens for smart city developments in other ways. The benefits of this branding are also observed in the number of applications to participate:

"[awareness] is something that is easily achieved, because you [municipality] are building a website, logo, get out there and if you get 80 participants then we have 120 applications, and you reach out through a lot of channels. There is big marketing strategy behind it, it is a big campaign." (Interviewee 1)

Civic hackathons also enable people to work together in a multi-disciplinary approach. Participants have different backgrounds and expertise that complement each other in building a solution for the challenge set by the initiator. Early on, hackathons were mainly receiving applicants from IT backgrounds who were experienced and interested in programming skills. However, current hackathons are looking to attract people from all sorts of backgrounds to motivate more innovative solutions that consider different perspectives in addition to the digital and technical ones. Thus, jury members in hackathons are no longer technology experts exclusively. Instead, juries are formed by business, social and science experts related to the hackathon theme. This approach makes the hackathon a strong tool in community building:

"[…] the goal was to make people [citizens] enthusiastic about meeting others who see the same problem and come with ideas." (Interviewee 2)

Citizen's networking benefits the initiator due to its contribution in achieving citizens interested in smart city challenges. Access to specialized talent is also part of the non-financial benefit gained by the initiator:

"One of the main goals is to get in touch with talented people within IT or programmer sector who are in high demand. They [initiators] really want this, it is also very important for the initiator to have enough people and connect with participants. We have coaches in the hackathons. There is a lot of networking going on." (Interviewee 1)

Respondents also emphasized the importance of the concept is to facilitate an informal, fun and interactive environment for participants to come with innovative solutions and allow a better integration among teams. Due to the complementary activities during the event such as ping-pong matches, workshops, and dinners, the community building is encouraged.

Typically, more than half of the participants do not register together with a team. Thus, teams are formed between people who did not know each other beforehand. Interview respondents consider a strong characteristic of hackathons that the team formation usually occurs at the event's beginning. Although not all teams continue with implementing their idea together, interviewees mentioned that participants started a new active network after the civic hackathon that extends the impact of the initiative.

Civic hackathons create an open environment in which participants are open to sharing their ideas with initiator staff. Based on the experience of the respondents, this learning process also motivates an innovative organizational culture within the municipality:

> *"The third goal is the internal culture to change internally, they [initiators] want to inspire their own employees or management to get them more in an innovative mindset and stimulate them to come out of their comfort zone so they think more out of the box." (Interviewee 1)*

Civic hackathons typically last between 24 and 48 hours. Due to this limited time to develop solutions worth pitching in front of the jury, the fast-paced progress experienced by the teams is characteristic of this ideation tool. However, after this fast experience, it is challenging to generate continuity and build a relationship with participants. Only by taking special action is how initiators can get continuous citizen involvement. Normally, a follow-up is not given to all participants from hackathons initiatives because there is a natural focus on the winners. And since the participant team is typically the owner of the solution created, the implementation is completely its responsibility. Due to the uncertain results at the beginning of the planning phase, initiators have difficulty managing expectations and partnering with (winning) teams. After the hackathon, some teams will look for expert advice from the initiator or a validation from a customer perspective. That provides a valuable way to build the relationship, but not all initiators are interested.

> *"After the hackathon, some initiators got involved, some others didn't. Sometimes they were involved more as a validation for the solution." (Interviewee 2)*

In case that initiators look for solutions to invest in, they prefer to count on an intermediary to manage the progress and communication between them and the team. For instance, interviewee 2 indicated one way to keep a continuous citizen involvement was to give winners a business model consultancy program as their prize:

> *"The key factor to follow up with the solutions was to give the prizes in which the company and the team get involved, as consultancy sessions." (Interviewee 2)*

Civic hackathons organizers/platforms act as a middleman between initiators and participants throughout the process. After a civic hackathon is finished, they may connect them again to allow for continuity. But this needs to be planned carefully in advance if continuous citizen involvement is desired. Offering the winning teams of a hackathon a place in a business incubator like UtrechtInc can be an effective way to keep (citizen) engagement high and at the same time ensure a higher inflow of viable smart city

innovations into the incubator program. Our respondents highlighted, however, that initiators typically do not invest resources in this last phase. Hence, they do not take an active role to follow-up with teams with the best solutions. Normally, a lack of resources in terms of people and time prevents initiators from either incorporating the solution into their organisation or taking the investor role. In IRIS, we have tried to organise a hackathon (ChangeU, see Chapter 8.5.) to see if we could overcome this problem.

The knowledge produced during a civic hackathon is entirely developed during the hackathon, meaning they have a very limited time to create a product further than a prototype that, in most cases, is validated with potential customers. To achieve this level of knowledge production, workshops on problem-oriented perspective, lean start-up and customer validation are given to participants. Some tools to build prototypes that are not digital applications are available for teams to use, such as building materials and 3D printers. These characteristics and facilities allow hackathons to produce prototypes as the most common knowledge produced.

Since the knowledge produced is not limited to digital applications, teams can create different types of knowledge. They are expected to give a pitch in front of a jury that will decide. The development of the solutions is expected to be further than an early-stage idea.

> *"[knowledge produced] It could either be an app, prototype or also, for example, one team did something with paperwork, and it was a good solution. In the end, we got more apps, as the most common solution. But you [participant] can also build a smart device." (Interviewee 2)*

An essential requirement for the knowledge produced in hackathons is to give a clear idea to the jury of how it works and what potential customers would see when using it. Furthermore, teams should present how did they validated the prototype they presented. Most of the teams use their own network to validate their prototype through surveys or quick remote interviews. In some cases, teams validate their idea either with other teams or staff from initiators present in the event. This makes the knowledge produced more focused on feasibility than an open call innovation crowdsourcing, for instance.

The knowledge produced depends on determining criteria for teams to win the prize. Criteria may include technical feasibility, the progress in validation and data used to motivate the relevance of the solution. Regarding the technical results, teams are expected to be more focused on programming and hacking activities to end up with a functional application.

> *"[…] in tech hackathons, they [participants] did use the data and technology so they usually build some code to proof how something would work. The products are developed, usually apps or tools. Is more difficult, cost more time if you do a tech hackathon. And you [initiator] need to provide enough hacking time to build this." (Interviewee 1)*

In this type of hackathons, initiators need to take into consideration that more resources will be needed. This is when the criteria of data available also take relevance due to its relationship with the development of the product. Based on the data available, teams can validate their idea and at the same time build a solution closely related to reality. According to respondents, data is not always offered by the initiators, which impacts the quality of the results. In some cases, teams bring their own data to work with. During the Avicenna hackathons, for example, the winning team had data that let them run some tests to prove the functionality and build a more advanced prototype:

> *"We [initiators] also have a team of tech guys and they were very good, but hey were missing a company to embrace them. They also won the gold price because they design this app able to analyze a biopsy without a microscope, using a picture and then the app tells you what kind of cells. They did that within the 48 hours."*
> *(Interviewee 2)*

In this example, the team had data of biopsies and cell patterns to try their solution on. Besides the outstanding solution this represents for the theme of e-health of Avicenna hackathon, the team excels on the pitch due to the strong validation presented. Based on this example, one can infer that data gives teams more tools to present prototypes or even ready-to-use solutions. One or more partners can facilitate the data and the municipality can complement it with public data available. In fact, respondents mentioned that hackathons usually rely on different partners to achieve a better knowledge production. In this regard, it is also important to consider the availability of human resources at the event to give support for teams in case of difficulties in understanding the data. This makes hackathons, in contrast to innovation crowdsourcing, rather intensive. In a shorter period, more needs to be organised and be available. This makes civil hackathons more complex logistically even if parts of the event can be organised online and organising them well takes more time, resources, and energy. But in terms of helpful knowledge produced, they can be more targeted and more successful at achieving more readily implementable ideas and solutions. The main challenge in a civic hackathon, as in innovation crowdsourcing, is to reach out to the right target audience of potential participants. In business ideation, there is strength in numbers and diversity. A more extensive and more diverse pool of participants will yield more and higher quality knowledge while generating more of non-financial benefits.

7.4. Civic Crowdfunding

Civic crowdfunding is more oriented on the financial commitment of participants. It, therefore typically starts with more developed solutions and serves more as a validation tool and selection device for a given set of alternative solutions than to generate new ideas and creative solutions. Civic crowdfunding aims to bring meaningful and bottom-up involvement in the development of smart cities. Therefore, community building is the most significant benefit obtained in civic crowdfunding and is the ideation tool that stands out with most references related to this benefit (56%). This ideation tool enables citizens to build their own communities around projects they relate to and consider impactful. An important challenge is to get

a diversity of people involved in the same project, not necessarily as leaders or participants but also as (financial) backers of projects.

In our research, there were three initiatives that we could analyse. All three used a digital platform to implement the civic crowdfunding as their main channel to achieve the ideation process. However, interviewee 8 highlighted that important community-building results were obtained in the physical environment also. In the context of smart cities, civic crowdfunding opens possibilities to get people to know each other through the digital platform and then participate in physical meetings to support projects. For instance, a market was started by citizens where local products could reach more people to test new products. The participants were very active in raising awareness of their civic crowdfunding campaign among their community. It took three months of both digital and physical promotion to get the community engaged and back this project. Through these promotion activities, the initiators were able to mobilize more people from their local areas. The initiators managed to then also involve these citizens in implementing this marketplace in the area.

"Crowdfunding can really make a difference between three people with a great idea, and three people and involved community around them that gives support, do coach, use the network and coming to help out." (Interviewee 7)

The constant communication that participants need to maintain with their backers also nurtures a long-term relationship between citizens. In smart cities, initiators frequently experience the challenge to involve as many citizens as possible. An additional challenge is to engage groups long-term with public issues. Most of the respondents believe that through civic crowdfunding this can be achieved, especially with younger members of communities:

"[…] because the way it works and the fact that it is normal platform we help to younger generation that typically you [municipality] don´t see contributing to the public-sector initiative." (Interviewee 6)

Civic crowdfunding can also be used to build communities offline. An exciting example took place at a mental disease day-care where the goal was to build a greenhouse as part of the treatment activities for their patients. During the event organized for the civic crowdfunding initiative, the community around the day-care center attended to back the project. During the event, citizens, businesses, and the municipality funded the project with a monetary pledge and resources such as soil and tools to build the greenhouse. Therefore, this project reached community building in different levels: citizens to citizens, citizens to municipality and business to citizens:

"Citizens from the village came, and they started to chat with people from the daycare, not realizing that those people were the ones living there. So, they became aware that those people are just people who you can talk to and are not strange at all." (Interviewee 8)

There are dedicated civic crowdfunding platforms, such as "Voor je Buurt", that help smart cities reach citizens' ideas related to specific purpose. In one case in The Netherlands, a municipality aimed to increase awareness on the preservation of biodiversity among citizens. To achieve this, they opted for a civic crowdfunding initiative in which citizens could back their favourite ideas on how to accomplish this goal in their region:

"For the province, the main benefit is that now they have almost twenty showcases, with a story, which they can use to show that not just something that they make a policy about, but they really make a difference in reaching their goal." (Interviewee 7)

The civic crowdfunding initiative gave the municipality the content to raise awareness in biodiversity while at the same time promoting collaboration with citizens in doing so. Creating relevant content for citizens that enhances the municipality's image can thus be part of the purpose pursued. Therefore, civic crowdfunding can be used to "build the brand and own name for municipalities" (Interviewee 7) as part of the awareness of the smart city development.

Besides the benefit of an innovative image and increased interaction, engaging with civic crowdfunding regularly would create a consistent storytelling to connect with citizens and get them onboard public issues and policymaking:

"I think the benefit is more about the impact, the visibility, the storytelling they can do with those projects. Because my neighbourhood garden is sexier than just a new policy around on how do we treat the borders around the province." (Interviewee 7)

Strongly related to building a community and a citizen-oriented brand is the continuous citizen involvement in civic crowdfunding campaigns. This is achieved by having the municipality fund or subsidize the selected projects and inform the backers on their progress. This does not end after the crowdfunding campaign has ended. After backers and the municipality fund the projects, citizens are expected to nurture a relationship with them and maintain communication. Continuity also happens within the community built during the crowdfunding campaign. Civic crowdfunding thus empowers citizens to take part of the smart city development in an active way, first by providing a platform to share ideas as a solution, second to create a community of backers and third by receiving economic support from either the municipality or other citizens.

In civic crowdfunding campaigns the ideas from citizens must enter the contest in a more developed stage than crowdsourcing and hackathons. Normally, the knowledge produced by citizens needs to be in the ready-to-use stage to attract backers. Typically, the proposed ideas will be implemented as proposed to maintain trust among the backers. In fact, the community built with backers and municipality generates a commitment from participants to deliver on the promises made in the crowdfunding campaign. Moreover, after getting the support from their communities, initiators often connect with volunteers willing to implement the proposed idea together. In an ideation process using civic crowdfunding smart city planners should therefore look at the knowledge produced differently:

> *"I would advise you [municipalities] to not only collect ideas but also collect initiatives. People need to have the ambition to go for it, start the project themselves and together with local municipalities. Collecting ideas can work, but citizens tend to say to governments like "do this or that, but I don't have any responsibilities". I believe that for city projects success people should get involved and feel responsible." (Interviewee 7)*

As interviewees 7 and 8 repeatedly mentioned, participants are committed to making their ideas a reality. The sense of responsibility developed after the campaign is strong towards their project, the community, and the municipality as backers. Through civic crowdfunding, citizens get empowered to build by themselves solutions that are relevant for both, themselves and smart city development.

7.5. Discussion, implications and conclusions

From the above, we can draw several conclusions. First, from the earlier parts in this report, we concluded that smart city (user) innovation-specific incubation programs are unnecessary or useful. Instead, smart city business model development would benefit most from designing smart city ideation activities, such that the flow of new ideas into incubation programs would result in more smart city business models. In this chapter, we presented an overview, based on literature review and interviews, of three broad categories of such ideation activities: innovation crowdsourcing, civic hackathons, and civic crowdfunding campaigns. These three were selected to represent a range of activities that could help identify and select smart city solutions. We evaluated these three types of events on their effectiveness in generating relevant smart city (user) innovations (knowledge production) but also on their ability to create non-financial benefits, mostly in the form of enhanced community building and engagement. As our smart city definition of chapter 2 and the set-up of the IRIS project already indicate, citizen engagement is an integral part of smart city development and in addition to generating feasible and working solutions to smart city challenges, the events described in this chapter all contribute to engaging (interested) citizens in smart city development as a natural corollary to the activities.

Specifically, on citizen engagement, we identified benefits in community building, continuous citizen involvement, image and branding benefits and citizen-oriented decision making and concluded from both the literature and the empirical data that the three types of events differ in their emphasis and

effectiveness in achieving these benefits. On knowledge production, we also found that both literature and our interviews suggest that the events discussed each has a specific focus on the technological readiness of ideas and solutions generated. In order of technological readiness of the ideas generated in the events, we tentatively conclude that an innovation crowdsourcing yields the least mature, a civic hackathon a more mature, and the civic crowdfunding campaigns yield the most mature solutions.

Based on the analysis of both the literature and our interviews, Table 27 below shows the strengths and weaknesses of the different types of ideation activities. Smart city planners, who should act as initiators to implement these civic ideation tools, can use these results to better select the appropriate event for their specific purposes. The proficiency of each ideation tool in achieving non-financial benefits and produce specific knowledge is indicated by the number of plus symbols. The more plus symbols the table shows, the more suitable the civic ideation tool is in the indicated outcome. Is important to highlight that the number of plus symbols represents the contest version of this tool for innovation crowdsourcing.

		Innovation Crowdsourcing	**Civic hackathon**	**Civic crowdfunding**
Non-financial benefits	Community building	++	+	+++
	Continuous citizen involvement	+++	+	++
	Citizen oriented decision-making	+++	+	++
	Image improvement	+	+++	++
Knowledge produced	Early stage ideas	+++	+	+
	Prototype	++*	+++	++
	Ready-to- implement	+*	++	+++

Table 28: Guide for selecting Ideation Tools reproduced from Meraza-Farfan (2018) Table 5

Finally, a general recommendation that emerged from the data analysis is to combine these methodologies to build on their benefits and complement each other. In any case, thorough planning is needed to contemplate all factors presented in the results section regarding challenges and key learnings. These findings are also relevant to make an informed selection of tools to generate the outcomes desired and expected by initiators.

In conclusion, we would encourage smart city developers to consider ideation as an integral part of both their citizen engagement strategy and their smart city business model development strategy. For the former, this chapter has shown that ideation tolls can be helpful in achieving engagement objectives as a natural corollary to the main aim of the activities, which is to generate new ideas in various stages of technological readiness that can then be fed into well-designed business incubation programs. The analysis in this chapter was kept limited to only three types of ideation events to keep the analysis manageable. In the chapter that concludes this report, we will present a list of ideation activities that have been co-organised and/or monitored by the IRIS project team. These are written up as recipes, such that

interested smart city developers in IRIS and beyond can easily follow these to organise their own ideation events.

8. Ideation Cookbook with Recipes and Step-by-Step Guide

In this chapter we have collected "recipes" for ideation activities that might be replicated in other lighthouse cities, follower cities or cities beyond and after the IRIS project. These recipes have also been published separately on the IRIS website and are reproduced here verbatim. These activities aim to generate, identify, and mobilize resources to push smart city solutions to their next stage. As was clear from Chapter 7, these types of events can also serve a secondary purpose of engaging citizens in smart city development.

The collected recipes here represent the events we were able to track during the IRIS project (2017-2021). For practical reasons, the emphasis has been on events in and around Utrecht, but we have tried to make explicit the resources and preconditions that were vital to the events' success, such that one can check in other contexts if similar activities might be replicated. Our data collection method for this chapter has been extremely pragmatic. We have scanned our networks, social media, and the internet for events we thought would fit our rather broad definition of an ideation tool and then contacted the organisers to obtain the information we needed. In all events, a level of collaboration with IRIS partners was present. In four out of the presented eight recipes (Energy Poverty Challenge, Citizen Innovation Challenge, Smart Lightning Challenge and ChangeU), the event was initiated and organised by IRIS (partners). This has resulted in a "cookbook" that now contains 8 recipes, of which six were organised with a clear focus on Utrecht, one was international, and one in and focused on Goteborg.

8.1. Start-up in Residence Utrecht

Start-up in Residence is a concept that originates from the United States of America and is being carried out by several Dutch municipalities, provinces, and ministries (https://startupinresidence.com/). Start-up in Residence challenges' entrepreneurs to come up with innovative solutions to social issues in the respective region. The municipality of Utrecht ran a Startup in Residence challenge in 2017, at the start of the IRIS project. The result was a range of concrete products and services, which were pitched to the municipality of Utrecht. For every posed challenge, the best solution was chosen from the entries. The selected start-ups then worked on the solution in an incubation program, guided by incubation experts and relevant civil servants. The municipality then decided whether to purchase the developed product or service. The program was started to pay more attention to starting entrepreneurs in the municipalities' procurement procedures.

Dish: challenge | 0.4 FTE | 3M preparation + 3M execution + 3M incubation | €300.000

Recipe for: 76 ideas | 6 start-ups

Ingredient List:

- Budget
    - €95.000-120.000 organization costs

    - €20.000 procurement budget per challenge
- Time
    - Preparation (12 weeks):
        - Finding and finalizing challenges
        - Tender for incubation program
    - Challenge (13 weeks):
        - Challenge open for entries: 6 weeks
        - First evaluation round: 10 days
        - Pitch preparation for selected entries: 3 weeks
        - Pitches and final evaluation: 1 week
    - Incubation (12 weeks)
        - Program: 12 weeks, 1 day per week activities
- Resources
    - Types of organizations involved
        - Departments of the Municipality
            - Economics (organization)
            - Public Services, Health, Education, Public Spaces, Mobility (challengers)
        - Incubation by Graduate Space
        - Recruitment of start-ups by StartHubs' subsidiary Battle of Concepts
    - Types of roles involved (mentors, organizing team, experts, etc.)
        - Organizing team
        - Judges for selection of ideas
        - Experts for guiding during incubation program
    - Location(s)
        - Registration and selection via www.startupinresidence.com/utrecht
        - Location for pitches
        - Location for meetings in incubation program
    - Terms and conditions

Planning

Preparation

First, the organizing team of Startup in Residence decided on the goals and deliverables for the program. The to be realized goals were:

1. Encouraging and facilitating starting entrepreneurs
2. Solving social issues (challenges) of the municipality of Utrecht in an innovative and creative way
3. Strengthening innovative thinking and working within the municipality of Utrecht

Deliverables to reach these goals:

1. Recruitment of 5 to 10 challenges within the municipality of Utrecht
2. At least 25 entries from start-ups to the challenges of the municipality of Utrecht

During the planning phase, the organizing team of Startup in Residence had two main tasks: first, find an organization to support during the incubation phase. Second, and more importantly, find enough departments of the municipality of Utrecht ready to join the program and pose a suitable challenge. Ultimately, five departments joined the program, posing the following nine societal issues (challenges):

- *How do we get people to eat something healthy in the sports canteen?*
- *How do we encourage more visits to the current leisure facilities and events in Leidsche Rijn?*
- *How do we ensure that all residents take sustainable energy measures via the regional energy desk?*
- *Developing means to reach pupils and their parents early on in intermediate vocational education and encourage them to make an occupational choice with a labour market perspective.*
- *How can we make flexible working in the hospitality industry more attractive to intermediate vocational education students?*
- *What can the municipality of Utrecht do to improve its business climate for start-ups and scale-ups and how can you (the start-up participating in this challenge) contribute to this?*
- *How can we reduce the number of service and construction buses in the city centre of Utrecht?*
- *How do we monitor the number of solar panels on Utrecht roofs and the amount of power they generate?*
- *Make getting married in Utrecht a 'piece of cake'!*
- *Wildcard*

All challenges were presented in a fixed format, that consisted of the following topics: 1) the challenge, 2) some context, facts & figures, 3) solution conditions, and 4) exclusion criteria. The first phase was concluded by a positive decision of the alderman for Economic Affairs to continue to the next phase.

Event

Startup in Residence Utrecht publicly launched at November 1, 2017. With help of Battle of Concepts – a company specialized in communication aimed at innovators, students, creative (young) professionals, and innovative start-ups – the ten preselected challenges were distributed through the StartHubs platform and Startups in Residence Utrecht website. A costly, but vital success factor to be able to reach out to thousands of potential applicants. The deadline for entries was set at December 11, 2017. While the challenges were 'open', potential participants had the opportunity to visit an information meeting on November 16, 2017 and ask questions through the StartHubs platform until November 23, 2017. All questions and answers were publicly published on November 29, 2017.

Startup in Residence Utrecht received a total of 76 entries. Between December 11 and December 20, 2017, all entries were checked by the organizing team based on the challenge requirements. Next, a more in-depth review was undertaken by the organizing team and representatives of incubator Graduate Space. 32 entries were selected for the following round, which was a live pitch between 8 and 11 January 2018. The pitches were judged by the challengers of the municipality of Utrecht, based on 8 criteria: 1) problem description, 2) substantiation of problem description, 3) quality of design criteria, 4) fit between problem description and proposed solution, 5) quality of solution (innovation, desirability, and technique), 6) level of ambition, 7) team quality (competent, eager), and 8) sustainable business model.

7 start-ups were selected to join the incubation program, led by Graduate Space. Three of ten initial challenges failed to find a suitable solution. Of the 25 entries that were not selected for the incubation program, 13 entries did join a feedback session organized by Graduate Space.

The incubation program, led by Graduate Space, consisted of Design Thinking sessions for one full day per week over the course of 3 months, starting at February 1, 2018. The focus of the incubation program was both the development of the product or service, and the newly formed company itself. Valuable co-creation sessions were organized with the respective departments of the municipality of Utrecht and start-ups were encouraged to challenge and coach each other. Furthermore, each start-up was coached by an experienced entrepreneur and additional experts were invited for deep dives on specific topics.

On May 1, 2018, all seven start-ups were invited to pitch their final solution to the departments of the municipality of Utrecht who posed the initial challenges. Of the seven start-ups, six were eventually awarded with a 'launching customer' contract by the municipality of Utrecht (one €40.000 contract and five €20.000 contracts).

Evaluation

After Startup in Residence Utrecht concluded, the program was thoroughly reviewed. Main feedback by the organizing team, and participating entrepreneurs and civil servants included:

- A key success factor is the reaching out to thousands of potential applicants. The difficulty of getting access to a network that is relevant cannot be underestimated. It is also a very costly ingredient.
- Both entrepreneurs and civil servants experienced the co-creation sessions as very valuable, inspiring, and refreshing.
- The seven developed products or services were positively received by the municipality of Utrecht, leading to six 'launching customer' contracts.
- Entrepreneurs value the incubation program, especially coaching and challenging each other. Time needs to be allocated to customization of the program, as the entrepreneurs' needs differ based on experience and problem-definition.
- Societal organizations relating to the respective municipality departments need to be included in the process early on, during the challenge formulation and reviewing of entries.
- While the wildcard is positively received by entrepreneurs, the entries mainly consist of existing products and there is a lack of ownership of the challenge within the municipality.

Reflection IRIS

It was too late for IRIS to get involved in Startup in Residence 2017. We have worked with the responsible team in 2018-2019 to try and get the municipality of Utrecht to run another iteration of Startup in Residence, but political priorities shifted, and it proved impossible to get a second round organised. The set-up of Startup in Residence is very suitable for smart city developers. The initiative needs to come from a large, central player in smart city planning, such that a diverse set of challenges can be collected, and resources can be made available to plan the event. It is advisable to link with partners that have a large network they can mobilize on the challenge and partners that can provide expertise on the incubation of

the winning solutions. The success rate of Startup in Residence (7 viable businesses out of 76 ideas submitted 10%) is impressive, but also has a lot to do with very clear challenges and relatively high stakes.

8.2. Smart Lighting Challenge

In the Smart Lighting Challenge Design Thinking was used to engage citizens in the implementation of smart lighting. This technique aims to lead to solutions that solve the problem in a manner that complies with citizens' needs and desires. Design Thinking consists of two phases: discovering the problem and the creative process. In three sessions, various residents of the Kanaleneiland-Zuid neighbourhood and experts participated, to co-create designs in which smart lampposts were used to create a safer neighbourhood. The highest rated idea was submitted to the traffic specialists of the municipality of Utrecht, to further develop the solution into a detailed plan.

Dish: co-creation | 0.8 FTE | 3M preparation + 2W execution | €3.000

Recipe for: 5 ideas

The Ingredient List

- Budget
  - €3.000 out-of-pocket costs
- Time
  - Preparation (12 weeks)
    - Problem definition
    - Understanding the neighbourhood
    - Selecting and briefing of sessions' participants
  - Event (2 weeks)
    - Three Design Thinking sessions: 1 evening per session
- Resources
  - Types of organizations involved
    - Organization by Municipality of Utrecht (4 x 0.2 FTE)
    - Design Thinking process guidance by HKU
  - Types of roles involved
    - Organizing team
    - Design Thinking experts
    - Neighbourhood residents
    - Entrepreneurs in the neighbourhood
  - Location(s)
    - Location for Design Thinking sessions

The Preparation Method

Planning

In the Smart Lighting Challenge, the technique Design Thinking was used by a team of trainees of the municipality of Utrecht to involve citizens in the design process of finding one or more solution(s) to perceived problems in their neighbourhood. This technique is a six-step process, divided into two phases, and aims to generate solutions that solve the perceived problem and comply with the neighbourhood's needs and desires.

The first phase is all about finding the right problem that needs to be solved. During this phase, it is required to collect and analyse as much information as possible regarding the problem. This involved talking to experts and engaging with the problem holders. After all the information and observations are carefully analysed, a design problem can be defined.

The design problem sets the stage for the second phase: finding the right solution. During this phase, participants ideate about possible ideas to solve the design problem. Next, a few ideas are chosen and turned into prototypes – inexpensive, minimalistic versions of a product or service which can be tested within the team, or with the problem holders. The last two steps are iterative: results of the testing phase can be used to improve the prototype, which can than again be tested. Alterations and refinements can be made until the final product or service is ready for deployment.

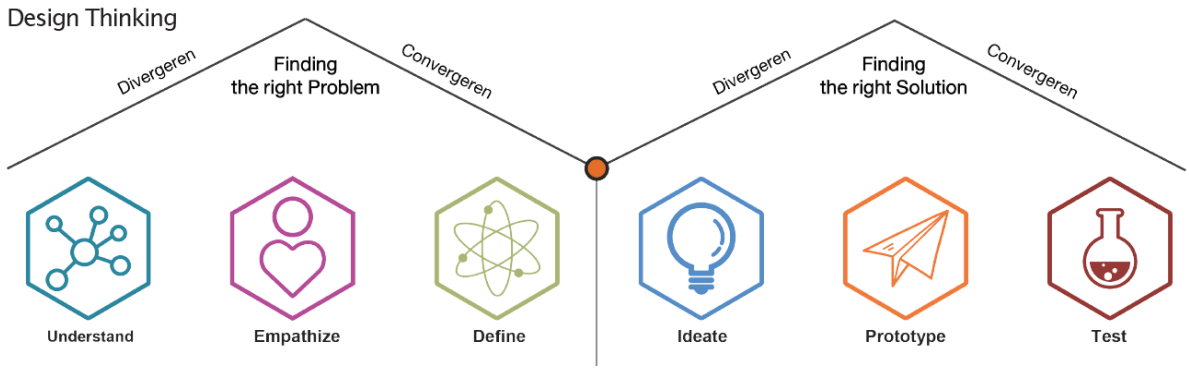

Figure 6: Design Thinking Process

Although the Smart Lighting Challenge indeed performed the six steps of the Design Thinking process, in terms of sequence of steps, the execution was not aligned with the sequence that this method proposes. The main factor being that the design question (Define) was already formulated before having executed the Understand and Empathize-phases.

During the preparation of the Smart Lighting Challenge, before executing the six steps of Design Thinking, a design question was formulated by the owner of the problem, the municipality of Utrecht: *'How can we create smart lampposts that contribute to a better/healthier/safer/finer neighbourhood for residents and entrepreneurs in Kanaleneiland-Zuid?'*. As this design question already assumes a solution (smart lampposts), assumes that the municipality is the problem owner (and not the residents), and leaves the problem undefined, potentially, a problematic foundation for the Design Thinking process was laid.

After determining the design question, the neighbourhood was visited. The representatives of the municipality of Utrecht reached out to various central residents in the neighbourhood, to invite them and their network to the Ideation-phase of the Smart Lighting Challenge. They carefully selected people they

wanted to approach, so the final group would be a representation of the neighbourhood's residents. Unfortunately, it was particularly hard to involve the young and residents with a migration background.

Next, the organizing team decided to prepare and organize three three-hour sessions, which all focused on different parts of the Design Thinking process. For every session, a goal and desired output were determined. To allow the three sessions to go well, facilitating roles were divided among the organizing team. This was crucial for efficiently organizing a process with no clear output.

The desired output of the first session was to collect wishes, needs, and dreams of residents and entrepreneurs in the neighbourhood. The goal of the second session was to have participants co-create new concepts that fit the needs of Kanaleneiland-Zuid's residents. In the third session, concepts of the second session and collected wishes and needs of the first session were matched.

Event

Realistically, the dish that was served during the Smart Lighting Challenge, consisted of steps Understand (first step), Empathize (second step), Ideate (fourth step), and in part Test (sixth step). During the Smart Lighting Challenge, the design question (third step) was already formulated during the Understanding-phase. As the residents could only give their input after the design question was defined, this poses the risk of residents feeling unheard. Also, prototyping and testing (fifth and sixth step) were done in the months after the event.

Session 1: Collecting (Understand, Empathize)

At the beginning of the process, attention was paid to managing expectations of all participants. During this session the organizing team talked with residents, professionals, and entrepreneurs from the neighbourhood. They processed this information in real time into so-called narrative sheets. To get the discussion going and to stimulate the thought process of the participants, thirty photos of the neighbourhood were shown. These pictures were on the table and functioned as the session's conversation starter. Also, participants were asked about their dream for Kanaleneiland – information that could later be used in the process. Next, participants wrote down quotes, anecdotes, and interesting details about the neighbourhood that formed the basis for the 'narrative' that was developed.

Figure 7: Narrative sheets

The result of the session was a filled out narrative sheet, that formed the basis for the second session. The narrative sheets did include a design question by residents; however, they did not align with the design question already posed by the municipality of Utrecht.

Session 2: Design (Ideate)

The information gathered in the collection session formed the basis for the design session. In the design session, a multidisciplinary group of content experts, designers, creatives, and civil servants joined together. New ideas and concepts were worked on in three groups according to the Crazy Eight methodology. This is a brainstorm methodology in which eight ideas are drawn in 30-second instalments on an A3 sheet. The ideas were potential solutions for problems that were collected in the collecting session. Of the Crazy Eight designs, each group picked the best ideas for further development and a pitch. No tangible prototypes were designed.

Concept	Explanation	Implementation for use	Residents	Theme
Free wi-fi	Making specific locations attractive for loitering teenagers by introducing wi-fi	Pleasant living	+	Free wi-fi
Sound sensor for signalling unsafe situations	Better security in the neighborhood due to brightly lighted areas	Giving teenagers a place to hang out	+	Social Interaction
Sound and light: Bring your own music, music lights to the beat signalling unsafe situations	Lights that adjust to the music	Pleasant living and amusement	-	Security
App interface with a lamppost for various applications, attractive to youths	Controlling a post with a telephone	Pleasant living and amusement	-	Social Interaction
Speakers for playing music	Playing music with the lamppost	Pleasant living and amusement	-	Social Interaction
Tinder light app: matchmaking	Finding and meeting each other by the lights colors	Pleasant living and amusement	+	Social Interaction
Mood lighting: dim your lights	Pleasant or unpleasant ambience for teenagers to hang out in	Pleasant living	+	Security
LEDs for showing the way	Bringing the social functions to the attention of the residents	Promotes social interaction and physical activity	-	Social Interaction
App for planning routes	Plotting your route and following it by the LEDs in the lampposts	Pleasant living and amusement	-	Convenience
Telephone/communication function	Creates social interaction in the neighborhood	Reduces social isolation	-	Social Interaction
Lighting configuration for projecting a zebra crossing	Practical solution for avoiding unsafe traffic situations	Unsafe traffic situations	++	Security

Table 29: Ideation Concepts

Session 3: Pitch (Test)

Testing the concepts put together in the design session is the last step of the first iteration of the Design Thinking process. The ideas can be found in the table above. By testing the ideas, the outcomes are validated with the end user. A Dragons' Den session was organized for this. During this last session the designers presented their ideas from the design session to the neighbourhood experts from the first session. Each design group presented two concepts in 3 minutes. In the session, the end users were allowed to ask questions. After the presentation the audience could 'invest' in ideas: end-users were given fictitious money to determine the value of the ideas. This, however, resulted in a heated discussion between residents about the usefulness and necessity of smart lighting, and its relation to the societal issues they had posed during Session 1. Whereas the project team was surprised by this, in hindsight, it

could have been expected since the design question was defined before understanding and empathizing with the residents.

Execution

The idea that received the highest 'investment' was a lamp post with a special lighting configuration for crosswalks, lighting up when someone wants to cross the street, to prevent unsafe traffic situations. This idea was then submitted to the traffic specialists of the municipality of Utrecht, to further develop the solution into a detailed plan. They made three visual prototypes of the original idea, which were presented to the residents of the Kanaleneiland-Zuid neighbourhood, who could then choose the final design.

Evaluation

- As the design question, the third step of the process, was done first, this resulted in a mismatch of expectations between the municipality and residents. Also, it should have been made clearer that the events during the Smart Lighting Challenge would only focus on Understanding, Empathizing, and Ideation, as Prototyping and Testing would happen in the months after the event.
- Take preconditions and limitations into consideration and manage expectations of participants regarding these preconditions and limitations. In the IRIS project, goals are set regarding sustainability, (technological) innovation and meeting the residents' needs, whereas sustainability isn't always a priority for residents.
- A good location is essential for the creative process. For the design sessions its best to choose a creative location with lots of space.
- It is important to involve residents that are representative for the residents in the neighbourhood. It is particularly hard to reach youth and people with a non-western background.

Reflection IRIS

The IRIS team was intensively involved in the set-up and execution of this ideation event. But in hindsight, we can conclude that perhaps a better integration of the various expertises in the Utrecht team would have helped. The design thinking method can be very helpful in generating viable ideas and solutions as well as engaging citizens. It is, however, essential to follow the steps in the correct order. If steps are missed or have been pre-structured, as was the case here, then it poses a risk. Residents have their own priorities, worries and concerns and it is risky to assume they will share the problem analysis or see the benefits of technological solutions the way experts and city planners do. If choices have already been made, setting up design thinking processes is complicated and may well create misaligned expectations and frustration. The ideas generated in the event were of high quality and implementable but perhaps less suitable for follow-up business model incubation. The value proposition of the proposed solutions typically had a strong public goods character, such that the municipality was the most likely and single client for the proposed solutions. In this case, business model development was therefore not foreseen, and the proposed solutions were developed further in-house.

8.3. Energy Poverty Challenge

The Energy Poverty Challenge is an initiative rooted in two developments that were part of the WP5 demonstration in Utrecht. The first development is a pressing social issue that is increasingly becoming an important challenge for multiple stakeholders in Utrecht: energy poverty. The second development is the municipality of Utrecht working on the realization of a City Innovation Platform (CIP), as part of the WP5 demonstration. The aim of CIP is to support the data economy, by matching supply and demand of data. Housing corporation Bo-Ex, the municipality of Utrecht, and Utrecht University joined hands to launch the Energy Poverty Challenge. A budget of €20.000 was allocated by the IRIS project to help the winning solution develop the product or service. The result is a concrete product or service, which is pitched to the municipality of Utrecht and Bo-Ex. The best solution is chosen from the entries.

Dish: challenge | 0,2 FTE | 3M preparation + 2M execution + 3M incubation | €20.000

Recipe for: 5 ideas | 1 startup

The Ingredient List

- Budget
  - €20.000 award money
- Time
  - Preparation (12 weeks):
    - Supporting base and budget: 2 weeks
    - Preliminary research: 8 weeks
    - Stakeholder workshop: 2 weeks
  - Challenge (8 weeks):
    - Challenge open for entries: 5 weeks
    - First evaluation round: 1 week
    - Pitch preparation for selected entries: 1 week
    - Pitches and final evaluation: 1 week
  - Incubation (12 weeks):
    - Program: 12 weeks, 1 day per week activities
- Resources
  - Types of organizations involved
    - Housing corporation Bo-Ex (challenger)
    - Municipality of Utrecht (challenge organization)
    - Utrecht University (research & business development)
    - UtrechtInc (incubation)
  - Types of roles involved (mentors, organizing team, experts, etc.)
    - Organizing team
    - Judges for selection of ideas
    - Experts for guiding during incubation program
  - Location(s)
    - Registration and selection via www.iris-utrecht.nl/challenge

- Location for pitches
- Location for meetings in incubation program

The Preparation Method

Planning

The Energy Poverty Challenge addressed a pressing social issue that is increasingly becoming an important challenge for multiple stakeholders in Utrecht: energy poverty. Energy poverty is a situation in which a household spends more than ten percent of the disposable income on energy cost. When people start getting difficulties paying the energy bill, they start building up payment arrears for both energy and rent. This can lead to being disconnected from the energy grid altogether or, in the worst-case scenario, to eviction. At the same time the municipality of Utrecht is working on the realization of a City Innovation Platform (CIP), as part of the WP5 demonstration. The aim of CIP is to support the data economy, by matching supply and demand of data through an open data platform with relevant local data. CIP offers an open ICT system and open application program interfaces (APIs) that encourage data sharing.

The first step in the preparation of the challenge was to have a clear supporting base within the IRIS-project. Housing corporation Bo-Ex (responsible for TT1, Energy Positive Districts & TT2, Flexible Energy Management and Storage), the municipality of Utrecht (WP5, Utrecht Demonstration & TT4, City Innovation Platform), and Utrecht University (WP3, Business Modelling) joined hands to launch the Energy Poverty Challenge. A budget of €20.000 was allocated by the IRIS project to help the winning solution develop the product or service.

Master students of the Utrecht University program Business Development & Entrepreneurship were asked to do a preliminary study into the scope of the local problem and its local target group, and develop and test a Minimum Viable Product (MVP). Recommendations by the students, combined with various national studies into the scope of the problem of energy poverty and the services already available, led to a workshop in which the challenge was ultimately designed. Participants of the workshop included stakeholders involved in the IRIS projects and experts from the municipality of Utrecht working with the target group.

Prerequisites for the solution to the challenge were

1. to include a data service for tenants of housing corporation Bo-Ex, which gives the tenants control over and/or better understanding of their energy bills, resulting in reduced energy bills and an increase in the disposable income of tenants;
2. An additional requirement for market parties was to make use of data-sets available through the City Innovation Platform in their proposed solution.

The challenge was finally presented on the website of the WP5 Utrecht demonstration. The challenge was presented in a format, that consisted of the following topics: 1) the challenge, 2) solution conditions, 3) context, facts & figures, and 4) next steps.

Event

The Energy Poverty Challenge publicly launched on May 21, 2019. The challenge was locally and nationally communicated through and by the Utrecht-based stakeholders in IRIS, including a press release to local media. The deadline for entries was set on June 28, 2019. While the challenge was 'open', potential participants had the opportunity to ask questions to the organizing team through a contact form.

Participation in the challenges was free of charge, and teams were allowed to send in multiple entries. Entries were allowed to be a maximum of five pages and should include topics like: 1) company or team description, 2) solution, 3) value proposition, 4) clients and/or end users, and 5) usage of data.

The Energy Poverty Challenge received a total of 5 entries. 2 entries were excluded from the challenge, as they did not meet the prerequisites of the challenge. Mainly, they missed an idea for a business model. 3 entries were invited to pitch their solution to a jury on July 9, 2019. The pitches were judged by 11 representatives: from Bo-Ex (1 representative), Utrecht University (2), incubator UtrechtInc (1), municipality of Utrecht (4), CIP-developer Civity (1), and two representatives from TT5, Citizen Engagement. The entries were scored on 15 criteria, divided into three themes: Market Potential (35% weight), Sustainability (25%), and Market Readiness (40%).

The judges unanimously concluded to select no entry to join the incubator program, led by UtrechtInc.

Evaluation

After the Energy Poverty Challenge concluded prematurely, the program was thoroughly reviewed. Main feedback by the organizing team and stakeholders included:

- The challenge formulation was clear. Possibly, in the preparation phase, more research could have been done with regards to wishes and needs of end users of the product or service.
- Communicating about the challenge in the right networks is a challenge. Many local outlets have been used and website-traffic shows a clear increase. It is not clear, however, if the right people and organizations have been reached. In addition to current efforts, communication towards incubators and/or start-up networks can be improved.
- The challenge focused on 'ready' ideas, whereas the award money was appropriate for the development of an idea: it was not balanced. Development of a prototype can cost up to €20.000, whereas the development of a functioning product can cost as much as €200.000. Therefore, the appropriate parties might not have been interested in participation.

Reflection IRIS

As this challenge was organised entirely by IRIS partners, the evaluation described above covers most of our lessons and reflections. The problem/challenge of reaching out to the correct networks and of matching the incentives to the desired output of the activity, are important lessons learned. In addition, it can be noted that an event is not a failed event if it does not deliver the ideas that were hoped for. Ideation is inherently an uncertain process with many factors and sometimes such events simply fail to deliver the quality of ideas one hopes for. It is then important to carefully evaluate and draw lessons from the event.

8.4. Utrecht Mobility Challenge

A challenge is a short-term and intensive innovation process in which participants are put into (diverse) teams, informed about a certain topic and/or problem question, and asked to come up with a suitable solution. In this case, the participants were students from Utrecht University (UU), the Utrecht University of Applied Sciences Utrecht (HU), and the ROC Utrecht (vocational education). The challenge was organized by an 'alliance' of Utrecht-based organizations: municipality of Utrecht, Economic Board Utrecht (EBU), and the before mentioned educational institutions. During the challenge the teams were guided by practitioners and experts to ensure relevance. In this case, the topic was mobility in the city of Utrecht. As the city becomes more congested, especially during commute-hours, teams were asked to think about new and smart solutions. As a conclusion to the process, teams pitched their ideas to a jury, who could choose multiple winners. Winning teams got the opportunity to work with relevant stakeholders and companies to put their idea into practice. In some cases, students also received study credits for their participation.

Dish: challenge | 6M preparation + 4D event

Recipe for: 7 ideas | 7 teams

The Ingredient List

- Time
    - Preparation (6 months):
    - Challenge (4 days):
        - Problem sketch (1 day - 14 November)
        - Official team-work days (3 days – 15, 21, 22, November)
        - Presentation and announcement winner (1 day – 22 November)
- Resources
    - Types of organizations involved
        - Stakeholders (judges, feedback, data, problem statement)
            - Municipality of Utrecht
            - Utrecht Province
            - Educational institutions (UU, HU, ROC)
            - Rijkswaterstaat
            - Practitioners (Sweco, Ideate, Fundamentals, INFO)
        - Funders
            - Educational institutions (UU, HU, ROC)
            - Municipality of Utrecht
            - Economic board Utrecht
            - Relevant companies
    - Types of roles involved (mentors, organizing team, experts, etc.)
        - Organizing team
        - Judges for selection of ideas
        - Mentors for guiding the teams

- Experts and practitioners for lectures
- Location(s)
  - Locations for lectures and training (preferably at relevant stakeholder)
  - Location for team meetings
  - Location for final

The Preparation Method

Planning

The Utrecht Challenge Alliance (UCA) is a partnership between the municipality of Utrecht, EBU, Utrecht University, the Utrecht University of Applied Sciences, and ROC Utrecht. It aims to facilitate finding innovative local solutions to societal problems, by combining the knowledge of students, professionals, and citizens. UCA's main focus is the organization of challenges. Furthermore, it is linked to IRIS through the participation of both Utrecht University and the municipality of Utrecht.

The UCA team specializes in organizing said challenges. The head of organization has in total been in charge of 8 similar challenges. First, the team is in contact with possible interested (local) companies and stakeholders; organizations with a problem they want a fresh outlook on. In this case, a salient topic was decided to be mobility in Utrecht. This phase usually starts round half a year before the eventual challenge takes place.

Compared to the eventual date of the challenge, preparation started even earlier on this occasion. On the original dates a mobility convention was taking place, making it incredibly difficult to find a jury and lecturers – thus the challenge was moved to a later date.

Upon deciding a subject, the 6 months are first filled with finding interested stakeholders and shaping the challenge. After publicly announcing the challenge, the next few weeks were spent on gathering participants as well as a lot of work behind the screens – but as noted, work already started beforehand. Participants are recruited through a multitude of manners – mainly through word-by-mouth promotion from knowledgeable teachers to students which are perceived as potentially interested. In some cases (ROC) students receive ECTS for their participation. Other channels of promotion are social media and their website – but their main method of recruiting participants is the word-to-mouth from participating or interested academics to their students.

Most of the organization is then put into the actual workdays. These require lectures, locations, and mentors to guide the teams. In this case the problem statement was the congested infrastructure of Utrecht; teams were asked to come up with new and creative solutions for this problem. The problem statement is formalized but not as strict as in other recipes; the team is urged to think out-of-the-box.

Event

There were 35 applicants, in the end forming 7 teams. The teams are formed by balancing the diversity of the participants, to optimize their output. Students were diverse in their educational backgrounds, both in level and direction. Some examples of studies represented are data driven design, smart sustainable cities, social geography, and civil engineering. Diversity is promoted as more theoretically versed (e.g.

university) students often have great theoretical knowledge, but fail to identify practical obstacles. More practically versed (e.g. ROC) students may be well-equipped to understand what works, but could use theoretical guidance. Different fields may similarly provide different insights. Thus, groups are formed such that students' skills are complementary.

For the mobility challenge, the challenge spanned four full workdays, once including work until after dinner (the third day). The first day consisted of a problem introduction, team formation and introduction, and an initial brainstorm. The second day started with a keynote lecture on the future of mobility, further providing information on the problem at hand. Teams were then asked to draft a few preliminary solutions they found promising, after which a meeting with experts followed (providing them feedback). A multitude of locations for these days was provided by Rijkswaterstaat, in their Utrecht office.

Then, after a break of six days, the challenge continued with the third day This day consisted out of another lecture providing insights on how to incite behavioural change. The rest of the day, until the evening, was used by the teams to pick one concept, after which they fully develop and test it. At the end of the workday their final draft was pitched to experts and mentors, after which they spent the evening finalizing their concept. The last day consisted out of a final test with feedback, the preparation of a pitch, after which it concluded with the pitches and the announcement of the winners.

In this case, expert lectures were provided by Sweco and Ideate. The 6 jury members were announced on the fourth day, consisting out of employees of relevant stakeholders, in this case being employees from the municipality of Utrecht, EBU, Rijkswaterstaat, Sweco, Vodafone, Ziggo, and Ideate. The judgement procedure is relatively informal. Jury members are a part of the stakeholders providing the original problem statement. As such, they are not given strict guidelines, but were urged to pick a winner: the team with the most feasible solution. In this case, the jury considered three different ideas equally feasible resulting in three winners.

Making sure there is sufficient follow up with the ideas is often difficult. As such, UCA provided winners with a second meeting, with a set-up like the TV-show Dragons' Den. In this session, the teams are urged to further develop their idea and pitch it once more to the stakeholders, who then can decide to take on the project if they deem it sufficiently relevant and feasible.

Evaluation

Together with UCA we have evaluated the Challenge. Furthermore, we drew lessons from their extensive review of previous challenges:

- Diversity in approaches helps create very refreshing ideas;
- Short-term and intensive approach helps maximize cooperation and generating new ideas;
- Out-of-the-box is a double-edged sword; it can give very refreshing ideas but similarly draw solutions which are not considered for a reason;
- Practitioners and stakeholders are very willing to get involved with the organization of a challenge;
- Ensuring the ideas are further worked with is difficult, but a set follow-up may help;

- The organization of an ideal challenge (with relevant locations and lectures) is logistically demanding, especially if the expertise is not in-house;
- Allowing all students to apply at times caused a language barrier: in this manner both international (non-Dutch speaking) students and Dutch students who less often require English could apply, making it at times difficult for either group to follow the other language or communicate amongst each other.

Reflection IRIS

Again, as IRIS researchers were involved in co-organising this challenge, the reflections of the organisation above coincide with our own. In this challenge the access to participants and their willingness to participate in all stages of the challenge, was much facilitated by the fact that participants were students that gained credits for their education with their participation. Of course, these student-oriented challenges can only be replicated in cities that have a significant student population. Student challenges, in collaboration with educators, can mobilize a lot of participants and students are typically enthusiastic, creative, and energetic. A downside of having only or mostly students as participants, is that they typically lack some real-world experience and are hard to motivate in the longer run and for follow-up activities.

8.5. ChangeU Student Hackathon

The ChangeU Student Hackathon is an initiative rooted in two developments in the WP5 demonstration in Utrecht. First, in the early stages of the IRIS project, inhabitants expressed their concern that smart energy and smart mobility weren't the pressing issues in their district (see also the recipe on the smart street lighting challenge). Second, the municipality of Utrecht is working on the realization of a City Innovation Platform (CIP), as part of the WP5 demonstration. The aim of the ChangeU Student Hackathon is to develop and incubate ideas that provide solutions to issues in the Kanaleneiland district, while using (open) data. A budget of €3000 was allocated to UtrechtInc Students, who organized a 16-day virtual activity, during which 16 teams of students worked on developing solutions.

Dish: hackathon | 0.5 FTE | 4M preparation + 2.5W execution + 10W incubation | €3.000

Recipe for: 13 ideas | 1 startup

The Ingredient List

- Budget
  - €2.500 award money
  - €500 out-of-pocket costs (workshops, representation)
- Time
  - Preparation (12 weeks):
    - Challenge definition
    - Program outline
    - Participant recruitment
  - Hackathon (2.5 weeks):
    - Kick-off

        - Workshops
        - Final
    - Incubation (10 weeks):
        - Program: 12 weeks, 1 day per week activities
- Resources
    - Types of organizations involved
        - UtrechtInc Students (hackathon organization)
        - Utrecht University (support & business development)
        - Municipality of Utrecht (challenger)
        - UtrechtInc (incubation)
    - Types of roles involved (mentors, organizing team, experts, etc.)
        - Organizing team
        - Judges for selection of ideas
        - Kanaleneiland residents for validating ideas
        - Experts for workshops with participants
        - Experts for guiding during incubation program
    - Location(s)
        - Registration and selection via www.changeu.nl
        - Virtual meeting room (Zoom) for all program activities

The Preparation Method

Planning

The ChangeU Student Hackathon is an initiative rooted in two developments in the WP5 demonstration in Utrecht. First, an underlying contextual factor, is that during an earlier project focusing on Smart Lighting (in TT4 City Innovation Platform), inhabitants expressed their concern that smart energy and smart mobility weren't the pressing issues in their district. ChangeU therefore uses the pressing issues as starting point for the hackathon. Second, the municipality of Utrecht is working on the realization of a City Innovation Platform (CIP), as part of the WP5 demonstration. The aim of CIP is to support the data economy, by matching supply and demand of data through an open data platform with relevant local data. CIP offers an open ICT system and open application program interfaces (APIs) that encourage data sharing. The aim of the ChangeU Student Hackathon is to develop and incubate ideas that provide solutions to issues in the Kanaleneiland district, while using (open) data.

The first step in the preparation of the activity was to attract a local partner with a great network of creative and open-minded 'problem solvers'. UtrechtInc Students (UIS), the student branch of the UtrechtInc incubator, hosted the hackathon, as they have a large local network of students from different study backgrounds. A representative of Utrecht University consulted the students during the organization of the activity and the Municipality of Utrecht joined as a challenger, providing both knowledge and budget for the award structure.

First, UIS simultaneously worked on three critical resources for the ChangeU Student Hackathon: (1) insights in Kanaleneiland district issues; (2) overview of available open data at local, national, and

European level; (3) program to inspire and engage students to develop ideas. To get insights in the local issues, UIS had several conversations with district stakeholders, both from the perspective of the resident and the municipality of Utrecht. Together, five topics were determined: Inclusive Labour Market; Community Health; Shared Space; Smart Mobility; Local Energy Transition. Next, in collaboration with a representative of Civity, the organization responsible for building CIP, an overview was created of available data. Lastly, the hackathon program was design in cooperation with UtrechtInc, to make sure that resulting ideas would fit the incubation program.

To attract as many participants as possible and get the participants to finish all stages of the program, the program was designed as a 'funnel': to get students to sign up, a lot of effort was put into designing a program that would also benefit the participant in terms of personal and professional development; to get teams to submit a solution, a compelling award structure was put in place. Also, students were given the option to either sign up as an individual or as a group of 3 to 5 participants. Individual sign-ups would then later be joined together in teams or added to existing teams of 3 or 4.

The activity details were presented on a website specifically designed for the ChangeU Student Hackathon. On the website, the following topics were explained: (1) general introduction; (2) sign up form; (3) explanation of local issues; (4) judges and judging criteria; (5) overview of frequently asked questions and answers; (6) a contact form; (7) terms and conditions of the activity.

Event

The ChangeU Student Hackathon publicly launched on January 15, 2021. The details of the activity were distributed via (student) organizations related to the three Utrecht-based higher educational institutions. The deadline to sign up was on February 10, 2021. 72 students signed up for the activity – 32 individually, 40 as a team. In total, 16 teams joined the ChangeU Student Hackathon.

Before the official kick-off of the hackathon, all participants received a participant guide – detailing the activity's program, participating teams, helpful resources, submission guidelines, and judging criteria. On February 12, an icebreaker was organized for individuals to get to know their team.

On February 15, 2021, ChangeU had its official kick-off. During the kick-off, all teams were introduced in the program of the hackathon and the challenges. The kick-off was followed by five workshops:

- Open Data 101 on February 16, 2021, during which Civity introduced participants in the world of open data.
- Ideation Crash Course on February 17, 2021, hosted by UIS to help bridge the gap between having an idea and making the first steps towards a business model.
- Ideating with Data Workshop on February 19, 2021, hosted by the Digital Society School, during which data and ideation were combined.
- Business Model Canvas Workshop on February 23, 2021, during which UtrechtInc explained everything about turning an idea into a business.
- Pitching Workshop on February 25, 2021, hosted by the Pitch Academy, to help participants convince a jury of their ideas.

Before the Grand Finale could take place on March 3, 2021, all participating teams had to submit a one-pager (deadline February 28) and 2-minute video pitch (deadline March 2). In the one-pager, teams were asked to answer 8 questions on their idea in up to 500 words. A template was provided for this purpose.

13 teams, consisting of in total 55 students, submitted an idea that was assessed. The one-pagers and video pitches were judged by 6 entrepreneurship/innovation/data experts and 5 Kanaleneiland residents. The one-pagers were scored on 5 criteria (comprehensibility, realizability, innovativeness, scalability, and benefit for society); the video pitch was scored on 2 criteria (convincingness and clarity). During the Grand Finale at March 3, the jury announced an Overall Winner (highest overall score on all criteria) and Most Convincing Pitch (highest score on the pitching criteria). The Kanaleneiland residents announced their favourite. Next, all submissions were published for an one-week audience vote. The Audience Favourite was announced at March 10.

Following the Grand Finale, all participants were encouraged to join the UtrechtInc incubation program. As UtrechtInc indicated most ideas were a not perfect fit for the program – quality and intrinsic motivation of the team would be a determining factor for the teams to succeed and grow into a business with a sustainable business model.

Evaluation

After the ChangeU Student Hackathon concluded, the program was thoroughly reviewed. Main feedback by the organizing team and stakeholders included:

- The 16-day program possibly was too short to get students to deliver a detailed plan on the business idea. In general, 'comprehensibility' and 'benefit to society' scored above average. The criteria of 'realizability', 'innovativeness', and 'scalability' were scored below average. An improvement can be to provide participants with feedback halfway during the activity, the better guide them into a solution direction.
- If the ideas need to be of better quality for the teams to join the incubation program, a 'bridging program' is required to bridge the quality gap between the event and the start of the program. However, this might contradict the 16-day effort that is requested of participants. Therefore, potentially, the event organizers can investigate (intrinsic) motivation of students as a way of selecting participants, instead of accepting all students who sign up.
- Due to Covid-19, the event had to be organized virtually. This might have had an impact on teamwork and team dynamics, especially if a team consisted of individuals who did not know each other until right before the event. During a next edition of the event, more focus could be put on the matchmaking of teams, to make sure there is a (better) fit between participants.
- Both in terms of chance of the team making an entry (100% versus 66%), as well as quality of the entry (6.19 versus 5.49 on a 10-point scale), teams consisting of individual sign-ups performed better compared to teams who signed up as a group. A possible explanation for this is that groups of individuals can and will continue if one team member drops out, whereas for teams who signed up as a group, losing one team member can result in the full team dropping out. In terms of quality, teams of individuals have different educational backgrounds. Teams who signed up as a group often stem from the same studies, resulting in a less diverse perspective.

- Thirteen teams are too many teams for the final event. Potentially organize a semi-final and select teams for the final.
- Program quality and award structure were named as most important factors for students to participate.

Reflection IRIS

As the event was co-organised and supported intensively by IRIS-Utrecht partners, the reflections of the IRIS team largely coincide with the above evaluation of the event. We might add that the winning team applied and was admitted into the next wave of the UtrechtInc validation program and is currently going through the program. This shows that indeed ideation events organised with a smart city focus, can help to generate, mobilize, and identify teams and ideas for smart city innovation. At the date of publishing this report it remains to be seen if the resulting venture can successfully complete the stages of business model creation and overcome the many challenges that entails.

8.6. Citizen Innovation Challenge

The aim of the Citizen Innovation Challenge was to find and incubate specifically user innovations in the district Kanaleneiland in Utrecht. The challenge intended to engage with ordinary citizens in a structured way to elicit problems they face and collect coping strategies that exist. Subsequently, it is assessed whether (some of) these coping strategies contain the starting point of a social impact venture that can be incubated, scaled-up and/or replicated to areas with comparable characteristics. The project was initiated by Utrecht University (UU) and Hogeschool voor de Kunsten Utrecht (HKU), with support of Labyrinth Research Agency. Labyrinth Research Agency is a local network partner that was able to reach out and effectively engage with citizens in Kanaleneiland, Utrecht. Labyrinth conducted a survey and organized focus groups to collect information on problems the inhabitants of Kanaleneiland are facing in their daily life. Using these insights, Utrecht University formulated topics on which citizens could send in their innovative coping strategies. The most innovative idea that also could be incubated in Utrecht could win a cash prize of €2.500.

Dish: challenge | 0,4 FTE | 3M preparation + 1M execution | €13.500

The Ingredient List

- Budget
  - €11.000 organization cost of local field partner
  - €2.500 award money
- Time
  - Preparation (12 weeks):
    - Street interviews: 10 weeks
    - Focus groups: 2 weeks
  - Challenge (5 weeks):
    - Challenge open for entries: 4 weeks
    - Final evaluation: 1 week

- Resources
  - Types of organizations involved
    - Hogeschool voor de Kunsten Utrecht (citizen engagement)
    - Utrecht University (research & business development)
    - Labyrinth Research Agency (local research and network partner)
  - Types of roles involved (mentors, organizing team, experts, etc.)
    - Organizing team
    - Judges for selection of ideas
    - Experts with district knowledge and network
  - Location(s)
    - Registration and selection via prijsvraagkanaleneiland.nl
    - Location for pitches

The Preparation Method

Planning

The Citizen Innovation Challenge is an initiative that stems from several activities in the IRIS project, both in WP5 Utrecht Demonstration and WP3 Business Modelling. At its core is TT5 Citizen Engagement. The main aim of TT5 is to actively engage and intrinsically motivate the inhabitants of the district Kanaleneiland Zuid to save energy, match the moment energy use to the supply of renewable energy, and to use electric means of transport. The project was initiated by Utrecht University (UU) and the Hogeschool voor de Kunsten Utrecht (HKU), with support of Labyrinth Research Agency.

The diversity in stakeholders and the crucial role of citizens as enablers of the energy transition, especially in the low-income and multicultural district Kanaleneiland Zuid, require co-creation and attractive and inclusive services that support them in their own objectives to engage, express ownership, and behaviour change.

During an earlier project focusing on Smart Lighting (in TT4 City Innovation Platform), inhabitants expressed their concern that energy and mobility weren't the pressing issues in their district. Therefore, the Citizen Innovation Challenge took another course and intended to engage with ordinary citizens in a structured way to elicit problems they face and collect existing coping strategies. The aim of the Citizen Innovation Challenge is to find and incubate user innovations in the district Kanaleneiland Zuid.

The first step in the preparation of the challenge was to attract a local network partner, deeply rooted in the local civic network. Labyrinth Research Agency helped implement the challenge, as they have a broad network in the district and have extensive experience with doing research amongst groups that are difficult to reach.

First, Labyrinth set-up, distributed, and collected a survey among inhabitants of Kanaleneiland Zuid. A team of interviewers visited different places in the neighbourhood to approach a wide range of people. The questionnaire consisted of several questions regarding several topics, i.e.: nuisance, neighbourhood, housing, public space, traffic, health, transport, income, work, youth, elderly, and cultural differences. Depending on the available time of respondents, 1 up to 12 topics were covered during the interview and

each topic was randomly chosen by the software system. Between July and September 2019, 126 respondents were interviewed, covering 205 topics.

After completing the street interviews, Labyrinth organized several focus groups with residents of Kanaleneiland. The aim of these focus groups was first to retrieve new ideas on how people cope with daily problems. The information and insights gathered during the street interviews were used to prepare for the focus groups.

The results of both the street interviews and focus groups was disappointing. On October 1, 2019, it was concluded to not continue the efforts on the challenge. UU analysed the efforts to date together with Labyrinth and concluded that:

- The target group does not feel it has the influence and/or ability to change the social issues in the district;
- There is a low degree of organization among residents. The critical mass is often limited to one person;
- Kanaleneiland Zuid is a former 'krachtwijk' (= neighbourhood where several social and societal problems occur simultaneously, i.e. unemployment, crime and addiction problems). Over the past years, the district was continuously monitored and received outside help. As these organizations tend to come and go, no organizations have been responsible for the district for a long time. This limits the amount of confidence inhabitants tend to have in outside organizations.

These three conclusions combined led to the overarching feeling that the challenge would not get enough inhabitants engaged and/or would not attract the desired types of user innovated ideas.

Labyrinth and UU then decided to collaborate on a different activity, less focused on ideation and more on informing and engaging citizens in an event around sustainable energy in the neighbourhood under the name of EnergieKanaleneiland, which contains the Dutch word "Energiek", meaning energetic. The event was planned for the spring of 2019 and then postponed in the first COVID-19 lockdown. The organisation of the event had progressed up to the preparation of marketing materials and the confirmation of participants and sponsors for the event in the fall of 2020 but once more had to be postponed because of the second COVID-19 wave in the Netherlands. At the time of writing this report, the event has yet to take place.

Event

Although the challenge was cancelled, the Citizen Innovation Challenge was supposed to launch on October 1, 2019, through prijsvraagkanaleneiland.nl. Inhabitants of Kanaleneiland Zuid could enter their ideas for the problems in the neighbourhood until October 27, 2019. Entries would be judged on two criteria: 1) readiness of the idea, and 2) does it improve the life of inhabitants of Kanaleneiland Zuid.

Dissemination of the challenge focused on channels being used in the district. These included online channels (Facebook groups and pages, Instagram, websites of social organizations active in the district), offline channels (flyers and posters in frequented spots), and local and district media. Especially multilanguage offline promotion was important, considering that the residents have below average access

to internet and not all residents have a sufficient level of Dutch. Considered languages were Dutch (B1-level), Arabic, Turkish and English.

The winner or winners were supposed to be announced on November 3, 2019. The total award money was budgeted at €2.500 that could be shared amongst the winning ideas or through a winner-takes-all principle. Students at the Utrecht University would than take on the ideas and further develop them using the Smart City Business Model Canvas developed by Giourka et al. (2019) in Task 3.3 of the IRIS project.

Evaluation

- It is critical to have a partner organization who has an engaged network of residents and business owners in the neighbourhood.
- The challenge needs to be more specific. It is too easy to submit ideas that are circulating already on the internet, when a very open challenge is formulated.
- Rewarding participants for submitting already existing coping strategies can also invite fraudulent submissions, where people try to win the prize money with other people's ideas. Having to check for this is rather time consuming and creates a negative atmosphere.
- The initial idea to try and elicit user innovations in a challenge had to be abandoned. From the literature we know that user innovations exist and can be important drivers of change, but true user innovations are too rare to expect a lot of submissions in challenges that are either very specific on the problems formulated or restricted in the audience they reach.
- Many of the problems people indicate as important in their daily lives are of the kind that make it hard for individuals to develop solutions. This is logical as most of the problems for which individuals can come up with solutions, have already been solved and are not perceived as relevant anymore.
- In complicated socio-economic environments, user-innovativeness is likely to be limited. The reason for this, apart from perhaps the lack of skills, resources and networks to make the innovations work, seems to be that people quickly get used to expecting solutions for problems from outside.

Reflection IRIS

As this challenge was set up by the IRIS team, the reflections above overlap completely. The Citizen Innovation Challenge may work as a recipe in more pro-active and assertive populations. In more challenging socio-economic environments it was decided that taking a few steps back and first engaging citizens with information and creating awareness would be advised.

8.7. Gothenburg Smart City Challenge

The Gothenburg Smart City Challenge is part of the *Leading in a Digital World* course lectured at Chalmers University of Technology in Gothenburg, Sweden. To help the City of Gothenburg fulfil its vision towards a Smart City, student teams developed a digital innovation and accompanying business model. In total, 100 Chalmers students, who are finalizing the third year at the Industrial Economics program, worked in 18 different teams to develop and present ideas over a timespan of eight weeks. Submitted ideas included

everything from reducing food waste, improved mobility and air quality, water use management, a student accommodation platform, waste sorting and even connected urban farming.

Dish: challenge | 1.0 FTE | 8W preparation + 8W execution | €1.000

Recipe for: 18 ideas

The Ingredient List

- Budget
  - Out-of-pocket printing costs for exhibition
- Time
  - Preparation (8 weeks):
    - Course outline
    - Preparing materials
  - Challenge (6 weeks):
    - Kick-off
    - Workshops
  - Showroom (9 weeks)
- Resources
  - Types of organizations involved
    - Chalmers University of Technology (organizing team)
    - City of Gothenburg, multiple departments (challenger)
  - Types of roles involved (mentors, organizing team, experts, etc.)
    - Organizing team
    - Judges for selection of ideas
    - Residents for validating ideas
  - Location(s)
    - Classrooms at University
    - Virtual Exhibition Area via stadsutveckling.goteborg.se/smart-city-challenge/
    - Exhibition Area

The Preparation Method

Planning

The Gothenburg Smart City Challenge is part of the *Leading in a Digital World* course lectured at Chalmers University of Technology in Gothenburg, Sweden. The purpose of the course is to expand the knowledge of leadership and strategic thinking in a global and digital world for the participants. The focus in this challenge is therefore educational. Still, the resulting ideas are of interest and could be fed into an incubation program as part of the smart city development strategy. The course enabled students to develop an understanding and skills through applying the appropriate frameworks, concepts, and methods in groups in a Live Case project for the City of Gothenburg. In self-assigned teams of maximum six people, students are to conceive of and pitch a digital innovation to help the City of Gothenburg pursue its vision of becoming a smart city as well as a circular and sustainable one.

Before the City of Gothenburg was invited to co-host the challenge, four lecturers worked on the course outline and framework of the activity. However, city officials already indicated their interest in joining beforehand. In the preparation, multiple departments of the City of Gothenburg were involved (i.e. urban planning, citizen wellbeing).

To help the City of Gothenburg fulfil its vision towards becoming a smart city, with a particular focus on open data and citizen engagement, student teams developed a digital innovation and accompanying business model to convince the City of Gothenburg's jury, the citizens of Gothenburg, the faculty, and the rest of the class that the innovation is a great innovation for the City of Gothenburg. The innovation was to be based on the following guidelines: novelty, digital, smart and circular measurable impact, user-focused, self-financing and self-sustaining, and idea quality.

To create an initial idea, teams were provided with an Initial Idea Worksheet, based on Babson's Entrepreneurial Thought & Action and IDEO's design methodology. The worksheet focusses on potential resources, pain that an idea can solve, which stakeholders are involved, and which challenges and/or opportunities are addressed. During the challenge, teams had to collect market information to develop the innovation, as well as test assumptions. To be valid entries, in the innovation, teams must use at least one digital tool and one dataset made available by the City of Gothenburg. Teams were also encouraged to use the electronic datasets available at Chalmers University of Technology.

Event

In total, 100 Chalmers students, who are finalizing the third year at the Industrial Economics program, worked in 18 different teams to develop and present ideas. Teams were self-assigned and consisted of maximum six people. Students were requested to aim for a diversity of backgrounds and skills in the team. Also, a request was made to strive for gender and background balance in the team's presentations. Each team had to select an innovation focus area and geographical location (one of the boroughs of Gothenburg), to make sure the challenge would result in wide range of different ideas. There was a limit of one team per innovation focus area and two teams per geographical area. Selection was on a first come, first serve basis.

As a final submission, teams were to prepare a one-page A0-sized poster in either Swedish or English pitching the team's innovation. Also, all teams needed to prepare a max. 3-minute video pitch. For two months the public was invited to vote for their favourite. Meanwhile, a jury including members from the city's various administrations and the teacher of the course, assessed the proposals.

The *Leading in a Digital World course* – containing the Gothenburg Smart City Challenge – started on January 22 2020 with a kick-off lecture. The challenge details were explained, which were simultaneously also made available via the course syllabus. The kick-off was followed by several activities and deliverables:

- Innovation Area on January 28, 2020, during which teams were to select an innovation area and geographic location;
- Handing in Initial Idea Worksheet on February 17, 2020;
- Pitch Workshop on February 26 & 27, 2020;

- Draft Pitch and Peer Feedback on March 4 & 5, 2020;
- Handing in Final Pitch Poster & Video on March 12, 2020;

From March 16 to May 31, 2020, the Innovation Pitch Videos were displayed online and the Innovation Pitch Posters were displayed at an exhibition area in the City of Gothenburg. The City of Gothenburg has created a jury to evaluate the innovations and selected the winners of the Gothenburg Smart City Challenge on May 31, 2020, together with citizens of Gothenburg.

Submitted ideas included everything from reducing food waste, improved mobility and air quality, water use management, a student accommodation platform, waste sorting and even connected urban farming. The proposal *Matvinn*, which simultaneously solves two issues, impressed both the public and the jury when voting for the winner of the Gothenburg Smart City Challenge. By saving food waste from school kitchens and allowing students' parents to bring food boxes home, the climate impact of food waste can be reduced while the everyday lives of families are made easier. The app has not been fully developed during the semester, but the team has been in contact with a school in Angered, Sweden, that has shown interest in the project.

All teams have been encouraged to keep working on their respective idea, as further development would be needed to qualify for an incubation program. A limited number of teams have indeed done so.

Evaluation

After the Gothenburg Smart City Challenge concluded, the program was thoroughly reviewed. Main feedback by the organizing team and stakeholders included:

- Although participation was mandatory, students were very engaged to join in such an activity, as it is concerning their own surroundings.
- The quality of the submissions did not meet the expected or hoped quality. Students would often use technologies in their idea without understanding them. Students need to be more critical about feasibility, especially in terms of technology used, privacy of users, and cost versus benefit.
- Teams were not really diverse, as all students have a similar background and are doing the same studies. It could also be that students have collaborated in other projects. To diversify teams. It might be interesting to randomize group composition and see how this affects the submission quality.
- The challenges the students needed to work on were formulated based on a combination of topics and neighbourhoods. This helped in diversifying the challenges students were working on. However, students found the goals of the City of Gothenburg not concrete enough, they could have been more specific.
- Students were encouraged to use the city's open data as this is one of the City of Gothenburg's goals, however, the open data portal was difficult to navigate. It would have been good to include a mandatory requirement for students to use at least one open data source and/or provide training to students on how to use the portal.

Reflection IRIS

Although this challenge was not part of the IRIS project in lighthouse city Goteborg, it was identified as a relevant recipe for smart city ideation tools and included in the cookbook. Of course, the preconditions for organising a student challenge as an integral part of an educational program, implies many very specific preconditions need to be met. But if these preconditions are met, the recipe can deliver important ideas that can be shifted into an incubation program relatively easily. These preconditions are present in Utrecht, Goteborg and Nice as the lighthouse cities in the IRIS project and in many cities beyond the IRIS project around Europe and the world. Importantly, an enthusiastic and skilful teacher/coordinator for the course is essential. Smart city planners are advised to reach out to such a person before considering setting up a challenge along these lines. As in the case of the student challenges organised and co-organised in Utrecht, this challenge generated novel and creative ideas and with proper support and guidance, these can be validated and tested to be made ready for more serious incubation efforts.

8.8. FIWARE (Digital) hackathon

A hackathon is an idea-creating event originating from the cybersecurity sector, where companies would ask hackers to expose security leaks for payment. A hackathon is a short and intensive session, which usually lasts 24-hours, during which teams are explained a problem and using some tools like data or basic training, are expected to pitch a solution or idea at the end of the session. Sometimes, parts of the problem, data, or introductory masterclasses are already provided beforehand. In the fall of 2019, FIWARE, a European consortium build around an open access big data platform, organized a digital hackathon. Such a hackathon differs from a physical one as information is spread online, and submissions are digitally received. Furthermore, it differs as the time-constraint for 24-hours can be relaxed. In the case of the FIWARE hackathon, both were true; participants received online information and were given several weeks to come up with a solution. The winner of the hackathon was announced at the FIWARE Global Summit in Berlin.

In the hackathon the goal was to use the open source FIWARE technologies, which are open-source tools which aim to aid developers in developing smart solutions. Their technologies could be used for four different aims: 1) the development and long-term sustainability of (but not limited to) European cities, 2) the implementation of innovative systems applied to the Smart Manufacturing sector, 3) the reuse of Open Data in the context of all the vertical domains of the hackathon, and 4) unleashing the innovation potential for the digital transformation of the European Agrifood Sector using FIWARE open source technologies. Participants could win €2.500,- per aim, with the possibility of multiple ideas winning for a single aim and the possibility of an idea winning multiple prizes (if it covered multiple aims). In addition, winners received fully paid attendance to the Smart City Expo World Congress in Barcelona, and a year of free FIWARE technical services as well as a year of free social media promotion through FIWARE's channels.

Dish: hackathon | 12W preparation + 14W execution | €10.000

The Ingredient List

- Budget
    - €10.000 prize (flexible)

- Time
    - Preparation (minimum of 12 weeks):
    - Challenge (14 weeks):
        - Hackathon launch (29 July)
        - First masterclass: week 7
        - Challenge open for entries: week 8, for 6 weeks
        - Pitches: week 11, 3 days
        - Announcement winner: week 14, 1 day
- Network
    - Promotion/distribution partners (to disseminate the call)
    - Reputation (to motivate participants)
- Resources
    - Types of organizations involved
        - Organization with problem question (FIWARE)
        - Event announcement winner (if chosen)
            - Location
            - Local governance
        - Judge providers
            - Practitioners, experts
    - Types of roles involved (mentors, organizing team, experts, etc.)
        - Organizing team
            - Promotional team
        - Judges for selection of ideas
        - Experts for providing webinars
    - Location(s)
        - Registration and selection via https://www.fiware.org/summit-berlin/startup-day/hackathon/
        - Location for final (if chosen)
    - Terms and conditions

The Preparation Method

Planning

FIWARE is a foundation with a twofold of major roles. First, they provide 'a framework of open-source platform components to accelerate the development of smart solutions'. These components should add to FIWARE's mission: 'to build an open sustainable ecosystem around public, royalty-free and implementation-driven software platform standards that will ease the development of new Smart Applications in multiple sectors'. In other words, they develop open-source development tools for new smart solutions. Their public API's can for example be used to allow objects to connect to the IoT. Second, the foundation supports a variety of start-up fostering initiatives. The foundation for example hosts a start-up accelerator and provides guidance to many incubators and other accelerator programs.

The FIWARE team has an employee specialized in organizing similar events. So far, they have organized around 8 events. Originating from the EU Future Internet Public Private Partnership (FI-PPP), FIWARE is in essence a European organization. Their network is spread all over Europe. As such, the hackathons are not focused on a specific locale and accept international submissions.

First, the team identified four clear aims for applications in the Smart Cities, Smart Manufacturing, Open Data, and Smart Agrifood topics. The aims of the hackathon were:

1. The development and long-term sustainability of (but not limited to) European cities;
2. The implementation of innovative systems applied to the Smart Manufacturing sector;
3. The reuse of Open Data in the context of all the vertical domains of the hackathon.
4. Unleashing the innovation potential for the digital transformation of the European Agrifood Sector using FIWARE open source technologies.

For this hackathon, the team set three clear themes – which are provide more structured guidance to participants. In essence, the aims serve a grander strategy, the themes are specific concepts which may help completing the aims. Participants needed to use the open FIWARE data to:

1. Enhance public administration efficiency;
2. Provide user-centred services;
3. Reduce the digital divide.

At times, aims are shaped towards the needs of cooperating stakeholders. Otherwise, they are geared towards specific needs of cities identified by the organization.

Participants then need to provide a new idea which uses the FIWARE data and platform which adheres to one or multiple of these goals. Furthermore, the ideas needed to be relevant for the aims in the four specified sectors. Teams registered using an online form. The final deadline for the proposal was on the same date as the first pitches.

Event

On July 29, 2019, FIWARE launched the FIWARE Hackathon, complete with the timeline. Besides monitoring submissions, organizing webinars, and promoting the Hackathon, there is little mid-period organisation required.

The jury was announced on the same date as the challenge. The jury is often regarded as one of the most important factors for a Hackathon, as they provide both expertise and legitimacy. For this Hackathon, the jury consisted out of a member of the EC, a project lead manager at EIT Digital, a senior researcher from ATB-Bremen, and the COO of FIWARE.

The deadline for submissions was 15 October 2019 (10:00 CET) – elevator pitches followed between the 15th and the 17th. Pitches were given a maximum of 10 points in total. These 10 points are made up out of a maximum of two points within the following 5 categories: the use of technology, extent of problem solving, quality of the pitch, marketability, and realism. The original registration required a short abstract of the idea and the problem which the idea aims to tackle, an architecture of the solution, a

demo/prototype, further plans for final development, and some basic market analysis. The final winner was decided by the jury based on elevator pitches which followed the registration deadline.

Winning ideas were then announced during FIWARE's start-up day in Berlin, on the October 24, 2019. In total, winners were decided by category, with a total prize pool of €10.000,-. In other words, the best Open Data, Smart Manufacturing, Smart City, and Smart Agrifood ideas could win €2.500,-. As ideas could cover multiple topics, it is also possible to win multiple prizes. If one category had a multitude of good proposals, multiple winners are also possible. This happened during this Hackathon; 3 ideas won €2.500,-. Next to the financial incentive, winners receive fully paid attendance to the FIWARE world summit in Barcelona, a year of free technical services on the FIWARE platform, and a year of free social media promotion through the FIWARE channels.

Lastly, much of the organizational work was put into two additional factors. First, FIWARE organizes a weekly webinar series at the start, during which experts provide lectures on certain specific topic. These webinars delve both into conceptualizations and coding options. Second, much time was spent on promotion. The event was promoted though official press releases, Eventbrite, social media accounts, and members of the FIWARE community. Next to contacting personal contact Eventbrite was identified as the most time/cost-efficient promotion technique.

Evaluation

- There is significant flexibility in the online form of a Hackathon, especially with regards to costs (next to an incentive, most of the costs are optional);
- Promotion is key and works significantly better if there is a decent reputation and network;
- The webinars aid teams by making sure their proposals better suit what is expected;
- Hackathons become increasingly easy to organize (and promote) as the organization becomes more experienced, making them suitable for repetition (e.g. annual);
- (Digital) Hackathons are not very dependent on third parties and may function well in logistically constrained situations;
- In the current set-up, a digital Hackathon is similar (but more hands-off) than a challenge;
- Guiding the idea to become more than just an idea is difficult, even when this is considered by the organizer.

Reflection IRIS

It proved beyond the scope and capabilities of IRIS to organize our own (online) hackathon for smart city ideation. Fortunately, the FIWARE hackathon had a smart city connection, and the organisation was willing to share information with us on how the hackathon was organized. This experience has taught us that it would make sense for smart city planners and developers to look around and reach out to organizers of hackathons. These organisations are looking for good themes and access to networks of experts and technology that smart city developers might be able to provide. In co-creating these events, the ideation can be targeted more on the challenges in a specific smart city context while one can benefit from the often-large networks and outreach of the hackathon organisers. To organise a successful smart city hackathon, several key resources, that are not often found in a single organisation, need to come

together. We would suggest that smart city planners interested in generating high quality smart city innovations and business models consider teaming up with organisations like FIWARE who have the capabilities and network to organise successful hackathons.

8.9. Summary and Conclusions

Across these events we can draw some relevant conclusions for smart city developers considering organising ideation events in the future:

Due to lack of data, we cannot make any conclusion on the effect of **team diversity** (cultural, gender, educational) on the quality of submissions. However, in one of the activities, there was a clear difference in the chance of the team making a submission, as well as quality of the entry, when comparing teams of individual sign-ups to teams who signed up as a group. A possible explanation for this is that groups of individuals can and will continue if one team member drops out, whereas for teams who signed up as a group, losing one team member can result in the full team dropping out. In terms of quality, teams of individuals have different educational backgrounds. Teams who signed up as a group often stem from the same studies, resulting in a less diverse perspective.

To 'attract' the desired ideas, it is crucial to develop an **open challenge question** and **very clear prerequisites**. The challenge question can best be framed as a 'How Might We …' question (IDEO Design Kit - https://www.designkit.org/methods/3). Do not add a potential solution to the challenge question. The prerequisites should be as specific as possible: not 'use data in your innovation', but 'use one or more of datasets x, y and z in your solution'.

Teams need to have some **basic entrepreneurial skills** (ideation, collaboration, creativity) in order successfully complete an activity. If the skills cannot be assumed for the participants at the start of the activity, workshops on these skills should be part of the activity. Activities often result in high quality ideas, but, however, need mentoring to turn into bankable ideas. This 'skill' or knowledge – business development and scalability – is often lacking. Most organizations who organized such an activity to find new business ideas, hosted a follow-up mentoring and/or incubation program shortly after the activity to guide teams with this next step. It is smart to plan this soon after, not to lose momentum.

Depending on the format/incentives, take note that not all people who sign up will join, and not all people who join submit an idea. Losses can be significant at every stage of the '**activity funnel**'. It is important to think about all the steps in the funnel and have incentives for participants to move to the next phase. Only when directly linked to a course in participants' education, you will get close to 100% pass rates. When the challenge is fully open, there will be no information at all on how many people consider participating. This makes planning difficult. Consider asking people who are interested to join to sign up to get detailed information about the activity.

Incentive (award structure) is often mentioned as an important factor to join an activity. However, the **award needs to be proportionate** to the expected effort: €1.000-2.000 for a winning idea submission; €10.000-20.000 when is expected to develop the idea into a business. The latter should be clear upfront and can be arranged via a non-exclusive launching customer contract.

9. Conclusions and Forward and Backward Linkages in WP3 and IRIS

9.1 Conclusions and Recommendations

The work presented in this deliverable aimed to promote new business model development in smart cities. We concluded from our research that smart city business incubation does not require a specific but rather a broad and open business incubation program, combined with specific and targeted smart city ideation activities. In that way, many new ideas can be mobilized and quickly selected on feasibility and viability. Accordingly, we describe how UtrechtInc has broadened its incubation programs and, as far as we can establish, has done so successfully. Moreover, a series of ideation events has generated, with more and less success, a flow of new ideas to make our lighthouse cities smarter and more sustainable. Based on the work described in this deliverable, we can now write out the steps a city planner or smart city developer would take to promote new business model incubation in their smart cities. These steps are:

1. Identify key players in the entrepreneurial ecosystem, notably business incubators and accelerators in your city.
2. Engage with them to try and "open" their programs for a broad range of incubates, especially from different target groups (students, scientists, entrepreneurs, employees at incumbents etc. etc.) and over a broad range of stages of development (first idea to validated business model) using the proposed reforms in chapter 6.
3. Select the appropriate type of events following the checklist developed in chapter 7.
4. Select the appropriate (set of) recipe(s) from the cookbook in chapter 8.
5. Evaluate and learn, then start again at 2.

Of course, if smart city developers set up and organize their own challenges and bring the participants and winners of these challenges into incubation programs, there is no need to really measure their degree of "smart city-ness". A good challenge, by design, will only yield business models that would qualify as smart-city innovations. But it is possible that compromises must be made. It is better to organize a broader challenge and open the incubation programs also for non-smart city business models, if in doing so one gains access to important networks or essential resources. The measures we have developed in chapter 4, however, have proven useful in assessing the performance of already existing programs and broader business incubation challenges. The Smart City Index can be used to "score" innovations in any stage of development, based on a short description of the business model. This SCI can then help researchers identify the factors that support smart city innovation in urban technology innovation systems and entrepreneurial ecosystems. The indices we have developed can also be used for projects, investments and activities that are not in their early stages of development. The smart city business model canvass (Giourka et al. 2019), for example, is a tool to systematically develop and improve the business model of

smart city projects. This also holds for the tools developed in the business model toolkit in Task 3.3. To be able to apply these tools usefully, identifying and scoring smart city projects in a consistent and systematic way, would be useful.

9.2 Explicit linking of the work to T3.1 on ecosystems

Task 3.1 zooms in on the characteristics of the local, regional, and national ecosystem or technology innovation system that surrounds the new, integrated solutions that IRIS demonstrates and develops. D3.2 zooms in on strengths and weaknesses in the technical innovation systems of our lighthouse and follower cities, while D3.3 puts this analysis in a broader context and develops an evidence based diagnostic toolkit for the ability of regional ecosystems to promote innovation and business development in general and smart city innovations on IRIS' five transition tracks specifically. The SCI presented in this report and published earlier as Hermse et al. (2020) can be helpful in generalizing the evidence based diagnostic tools to smart cities beyond the rather specific IRIS transition tracks. This will help make these tools suitable for application also beyond IRIS. By evaluating the performance of local, regional, and national ecosystems on bringing forth smart city innovations, the general applicability of out innovation system assessment tools can be extended in future work. Our work on the business incubation landscape in Utrecht, Gothenburg and Nice has informed a range of activities to improve the functioning of these ecosystems in the project.

9.3 Explicit linking of the work to T3.3 on business model development

Task 3.3 brings the work in T3.1 and T3.2 together. It shows how the lighthouse, follower and potential replication cities could assess and strengthen their local ecosystems, while it also presents tools and techniques adapted from business incubation that have been helpful for the innovators in the IRIS project (the smart city business model canvass), seeking to fit their integrated replicable solutions to new local, regional, and national contexts. The early work presented in chapters 2-3 of this report informed the

9.4 Explicitly linking the work to T3.4-3.5 and the other WP.

Tasks 3.4 and 3.5 present how this work can be extended beyond IRIS in time and space. To make our tools and approaches applicable beyond IRIS, we extended and generalized our definition of smart city innovation and investigated how business incubation programs can contribute to the development of smart city projects that were not part of the IRIS demonstration projects. The recipes for ideation activities and challenges are all replicable in other cities and for other smart city challenges. The tools developed to help smart city developers pick the right recipe for their specific challenges are also useful beyond IRIS. Together, the tasks in WP3 thus present research and develop toolkits and strategies that both innovators and ecosystem managers in lighthouse cities, follower cities and urban developers inside and outside of Europe can apply to accelerate smart city development, whether they seek to adopt and replicate the integrated IRIS solutions of our project or develop new smart city business altogether.

9.5 Explicitly linking the work to the other work packages

Our ideation recipes (Startup in Residence, Smart Lighting Challenge, Energy Poverty Challenge, Utrecht Mobility Challenge, ChangeU Student Hackathon and Citizen Innovation Challenge, Gothenburg Smart City Challenge) were part of the demonstration work packages (WP5, Utrecht and WP7, Gothenburg). The challenges were organized and developed in close collaboration with IRIS partners in these work packages, and resulting ideas and projects are still contributing to the demonstration and pilot projects in IRIS. The description of the Business Incubation program in chapter 6 and Ideation activities in chapter 8 are aimed to be replication activities (WP8)

References

Adegbite, O. (2001). Business Incubators and Small Enterprise Development: The Nigerian Experience. *Small Business Economics*, *17*(3), 157–166. https://doi.org/10.1023/A:1011801018398

Adiyarta, K., Napitupulu, D., Syafrullah, M., Mahdiana, D., & Rusdah, R. (2020). Analysis of smart city indicators based on prisma: Systematic review. *IOP Conference Series: Materials Science and Engineering*, *725*, 012113. https://doi.org/10.1088/1757-899X/725/1/012113

Aernoudt, R. (2004). Incubators: Tool for Entrepreneurship? *Small Business Economics*, *23*(2), 127–135. https://doi.org/10.1023/B:SBEJ.0000027665.54173.23

Aerts, K., Matthyssens, P., & Vandenbempt, K. (2007). Critical role and screening practices of European business incubators. *Technovation*, *27*(5), 254–267. https://doi.org/10.1016/j.technovation.2006.12.002

Aharonson, B. S., & Schilling, M. A. (2016). Mapping the technological landscape: Measuring technology distance, technological footprints, and technology evolution. *Research Policy*, *45*(1), 81–96. https://doi.org/10.1016/j.respol.2015.08.001

Albort-Morant, G., & Ribeiro-Soriano, D. (2016). A bibliometric analysis of international impact of business incubators. *Journal of Business Research*, *69*(5), 1775–1779. https://doi.org/10.1016/j.jbusres.2015.10.054

Alexy, O., Criscuolo, P., & Salter, A. (2012). Managing Unsolicited Ideas for R&D. *California Management Review*, *54*(3), 116–139. https://doi.org/10.1525/cmr.2012.54.3.116

Amason, A. C., Shrader, R. C., & Tompson, G. H. (2006). Newness and novelty: Relating top management team composition to new venture performance. *Journal of Business Venturing*, *21*(1), 125–148. https://doi.org/10.1016/j.jbusvent.2005.04.008

AMEZCUA, A. S. (2010). Performance analysis of entrepreneurship policy: Which business incubators generate the highest levels of economic performance?. *Frontiers of Entrepreneurship Research,*. https://scholar-google-nl/citations?view_op=view_citation&hl=en&user=w2TBYv4AAAAJ&citation_for_view=w2TBYv4AAAAJ:d1gkVwhDpl0C

AMEZCUA, A. S., GRIMES, M. G., BRADLEY, S. W., & WIKLUND, J. (2013). Organizational Sponsorship and Founding Environments: A Contingency View on the Survival of Business-Incubated Firms, 1994-2007. *The Academy of Management Journal*, *56*(6), 1628–1654.

Andreesen, M. (2007). Product/market fit. *Business Management For Electrical*.

Arlotto, J., Sahut, J.-M., & Teulon, F. (2011). What is the performance of incubators? The point of view of coached entrepreneurs. *International Journal of Business*, *16*(4), 341–352.

Ayatse, F. A., Kwahar, N., & Iyortsuun, A. S. (2017). Business incubation process and firm performance: An empirical review. *Journal of Global Entrepreneurship Research*, *7*(1), 1–17.

Baldwin, C., Hienerth, C., & von Hippel, E. (2006). How user innovations become commercial products: A theoretical investigation and case study. *Research Policy*, *35*(9), 1291–1313. https://doi.org/10.1016/j.respol.2006.04.012

Bank, N., Fichter, K., & Klofsten, M. (2017). Sustainability-profiled incubators and securing the inflow of tenants – The case of Green Garage Berlin. *Journal of Cleaner Production*, *157*, 76–83. https://doi.org/10.1016/j.jclepro.2017.04.123

Baraldi, E., & Ingemansson Havenvid, M. (2016). Identifying new dimensions of business incubation: A multi-level analysis of Karolinska Institute's incubation system. *Technovation*, *50–51*, 53–68. https://doi.org/10.1016/j.technovation.2015.08.003

Barbero, J. L., Casillas, J. C., Ramos, A., & Guitar, S. (2012). Revisiting incubation performance: How incubator typology affects results. *Technological Forecasting and Social Change*, *79*(5), 888–902. https://doi.org/10.1016/j.techfore.2011.12.003

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G., & Portugali, Y. (2012). Smart cities of the future. *The European Physical Journal Special Topics*, *214*(1), 481–518. https://doi.org/10.1140/epjst/e2012-01703-3

Bergek, A., & Norrman, C. (2008). Incubator best practice: A framework. *Technovation*, *28*(1), 20–28. https://doi.org/10.1016/j.technovation.2007.07.008

Blank, S. (2013). Why the lean start-up changes everything. *Harvard Business Review*, *91*(5), 63–72.

Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent dirichlet allocation. *The Journal of Machine Learning Research*, *3*, 993–1022.

Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, *65*, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

Bøllingtoft, A., & Ulhøi, J. P. (2005). The networked business incubator—Leveraging entrepreneurial agency? *Journal of Business Venturing*, *20*(2), 265–290. https://doi.org/10.1016/j.jbusvent.2003.12.005

Brabham, D. C. (2008). Crowdsourcing as a Model for Problem Solving: An Introduction and Cases. *Convergence*, *14*(1), 75–90. https://doi.org/10.1177/1354856507084420

Bradonjic, P., Franke, N., & Lüthje, C. (2019). Decision-makers' underestimation of user innovation. *Research Policy*, *48*(6), 1354–1361. https://doi.org/10.1016/j.respol.2019.01.020

Bruneel, J., Ratinho, T., Clarysse, B., & Groen, A. (2012). The Evolution of Business Incubators: Comparing demand and supply of business incubation services across different incubator generations. *Technovation*, *32*(2), 110–121. https://doi.org/10.1016/j.technovation.2011.11.003

Bryman, A. (2016). *Social research methods* (5th edition). Oxford university press.

Burgelman, R. A. (1983a). A process model of internal corporate venturing in the diversified major firm. *Administrative Science Quarterly*, 223–244.

Burgelman, R. A. (1983b). Corporate Entrepreneurship and Strategic Management: Insights from a Process Study. *Management Science*, *29*(12), 1349–1364. https://doi.org/10.1287/mnsc.29.12.1349

Campbell, C., Kendrick, R. C., & Samuelson, D. S. (1985). Stalking the latent entrepreneur: Business incubators and economic development. *Economic Development Review*, *3*(2), 43–49.

Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart Cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82. https://doi.org/10.1080/10630732.2011.601117

Certoma, C., Corsini, F., & Rizzi, F. (2015). Crowdsourcing urban sustainability. Data, people and technologies in participatory governance. *Futures*, *74*, 93–106.

Ceschin, F. (2013). Critical factors for implementing and diffusing sustainable product-Service systems: Insights from innovation studies and companies' experiences. *Journal of Cleaner Production*, *45*, 74–88. https://doi.org/10.1016/j.jclepro.2012.05.034

Chakma, J., Masum, H., & Singer, P. A. (2010). Can incubators work in Africa? Acorn Technologies and the entrepreneur-centric model. *BMC International Health and Human Rights*, *10*(1), S7. https://doi.org/10.1186/1472-698X-10-S1-S7

Cockayne, D. (2019). What is a startup firm? A methodological and epistemological investigation into research objects in economic geography. *Geoforum*, *107*, 77–87.

Cohen, S. (2013). What do accelerators do? Insights from incubators and angels. *Innovations: Technology, Governance, Globalization*, *8*(3–4), 19–25.

Cohen, S. L., Bingham, C. B., & Hallen, B. L. (2019). The role of accelerator designs in mitigating bounded rationality in new ventures. *Administrative Science Quarterly*, *64*(4), 810–854.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 128–152.

Colombo, M. G., & Delmastro, M. (2002). How effective are technology incubators?: Evidence from Italy. *Research Policy*, *31*(7), 1103–1122. https://doi.org/10.1016/S0048-7333(01)00178-0

Coyne, K. P., Clifford, P. G., & Dye, R. (2007). Breakthrough thinking from inside the box. *Harvard Business Review*, *85*(12), 70–78.

Dahlander, L., & Piezunka, H. (2014). Open to suggestions: How organizations elicit suggestions through proactive and reactive attention. *Research Policy*, *43*(5), 812–827. https://doi.org/10.1016/j.respol.2013.06.006

de Jong, J. P. J., von Hippel, E., Gault, F., Kuusisto, J., & Raasch, C. (2015). Market failure in the diffusion of consumer-developed innovations: Patterns in Finland. *Research Policy*, *44*(10), 1856–1865. https://doi.org/10.1016/j.respol.2015.06.015

De Jong, J. P., & von Hippel, E. (2008). User innovation in SMEs: Incidence and transfer to producers. *EIM's Research Program on SMEs and Entrepreneurship Research Reports, H200814*.

De Jong, J. P., & von Hippel, E. (2009). Transfers of user process innovations to process equipment producers: A study of Dutch high-tech firms. *Research Policy*, *38*(7), 1181–1191.

Dee, N., Gill, D., Weinberg, C., & McTavish, S. (2015). Startup support programmes: What's the difference. *NESTA, London. ME SD*, *1*(2), 3.

Dvouletý, O., Longo, M. C., Blažková, I., Lukeš, M., & Andera, M. (2018). Are publicly funded Czech incubators effective? The comparison of performance of supported and non-supported firms. *European Journal of Innovation Management*, *21*(4), 543–563. https://doi.org/10.1108/EJIM-02-2018-0043

Eckinger, C., & Sanders, M. (2019). User Innovation and Business Incubation. *USE Working Paper Series*, *19*(16).

Edison, H. (2015). A Conceptual Framework of Lean Startup Enabled Internal Corporate Venture. *Product-Focused Software Process Improvement*, 607–613. https://doi.org/10.1007/978-3-319-26844-6_46

Edison, H., Smørsgård, N. M., Wang, X., & Abrahamsson, P. (2018). Lean internal startups for software product innovation in large companies: Enablers and inhibitors. *Journal of Systems and Software*, *135*, 69–87.

Ensley, M. D., & Hmieleski, K. M. (2005). A comparative study of new venture top management team composition, dynamics and performance between university-based and independent start-ups. *Research Policy*, *34*(7), 1091–1105. https://doi.org/10.1016/j.respol.2005.05.008

Eveleens, C. P. (2019). *Interfering with innovative entrepreneurship: How business incubation impacts the performance of start-ups* [PhD Thesis]. Universiteit Utrecht.

Fecher, F., Winding, J., Hutter, K., & Füller, J. (2020). Innovation labs from a participants' perspective. *Journal of Business Research*, *110*, 567–576. https://doi.org/10.1016/j.jbusres.2018.05.039

Field, A., Miles, J., & Field, Z. (2012). *Discovering statistics using R*. Sage publications.

Fietkiewicz, K. J., Mainka, A., & Stock, W. G. (2017). eGovernment in cities of the knowledge society. An empirical investigation of Smart Cities' governmental websites. *Government Information Quarterly*, *34*(1), 75–83. https://doi.org/10.1016/j.giq.2016.08.003

Firth, D. (1993). Bias reduction of maximum likelihood estimates. *Biometrika*, *80*(1), 27–38.

Fleming, L., & Sorenson, O. (2001). Technology as a complex adaptive system: Evidence from patent data. *Research Policy*, *30*(7), 1019–1039. https://doi.org/10.1016/S0048-7333(00)00135-9

Flowers, S., von Hippel, E., de Jong, J., & Sinozic, T. (2010). *Measuring user innovation in the UK: The importance of product creation by users*.

Franke, N., & Shah, S. (2003). How communities support innovative activities: An exploration of assistance and sharing among end-users. *Research Policy*, *32*(1), 157–178. https://doi.org/10.1016/S0048-7333(02)00006-9

Franke, N., Von Hippel, E., & Schreier, M. (2006). Finding commercially attractive user innovations: A test of lead-user theory. *Journal of Product Innovation Management*, *23*(4), 301–315.

Freeman, J., Carroll, G. R., & Hannan, M. T. (1983). The liability of newness: Age dependence in organizational death rates. *American Sociological Review*, 692–710.

Freeman, J., & Engel, J. S. (2007). Models of innovation: Startups and mature corporations. *California Management Review*, *50*(1), 94–119.

Frenken, K., Van Oort, F., & Verburg, T. (2007). Related Variety, Unrelated Variety and Regional Economic Growth. *Regional Studies*, *41*(5), 685–697. https://doi.org/10.1080/00343400601120296

Gambardella, A., Raasch, C., & von Hippel, E. (2017). The user innovation paradigm: Impacts on markets and welfare. *Management Science*, *63*(5), 1450–1468.

Garvin, D. A. (1983). Spin-offs and the new firm formation process. *California Management Review*, *25*(2), 3–20.

Gault, F., & Von Hippel, E. (2009). *The prevalence of user innovation and free innovation transfers: Implications for statistical indicators and innovation policy*.

Giffinger, R., Fertner, C., Kramar, H., & Meijers, E. (2007). City-ranking of European medium-sized cities. *Cent. Reg. Sci. Vienna UT*, 1–12.

Giourka, P., Sanders, M. W., Angelakoglou, K., Pramangioulis, D., Nikolopoulos, N., Rakopoulos, D., Tryferidis, A., & Tzovaras, D. (2019). The smart city business model canvas—A smart city business modeling framework and practical tool. *Energies*, *12*(24), 4798.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, *17*(S2), 109–122. https://doi.org/10.1002/smj.4250171110

Grimaldi, R., & Grandi, A. (2005). Business incubators and new venture creation: An assessment of incubating models. *Technovation*, *25*(2), 111–121. https://doi.org/10.1016/S0166-4972(03)00076-2

Hackett, S. M., & Dilts, D. M. (2004a). A real options-driven theory of business incubation. *The Journal of Technology Transfer*, *29*(1), 41–54.

Hackett, S. M., & Dilts, D. M. (2004b). A Systematic Review of Business Incubation Research. *The Journal of Technology Transfer*, *29*(1), 55–82. https://doi.org/10.1023/B:JOTT.0000011181.11952.0f

Hallen, B. L., Bingham, C. B., & Cohen, S. (2016). Do accelerators accelerate? The role of indirect learning in new venture development. *The Role of Indirect Learning in New Venture Development (January*, *19*, 2016.

Hannan, M. T., & Freeman, J. (1989). *Organizational ecology*. Harvard university press.

Hansen, M. T., Chesbrough, H. W., Nohria, N., & Sull, D. N. (2000). Networked incubators. *Harvard Business Review*, *78*(5), 74–84.

Hausberg, J. P., & Korreck, S. (2018). Business incubators and accelerators: A co-citation analysis-based, systematic literature review. *Journal of Technology Transfer*, 1–26. https://doi.org/10.1007/s10961-018-9651-y

Heikkinen, T., Belt, P., Mottonen, M., Harkonen, J., & Haapasalo, H. (2018). Managing radical innovations in established companies. *International Journal of Management Practice*, *11*(4), 422–447.

Heinze, G., & Schemper, M. (2002). A solution to the problem of separation in logistic regression. *Statistics in Medicine*, *21*(16), 2409–2419. https://doi.org/10.1002/sim.1047

Henderson, R. (1993). Underinvestment and Incompetence as Responses to Radical Innovation: Evidence from the Photolithographic Alignment Equipment Industry. *The RAND Journal of Economics*, *24*(2), 248–270. https://doi.org/10.2307/2555761

Henderson, R. M., & Clark, K. B. (1990). Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms. *Administrative Science Quarterly*, *35*(1), 9–30. https://doi.org/10.2307/2393549

Henkel, J., & Von Hippel, E. (2004). Welfare implications of user innovation. *The Journal of Technology Transfer*, *30*(1–2), 73–87.

Hermse, M., Nijland, I., & Picari, M. (2020). Classification of Smart City Startups: Smart City Index. *Working Paper*.

Hienerth, C. (2006). The commercialization of user innovations: The development of the rodeo kayak industry. *R&D Management*, *36*(3), 273–294. https://doi.org/10.1111/j.1467-9310.2006.00430.x

Hyytinen, A., Pajarinen, M., & Rouvinen, P. (2015). Does innovativeness reduce startup survival rates? *Journal of Business Venturing*, *30*(4), 564–581. https://doi.org/10.1016/j.jbusvent.2014.10.001

Ismagilova, E., Hughes, L., Dwivedi, Y. K., & Raman, K. R. (2019). Smart cities: Advances in research—An information systems perspective. *International Journal of Information Management*, *47*, 88–100. https://doi.org/10.1016/j.ijinfomgt.2019.01.004

Johnson, M. W., Christensen, C. M., & Kagermann, H. (2008). Reinventing Your Business Model. *Harvard Business Review*. https://hbr.org/2008/12/reinventing-your-business-model

Kirsty, D. (2010). The state of entrepreneurship in South Africa. *Mount Nelson Hotel. White Paper Deliberation and Key Findings*.

Klepper, S. (2001). Employee startups in high-tech industries. *Industrial and Corporate Change*, *10*(3), 639–674.

Klepper, S. (2007). Disagreements, Spinoffs, and the Evolution of Detroit as the Capital of the U.S. Automobile Industry. *Management Science*, *53*(4), 616–631. https://doi.org/10.1287/mnsc.1060.0683

Klepper, S. (2009). Spinoffs: A review and synthesis. *European Management Review*, *6*(3), 159–171. https://doi.org/10.1057/emr.2009.18

Klepper, S., & Sleeper, S. (2005). Entry by spinoffs. *Management Science*, *51*(8), 1291–1306.

Koellinger, P. (2008). Why are some entrepreneurs more innovative than others? *Small Business Economics*, *31*(1), 21.

Kolassa, J. (2021). *Smart-city entrepreneurship – the role of business incubation for kick-starting the urban transition* [Master's Thesis]. Utrecht University.

Krafft, J., & Quatraro, F. (2011). The dynamics of technological knowledge: From linearity to recombination. In *Handbook on the economic complexity of technological change*. Edward Elgar Publishing.

Kraft, C. (2012). *User experience innovation: User centered design that works*. Apress.

Lawless, J. F. (1987). Negative Binomial and Mixed Poisson Regression. *The Canadian Journal of Statistics / La Revue Canadienne de Statistique*, *15*(3), 209–225. https://doi.org/10.2307/3314912

Leblebici, H., & Shah, N. (2004). The Birth, Transformation and Regeneration of Business Incubators as New Organisational Forms: Understanding the Interplay between Organisational History and Organisational Theory. *Business History*, *46*(3), 353–380. https://doi.org/10.1080/0007679042000219175a

Leonard, D., & Sensiper, S. (1998). The role of tacit knowledge in group innovation. *California Management Review*, *40*(3), 112–132.

Lindelöf, P., & Löfsten, H. (2003). Science Park Location and New Technology-Based Firms in Sweden – Implications for Strategy and Performance. *Small Business Economics*, *20*(3), 245–258. https://doi.org/10.1023/A:1022861823493

Lombardi, P., Giordano, S., Farouh, H., & Yousef, W. (2012). Modelling the smart city performance. *Innovation: The European Journal of Social Science Research*, *25*(2), 137–149. https://doi.org/10.1080/13511610.2012.660325

Lose, T., & Tengeh, R. K. (2016). An evaluation of the effectiveness of business incubation programs: A user satisfaction approach. *Investment Management and Financial Innovations*, *13, Iss. 2 (contin. 2)*, 370–378.

Lukeš, M., Longo, M. C., & Zouhar, J. (2019). Do business incubators really enhance entrepreneurial growth? Evidence from a large sample of innovative Italian start-ups. *Technovation*, *82–83*, 25–34. https://doi.org/10.1016/j.technovation.2018.07.008

Lumpkin, G. T., & Dess, G. G. (1996). Clarifying the Entrepreneurial Orientation Construct and Linking It To Performance. *Academy of Management Review*, *21*(1), 135–172. https://doi.org/10.5465/amr.1996.9602161568

Lüthje, C. (2004). Characteristics of innovating users in a consumer goods field: An empirical study of sport-related product consumers. *Technovation*, *24*(9), 683–695.

Lüthje, C., Herstatt, C., & von Hippel, E. A. (2002). *The Dominant Role of* (SSRN Scholarly Paper ID 322800). Social Science Research Network. https://doi.org/10.2139/ssrn.322800

Macpherson, A., & Holt, R. (2007). Knowledge, learning and small firm growth: A systematic review of the evidence. *Research Policy*, *36*(2), 172–192. https://doi.org/10.1016/j.respol.2006.10.001

Madaleno, M., Nathan, M., Overman, H. G., & Waights, S. (2018). *Incubators, Accelerators and Regional Economic Development* (SSRN Scholarly Paper ID 3261715). Social Science Research Network. https://papers.ssrn.com/abstract=3261715

Malek, K., Maine, E., & McCarthy, I. P. (2014). A typology of clean technology commercialization accelerators. *Journal of Engineering and Technology Management*, *32*, 26–39. https://doi.org/10.1016/j.jengtecman.2013.10.006

Manville, C., Cochrane, G., Cave, J., Millard, J., Pederson, J. K., Thaarup, R. K., Liebe, A., Wissner, M., Massink, R. A., & Kotterink, B. (2014). *Mapping smart cities in the EU*.

McAdam, M., & Marlow, S. (2008). A preliminary investigation into networking activities within the university incubator. *International Journal of Entrepreneurial Behavior & Research*, *14*(4), 219–241. https://doi.org/10.1108/13552550810887390

McFadden, D. (1973). *Conditional logit analysis of qualitative choice behavior*.

Memon, A. B., & Meyer, K. (2017). Why we need dedicated web-based collaboration platforms for inter-organizational connectivity? A research synthesis. *International Journal of Information Technology and Computer Science*, *9*(11), 1–11.

Meraza Farfan, E. (2018). *Developing Smart Cities with citizens: Involving citizens in idea generation for Smart City development*. Utrecht University.

Mian, S., Lamine, W., & Fayolle, A. (2016). Technology Business Incubation: An overview of the state of knowledge. *Technovation*, *50–51*, 1–12. https://doi.org/10.1016/j.technovation.2016.02.005

Morin, R. P. D. (2019). *Incubation performances and impact of start-up's resources. Study-case of a research-based incubator in Nice.* [Master's Thesis].

Morrison, P. D., Roberts, J. H., & Von Hippel, E. (2000). Determinants of user innovation and innovation sharing in a local market. *Management Science*, *46*(12), 1513–1527.

Mulolli, E., Islami, X., & Skenderi, N. (2017). Business Incubators as a Factor for the Development of SMEs in Kosovo. *Mulolli, E., Islami, X., & Skenderi*, *2017*, 659–666.

Nam, T., & Pardo, T. A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. *Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times*, 282–291.

Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., & Scorrano, F. (2014). Current trends in Smart City initiatives: Some stylised facts. *Cities*, *38*, 25–36. https://doi.org/10.1016/j.cities.2013.12.010

Nijland, I. (2020). *Effects of Business Incubation on the Performance of Smart City Start-ups in Utrecht and Gothenburg* [Master's Thesis]. Utrecht University.

Osterwalder, A., Pigneur, Y., & Tucci, C. (2005). Clarifying Business Models: Origins, Present, and Future of the Concept. *Communications of the Association for Information Systems*, *Volume 16*(1). http://aisel.aisnet.org/cgi/viewcontent.cgi?article=3016&context=cais

Patton, D. (2014). Realising potential: The impact of business incubation on the absorptive capacity of new technology-based firms. *International Small Business Journal*, *32*(8), 897–917. https://doi.org/10.1177/0266242613482134

Patton, M. Q. (2002). *Qualitative research and evaluation methods*. SAGE.

Peters, L., Rice, M., & Sundararajan, M. (2004). The Role of Incubators in the Entrepreneurial Process. *The Journal of Technology Transfer*, *29*(1), 83–91. https://doi.org/10.1023/B:JOTT.0000011182.82350.df

Phan, P. H., Siegel, D. S., & Wright, M. (2005). Science parks and incubators: Observations, synthesis and future research. *Journal of Business Venturing*, *20*(2), 165–182. https://doi.org/10.1016/j.jbusvent.2003.12.001

Picari, M. (2020). *Smart City start-ups; A Comparative Analysis between Utrecht and Nice* [Master's Thesis]. Utrecht University.

Polzin, F., Sanders, M., & Stavlöt, U. (2018). Do investors and entrepreneurs match? – Evidence from The Netherlands and Sweden. *Technological Forecasting and Social Change*, *127*, 112–126. https://doi.org/10.1016/j.techfore.2017.07.016

Rafols, I., & Meyer, M. (2010). Diversity and network coherence as indicators of interdisciplinarity: Case studies in bionanoscience. *Scientometrics*, *82*(2), 263–287.

Rauter, R., Jonker, J., & Baumgartner, R. J. (2017). Going one's own way: Drivers in developing business models for sustainability. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2015.04.104

Ries, E. (2011). *The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses*. Currency.

Riggs, W., & Von Hippel, E. (1994). Incentives to innovate and the sources of innovation: The case of scientific instruments. *Research Policy*, *23*(4), 459–469.

Samarakkody, A. L., Kulatunga, U., & Bandara, H. (2019). *What differentiates a smart city? A comparison with a basic city*. https://doi.org/10.31705/WCS.2019.61

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., & Oliveira, A. (2011). Smart cities and the future internet: Towards cooperation frameworks for open innovation. *The Future Internet Assembly*, 431–446.

Schuurman, D., Baccarne, B., De Marez, L., & Mechant, P. (2012). Smart Ideas for Smart Cities: Investigating Crowdsourcing for Generating and Selecting Ideas for ICT Innovation in a City Context. *Journal of Theoretical and Applied Electronic Commerce Research*, *7*(3), 49–62. https://doi.org/10.4067/S0718-18762012000300006

Schwartz, M. (2013). A control group study of incubators' impact to promote firm survival. *The Journal of Technology Transfer*, *38*(3), 302–331. https://doi.org/10.1007/s10961-012-9254-y

Schwartz, M., & Hornych, C. (2008). Specialization as strategy for business incubators: An assessment of the Central German Multimedia Center. *Technovation*, *28*(7), 436–449. https://doi.org/10.1016/j.technovation.2008.02.003

Sedita, S. R., Apa, R., Bassetti, T., & Grandinetti, R. (2017). Measuring the effect of business incubators on the innovation performance of start-ups. *Academy of Management Proceedings*, *2017*(1), 10677.

Shah, S. K., & Tripsas, M. (2007). The accidental entrepreneur: The emergent and collective process of user entrepreneurship. *Strategic Entrepreneurship Journal*, *1*(1–2), 123–140. https://doi.org/10.1002/sej.15

Silva, B. N., Khan, M., & Han, K. (2018). Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities. *Sustainable Cities and Society*, *38*, 697–713. https://doi.org/10.1016/j.scs.2018.01.053

Smilor, R. W. (1987). Managing the incubator system: Critical success factors to accelerate new company development. *IEEE Transactions on Engineering Management*, *3*, 146–155.

Smith, S. W., & Hannigan, T. J. (2015). Swinging for the fences: How do top accelerators impact the trajectories of new ventures. *Druid*, *15*, 15–17.

Soetanto, D. P., & Jack, S. L. (2013). Business incubators and the networks of technology-based firms. *The Journal of Technology Transfer*, *38*(4), 432–453. https://doi.org/10.1007/s10961-011-9237-4

Sorrell, S. (2015). Reducing energy demand: A review of issues, challenges and approaches. *Renewable and Sustainable Energy Reviews*, *47*, 74–82. https://doi.org/10.1016/j.rser.2015.03.002

Sproull, L., & Patterson, J. F. (2004). Making information cities livable. *Communications of the ACM*. https://dl.acm.org/doi/abs/10.1145/966389.966412

Stokan, E., Thompson, L., & Mahu, R. J. (2015). Testing the Differential Effect of Business Incubators on Firm Growth. *Economic Development Quarterly*, *29*(4), 317–327. https://doi.org/10.1177/0891242415597065

Sun, J., & Poole, M. S. (2010). Beyond connection: Situated wireless communities. *Communications of the ACM*, *53*(6). https://dl.acm.org/doi/abs/10.1145/1743546.1743579

Sussman, F. S., Gerald. (2001). Telecommunications and Transnationalism: The Polarization of Social Space. *The Information Society*, *17*(1), 49–62. https://doi.org/10.1080/019722401750067423

Tan, M. (1999). Creating the Digital Economy: Strategies and Perspectives from Singapore. *International Journal of Electronic Commerce*, *3*(3), 105–122. https://doi.org/10.1080/10864415.1999.11518344

Taylor Buck, N., & While, A. (2017). Competitive urbanism and the limits to smart city innovation: The UK Future Cities initiative. *Urban Studies*, *54*(2), 501–519. https://doi.org/10.1177/0042098015597162

Thompson, P., & Klepper, S. (2005). *Spinoff entry in high-tech industries: Motives and consequences*.

Udell, G. G. (1990). Are business incubators really creating new jobs by creating new business and new products. *Journal of Product Innovation Management*, *7*(2), 108–122. https://doi.org/10.1016/0737-6782(90)90053-H

Urban, G. L., & Von Hippel, E. (1988). Lead user analyses for the development of new industrial products. *Management Science*, *34*(5), 569–582.

Válková, K. (2020). *A Comparative Study of the Business Incubation and Corporate Entrepreneurship Processes in the Context of Smart City Innovation*. Utrecht University.

Van Rijnsoever, Frank J., Van Weele, Marijn A., & Eveleens, Chris P. (2017). Network brokers or hit makers? Analyzing the influence of incubation on start-up investments. *International Entrepreneurship and Management Journal*, *13*(2), 605null. https://doi.org/10.1007/s11365-016-0416-5

van Weele, M., van Rijnsoever, F. J., Eveleens, C. P., Steinz, H., van Stijn, N., & Groen, M. (2018). Start-EU-up! Lessons from international incubation practices to address the challenges faced by Western European start-ups. *The Journal of Technology Transfer*, *43*(5), 1161–1189. https://doi.org/10.1007/s10961-016-9538-8

Vásquez-Urriago, Á. R., Barge-Gil, A., & Modrego Rico, A. (2016). Science and Technology Parks and cooperation for innovation: Empirical evidence from Spain. *Research Policy*, *45*(1), 137–147. https://doi.org/10.1016/j.respol.2015.07.006

Von Hippel, E. (1988). *The sources of innovation*. Oxford University Press.

von Hippel, E. (2005). Democratizing innovation: The evolving phenomenon of user innovation. *Journal Für Betriebswirtschaft*, *55*(1), 63–78. https://doi.org/10.1007/s11301-004-0002-8

von Zedtwitz, M., & Grimaldi, R. (2006). Are Service Profiles Incubator-Specific? Results from an Empirical Investigation in Italy*. *The Journal of Technology Transfer*, *31*(4), 459–468. https://doi.org/10.1007/s10961-006-0007-7

Winkowska, J., Szpilko, D., & Pejić, S. (2019). Smart city concept in the light of the literature review. *Engineering Management in Production and Services*, *Vol. 11*(2). https://doi.org/10.2478/emj-2019-0012

Winter, S. G. (1984). Schumpeterian competition in alternative technological regimes. *Journal of Economic Behavior & Organization*, *5*(3), 287–320. https://doi.org/10.1016/0167-2681(84)90004-0

Yigitcanlar, T., Kamruzzaman, Md., Buys, L., Ioppolo, G., Sabatini-Marques, J., da Costa, E. M., & Yun, J. J. (2018). Understanding 'smart cities': Intertwining development drivers with desired outcomes in a multidimensional framework. *Cities*, *81*, 145–160. https://doi.org/10.1016/j.cities.2018.04.003

Yin, R. K. (2014). *Case Study Research: Design and Methods* (5th ed.). SAGE Publications, Inc.

Yu, J., & Nijkamp, P. (2009). Methodological challenges and institutional barriers in the use of Experimental Method for the evaluation of business incubators: Lessons from the US, EU and China. *2009 Atlanta Conference on Science and Innovation Policy*, 1–9. https://doi.org/10.1109/ACSIP.2009.5367841

Yu, S. (2020). How Do Accelerators Impact the Performance of High-Technology Ventures? *Management Science*, *66*(2), 530–552. https://doi.org/10.1287/mnsc.2018.3256

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, *27*(2), 185–203.

Zanders, L., Polzin, F., & Sanders, M. (2019). *Smart city business model incubation: Development and barriers in the city of Utrecht*. Utrecht University.

Zhuhadar, L., Thrasher, E., Marklin, S., & de Pablos, P. O. (2017). The next wave of innovation—Review of smart cities intelligent operation systems. *Computers in Human Behavior*, *66*, 273–281. https://doi.org/10.1016/j.chb.2016.09.030

Annex

Interview Guide Spinout Innovations Chapter 3

- **Introduction**
  - Introduction of the researchers
  - Explanation of the IRIS project and SCUIBI (the business incubation process)
  - Assurance of confidentiality!
- **Company's engagement in smart city innovation / background**
  - How does your company act in these five transition pathways (mobility, energy, …)?
  - Person of the entrepreneur/team/business: experience, motivation, etc.
  - Where does your company see NEW (business) opportunities/ideas regarding the transition tracks?
- **The business idea *(focus on most promising business idea?)***
  - (What's the name of the business idea?)
  - Please describe the product/service (as it currently stands)
  - (Can you give a brief description/summary ('30 second pitch') about the idea?)
  - Has it been tried out already (pilot), or is it a wild guess? Or is it emerging?
- **Origin of the idea**
  - Where does the idea originate: Incumbent/spin-off interview, challenge, user-source, other?
  - Can you please explain the origin of the idea?
- **Customer value proposition/value proposition canvas (required!)**  
  - What kind of customer demand do you see arising in the future?
  - What core value would you deliver to the customer? Which customer needs would you satisfy?
  - What kind of problems do the clients of your company face in these areas and how do they solve these problems today?
  - What would be potential solutions and could they be commercially exploited?
  - What kind of customers do you intend to serve? Who is your most important customer?
  - What bundles of products and services are we offering to each Customer Segment?

- **Key resources (optional)** 
  - What key resources does your value proposition require?
  - **What resources are important the most in distribution channels, customer relationships, revenue stream…?**
  - Who are your key partners/suppliers? What are the motivations for the partnerships?
  - Which Key Resources are we acquiring from partners?
- **Key processes (optional)** 
  - What key activities does your value proposition require?
  - What activities are important the most in distribution channels?
  - And in customer relationships?
  - And in production/manufacturing?
  - Which Key Activities do partners perform?
- **Profit formula (optional)** 
  - How will you make money with this idea?
  - What kind of revenue model do you foresee?
  - What does the cost structure look like?
- **Business idea development**
  - Is your company actively pursuing these ideas (for example through the creation of spin-offs or through or forms of 'start-up support')?
  - Which barriers prevent the commercialisation of (your) smart city ideas?
- **End of the interview**
  - Any comments, remarks, feedback from the interviewee?
  - Can be contacted for clarifications/additional information?
  - Who else would you suggest we could speak to with these questions? (You can always email it to us)

Potential follow-up questions for individual business model elements

Questions for developing new products

(if there are insufficient ideas coming from the interviewee)

De-average buyers and users

Which customers use or purchase our product in the most unusual way?

Do any customers need vastly more or less sales and service attention than most?

For which customers are the support costs (order entry, tracking, customerspecific design) either unusually high or unusually low?

Could we still meet the needs of a significant subset of customers if we stripped 25% of the hard or soft costs out of our product?

Who spends at least 50% of what our product costs to adapt it to their specific needs?

Examine binding constraints

What is the biggest hassle of purchasing or using our product?

What are some examples of ad hoc modifications that customers have made to our product?

For which current customers is our product least suited?

For what particular usage occasions is our product least suited?

Which customers does the industry prefer not to serve, and why?

Which customers could be major users, if only we could remove one specific barrier we've never previously considered?

Explore unexpected successes

Who uses our product in ways we never expected or intended?

Who uses our product in surprisingly large quantities?

Imagine perfection

How would we do things differently if we had perfect information about our buyers, usage, distribution channels, and so on?

How would our product change if it were tailored for every customer?

Look beyond the boundaries of our business

Who else is dealing with the same generic problem as we are but for an entirely different reason? How have they addressed it?

What major breakthroughs in efficiency or effectiveness have we made in our business that could be applied in another industry?

What information about customers and product use is created as a by-product of our business that could be the key to radically improving the economics of another business?

Revisit the premises underlying our processes and products

Which technologies embedded in our product have changed the most since the product was last redesigned?

Which technologies underlying our production processes have changed the most since we last rebuilt our manufacturing and distribution systems?

Which customers' needs are shifting most rapidly? What will they be in five years?

Explanations

Value Proposition

Describes the bundle of products and services that create value for a specific Customer Segment.

The Value Proposition is the reason why customers turn to one company over another. It solves a customer problem or satisfies a customer need. Each Value Proposition consists of a selected bundle of products and/or services that caters to the requirements of a specific Customer Segment. In this sense, the Value Proposition is an aggregation, or bundle, of benefits that a company offers customers. Some Value Propositions may be innovative and represent a new or disruptive offer. Others may be similar to existing market offers, but with added features and attributes.

Customer Segments

Defines the different groups of people or organizations an enterprise aims to reach and serve.

Customers comprise the heart of any business model. Without (profitable) customers, no company can survive for long.

In order to better satisfy customers, a company may group them into distinct segments with common needs, common behaviors, or other attributes. A business model may define one or several large or small Customer Segments. An organization must make a conscious decision about which segments to serve and which segments to ignore. Once this decision is made, a business model can be carefully designed around a strong understanding of specific customer needs.

Customer groups represent separate segments if:

- Their needs require and justify a distinct offer
- They are reached through different Distribution Channels
- They require different types of relationships
- They have substantially different profitabilities
- They are willing to pay for different aspects of the offer

Channels

Describes how a company communicates with and reaches its Customer Segments to deliver a Value Proposition.

Communication, distribution, and sales Channels comprise a company's interface with customers. Channels are customer touch points that play an important role in the customer experience.

Channels serve several functions, including:

- Raising awareness among customers about a company's
- products and services
- Helping customers evaluate a company's Value Proposition
- Allowing customers to purchase specific products and services
- Delivering a Value Proposition to customers
- Providing post-purchase customer support

Customer Relationships

Describes the types of relationships a company establishes with specific Customer Segments.

A company should clarify the type of relationship it wants to establish with each Customer Segment. Relationships can range from personal to automated.

Customer relationships may be driven by the following motivations:

- Customer acquisition
- Customer retention

Boosting sales (upselling)

Key Resources

Describes the most important assets required to make a business model work.

Every business model requires Key Resources. These resources allow an enterprise to create and offer a Value Proposition, reach markets, maintain relationships with Customer Segments, and earn revenues.

Different Key Resources are needed depending on the type of business model. A microchip manufacturer requires capital-intensive production facilities, whereas a microchip designer focuses more on human resources. Key resources can be physical, financial, intellectual, or human. Key resources can be owned or leased by the company or acquired from key partners.

Key Activities

Describes the most important things a company must do to make its business model work.

Every business model calls for a number of Key Activities. These are the most important actions a company must take to operate successfully. Like Key Resources, they are required to create and offer a Value Proposition, reach markets, maintain Customer Relationships, and earn revenues. And like Key Resources,

Key Activities differ depending on business model type. For software maker Microsoft, Key Activities include software development. For PC manufacturer Dell, Key Activities include supply chain management. For consultancy McKinsey, Key Activities include problem solving.

Key Partnerships

Describes the network of suppliers and partners that make the business model work.

Companies forge partnerships for many reasons, and partnerships are becoming a cornerstone of many business models. Companies create alliances to optimize their business models, reduce risk, or acquire resources.

We can distinguish between four different types of partnerships:

- Strategic alliances between non-competitors
- Competition: strategic partnerships between competitors

Joint ventures to develop new businesses

Cost Structure

Describes all costs incurred to operate a business model.

This building block describes the most important costs incurred while operating under a particular business model. Creating and delivering value, maintaining Customer Relationships, and generating revenue all incur costs. Such costs can be calculated relatively easily after defining Key Resources, Key Activities, and Key Partnerships. Some business models, though, are more cost-driven than others. So-called “no frills” airlines, for instance, have built business models entirely around low Cost Structures.

Revenue Streams

Represents the cash a company generates from each Customer Segment (costs must be subtracted from revenues to create earnings).

If customers comprise the heart of a business model, Revenue Streams are its arteries. A company must ask itself, For what value is each Customer Segment truly willing to pay? Successfully answering that question allows the firm to generate one or more Revenue Streams from each Customer Segment. Each Revenue Stream may have different pricing mechanisms, such as fixed list prices, bargaining, auctioning, market dependent, volume dependent, or yield management.

A business model can involve two different types of Revenue Streams:

- Transaction revenues resulting from one-time customer payments
- Recurring revenues resulting from ongoing payments to either deliver a Value Proposition to customers or provide post-purchase customer support

Table 30: Complete Literature Base for User Innovation Index

Study	Research	Title	Description	UI Variable	UI definition	UI operationalisation	Methodology	Sample
Baldwin, von Hippel (2011)	Theoretical	Modelling a paradigm shift: From producer innovation to user and open collaborative innovation	Assessment of the economic viability of innovation by producers relative to two increasingly important alternative models: innovations by single user individuals or firms, and open collaborative innovation.	Single user innovator	- Single user innovator is a single firm or individual that creates an innovation in order to use it. Examples are a single firm creating a process machine in order to use it, a surgeon creating a new medical device in order to use it, and an individual consumer creating a new piece of sporting equipment in order to use it {p. 9} - Individual user innovators depend only on their own in-house use of their design to recoup their innovation-related investments {p. 2}	*Implicitly stated:* - Investment in a design whose value to her is vs (includes all aspects of the innovation that the user values (i.e. improved performance, lower cost, lower environmental impact, greater flexibility, and/or enhanced capabilities) {p. 13} - Effort of innovation is worthwhile (for this innovator and this design) if this value is greater than the user's design cost: ds < vs {p. 13} - To attract users who can innovate on their own, the producer's price must be less than the user's design cost, which by definition is less than the user's value: p<ds <vs {p. 26}	Statistical analysis; development of theoretical model	*Not given*
				Firm user	*Not explicitly stated*	- Process innovations developed by user firms, reduce the process user's costs (production, transactions, communication, design) without changing consumers' willingness to pay for the product {p. 14}		
				Collaborative inovation	*Not explicitly stated*	pen collaborative innovation: - User innovators will choose to participate in an open collaborative innovation project if the increased communication cost each incurs by joining the project is more than offset by the value of designs obtained from others {p. 17}		
De Jong & von Hippel (2008)	Empirical	User innovation in SMEs: incidence and transfer to producers	Measure of the incidence of user innovation in a broad sample of firms and assessment if current innovation surveys adequately capture user innovation.	User Innovation	- User innovation refers to innovations developed by end users, rather than by producers. Users can be either firms or individual consumers, they are distinguished from producers by the fact that they expect to benefit from using a product or a service (von Hippel, 2005) {p. 6} - Users primarily innovate to satisfy their process-related needs which producers are (initially) unable or unwilling to solve. User innovators tend to be found at the early stages of the life-cycles of products, technologies and industries (von Hippel, 2005) {p. 6}	- User creation: developing entirely new techniques, equipment or software for your own use, because there is no appropriate market supply {p. 12} - User modification: any modification your firm may do to existing techniques, equipment or software to improve their usefulness to your business. This does NOT include modifications of your own products for customers {p. 13}	Survey	2,416 SMEs in NL Technology based small firms in NL
Baldwin, Hienerth, & von Hippel (2008)	Empirical	How user innovations become commercial products: A theoretical investigation and case study	Modelling of the pathways commonly traversed as user innovations are transformed into commercial products.	User innovators	- User innovators seek to develop new designs for their own personal use or (in the case of user firms) internal corporate	*Implicitly stated:* - Users develop innovations in order to satisfy their own needs - Users identify new market opportunities - User innovation platforms are built on	Case study; statistical analysis	Case study – Kayak industry

					benefit They do not anticipate selling goods or services based on their innovations, although they may later go into business as user-manufacturers. Designing for use and testing by use are the essential characteristics of user-innovators: they may subcontract production and parts supply, but they cannot subcontract the innovation's design or testing and be user-innovators under our definition {p. 7} - Our theory views user-innovators as economic actors who perceive their time and effort to be valuable and respond rationally to changing incentives {p. 12}	easily modifiable innovations - User innovations are tailor-made products - Design searches by user-innovators are motivated by the users' own desires for a better product {p. 8} - Modification of existing /mass products - User innovators innovate if there is a high probability that the new design will be better than the old design - Users create new designs as long as the expected value is higher than the opportunity cost		
De Jong & von Hippel (2009)	Empirical	Measuring user innovation in Dutch high-tech SMEs: Frequency, nature & transfer to producer	Detailed survey of 498 "high tech" SMEs in the Netherlands shows process innovation by user firms to be common practice.	User innovators	We define user-innovators as firms or individual consumers that benefit from using a product or a service they develop {p. 4}	*Explicitly stated* {p. 11} - Had the respondent developed new processes equipment or software for his own use within the last 3 years - Had the respondent modified existing process equipment or software for his own use - User developed process innovations - Even for new developments, innovating actors adapt and incorporate the components of existing machines and software into their new designs (von Hippel, 1988, 2005) {p. 16}	Survey	498 high tech SMEs (NL) spanning a broad range of industries
				Producer innovators (Non-UI)	Producer-innovators are firms or individuals that benefit from selling a product or a service they develop {p. 4}			
Gault & von Hippel, (2009)	Empirical	The prevalence of user innovation and free innovation transfers: Implications for statistical indicators and innovation policy	Report upon a pilot project in which a novel set of statistical indicators were deployed in a 2007 survey of 1,219 Canadian manufacturing plants. Responses to the survey showed that data on both user innovation and the transfers of these innovations could be reliably collected, and that novel findings important to policymaking would result.	Producer innovators (Non-UI)	Producer-innovators are firms or individuals that benefit from selling a product or a service they develop (von Hippel, 1988, 2005) (p. 3)	*Explicitly stated in survey question* - Significantly modified one or more AMT process equipment types to better suit their production needs {p. 13} - Whether they had developed entirely new equipment within one of the 26 AMT categories within the last 3 years {p. 13} - Development of new technologies for in-house use {p. 13}	Survey	Statistics Canada (2007) 1,219 Canadian manufacturing plants
				End-users	*Not explicitly stated*	End-users/consumers: working individually or in groups, are the actual developers of many consumer products later commercialized and sold to the general marketplace by producers {p. 3}		
				User innovators	We define user-innovators as firms or individual consumers that benefit from using a product or a service they develop (von Hippel, 1988, 2005) (p. 3)	*Not given*		

Flowers, von Hippel, de Jong, & Sinozic (2010)	Empirical	Measuring user-innovation in the UK – the importance of product creation by users	This report sets out to address this gap in the understanding of the role of users – including individual consumers and business firms – in processes of innovation across a range of sectors.	Consumer-level innovation	Widespread creation and modification of consumer products by consumers themselves independent of producer involvement {p. 5} > Creating or modifying products or software they use in their daily lives with the goal of better addressing their own personal needs {p. 14-15}	- Content Production - User modification (software/product) - User creation from scratch (software/product) - User innovation (combining user modification, user creation, software & product) {p. 37}	Research report; closed questionnaire survey	Firm survey: 1,004 UK firms with 10-250 employees Initial Consumer survey: 2,109 UK consumers aged 15 and over Consumer follow-up survey: 344 UK consumers aged 15 and over
				Firm-level innovation	Flowers, von Hippel, de Jong,, & Sinozic (2010)	- User modification (software, physical products) - User creation from scratch (software, physical products) - User innovation (combination of 'user modification' and 'user creation') { p. 35}		
				Non-UI	*Not explicitly stated*	- Developed as part of their jobs - Had been developed for commercial – rather than user – purposes - Simply homemade replicas of products already available on the marketplace - Modifications and improvements that manufacturers had anticipated users would undertake and had made provisions for – such as software upgrades {p. 14}		
Morrison, Roberts, & von Hippel (2000)	Empirical	Determinants of user innovation and innovation sharing in a local market	Exploring the characteristics of innovation, innovators, and innovation shar ing by library users of OPAC information search systems in Australia.	Lead users	Lead users of a novel or enhanced product, process, or service are defined as those who display two characteristics with respect to it: -Lead users face needs that will be general in a marketplace-but face them months or years before the bulk of that marketplace encounters them, and -Lead users are positioned to benefit significantly by obtaining a solution to those need {p. 569}	*Not given*	Questionnaires,;personal interviews	464 Australian libraries selected using stratified random sampling
				User innovations	*Not explicitly stated*	*Implicitly stated:* - OPAC modifications/additional improvements by employees - Customization of OPACs according to owns novel ideas and local settings {p. 6} - Easily modifiable - Low cost		
Urban, & von Hippel (1988)	Empirical	Lead user analysis for the development of new industrial products	Integration of market research within this lead user methodology and reporting of a test of it in the rapidly evolving field of computer-aided systems for the design of printed circuit boards (PC-CAD).	Lead users	Lead users of a novel or enhanced product, process, or service are defined as those who display two characteristics with respect to it: -Lead users face needs that will be general in a marketplace-but face them months or years before the bulk of that marketplace encounters them, and -Lead users are positioned to benefit	*Not given*	Case study with focus on n computer aided design (CAD) systems which used to design the printed circuit boards used in electronic products, PC-CAD	market of over 40 competing firms

					significantly by obtaining a solution to those need {p. 569}			
				User innovations	*Not explicitly stated*	*Explicit criteria to extract user innovation from sample* - High expected benefit from solving a need - Evidence of user product development or product modification - User dissatisfaction with existing products (services or processes)		
Von Hippel (2005)	Theoretical	Democratizing innovation: the evolving phenomenon of user innovation	Provide an overview of what the international research community now understands about user-centred innovation.	User innovators	Can develop exactly what they want, rather than relying on manufacturers to act as their (often very imperfect) agents {p. 2} > Do not have to develop everything they need on their own: they can benefit from innovations developed and freely shared by others {p. 2}	*Explicitly stated*: - Developed for in-house/own use {p. 3} - Development of improvement {p. 4} - Developed because of strong need {p. 5} - Developing or modifying product {p. 5} - Drivers: Agency costs & Enjoyment (individual) {p. 9} - Functional novelty {p. 11} - Require user-need information & use context information {p. 11} - Low cost {p. 11} - Types: new functional capability, sensitivity, resolution or accuracy improvement, convenience or reliability improvement	*Not given*	*Not given*
				Manufacturer innovators (Non-UI)	Manufacturer-centric model, in which products and services are developed by manufacturers in a closed way, with the manufacturers using patents, copyrights, and other protections to prevent imitators from free riding on their innovation investments {p. 2}	*Not given*		
Franke, von Hippel, & Schreier (2006)	Empirical	Finding commercially attractive user innovations: A test of lead-user theory	The present study empirically tests and confirms the basic tenets of lead-user theory. It also uncovers some new refinements and related practical applications.	Lead users	Lead users are defined as members of a user population who (1) anticipate obtaining relatively high benefits from obtaining a solution to their needs and so may innovate and (2) are at the leading edge of important trends in a marketplace under study and so are currently experiencing needs that will later be experienced by many users in that marketplace (von Hippel, 1986) (p. 302)	*Not given*	Survey; attractiveness evaluation by 6 external experts	Memberships of several important European kite-surfing communities via a multisampling method 15 samples of kite surfers
				User innovations	*Not explicitly stated*	*Implicitly stated:* - User innovation: - User perceive high-expected benefit from innovation - Innovation-related resources are provided - Improvements - Innovations are meaningful - More attractive innovations & high expected benefit (diagram, p. 311)		
De Jong,, von Hippel, Gault, Kuusisto, & Raasch (2015)	Empirical	Market failure in the diffusion of consumer-developed innovations:	Utilization of a broad sample of consumers in Finland to explore the extent to which innovations	Consumer innovation	Consumers as user innovators are motivated to create innovations to serve their own	- Creation/modification of products or applications for personal use in the past three years during leisure time {1858}	Survey	Random sample of Finland's population

		Patterns in Finland	developed by individual users are deemed of potential value to others, and the extent to which they diffuse as a function of perceived general value.		needs, not those of others, and consumer needs have shown to be heterogeneous {1857}	- Innovations that produce some level of functionality (development of customized versions of existing products that are not available on the market & that provide important value for the developer {p. 1858}		
				Non-UI	*Not explicitly stated*	- If developed as part of the respondent's job or whether the respondent knew of an equivalent product available on the market that he could have bought {p. 1858} - Purely aesthetic improvements {p. 1858}		
Henkel, & von Hippel (2005)	Theoretical	Welfare implications of user innovation	In this paper we explore the implications of adding innovation by users to existing models of social welfare that currently assume innovation by manufacturers only.	User innovators	- Users tend to develop innovations that only they or a few may want, and that create a high consumer surplus for themselves { p. 73} - Users tend to develop new functionality which they require {p. 74}	*Explicitly stated:* - Users tend to develop innovations that only they or a few may want, and that create a high consumer surplus for themselves {p. 74} - Users will tend to develop products having (so far) relatively small marketplace demand—because manufacturer products are not likely to be present there—and for which the user itself has high and inelastic demand (very precise requirements) { p. 78} - Costs (product development) are fully covered by the benefit the user innovator derives from in-house use of the innovation {p. 79} - Users are the generators of information regarding their needs {p. 80} - Innovative products fill small niches of high need {p. 82}	Analysis	*Not given*
				Manufacturer innovators (Non-UI)	Manufacturers tend to develop products that many will want, and where they see a chance to capture a large share of the surplus the innovations will create {p. 73}	- Manufacturers tend to develop products that many will want, and where they see a chance to capture a large share of the surplus the innovations will create - Manufacturers can study these early user innovations to gain information about both emerging market needs and possible solutions that would be difficult to obtain otherwise		
Franke, & Shah (2002)	Empirical	How communities support innovative activities: an exploration of assistance and sharing among end-users	This study is the first to explicitly examine how user-innovators gather the information and assistance they need to develop their ideas and how they share and diffuse the resulting innovations.	User innovators	- Research has shown that many important industrial product and process innovations are developed within firms where the product is used, rather than by firms who manufacturer the product for sale to others (von Hippel, 1988) {p. 157} - User-innovators expect to benefit by direct use (Enos, 1962; Knight, 1963; Freeman, 1968; Shaw, 1985; von Hippel, 1988) {p. 158}	*Explicit characteristics identified in sample (UI):* - Newness, Urgency, Market Potential, Commercialisation {p. 163}	Interviews with questionnaires	Sample of communities engaged in innovative activity (sailplaning, kayoing, boarder cross, handicapped cycling)
Hienerth (2006)	Empirical	The commercialization of user innovations: the development of the rodeo kayak industry	In this study, we analyse the commercialization process of user innovations in open communities.	User innovators	- User innovators generate new applications, products and problem solutions (in different development stages) themselves, often based on existing	*Explicit sample criteria*: {p. 279} - Type of innovation: radical innovation - Innovation motive: individual needs, fun - Competition (technical/economical): no competition - Industry life-cycle:	Case study analysis	Sample of 410 registered starters and staff members in the rodeo kayak industry

					products from manufacturers, developing new uses and techniques or completely new products and solutions - User innovators have a direct personal need but usually no commercial interest. Thus, no manufacturer is involved in their innovative activities; users themselves test and retest their innovations (von Hippel, 1988; von Hippel and Tyre, 1995; Thomke and von Hippel, 2002) {p. 275}	pre-industry stage Implicitly stated: - Innovated, designed and shaped new products and materials according to their personal needs {p. 280} - Modification of existing products {p. 280} - Want to create something new for own use {p. 281}		
Bogers, Afuah, & Bastian (2010)	Theoretical	Users as Innovators: A Review, Critique, and Future Research Directions	In this article, the authors review this growing literature, critique it, and develop some of the research questions that could be explored to contribute to this literature and to the theoretical perspectives that underpin the literature.	Intermediate user as innovator	Intermediate users are users such as firms that use equipment and components from producers to produce goods and services. Intermediate users also include, for example, scientists, librarians, webmasters, and surgeons {p. 859}	*Explicitly stated:* Users innovate because their knowledge is sticky and they expect to benefit significantly from using the innovation {p. 861}	Review & critique	*Not given*
				Consumer user as innovator	Consumer users-users of consumer goods are typically individual end customers or a community of end users {p. 859}	Users innovate because they draw on sticky and local knowledge, and they expect to benefit from using and possibly selling the innovation and from enjoying the innovation process {p. 861}		
Luthje, Herstatt, & von Hippel (2002)	Empirical	The dominant role of 'local' information in user innovation: the case of mountain biking	In this paper we examine the specificity with which innovations developed by user-innovators address their in-house needs.	User innovators	- User innovators do tend to develop innovations to serve precisely their own needs. - They do not do this out of ignorance of the market: user-innovators in our sample have an accurate understanding of the breadth of potential marketplace demand for the innovations that they have developed (p. 2)	*Explicitly stated characteristics:* - Newness, technical sophistication, personal benefit, market potential *Findings:* - User-innovators do not stray significantly from attempting to solve their own in-house needs {p. 2} - User-innovators tend to use only their own pre-existing stocks of solution-related knowledge to develop their innovations {p. 2} - Users operate in a "low-cost innovation zone" when they develop innovations precisely responsive to problems they encounter in the normal course of their activities, and that they address by using solution information already in hand {p. 3} Reported that they gained a high personal benefit from using their innovations in their own mountain biking activities {p. 16} The higher the amount and "extreme nature" of use experience, the more probable that a user has ideas and concepts for new or improved products {p. 19}	Survey	2 samples of Mountain bikers (255 members of MTB clubs, 1,209 members of MTB online forums)
Luthje (2004)	Empirical	Innovating consumers	The author reports on a survey of the innovation activities and characteristics of 153 users of outdoor-related consumer products.	Innovating consumers	*Not explicitly stated*	*Explicit findings:* - Expectation of innovation related benefits {p. 5} - Level of user expertise - Use expertise: frequent use of products {p. 6} - Product related knowledge: know-how	Survey	153 users of outdoor-related consumer product

						about the product architecture and the used materials and technologies of the existing products in the market {p. 6} - Modifications of existing product parts as well as the addition of new elements to existing goods {p. 9-10} - Significant: commitment to product & innovation related core benefit {p. 14} - Not-significant: expected financial reward {p. 14}		
Gambardella, Raasch, & von Hippel (2016)	Theoretical	The User Innovation Paradigm: Impacts on Markets and Welfare	We build a microeconomic model of a market that incorporates demand side innovation and competition.	Single user innovator	- Single firm or individual that creates an innovation in order to use it - Examples: single firm creating a process machine in order to use it, a surgeon creating a new medical device in order to use it, and an individual consumer creating a new piece of sporting equipment in order to use it (von Hippel 2005) {p. 1452} - Innovating users find it viable to develop and self-provide innovative designs related to the producer	*Explicit criteria & implicit through model:* - User activities with no producers involved {p. 1452} - Users developing new products/services to serve their own in-house needs {p. 1453} - Users possess sticky information regarding their needs and context of use (von Hippel 2005) {p. 1453} - Innovations produced for own use but many users have similar interests {p. 1453} - Users derive utility from using the innovation they have created & from the innovating process (fun, learning) {p. 1456} - Maximise utility {p. 1456}	Logical analysis; theoretical model	*Not given*
				Producer innovator (non UI)	- Single firm or individual anticipating profiting from their designs by selling design information or products based on that "recipe" to others: by definition, they obtain no direct use-value from them. - Examples: firm or individual that patents an invention and licenses it to others and a firm that develops a new product or service to sell to its customers (von Hippel 2005, Baldwin & von Hippel 2011). {p.1452} Non-innovating users do not have a viable option of innovating. - Their costs may be too high, for example, because they lack needed skills or access to tools {p. 1455}	*Not given*		
De Jong (2016)	Theoretical	The empirical scope of user innovation	This chapter summarizes and discusses the empirical work concerned with the scope of user innovation in broader samples.	User innovators	- User innovation refers to innovations developed by end users, rather than by producers {p. 3} - User-innovators can be either firms or individual consumers. They are distinguished from producer-innovators by the fact that they expect to benefit from their innovation efforts by using a	*Explicitly stated*: - To qualify as a process innovator it is sufficient to adopt a piece of technique, equipment or software, while user innovation excludes adoption, and requires some kind of development effort and functional novelty {p. 5} > Consumers may innovate in their leisure time by creating and/or modifying everyday items for their own benefit {p. 7} - Respondents knew of equivalent products	Summary of other work	*Not given*

					product or a service. All others, lumped together under the term 'producers' only benefit from innovation by selling their output by licensing or product commercialization (von Hippel, 2005) {p. 3} - Innovating user firms modify existing techniques, equipment or software for in-house use, or create those entirely from scratch for internal purposes (von Hippel, 2005) {p. 4}	already available on the market, or if they had developed the innovation as part of their jobs, their claimed innovations were excluded {p. 7-8} - Consumer surveys shows that in absolute numbers, many consumers develop or modify products for personal use, and spend considerable time and money on it {p. 8} - It is important to distinguish user innovation from broader process innovation indicators --> no adoptions {p. 5}		
Von Hippel, De Jong, & Flower (2012)	Empirical	Comparing business and household sector innovation in consumer products: findings from a representative study in the United Kingdom	Measuring the development and modification of consumer products by product users in a representative sample of 1,173 UK consumers aged 18 and over.	User innovators	- Individual consumers who develop or modify consumer products are "household sector innovators," where the household sector is defined as com prising individuals in all resident households and also includes their unincorporated businesses (Ferran, 2000) {p. 1670} - User innovators are defined as innovators who expect to benefit from their innovation via use rather than from production and sales (von Hippel 1988, 2005). User innovators can be firms or individual consumers. When they are consumers working independently of their jobs to solve their own consumer needs, they also fall within the category of household sector innovators (Ferran 2000) {p. 1670}	*Explicitly from survey questions:* - Created a product from scratch or modified a product {p. 1672} - They often accomplish this by modifying and combining items that they have around the house or purchase at low cost to create a new or modified product to serve a n		
				Non-UI	*Not explicitly stated*	- The respondent knew of an equivalent product available on the market {p.1673} - That he or she could have bought, rather than creating a "homebuilt" one - Whether the innovation had been developed as part of the respondent's - Lack of novel user-developed content		

Table 31: Literature Reviews on Smart City Development

Author(s)	Year of publication	Times cited (total)	Times cited (per year)	Title	Journal/ Other
Albino, Berardi & Dangelico (2015)	2015	1566	261	Smart Cities: Definitions, Dimensions, Performance, and Initiatives	Journal of Urban Technology
Nam & Pardo (2011)	2011	1967	197	Conceptualizing Smart City with Dimensions of Technology, People and Institutions	12th Annual International Digital Government Research Conference
Ahvenniemi et al. (2017)	2017	484	121	What are the differences between sustainable and smart cities?	Cities
Meijer & Bolívar (2016)	2016	575	115	Governing the smart city: a review of the literature on smart urban governance	International review of administrative sciences
Cocchia (2014)	2014	621	89	Smart and digital city: A systematic literature review	Smart City
Silva, Khan & Han (2018)	2018	247	82	Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities	Sustainable Cities and Society
Ismagilova et al. (2019)	2019	105	53	Smart cities: Advances in research- An information systems perspective	International Journal of Information Management
Yigitcanlar et al. (2018)	2018	111	37	Understanding 'smart cities': Intertwining development drivers with desired outcomes in a multidimensional framework	Cities
Hojer & Wangel (2014)	2014	256	37	Smart Sustainable Cities: Definition and Challenges	ICT Innovations for Sustainability
Allam & Newman (2018)	2018	93	31	Redefining the Smart City: Culture, Metabolism and Governance	Smart City
Wilhelm & Ruhlandt (2018)	2018	73	24	The governance of smart cities: a systematic literature review	Cities
Eremia, Toma, & Sanduleac (2017)	2017	86	22	The smart city concept in the 21st century	Procedia Engineering
Dameri & Rosenthal-Sabroux (2014)	2014	90	13	Smart City and Value Creation	Smart City
Cavada, Hunt, & Rogers (2014)	2014	59	8	Smart Cities: Contradicting Definitions and Unclear Measures	World Sustainability Forum
Hasija, Shen, & Teo (2020)	2020	3	3	Smart City Operations: Modeling Challenges and Opportunities	Manufacturing & Service Operations Management
Winkowska, Szpilko, & Pejić (2019)	2019	4	2	Smart city concept in the light of the literature review	Engineering Management in Production and Services
Bleus, & Crutzen (2018)	2018	1	0	Business Model and Smart City, a Literature Review	ISPIM Innovation Conference
Abdi & Shahbazitabar (2020)	2020	0	0	Smart City: A review on concepts, definitions, standards, experiments, and challenges	Journal of Energy Management and Technology
Adiyarta et al. (2020)	2020	0	0	Analysis of smart city indicators based on prisma: systematic review	IOP Conference
Samarakkody, Kulatunga & Dilum Bandara (2019)	2019	0	0	What differentiates a smart city? A comparison with a basic city	Proceedings 8th World Construction Symposium

Table 32: Complete Literature Base for Smart City Index

Author(s)	Year of Publication	Times cited (total)	Times cited (per year)	Title	Journal/ Other	Definition of smart city	Keywords in definition
Caragliu, Del Bo, & Nijkamp (2011)	2011	3325	332.50	Smart Cities in Europe	Journal of Urban Technology	A city is smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance	Human capital, social capital, investment, modern, ICT, sustainable, economic, growth, quality of life, resource management, governance, city, transport
Townsend (2013)	2013	1617	202.13	Smart cities—big data, civic hackers and the quest for a New Utopia	Book	Smart cities are places where information technology is combined with infrastructure, architecture, everyday objects, and even our own bodies to address social, economic and environmental problems	IT, infrastructure, social wealth, place, social, economic, environmental
Neirotti et al. (2014)	2014	1381	197.29	Current trends in smart city initiatives–some stylised facts	Cities	Smart cities are characterized by a pervasive use of Information and Communication Technologies (ICT), which, in various urban domains, help cities make better use of their resources	ICT, urban, resource management
Hollands (2008)	2008	2439	187.62	Will the real smart city please stand up?	City: analysis of urban trends, culture, theory, policy, action	Smart city as (1) a celebratory label, (2) a marketing hype rather than a practical engine for infrastructural change, and (3) a loaded term carrying an uncritical, pro-development stance. For the author serious smart city projects consider human capital as the most important component.	City, monitoring, integration, optimization, resource management, maintenance, security, citizen, services, infrastructure, energy
Backici et al. (2012)	2012	727	80.78	A Smart City initiative: The Case of Barcelona	Journal of the Knowledge Economy	Smart city as a high-tech intensive and advanced city that connects people, information and city elements using new technologies in order to create a sustainable, greener city, competitive and innovative commerce, and an increased life quality.	Technology, social, city, information, sustainable, green, innovation, competition, quality of life, business
Harrison et al. (2010)	2010	861	78.27	Foundations for Smarter Cities	IBM Journal of Research and Development	A city connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city	City, IT, social, infrastructure, intelligence, business
Lombardi et al. (2012)	2012	650	72.22	Modelling the Smart City Performance	Innovation: The European Journal of Social Science Research	The application of information and communications technology (ICT) with their effects on human capital/education, social and relational capital, and environmental issues is often indicated by the notion of smart city.	ICT, education, human capital, social capital, relational capital, environmental
Lee, Hancock, & Hu (2014)	2014	500	71.43	Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco	Technological Forecasting and Social Change	A smart city aims to resolve various urban problems (public service unavailability or shortages, traffic, over-development, pressure on land, environmental or sanitation shortcomings and other forms of inequality) through ICT-based technology connected up as an urban infrastructure. The ultimate goal is to revitalize some of the city's structural (environmental and social) imbalances through the efficient redirection of information. Smart cities are envisioned as creating a better, more sustainable city, in which people's quality of life is higher, their environment more liveable and their economic prospects stronger.	Solutions, environmental, inequality, ICT, infrastructure, efficiency, sustainable, city, quality of life, livability, economic, social, information
Washburn & Sindhu (2010)	2010	683	62.09	Helping CIOs Understand "smart City" Initiatives: Defining the Smart City, Its Drivers, and the Role of the CIO	Cambridge, MA: Forrester Research, Inc.	The use of smart computing technologies to make the critical infrastructure components and services of a city- which include city administration, education, healthcare, public safety, real estate, transportation, and utilities - more intelligent, interconnected and efficient	Technology, infrastructure, services (administration, education, healthcare, public safety, real estate, transportation, utilities), intelligence, interconnected, efficiency
Gretzel et al. (2015, p. 559)	2015	343	57.17	Conceptual foundations for understanding smart tourism ecosystems	Computers in Human Behavior	A smart city is a city that uses advanced ICT to optimize resource production and consumption	ICT, resource management
Zygiaris (2013)	2013	451	56.38	Smart City Reference Model: Assisting Planners to Conceptualize the Building of Smart City	Journal of the Knowledge Economy	The term "smart city" is understood as a certain intellectual ability that addresses several innovative socio-technical and socio-economic aspects of growth. These aspects lead to smart city conceptions as "green" referring to urban infrastructure for environment protection and reduction of CO2	Intelligence, innovation, technology, economic, growth, green, infrastructure, environment, interconnected, intelligence, information, data, sensors, activators, knowledge, creative, human capital, city

				Innovation Ecosystems		emission, "interconnected" related to revolution of broadband economy, "intelligent" declaring the capacity to produce added value information from the processing of city's real-time data from sensors and activators, whereas the terms "innovating", "knowledge" cities interchangeably refer to the city's ability to raise innovation based on knowledgeable and creative human capital	
Lazaroiu & Roscia (2012)	2012	462	51.33	Definition Methodology for the Smart Cities Model	Energy	A community of average technology size, interconnected and sustainable, comfortable, attractive and secure.	Community, technology, sustainable, interconnected, comfortable, attractive, security
Antopoulos et al. (2019)	2019	101	50.50	A Unified Smart City Model (USCM) for smart city conceptualization and benchmarking	Smart Cities and Smart Spaces: Concepts, Methodologies, Tools, and Applications	All means of innovations in the urban atmosphere (ICT-based, yet not necessarily) that purpose to improve the city dimensions including economy, people, government, mobility, environment and living	Innovation, urban, ICT, economy, people, government, mobility, environment, quality of life
Dameri (2013)	2013	360	45.00	Searching for smart city definition: A comprehensive proposal	International Journal of Computer Technology	A Smart City is a well-defined geographical area, in which high technologies such as ICT, logistic, energy production, and so on, cooperate to create benefits for citizens in terms of well-being, inclusion and participation, environmental quality, intelligent development; it is governed by a well-defined pool of subjects, able to state the rules and policy for the city government and development"	Geographical area, technology, energy, well-being, citizen, inclusion, participation, environmental, intelligence, development, rules, policy, governance, ICT, logistics
Marsal-Llacuna et al. (2015)	2015	258	43.00	Lessons in urban monitoring taken from sustainable and livable cities to better address the Smart City initiative	Technological Forecasting and Social Change	Smart Cities initiatives try to improve urban performance by using data, information and information technologies (IT) to provide more efficient services to citizens, to monitor and optimize existing infrastructure, to increase collaboration among different economic actors, and to encourage innovative business models in both the private and public sectors.	Urban, data, services, citizens, efficient, innovation, IT, monitoring, optimization, infrastructure, collaboration, economic, governance, performance, information
Piro et al. (2014, p. 169)	2014	291	41.57	Information centric services in smart cities	Journal of Systems and Software	A smart city is intended as an urban environment which, supported by pervasive ICT systems, is able to offer advanced and innovative services to citizens in order to improve the overall quality of their life.	ICT, innovation, social, quality of life, urban, citizens, services
Hernandez-Munoz et al. (2011)	2011	409	40.90	Smart cities at the forefront of the future internet	The future internet assembly	A city that represents an extraordinary rich ecosystem to promote the generation of massive deployments of city-scale applications and services for a large number of activity sectors	City, ecosystem, services
Khatoun & Zeadally (2016, p. 46)	2016	202	40.40	Smart cities: Concepts, architectures, research opportunities	Communications of the ACM	A smart city is an ultra-modern urban area that addresses the needs of businesses, institutions and especially citizens	Urban, business, institutions, citizens, modern
van Zoonen (2016, p. 472)	2016	164	32.80	Privacy concerns in smart cities	Government Information Quarterly	In a smart city, ICT-infused infrastructures enable the extensive monitoring and steering of city maintenance, mobility, air and water quality, energy usage, visitor movements, neighbourhood sentiment, and so on.	ICT, monitoring, resource management, transportation, city, mobility, energy, maintenance, community
Winters (2011)	2011	310	31.00	Why are smart cities growing? Who moves and who stays	Journal of Regional Science	I consider "smart cities" to be metropolitan areas with a large share of the adult population with a college degree	Urban, citizens, high education
Gil-Garcia, Zhang, & Puron-Cid (2016)	2016	153	30.60	Conceptualizing smartness in government: An integrative and multi-dimensional view	Government Information Quarterly	A city is smart when there are actions taken towards innovation in management, technology, and policy, all of which entail risks and opportunities	Innovation, management, technology, policy, opportunities, risks, city
Toppeta (2010)	2010	318	28.91	How innovation and ict can build smart, "livable", sustainable cities	Innovation Knowledge Foundation	A city "combining ICT and Web 2.0 technology with other organizational, design and planning efforts to dematerialize and speed up bureaucratic processes and help to identify new, innovative solutions to city management complexity, in order to improve sustainability and livability	ICT, technology, design, planning, governance, innovation, solutions, sustainability, livability, efficiency, management, city, organization
Schuurman et al. (2012, p. 51)	2012	243	27.00	Smart ideas for smart cities: Investigating crowdsourcing for generating and selecting ideas for ICT innovation in a city context	Journal of Theoretical and Applied Electronic Commerce Research	In smart cities collaborative digital environments facilitate the development of innovative applications, starting form the human capital of the city, rather than believing that the digitalization *in se* can transform can improve cities.	Innovation, improvement, development, collaboration, human capital, city, digital

Kourtit et al. (2012)	2012	240	26.67	Smart Cities in Perspective - a Comparative European Study by Means of Self-organizing Maps	Innovation: The European Journal of Social Science Research	Smart cities have high productivity as they have a relatively high share of highly educated people, knowledge-intensive jobs, output-oriented planning systems, creative activities and sustainability-oriented initiatives.	Productivity, education, (skilled) job, creativity, sustainability, planning, systems, activities
Huovila et al. (2019)	2019	51	25.50	Comparative analysis of standardized indicators for Smart sustainable cities: What indicators and standards to use and when?	Cities	An innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects	Innovation, city, ICT, quality of life, efficiency, services, competition, economic, social, environmental, cultural, sustainable
Hall et al. (2000)	2000	533	25.38	The vision of a smart city	2nd International Life Extension Technology Workshop (Paris)	An urban centre of the future, made safe, secure environmentally green, and efficient because all structures–whether for power, water, transportation, etc. are designed, constructed, and maintained making use of advanced, integrated materials, sensors, electronics, and networks which are interfaced with computerized systems comprised of databases, tracking, and decision-making algorithms	Urban, green, efficiency, integration, interface, ICT, algorithms, safety, security, transportation, energy, water, design, sensors, networks, technology, database
Lee & Lee (2014, p. 93)	2014	175	25.00	Developing and Validating a citizen-centric typology for smart city services	Government Information Quarterly	A city which develops and manages a variety of innovative services that provide information to all citizens about all aspects of city life via interactive and internet-based applications	City, innovation, information, services, ICT, technology, citizens, internet, livability
Belissent (2010)	2010	266	24.18	Getting clever about smart cities: New opportunities require new business models	Cambridge: Forrester	A city that uses ICTs to make the critical infrastructure components and services of a city–administration, education, healthcare, public safety, real estate, transportation, and utilities–more aware, interactive, and efficient	ICT, infrastructure, services (administration, education, healthcare, public safety, real estate, transportation, utilities), interaction, efficiency
Pereira et al. (2017, p. 528)	2017	88	22.00	Delivering public value through open government data initiatives in a smart city context.	Information Systems Frontiers	A smart city encompass an efficient, technologically advanced, sustainable and socially inclusive city	Efficient, technology, sustainable, social, inclusion, city
Zhuhadar et al. (2017, p. 274)	2017	86	21.50	The next wave of innovation-Review of smart cities intelligent operation systems.	Computers in Human Behavior	Those cities that have the greatest quality of life and economic wellbeing for their citizens	Quality of life, economic, well-being, citizens, city
Paskaleva (2009)	2009	257	21.42	Enabling the smart city: The progress of city e-governance in Europe	International Journal of Innovation and Regional Development	A city that takes advantages of the opportunities offered by ICT in increasing local prosperity and competitiveness–an approach that implies integrated urban development involving multi-actor, multi-sector and multi-level perspectives	ICT, development, competition, opportunities, collaboration, city, prosperity
Komninos (2011)	2011	214	21.40	Intelligent Cities: Variable Geometries of Spatial Intelligence	Intelligent Buildings International	(Smart) cities as territories with high capacity for learning and innovation, which is built-in the creativity of their population, their institutions of knowledge creation, and their digital infrastructure for communication and knowledge management.	Territories, learning, innovation, creativity, knowledge, digital, citizens, ICT
Kourtit & Nijkamp (2012)	2012	187	20.78	Smart Cities in the Innovation Age	Innovation: The European Journal of Social Science Research	Smart cities are the result of knowledge-intensive and creative strategies aiming at enhancing the socio-economic, ecological, logistic and competitive performance of cities. Such smart cities are based on a promising mix of human capital (e.g. skilled labor force), infrastructural capital (e.g. high-tech communication facilities), social capital (e.g. intense and open network linkages) and entrepreneurial capital (e.g. creative and risk-taking business activities).	City, economic, ecological, logistic and competitive performance, human capital, social capital, entrepreneurship, creativity, knowledge, infrastructure, business
Odendaal (2003)	2003	366	20.33	Information and communication technology and local governance: understanding the difference between cities in developed	Computers, Environment and Urban Systems	A city that capitalises on the opportunities presented by ICTs in promoting its prosperity and influence.	City, opportunities, ICT, capitalization, prosperity

				and emerging economies			
Xie et al. (2019)	2019	37	18.50	A Survey of Blockchain Technology Applies to Smart Cities: Research Issues and Challenges	IEEE Communications Surveys and Tutorials	Upgraded quality of life, sustainable urban environment, use of advanced ICT, public government openness, encouraged community participation, effective management of traffic and public transport, intelligent device control, optimum resource utilization, improved environmental protection, and improved public services	Quality of life, sustainable, urban, ICT, governance, community, participation, efficiency, transport, resource management, environmental, public services
Lara et al. (2016)	2016	92	18.40	Smartness that matters: Towards a comprehensive and human-centred characterisation of smart cities	Journal of Open Innovation: Technology, Market, and Complexity	A community that systematically promotes the overall wellbeing for all of its members, and flexible enough to proactively and sustainably become an increasingly better place to live, work and play	Community, well-being, livability, sustainability, proactive, citizens, flexibility, quality of life
Yeh (2017, p. 556)	2017	72	18.00	The effects of successful ICT-based smart city services: From citizens' perspectives	Government Information Quarterly	A general definition involves the implementation and deployment of information and communication technology (ICT) infrastructures to support social and urban growth through improving the economy, citizens' involvement and government efficiency	ICT, social, growth, urban, economy, efficiency, citizen (involvement), government
Hussain et al. (2015, p. 253)	2015	107	17.83	Health and emergency-care platform for the elderly and disabled people in the smart city	Journal of Systems and Software	The smart cities are using digital technologies to enhance the quality and performance of urban services	Digital, technology, quality, performance, urban, services
Ygitcanlar (2015)	2015	100	16.67	Smart cities: an effective urban development and management model?	Australian Planner	A city in which the traditional services and networks based on digital technologies are made more efficient for the benefit of its businesses, services, and inhabitants	City, technology, digital, efficiency, businesses, services, networks, inhabitants
Gascó-Hernandez (2018, p. 50)	2018	45	15.00	Building a smart city: lessons from Barcelona	Communications of the ACM	A smart city is an umbrella term of how information and communication technology can help improve the efficiency of a city's operations and its citizens' quality of life while also promoting the local economy	ICT, efficiency, improvement of operations, quality of life, citizens, city
Barrionuevo, Berrone, & Ricart (2012)	2012	134	14.89	Smart Cities, Sustainable Progress	IESE Insight	Being a smart city means using all available technology and resources in an intelligent and coordinated manner to develop urban centers that are at once integrated, habitable, and sustainable.	Technology, resource management, intelligence, coordination, urban, integration, sustainable, habitable
Ygitcanlar (2016)	2016	73	14.60	Technology and the city: Systems, applications and implications	New York: Routledge	An ideal form to build the sustainable cities of the 21st century, in the case that a balanced and sustainable view on economic, societal, environmental and institutional development is realised.	City, sustainable, economic, societal, environmental, institutional, development
Mahizhnan (1999)	1999	313	14.23	Smart cities: The Singapore case	Cities	Information technologies represent the key concept. The vision of an intelligent city is not confined to economic excellence that can be led by information technologies, but an integral part of this vision is its concern for the quality of life for the ordinary citizen.	IT, quality of life, economic, citizen, city
Chatterjee, Kar, & Gupta (2018)	2018	38	12.67	Success of IoT in Smart Cities of 2018 Journal India: An empirical analysis	Government Information Quarterly	Smart Cities where the citizens are expected to use Information and Communication Technology with the help of internet.	ICT, citizen, internet
Rana et al. (2018, p. 1)	2018	37	12.33	Barriers to the development of smart cities in Indian context	Information Systems Frontiers	Smart cities can be defined as a technologically advanced and modernised territory with a certain intellectual ability that deals with various social, technical, economic aspects of growth based on smart computing techniques to develop superior infrastructure constituents and services	Technological, intelligence, social, technical, economic, infrastructure, modern, services, growth, territory
Komninos et al. (2015)	2015	72	12.00	Smart city ontologies: Improving the effectiveness of smart city applications	URENIO Research	Smart cities are created by a convergence of top-down and bottom-up processes, wherein market forces and strategic planning come together to build broadband networks, urban operational systems, embedded systems, and software, all of which change the functioning and life in cities.	Top-down, bottom-up, planning, network, operational, systems, software, quality of life, city
Giffinger et al. (2007)	2007	148	10.57	Smart cities: ranking of European medium-sized cities	Vienna: Centre of Regional Science - Vienna UT	A city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens	Economy, people, governance, mobility, environment, livability, awareness, citizens, activities, self-decisive, city

Thite (2011)	2011	105	10.50	Smart Cities: Implications of Urban Planning for Human Resource Development	Human Resource Development International	Creative or smart city experiments [. . .] aimed at nurturing a creative economy through investment in quality of life which in turn attracts knowledge workers to live and work in smart cities. The nexus of competitive advantage has [. . .] shifted to those regions that can generate, retain, and attract the best talent.	Creativity, economic, quality of life, livability, competitive advantage, talent acquirement, knowledge
Cretu (2012)	2012	84	9.33	Smart Cities Design Using Event-driven Paradigm and Semantic Web	Informatica Economica	A smart city has well designed ICT infrastructure, transforms real time data into meaningful information, a smart city allows inhabitants to predefine automated actions in response to events	ICT, data, information, inhabitants, automation, events
Eger (2009)	2009	110	9.17	Smart growth, smart cities, and the crisis at the pump a worldwide phenomenon	The Journal of E-Government Policy and Regulation	A particular idea of local community, one where city governments, enterprises and residents use ICTs to reinvent and reinforce the community's role in the new service economy, create jobs locally and improve the quality of community life	Community, governance, technology, livability, productivity, ICT, quality of life, city, businesses, inhabitant, economy
Bartoli et al. (2011)	2011	85	8.50	Security and privacy in your smart city	Proceedings of the Barcelona smart cities congress	The main topics are SCs are related to of their smart inhabitants, quality of social interaction, educational degree, integration with public life, as well as openness to the wider world.	Inhabitants, social, education, integration, openness
Peng, Nunes & Zheng (2017)	2017	32	8.00	Impacts of low citizen awareness and usage in smart city services: the case of London's smart parking system	Information Systems and e-Business Management	Smart cities are essentially built by utilising a set of advanced information and communication technologies (ICT), including smart hardware devices (e.g. wireless sensors, smart meters, smart vehicles, and smartphones), mobile networks (e.g. WIF, 3G/4G/5G network), data storage technologies (e.g. data warehouse, cloud platform), and software applications (e.g. back-office control systems, mobile apps, big data analytical tools)	ICT, data, network, technology, software, hardware, devices
Chen (2010)	2010	88	8.00	Smart Grids, Smart Cities Need Better Networks	IEEE Network	Smart cities will take advantage of communications and sensor capabilities sewn into the cities' infrastructures to optimize electrical, transportation, and other logistical operations supporting daily life, thereby improving the quality of life for everyone	Communications, sensors, infrastructure, optimization, electricity, transportation, logistics, quality of life
Corbett and Mellouli (2017, p. 428)	2017	31	7.75	Winning the SDG battle in cities: How an integrated information ecosystem can contribute to the achievement of the 2030 sustainable development goals	Information Systems Journal	Smart cities seek to leverage advanced communication technologies and IS (information systems) in order to improve all areas of city administration, enhance citizens' quality of life, engage citizens and provide more sustainable and resilient public services	ICT, city, administration, quality of life, citizen (engagement), sustainable, services
Thuzar (2011)	2011	77	7.70	Urbanization in SouthEast Asia: developing smart cities for the future?	Regional Outlook	Smart cities of the future will need sustainable urban development policies where all residents, including the poor, can live well and the attraction of the towns and cities is preserved. […] Smart cities are […] cities that have a high quality of life; those that pursue sustainable economic development through investments in human and social capital, and traditional and modern communications infrastructure (transport and information communication technology); and manage natural resources through participatory policies. Smart cities should also be sustainable, converging economic, social, and environmental goals	Development, city, quality of life, policy, inhabitants, human capital, social capital, ICT, resource management, sustainable, economic, environmental, infrastructure, transport, modern
Schiavonea, Paolonec, & Mancinia (2019)	2019	15	7.50	Business model innovation for 2019 urban smartization	Technological Forecasting & Social Change	Smart cities are the result of a combination of investments made in resources (human, social, creative, infrastructural, technological and business capital) that encourage sustainable economic growth under the conditions of a strong management and governance system (Caragliu et al., 2011)	Investments, resources, sustainable, economic, growth, governance, human capital, social capital, creativity, infrastructure, business capital, technology
Schaffers et al. (2012, p. 2)	2012	66	7.33	Special issue on smart applications for smart cities - new approaches to innovation: Guest editors' introduction	Journal of Theoretical and Applied Electronic Commerce Research	The smart city is an urban innovation ecosystem, a living laboratory acting as agent of change	Urban, innovation, ecosystem, laboratory

Zhao (2011)	2011	70	7.00	Towards sustainable cities in China: Analysis and assessment of some Chinese cities in 2008	Berlin: Springer	A city that improves the quality of life, including ecological, cultural, political, institutional, social, and economic components without leaving a burden on future generations.	City, quality of life, ecological, cultural, political, institutional, social, economic, sustainable
Heaton & Parkilad (2019)	2019	14	7.00	A conceptual framework for the alignment of infrastructure assets to citizen requirements within a Smart Cities Framework	Cities	The concept of Smart City engages with cities' stakeholders and encompasses all of the built and natural environment	City, stakeholders, environment
Rios (2012)	2012	62	6.89	Creating the smart city	Thesis	A city that gives inspiration, shares culture, knowledge, and life, a city that motivates its inhabitants to create and flourish in their own lives—it is an admired city, a vessel to intelligence, but ultimately an incubator of empowered spaces	City, culture, knowledge, life, intelligence, inhabitants, incubator
El-Haddadeh et al. (2018, p. 1)	2018	20	6.67	Examining citizens' perceived value of internet of things technologies in facilitating public sector services engagement	Government Information Quarterly	Smart cities are all about networks of sensors, smart devices, real-time data, and ICT integration in every aspect of human life	Network (of sensors, smart devices, real-time data), ICT, citizen
Qian et al. (2019)	2019	13	6.50	The Internet of Things for Smart Cities: Technologies and Applications (Guest editorial)	IEEE Network	Human and societal capital investments, modern-day communication, infrastructure, sustainable economic growth, participatory governance, natural resources management, and advanced infrastructure (physical, modern ICT, social, and business) integration to sustain the city's collective intelligence	ICT, communication, sustainable, economic, growth, governance, resource management, human capital, social capital, investment, physical infrastructure, business, integration, intelligence
Outlook (2014)	2014	43	6.14	Early Release Overview	US Energy Information Administration	A city that uses ICT to be more interactive, efficient, and making citizens more aware of what is happening in the city.	City, ICT, interaction, efficiency, awareness, citizens
Calderoni, Maio, & Palmieri (2012, p. 74)	2012	55	6.11	Location-aware mobile services for a smart city: Design, implementation, and deployment	Journal of Theoretical and Applied Electronic Commerce Research	A smart city is high-performance urban context, where citizens are more aware of, and more integrated into the city life, thanks to an intelligent city information system	Performance, urban, citizen, awareness, integration, IT
Partridge (2004)	2004	96	5.65	Developing a human perspective to the digital divide in the smart city	ALIA 2004 Biennial Conference: Challenging ideas, Gold Coast, Australia	A city that actively embraces new technologies seeking to be a more open society where technology makes easier for people to have their say, gain access to services and to stay in touch with what is happening around them, simply and cheaply	City, technology, quality of life, services, openness
Alkandari, Alnasheet, & Alshaikhli (2012)	2012	48	5.33	Smart cities: a survey	Journal of Advanced Computer science and Technology Research	A city that uses a smart system characterised by the interaction between infrastructure, capital, behaviours and cultures, achieved through their integration	Systems, interaction, integration, infrastructure, capital, behaviour, city, culture
Heo et al. (2014)	2014	35	5.00	Escaping from ancient Rome! Applications and challenges for designing smart cities	Transactions on Emerging Telecommunications Technologies	An urban environment which able to improve the quality of citizens' life by using ICT systems	Urban, quality of life, citizens, ICT
Chong et al. (2018, p. 10)	2018	14	4.67	Dynamic capabilities of a smart city: An innovative approach to discovering urban problems and solutions	Government Information Quaterly	Smart city is an integration of infrastructures and technology-mediated services, social learning for strengthening human infrastructure, and governance for institutional improvement and citizen engagement	Integration, infrastructure, technology, services, social learning, human, governance, instiutional, improvement, citizen (engagement)
Guan (2012)	2012	41	4.56	Smart Steps To A Battery City	Government News	A city that is prepared to provide conditions for a healthy and happy community under the challenging conditions that global, environmental, economic and social trends may bring.	City, community, challenges, environment, economic, social, quality of life, global
Shafiullah et al. (2010)	2010	44	4.00	Potential challenges: integrating renewable energy with the smart grid	20th Australasian Universities Power Engineering Conference	Smart cities are characterized by the pervasive use of ICT to smartness application in natural resources and energy, transportation and mobility, buildings, living, government, economy, and people.	ICT, energy, transportation, mobility, buildings, living, government, economy, people, resource management
Chang et al. (september, 2019)	2019	5	2.50	Multivariate relationships between campus	Applied Energy	The main features of the smart city are smart economy, smart mobility, smart environment,	Economy, mobility, environment, people, living, governance

				design parameters and energy performance using reinforcement learning and parametric modeling		smart people, smart living, and smart governance.	
Mandeville et al. (2014)	2014	17	2.43	Mapping smart cities in the EU	Economic and scientific policy	A city seeking to address public issues via ICT-based solutions on the basis of a multi-stakeholder, municipally based partnership	City, ICT, solutions, issues, partnerships, municipality
David & Koch (2019)	2019	3	1.50	"Smart Is Not Smart Enough!" Anticipating Critical Raw Material Use in Smart City Concepts: The Example of Smart Grids	Urban Transformations Towards Sustainability	A city that tries to make resource production and allocation in urban areas more efficient, and thus more sustainable through new sociotechnical innovations such as smart grids, smart meters, or solar panels.	City, resource management, efficiency, sustainable, innovation, technology (solar panels, smart meters, smart grids), urban

Table 33: Appearances of keywords in definitions

#	Themes	% of appearances in total number of definitions
1.	Technology (data, sensors, activators, internet, ICT, IT, database, algorithm, grid, digital, solar panels, smart meters, WIFI, software, hardware, smart devices)	80.9%
2.	City/ urban challenges (territory, place, geographical area)	75.6%
3.	Sustainability (green, environmental, ecological)	50.2%
4.	ICT (if 1, also add 1 to technology)	49.6%
5.	Social capital (social, social wealth, inclusion, community)	48.4%
6.	Economic (economy)	38.6%
7.	Quality of life (liveability, prosperity, habitable, well-being)	38.1%
8.	Human capital (intelligence, skilled workers/ jobs, (high) education, knowledge)	35.4%
9.	Resource management	34.8%
10.	Infrastructure	32.2%
11.	Citizen (inhabitants, people)	29.2%
12.	Transportation (mobility, transport)	23.4%
13.	Innovation	17.8%
14.	Growth	17.5%
15.	Efficiency (efficient)	14.3%
16.	Safety (security)	14.1%
17.	Energy	10.9%
18.	Business (entrepreneurship)	10.5%
19.	Integration	10.5%
20..	Collaboration (participation, partnership, relational capital, coordination, stakeholder)	9.5%
21.	Network (interconnected)	8.6%
22.	Creativity	5.8%