IRIS Utrecht presenteert:

Founders' human capital and technology-based start-ups: Determinant of success?

Auteur:
Maaike Hermse

Achtergrond/context van het rapport of product:
Because of urbanization and the pressure on the quality of life in cities that comes with it, it is relevant to know how smart city initiatives can be encouraged. This thesis looks at the human capital of smart city startups to gain a better insight into what makes them thrive.

Kernvraag:
Is founders' human capital a determinant of success for technology-based new ventures?

Samenvatting:
Start-ups are essential in bringing innovation to the market. However, their survival chances are not that great. Looking at what makes a new venture successful can prove useful for entrepreneurs and policymakers in mitigating this problem. This paper is thus an attempt to get a better insight into what makes start-ups thrive, focusing specifically on education and work experience. For this purpose, I collected data on the education and experience of the founders of 194 Dutch start-ups. In light of the context of smart city entrepreneurship, the sample consists solely of technology-based start-ups. The effect of these factors was tested on three variables of success: survival, investment, and firm size. Even though the empirical results are not consistent across the three measures, the results of this paper have some implications. Based on this sample, it seems that entrepreneurial experience positively influences new venture survival and firm size. Additionally, start-up classified as smart city as well as the number of founders, are positively related to investment. Finally, work experience has a positive effect on the survival chance of a start-up.

Tags:
Human capital; start-up success; smart city; technology

Contact:
m.m.hermse@students.uu.nl

Master Thesis U.S.E.

Founders' human capital and technology-based new ventures: determinant of success?

Maaike Hermse (5672945)
m.m.hermse@students.uu.nl

Supervisor: Friedemann Polzin

Abstract: Start-ups are essential in bringing innovation to the market. However, their survival chances are not that great. Looking at what makes a new venture successful can prove useful for entrepreneurs and policymakers in mitigating this problem. This paper is thus an attempt to get a better insight into what makes start-ups thrive, focusing specifically on education and work experience. For this purpose, I collected data on the education and experience of the founders of 194 Dutch start-ups. In light of the context of smart city entrepreneurship, the sample consists solely of technology-based start-ups. The effect of these factors was tested on three variables of success: survival, investment, and firm size. Even though the empirical results are not consistent across the three measures, the results of this paper have some implications. Based on this sample, it seems that entrepreneurial experience positively influences new venture survival and firm size. Additionally, start-up classified as smart city as well as the number of founders, are positively related to investment. Finally, work experience has a positive effect on the survival chance of a start-up. No significance was found of education in the economic and technical field.

JEL codes: L25, L26, C12
Keywords: Human capital, start-up success, smart city, technology

---

[1] I want to thank Friedemann Polzin and Mark Sanders for their supervision and useful feedback throughout this whole process. I also want to thank Jip Leendertse and Loek Zanders for helping us with the classification scheme of smart city start-ups ups. Additionally, I would like to thank my fellow students, especially Imke Nijland and Martina Picari, for their helpful comments and support in conceptualizing this thesis.

Table of Contents

1. Introduction

This paper is an attempt to provide better insight into what makes start-ups successful. A start-up is a new organisation built on innovation in terms of technologies, business models, or both (Kollmann et al., 2016). It is commonly agreed upon that start-ups play an essential role in the economy by facilitating growth and creating employment (Brown et al., 2019; Fritsch & Noseleit, 2012). Furthermore, they have advantages compared to more mature firms, including the capacity to be flexible in a dynamic environment (Audretsch, 2004). However, a high proportion of start-ups fail each year (Colombo & Grilli, 2005). Since innovation is vital in driving economic development (Baumol, 2002), it is useful for both entrepreneurs and policymakers to know what it takes to make a start-up successful. Even though many contexts might benefit from this influx of innovation, this paper steers more towards the context of innovative solutions for urban challenges.

Urban areas have an important social and economic role, therefore attracting new inhabitants each year (Mori & Christodoulou, 2012). In the European Union, it is projected that by 2050 around 84% of the population will live in cities (European Commission, 2019). This increase in citizens brings forward particular challenges such as a substantial increase in the use of water, electricity, and other resources, as well as a higher amount of waste, pollution, and congestion. Generally, it leads to a decrease in the quality of life of its inhabitants (Brennan, 1999). Over the last decades, potential solutions for these urban challenges have been collected under the concept of smart city solutions. There is no clear definition of what makes a city smart; however, looking at literature, some common ground is found. The idea is that by using technology and collaborating among different stakeholders, the city can be made more efficient and sustainable. In practice, it can range from renewable energy sources for transportation (Brenna et al., 2012) to using sensors in making urban parking easier for the public. Overall, it's meant to improve the liveability of the city (Caragliu, Del Bo, & Nijkamp, 2011; Lombardi et al., 2012). In this context, scholars state the importance of successful entrepreneurship in finding new technologies or business models that contribute to making the smart city come to life (Harrington, 2017). Thus, knowing what factors determine a successful start-up can help governments better stimulate new ventures contributing to urban innovation (Keeble, 1993).

Although the existing literature on smart city entrepreneurship is still in an early stage, papers on what determines success for start-ups, in general, are abundant. Based on our working paper on smart city start-ups (see Appendix A), we found that, among others, human capital plays an essential role in smart cities. Human capital consists of the skills and knowledge that individuals acquire through investments in formal education, corporate training, and other experiences (Becker, 1964). Even though human capital is a well-studied concept in terms of its effect on success, there still are some inconsistencies in researchers' findings (Unger et al., 2011). Some scholars argue that indeed human capital has a positive influence on start-up success (Brüderl, Preisendörfer, & Ziegler, 1992; Giones, Gozun, & Miralles, 2019). However, other research has shown a negative impact (Stuart & Abetti, 1990) or even no significance of human capital at all (Khan et al., 2019; Stuetzer, Goethner, & Cantner, 2012). Possible explanations for these inconsistencies are (1) a lack of focus on the context of the new firm (Ratinho et al., 2020), (2) the differences among focusses on start-up team (Cooper, Gimeno-Gascon, & Woo, 1994) and entrepreneurs (Bosma et al., 2004; Gimeno et al., 1997), and (3) the different proxies that are collected under the umbrella term of human capital, such as education and industry experience. Finally, defining the multidimensional concept of success proves to be not so straight forward (Eveleens, Van Rijnsoever, & Niesten, 2016).

The aim of this paper is thus to determine the effect of certain human capital factors on start-up success while taking into account the different choices stated above. In light of the context of smart city entrepreneurship, the focus is put on technology-based new ventures in specific. Smart city start-ups form a sub-set in the technology-based ventures. Furthermore, the constructs of human capital are measured across the founders of the start-up. Finally, to mediate for the multidimensional nature of success (Stam, Arzlanian, & Elfring, 2014), I consider three measures. The research question is as follows:

Is founders' human capital a determinant of success for technology-based new ventures?

The focus of this question is two-fold: (1) technology-based start-ups, and (2) smart city start-ups. To test the hypotheses that follow from the literature review on the topic of human capital and start-up success, I collect data on founders' human capital for a sample of 194 Dutch, technology-based start-ups. After executing multiple regression, the results are described and discussed in the subsequent section. The theoretical and practical implications are furthermore discussed, as well as the limitations and possibilities for future research.

2. Theory

2.1 Start-up success

Start-ups have a role to play in society. A start-up is a new organisation built on innovation in terms of technologies, business models, or both (Kollmann et al., 2016). These new ventures, if successful, play an essential role in facilitating economic growth by creating new employment and increasing innovation (Brown et al., 2019; Fritsch & Noseleit, 2012). However, in this rapidly changing innovative environment, a high proportion of start-ups fail (Colombo & Grilli, 2005). Therefore, scholars attempt to get more insight into what makes a start-up successful and what does not.

Over the last decades, success has been a recurring concept in literature. However, it is not clear what success exactly entails. Since the concept is multidimensional by nature (Stam et al., 2014), it isn't straight forward to measure. One commonly chosen construct is survival. Even though surviving as a business doesn't always mean success is achieved, Brüderl et al. (1992) consider it a good indicator of success, nevertheless. Next, growth also holds importance for scholars when referring to a successful venture. Gupta, Guha, and Krishnaswami (2013) state that a start-up is successful when it is growing and can, therefore, be measured by revenue, sales, and employee growth. Furthermore, also receiving venture capital indicates success (Spiegel et al., 2016). Although receiving external investment is difficult (Van Osnabrugge, 2000), the start-ups that manage to get funded are more likely to grow (Colombo & Grilli, 2010). Thus, capturing success in multiple ways is important in the existing literature on factors influencing it.

In the existing literature, the factors of start-up success are often categorised into three groups: external, firm-associated, and entrepreneur-associated factors (Sandberg & Hofer, 1987). The first category is related to the environment in which the firm operates. Research has shown that, in this category, market size, entry-level, and industry type have an influence (Chrisman, Bauerschmidt, & Hofer, 1998; Schutjens & Wever, 2000). In the second category, scholars argue the importance of firm size (Schutjens & Wever, 2000), the presence of a business partner (Groenewegen & De Langen, 2012), start-up capital (Brüderl et al., 1992; Lasch, Le Roy, & Yami, 2007, and the quality of the business plan (Groenewegen & De Langen, 2012). Finally, factors linked to the entrepreneur of the venture include age (Van Praag, 2003), gender (Block & Sandner, 2007), push and pull factors (Busstra & Verhoef, 1993), social capital (Baron & Markman, 2003), and human capital. In this thesis, I explore the relationship between human capital and success.

2.2 Human capital and start-up success

Since a company's success is partially dependent on external and internal resources (Cooper et al., 1994), it is interesting to research human capital’s influence on it. As a start-up is smaller than big corporations, it can, therefore, be argued that the resources come from internal sources (Cooper et al., 1994). One possible resource is the personal contributions of the entrepreneur; in other words, founders' human capital (Krueger & Brazeal, 1994).

The human capital theory of Becker (1964) forms the foundation of the existing literature. Becker (1964) states that human capital consists of the skills and knowledge that individuals acquire through investments in formal education, corporate training and other experiences. A variety of measures are used to capture human capital, including formal education, business classes, work experience, and related industry experience (Unger et al., 2011). Some research on this concept has explicitly looked at the distinction between two types, namely general and specific (Giones et al., 2019; Rauch & Rijskdijk, 2013). General human capital is seen as the acquisition of knowledge that is not directly tied to a specific experience, which covers general work experience, and education. Specific capital is then related to the knowledge gained while holding a particular position in a firm or a particular experience. This knowledge is, therefore, less transferable in general. Commonly used concepts to measure specific capital are start-up experience, industry experience, and managerial experience (Delmar & Shane, 2006). Initially, the concept of human capital was used in research to test its effect on the distribution of employee income (Unger et al., 2011). It, therefore, used to appear more in research on large corporations. However, as of the end of the last century, scholars have increasingly applied the acquirement of knowledge to an entrepreneurial context, including start-up success (Bates, 1990; Bosma et al., 2004; Dencker, Gruber, & Shah, 2009).

Even though there is a large amount of research on the effect of human capital on start-up success, the results are inconsistent. To achieve success, on the one hand, scholars argue that a founders' human capital has a positive effect on its chance to survive (Brüderl et al. 1992; Lussier & Corman, 1995). A meta-analysis of Unger et al. (2011) supports that finding, showing a small but significant relationship between human capital and start-up success. On the other hand, Stuart and Abetti (1990) found a negative influence of the level of education on the success of a start-up. They argue that the time spent gaining practical skills while actually managing a new firm is more important than the knowledge acquired in higher education. Finally, other scholars have even shown that there is no significant effect of human capital on start-up success (Davidsson & Honig, 2003; Khan et al., 2019; Stuetzer et al., 2012).

These different findings show the diversity in literature on human capital. The variety of these outcomes can be explained by several factors, based on the literature review done for this thesis. Firstly, the concept of success, as previously discussed, is not easy to measure in one single way. Thus, by using different constructs in both holistic and specific human capital-related research, different effects arise. Secondly, human capital is an umbrella term, enveloping various tangible and intangible aspects particular to an individual. In literature, the level of education and years of general work experience are two common variables when researching effect on a business' success (Bates, 1990; Dahl & Reichstein, 2007; Khan et al., 2019). Thirdly, research is specific to countries and industries or types of start-ups. Some research was carried out on American firms (Gimeno et al., 1997; Shrader & Siegel, 2007), others on Dutch (Bosma et al., 2004; Van Praag, 2003) and Swedish new ventures (Davidsson & Honig, 2003). Additionally, some scholars focus more on mixed industries and a mix of start-ups types (Bosma et al., 2004; Brüderl et al., 1992; Cooper et al., 1994; Dahl & Reichstein, 2007), while others focus more on specific contexts such as incubated firms (Gimmon & Levie, 2010; Peña, 2002) and high-tech start-ups (Colombo & Grilli, 2010; Hsu, 2007; Shrader & Siegel, 2007). Fourthly, another difference is that some scholars focus on the entrepreneur (Bates, 1990; Bosma et al., 2004; Denker et al., 2009; Gimeno et al., 1997), while others focus more on the venture itself (Colombo & Grilli, 2010; Cooper et al., 1994; Peña, 2002; Stuart & Abetti, 1990).

In light of these diverse findings, I opt to focus on one specific context: technology-based start-ups. In entrepreneurial literature, defining a particular context is essential, yet often overlooked (Ratinho et al., 2020). In this paper, I do not distinguish between high-tech or low-tech, as Unger et al. (2011) show that the effect of human capital is equally as strong for both. Scholars suggest that the knowledge of an entrepreneur affects his or her ability to adapt (Dencker et al., 2009). Since the industry of technology-based firms is considered dynamic, entrepreneurs need to be able to quickly adapt to environmental changes (Unger et al., 2011). Shane (2000) argues that this entrepreneurial knowledge flows from prior work experience and education. Thus, education and work experience form the focus of this paper. An overview of previous research specific to these two constructs can be found in Appendix B.

The multitude of tangible and intangible assets brought to the table is essential for the survival and growth of new ventures (Bates, 1990) and sets one firm apart from the other. These skills and competencies of individuals come from different sources and are collected throughout his or her lifetime (Katz, 1994). Some researchers argue that higher educated individuals are more capable of processing information, especially in an innovative environment (Hambrick & Mason, 1984). Additionally, in terms of attracting external capital, highly educated entrepreneurs have a more appealing profile (Baum & Silverman, 2004; Cooper et al., 1994). Therefore, this intangible knowledge that flows from education might influence success. Although general education has already gotten much attention by scholars (Bosma et al., 2004; Brüderl et al., 1992; Cooper et al., 1994), the field of education has been less studied. Two relevant educational areas in research on technology-based firms are business and technology (Ratzinger et al., 2017). Although Davidsson and Honig (2003) did not find an influence of business education on success, other scholars did (Kollmann, 2006; Ratzinger et al., 2017). They argue that in the technology industry, a specific skill set that is matched to this industry improves the chance of success. Thus, an understanding of business or a technical background may prove useful in making a new venture succeed. Finally, these internal resources of human capital can come from multiple sources: founders and employees. However, the specific knowledge of a founder might prove more effective for they have a high stake in their company (Colombo & Grilli, 2010). Therefore, this thesis focuses on the founders' education in two different educational fields: economic and technical. Thus, the hypotheses regarding education and its effect on the success of technology-based start-up are as follows:

> *H1. Founders' education in an economic field has a positive effect on the success of technology-based start-ups*

> *H2. Founders' education in a technical field has a positive effect on the success of technology-based start-ups*

Next to education, founders' general work experience might also influence the success of a start-up. Individuals' lack of education can be compensated by practical experience (Gruber, MacMillan, & Thompson, 2010). On-the-job training and real-life challenges can give a more functional and applied intangible knowledge that can also be useful in solving practical problems (Sternberg, 2004). The challenges entrepreneurs were confronted by in their previous position might facilitate the hurdles encountered during the early stages of founding a new venture (Bosma et al., 2004; Rauch & Rijsdijk, 2013). Thus, the hypothesis regarding work experience and its effect on the success of technology-based start-ups is as follows:

> *H3. Founders' work experience has a positive effect on the success of technology-based start-ups*

2.3 Smart city start-up success

The three hypotheses above apply to the more general context of this thesis, mainly technology-based firms. One specific start-up that falls under this type is the smart city start-up. Over the last decades, literature shows an increased interest in smart cities. However, what makes a city smart is still up for debate. The definition of Caragliu et al. (2011, p.50) gives some insight into what it entails. They define a city as 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". Through this definition, it becomes clear that the challenges a city faces require multiple efforts and collaboration to solve. ICT and technology, in general, play an essential role in this context (Chourabi et al., 2012; Lombardi et al., 2012). Furthermore, innovations are used to make life in the city more efficient and improve the quality of life of its inhabitants (Nam & Pardo, 2011). Additionally, an essential factor for smart cities seems to be human capital, specifically a highly educated workforce (Harrison et al., 2010; Lombardi et al., 2012). This is where entrepreneurship comes in. Harrington (2017) argues that one of the four pillars of smart cities consists of entrepreneurs and highlights their importance in society for building innovative organisations. Due to the argued importance of entrepreneurship, it is interesting to look at the factors of success for smart city start-ups in specific. However, this field remains rather unexplored. In light of the highly innovative context, based on technology, and the theory stated above about education (Kollmann, 2006; Ratzinger et al., 2017), here technical knowledge might affect smart city start-ups in specific. The hypothesis for smart city start-ups is thus as follows:

> *H4. Founders' education in a technical field has a positive effect on the success of smart city start-ups*

3. Empirical strategy

3.1 Research design and data collection

In this study, I use a quantitative cross-sectional approach to test the effect of founders' human capital on the success of technology-based, including smart city, start-ups. This research follows a deductive logic with the firm as the unit of analysis.

The initial data was collected from Crunchbase, an online database for start-ups. Over the last years, it has increasingly been used in the field of economic and managerial research (Dalle, den Besten, & Menon, 2017), making it a useful database for the scope of this thesis. It is good to mention that its online content is sourced from multiple channels. Among others, it uses publicly available information, venture capitalists, and data partners to gather information. The content is also partly sourced by the crowd, which is moderated before uploading (Dalle et al., 2017). From this database, I collected information on the name, location, employees, founders, and investment of the start-ups. However, solely the data on investment was considered as complete in the downloaded sample. All other required information was partially or completely not available via this source. Therefore, LinkedIn, company websites, Facebook, Twitter, and Google were used as additional sources to fill in the missing data on start-up success, founders, and market characteristics (see Table 1). Additionally, the information on the status of the firm was not reliable on Crunchbase. Therefore, I determined survival using the company's LinkedIn, website, Facebook and Twitter page. When available, the sites Drimble.nl and Tracxn.com were used.

The initial data was narrowed down in the following ways. Firstly, the chosen sample was taken from start-ups founded in the Netherlands in 2016. This four-year period after the foundation is argued as an appropriate timeframe in research on early-stage firm survival and economic growth (Fritsch & Noseleit, 2012). Next, a selection of the following cities was made: Amsterdam, Rotterdam, The Hague, Utrecht, Eindhoven, and Delft. The first five represent the largest cities in the Netherlands (Statista, 2020); therefore, suitable for research on smart cities (Mora & Bolici, 2017). Also, Amsterdam is seen as the first smart city in Europe (Hollands, 2008). Additionally, Delft was selected in light of the focus in technology-based new ventures. It has the top technical university in the country and is the location of the first Dutch tech-incubator of the Netherlands, YES!Delft. The choice of these cities thus gives a good approximation of the status of smart city entrepreneurship in 2016. For determining whether a company is technology-based, I use the SCI (Hermse et al., 2020).

The final sample consists of 194 technology-based start-ups. It represents the companies for which all data on the founders' human capital was found. This data collection was done in May 2020. Finally, both failed and survived companies are included in the sample in an attempt to eliminate survival bias.

Table 1: Overview of data collection sources

Data	Variable	Sources
Start-up success	Survival Investment Size	LinkedIn, company website, Twitter, Facebook, Drimble.nl, Tracxn.nl Crunchbase LinkedIn
Founders' human capital	Education Experience	LinkedIn LinkedIn, company website

3.2 Dependent variables

This section contains the operationalisation of the dependent, independent, and control variables used in this research. An overview can be found in Table 7 (see Appendix C). Foremost, the dependent variable in this paper is success. In terms of choosing variables, Venkatraman and Ramanujan (1986) highlight the choice between financial and non-financial indicators. As discussed before, it is recommended to measure success using multiple variables. By doing this, the validity of the variable increases (Eveleens et al., 2016). Therefore, at least one variable from both financial and non-financial categories is chosen. Thus, firstly, I use the variable of start-up *Survival* (Eveleens, 2019; Groenewegen & De Langen, 2012; Millan, Congregado, & Roman, 2010; Van Praag, 2003). It is operationalised as a binary variable that measures whether a company is still operating at the time of the data collection. Note here that acquired start-ups are coded as survived (Bates, 1990). The second non-financial variable is the *Size* (Colombo & Grilli, 2010; Davidsson & Honig, Giones et al., 2019; 2003; Peña, 2002). The firm's number of employees at the time of data collection operationalises this variable. If the company did not survive, this variable was set to zero. Thirdly is a financial variable: *Investment* (Colombo & Grilli, 2010; Gimmon & Levie, 2010; Hsu, 2007). This concept was operationalised as a binary variable that reflects whether the start-up was externally funded or not.

3.3 Independent variables

In this research, I use five independent variables. The first two are used to classify a start-up as smart but do so in a different way. Firstly, *Smart city*, which is operationalised as a binary variable coded one if the firm is smart city; zero if it is not. Secondly, *Smart city score,* a categorical variable ranging from 0-6 – where 0 to 1 is equal to the *smart city* binary variable and 2 to 6 are intensity factors (Hermse et al., 2020). The next two independent variables measure the founders' education. Education is often operationalised as the achieved level, ranging from a high school degree to a master's degree and higher (Dahl & Reichstein, 2007; Hsu, 2007; Schuntjes & Wever, 2000). Here, however, I measure education for two specific fields, economic and technical education (Colombo & Grilli, 2010). Firstly, *Economic education* is operationalised as the average years of higher education across founders followed in the economic. In terms of economic field, management, marketing, business, finance, econometrics, and entrepreneurship are included. Secondly, *Technical education* is operationalised as the average years of higher education across founders followed in the technical field. In terms of technical field, science, (industrial) engineering, AI, computer science, IT, and architecture are included. The term higher education includes both University and University of Applied Sciences degrees. The decision to measure the average is to correct for the number of founders. The choice to measure years is made in order to better represent the entrepreneurs that have educational experience in both fields (f.e a bachelor's in engineering and a master's in business administration). Finally, the fifth independent variable is years of *Work experience*. This is operationalised as the average of the number of years of full-time employment across founders, in any sector. Here, military duty, freelance work, and assisting jobs during studies are not taken into account.

3.4 Controls

For the models in this thesis, I use four control variables, represented in research as human capital factors that influence start-up success. The first is *Entrepreneurial experience.* Scholars argue that the skills learnt by doing are an essential element of the knowledge that the founders bring to the start-up (Delmar & Shane, 2006). *Entrepreneurial experience* is operationalised by a binary variable that is coded one when at least one founder has prior experience in founding a start-up (Cassar, 2014; Delmar & Shane, 2006). Another control that influences success is the size of the founding team (Cooper, Woo, & Dunkelberg, 1989). Research has shown that larger teams bring more resources in the company

(Beckman, Burton, & O'Reilly, 2007; Dencker et al., 2009; Ratzinger et al., 2017). It also is a criterium on which venture capitalists select to finance a start-up (Baum & Silverman, 2004). Industries based on a high level of technology might need more resources, therefore, team are encouraged (Gartner, 1985). The *Number of founders* is operationalised as a count variable reflecting the number of initial founders of the new venture. Next, differences in *Gender* are controlled for by introducing the percentage of males in a founding team (Chowdhury, 2005; Leendertse, 2018). However, even though scholars have found that females a more prone to failure (Block & Sandner, 2007), it has been shown that females still constitute a minority in the pool of entrepreneurs (Millan et al., 2010). Furthermore, research shows that market type also has an effect on success (Eveleens, 2019; Haber & Reichel, 2007). It is operationalised as a binary variable *Market B2C,* coded zero when a company operates in a B2B environment and one when it operates in a B2C. Note here that in case both situations apply, the variable is coded zero.

3.5 Descriptive statistics

The sample consists of 194 start-ups for which all required data was available. Table 2 shows the number of observations, the mean, standard deviation, and range for each variable I use. In terms of dependent variables, *Survival* is the first one. In this sample, 28 out of 194 companies did not survive, setting the percentage of survived firms at 85.6%. For the second variable *Investment*, the proportion is way lower: one-third of the start-ups received external funding. The last dependent variable is *Size*, measured in the number of employees. The range of this variable is altered after taking out two severe outliers, decreasing the maximum value from 1316 to 102 (see Appendix D). The average number of employees is 10.5. Furthermore, in terms of independent variables, both *Economic education* and *Technical education* have low means, respectively, an average of 1.7 years and 2.5 years per founder. Both standard deviations are higher than the means, which has to do with the high number of zeros in the data sample. Finally, the average *Work experience* is 10.4 years per founder. In terms of control variables, 66.5% of the start-ups has at least one founder with prior *Entrepreneurial experience*. With regards to the variable *Gender*, the sample is heavily skewed towards a high percentage of males in the founding team. This is due to the small number of women in this dataset. The average *Number of founders* lies close to 2. In the ample, around 48% of the start-ups are founded by two individuals. Finally, the industry is in 32.5% of the cases a *Market B2C.*

Table 2: Descriptive statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Survival	194	0.856	0.352	0	1
Investment	194	0.330	0.471	0	1
Size	192	10.495	13.813	0	102
Smart city	194	0.119	0.324	0	1
Smart city score	194	0.371	1.085	0	6
Economic education	194	1.733	2.169	0	11
Technical education	194	2.490	3.108	0	13.5
Work experience	194	10.386	6.360	0	29.7
Entrepreneurial experience	194	0.665	0.473	0	1
Gender	194	0.904	0.257	0	1
Number of founders	194	1.773	0.762	1	4
Market B2C	194	0.325	0.469	0	1

Next, I show the results of coding the dataset using the SCI (Hermse et al., 2020). In Table 3, both absolute numbers and percentages are shown per city and per theme. The themes are the following: "City" (*City)*, "Technology" (*Tech)*, "Quality of life" (*Qual of Life)*, "Citizen" (*Citiz*), "Sustainability" (*Sust)*, "ICT" (*ICT*), and "Economic" (*Econ*). Since the sample consists only of technology-based start-ups, the percentage of "Technology" is logically always 100%. Note that when "ICT" is coded one, "Technology" is also coded one – not vice versa. Additionally, "Citizen" can only be coded when there is a mention of the keyword "City". In total, I found twenty-three smart city start-ups in this sample (see Table 3), consisting of 11.9%. In the last column of Table 3, it is clear the largest city, Amsterdam, has the highest number of smart city start-ups of the sample, constituting of 43.5%. This leans toward supporting the approach on smart city research of Mora & Bolici (2017). Furthermore, the smaller the city gets, the lower the percentages, except for The Hague. Out of thirteen technology-based start-ups, not one was smart city. Even though this sample doesn't show any smart city initiatives in 2016, the city started to make an effort in 2018 (Sangen, 2018). What is interesting to see is that Rotterdam has the highest percentage of smart city ventures. This is the same year a Rotterdam-led initiative regarding Smart City was approved (Gemeente Rotterdam, 2016). The approval came for a subsidy of the EU in light of the Horizon 2020 programme, which supports initiatives regarding ICT, Energy and Mobility. Furthermore, a high percentage of technology-based start-ups in the sample are based on ICT (83.5%), supporting its importance found in definitions (Caragliu et al., 2011). Finally, in the business ideas behind the start-ups, an effort to make cost-effective initiatives is made evident by the 30.9% of the cases that cover the theme "Economic".

Table 3: Results of smart city coding

Location	#		City	Tech	Qual of Life	Citiz	Sust	ICT	Econ	SC (#)	SC (% of sample)
Amsterdam	109	#	10	109	10	5	16	99	38	**10**	**43.5%**
		%	9.2%	100%	9.2%	50.0%	14.7%	90.8%	34.9%		
Rotterdam	30	#	6	30	8	12	6	21	9	**6**	**26.1%**
		%	20.0%	100%	26.7%	40.0%	20.0%	70.0%	30.0%		
The Hague	13	#	0	13	0	0	2	10	1	**0**	**0.0%**
		%	0.0%	100%	0.0%	0.0%	15.4%	76.9%	7.7%		
Utrecht	19	#	3	19	3	1	4	17	4	**3**	**13.0%**
		%	15.8%	100%	15.8%	0.0%	21.1%	89.5%	21.1%		
Eindhoven	6	#	2	6	1	1	1	3	2	**2**	**8.7%**
		%	33.3%	100%	16.7%	16.7%	16.7%	50.0%	33.3%		
Delft	17	#	2	17	4	2	6	12	6	**2**	**8.7%**
		%	11.8%	100%	23.5%	11.8%	35.3%	70.6%	35.3%		
Total sample	**194**	**#**	**23**	**194**	**26**	**5**	**35**	**162**	**60**	**23**	**100.0%**
		%	**11.9%**	**100%**	**13.4%**	**2.6%**	**18.0%**	**83.5%**	**30.9%**		

3.6 Data analysis

To test the relationship between the dependent and independent variables of this research, I regress a series of models using Stata (StataCorp, 2013). The independent variables *Survival* and *Investment* are both binary variables. Thus, a Binary Logit Model (BLM) is a suitable regression to use for these two dependents. The third dependent *Size* is measured by the number of employees and consists of a count variable. A variable is considered as such when it only has positive, nonnegative integer values (Hilbe, 2014). In this case, using OLS can cause biased results (Coxe, West, & Aiken, 2009), thus, a different model is applied. For count variables, either a Poisson or Negative Binomial model would be an appropriate choice (Long, 1997). To test whether Poisson is a good fit, I check for overdispersion or whether the variance is significantly higher than the mean (see Appendix E). For this variable, the overdispersion is significantly high, therefore, the Negative Binomial model is preferred.

Before I regress the models, I need to verify the required assumptions. The first assumption is multicollinearity. For this, I check the variational inflation factors (see Table 11 in Appendix F). The values are relatively high for smart city and smart city score (>9), since the first variable is nested in the score variable. Next, the interaction effect between smart city score and technological education also shows a highly correlation due to the multiplication of these two variables. The remaining values are below 2; therefore, no problem of multicollinearity persists (Field, Miles, & Field, 2012). Additionally, I also make a Spearman's correlation matrix (see Table 5). In Table 5, the highly correlated variables are again the two smart city variables. Additionally, the values in the table show a slightly positive relationship between *Survival* and *Size*, whereas the association between *Survival* and

Investment is negative. Finally, I check the distribution of *Size* for outliers. This is used in combination with Nick Cox's extremes, which gives the five highest and lowest values of a variable. Based on these graphics, I regress *Size* excluding the high outliers. The test with outliers gave a substantially different outcome, therefore, they were taken out.

For each of the three independent variables, I regress five models (see Appendix G). Model 1 contains only the control variables. Model 2 consists of adding the independent variables of education and experience to the control variables, completed with the binary *Smart city* variable. In Model 4, I then add the interaction variable between *Smart city* and *Technical education.* Model 3 consists then of adding the independent variables, complemented with the *Smart city score* variable, whereas Model 5 contains the interaction effect of the *Smart city score* and *Technical education*. To assess the individual performance of the models, I use a McFadden pseudo-R-squared test. A performant model gets a value between 0.2 and 0.4 (McFadden, 1973). I afterwards perform a *lrtest*, which measures the likelihood ratio of the models in comparison with Model 1.

Table 4: Correlations

	Variables	1	2	3	4	5	6	7
1	Survival	1.000						
2	Investment	-0.052	1.000					
3	Size	0.314	0.232	1.000				
4	Smart city	0.062	0.147	-0.017	1.000			
5	Smart city score	0.088	0.173	-0.002	0.935	1.000		
6	Economic education	0.040	-0.086	0.110	-0.024	-0.004	1.000	
7	Technical education	-0.074	0.136	-0.049	-0.054	-0.028	-0.410	1.000
8	Work experience	0.187	-0.151	0.032	-0.006	0.009	-0.001	-0.065
9	Entrepreneurial experience	0.177	0.125	0.157	0.023	0.071	0.010	-0.096
10	Gender	-0.069	0.069	0.077	-0.017	0.018	0.115	0.161
11	Number of founders	0.011	0.241	0.119	-0.162	-0.129	-0.049	0.037
12	Market B2C	-0.120	0.047	0.055	0.152	0.096	0.047	-0.080

	Variables	8	9	10	11	12
1	Survival					
2	Investment					
3	Size					
4	Smart city					
5	Smart city score					
6	Economic education					
7	Technical education					
8	Work experience	1.000				
9	Entrepreneurial experience	0.171	1.000			
10	Gender	-0.003	0.035	1.000		
11	Number of founders	-0.077	0.222	0.104	1.000	
12	Market B2C	-0.165	0.024	-0.071	0.035	1.000

4. Results

Table 5 shows the results of the models testing the effect of the independent variables on success. The first column of each variable shows the results of the control model, the second shows the results of the full model using the binary variable for *Smart city,* and finally, the third column shows the results of the full model using the variable of *Smart city score*.

Table 5: Regression of models testing the effect of human capital on success

	Dependent variable								
	SURVIVAL			INVESTMENT			SIZE		
Var	Control	Full (binary)	Full (score)	Control	Full (binary)	Full (score)	Control	Full (binary)	Full (score)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SMART -CITY		0.027 (0.075)			0.294** (0.148)			0.010 (0.318)	
SC SCORE			0.022 (0.034)			0.077* (0.043)			0.008 (0.102)
SC*TEC HEDUC		0.043 (0.053)			0.008 (0.038)			-0.025 (0.090)	
SCORE *TECH EDUC			0.015 (0.022)			0.007 (0.014)			-0.009 (0.028)
ECO-EDUC		0.006 (0.011)	0.006 (0.012)		-0.006 (0.019)	-0.008 (0.019)		0.053 (0.041)	0.053 (0.041)
TECH-EDUC		-0.005 (0.007)	-0.004 (0.004)		0.018 (0.014)	0.017 (0.014)		-0.008 (0.030)	-0.001 (0.030)
WORK EXP		0.007** (0.004)	0.007* (0.004)		-0.013** (0.006)	-0.013** (0.006)		-0.002 (0.014)	-0.002 (0.014)
ENTRE-EXP	0.139** (0.061)	0.094* (0.056)	0.090* (0.055)	0.081 (0.073)	0.116 (0.075)	0.105 (0.076)	0.422** (0.181)	0.435** (0.188)	0.436** (0.188)
GEN-DER	-0.124 (0.110)	-0.110 (0.101)	-0.107 (0.098)	0.102 (0.153)	0.068 (0.161)	0.060 (0.163)	0.475 (0.333)	0.425 (0.341)	0.422 (0.340)
NFOUD-ERS	-0.010 (0.032)	-0.001 (0.029)	0.001 (0.028)	0.131*** (0.047)	0.145*** (0.049)	0.143*** (0.050)	0.130 (0.114)	0.128 (0.116)	0.129 (0.116)
MARK-ET B2C	-0.100* (0.057)	-0.098* (0.056)	-0.094* (0.054)	0.046 (0.075)	-0.003 (0.077)	0.005 (0.077)	0.103 (0.176)	0.185 (0.177)	0.104 (0.177)
Cons-tant	-	-	-	-	-	-	1.339*** (0.366)	1.306*** (0.405)	1.304*** (0.397)
Obser-vations	194	194	194	194	194	194	192	192	192
McFadd-en R2	0.065	0.112	0.115	0.052	0.114	0.118	0.008	0.010	0.010
Log Likeli-hood	-74.880	-71.124	-70.828	-116.560	-109.015	-108.474	-644.485	-643.333	-643.314
LR-test		7.51	8.10		15.09**	16.17***		2.30	2.34

*Note: *p<0.10, **p<0.05, ***p<0.01*

The fit of the models of *Survival* and *Investment* are both significant at a 5%-level. To keep consistency across the different dependent variables, I keep the same variables in the regression of *Size*. However, here the group of independent variables does not reliably predict the dependent variable (prob>chi2 is above 10%). Furthermore, looking at the McFadden value for *Survival*, it grows substantially from 0.065 to 0.115 when adding the independent variables and the interaction effect. It shows an improvement in the performance of the model. The same goes for the models of *Investment*. Here, the *lrtest* I use is significant at a 5%-level for the comparison between the two models and the control model, meaning it increases the effect on *Investment* significantly. Finally, the performance of the regression on *Size* is very insignificant, apparent by the low McFadden value (0.010).

Overall, the results in Table 5 show that there is little consistency in the effect of each independent variable on different variables measuring success. The insignificant results of education across the dependent variables provide evidence that hypothesis 1 and 2 cannot be supported. *Economic education* has a slightly positive but insignificant effect on *Survival* and *Size*, whereas this effect is negative for *Investment*. This relationship is probably affected by the negative correlation between *Investment* and the other dependent variables (see Table 4). The effect of *Technical education* is also insignificant on smart city start-ups, comparable to Colombo and Grilli (2010). Interesting is the difference in the effect of *Technical education* between the whole sample and smart city entrepreneurship. Although it is really small, where *Technical education* negatively affects technology-based start-ups, it has a slight positive, however insignificant, effect on smart city start-ups. Thus, overall hypothesis 4 is also rejected. Furthermore, *Work experience* does not have a generally positive impact on success, thus, hypothesis 3 is also rejected. However, the influence is significant on *Survival*, supporting the theory that more work experience increases the chance of survival (Brüderl et al., 1992; Ratzinger et al., 2017). Finally, an interesting finding has to do with the variable of smart city start-ups. Both the binary variable and the score variable have a positive effect on *Survival*, *Investment*, and *Size*. However, this effect is only significant for *Investment*, at a 5%-level for the binary variable and a 10%-level for the smart city score. In this sample, smart city start-ups are more likely to be funded.

Regarding the control variables, there are some significant effects on the dependents measuring success. Firstly, *Entrepreneurial experience* is both significant in the models of *Survival* and the models of *Size* at a 10%-level. The influence is, in both cases, positive; however, the effect is higher and more significant in the case of *Size* (at a 5%-level). Next, the effect of the *Number of founders* is also positive and significant at a 1%-level for *Investment.* Thus, a larger founding team has a positive impact on getting external financing. Furthermore, the results also show a negative effect at a significant level of 5% of the market environment in case of B2C companies, meaning that technology-based start-ups that sell products or services to consumers have less chance to succeed than technology-based start-ups in B2B environments. For *Gender,* in other words, the percentage of males in the founding team, all the effects are insignificant and take both positive to negative values for different dependents.

In terms of robustness, I use three dependent variables to measure success. Also, I regress five models for each dependent variable (see Appendix G). Furthermore, I check for the difference for smart city using a binary smart city variable and the score variable.

5. Discussion and Conclusion

5.1 Contributions and implications

The objective of this research was to examine whether founders' human capital is beneficial to the success of technology-based start-ups. Based on the results, the importance of certain intangible factors on early-stage start-ups is found. Firstly, entrepreneurial experience seems to be important in increasing the survival chance of a new firm, as well as its employee growth (Delmar & Shane, 2006). Secondly, the higher the number of founders, the higher the chance of receiving external funding. Therefore, this seems to support the claim that a higher number of founders is important for external funders (Cooper et al., 1989). Thirdly, the influence of work experience is positively related to the survival chances of a firm, which is consistent with Brüderl et al. (1992). However, the opposite effect was found on receiving external funding. This difference suggests that other factors might be more important for external funders than work experience. Fourthly, it is interesting to see that being a smart-city start-up positively influences the chance of getting externally funded. To know what the underlying factors are of this effect, additional research is needed. Generally, a theoretical implication of this paper is that the complexity regarding the multidimensional nature of success is yet again supported (Eveleens et al., 2016; Stam et al., 2014). This is shown by the multiplicity of factors contributing to one element of success, but at the same time having a negligible effect on another.

The results regarding education are inconsistent with other research. On the one hand, while choosing the same dependents for success and independents for education, the insignificance of economic education differs from Colombo and Grilli (2010). This lack of consistency may be explained by some of the following differences. Firstly, while both datasets consist of new ventures, the dataset of this paper contains Dutch firms founded in 2016 and theirs contains Italian firms founded in 1980, 2000, 2004. Thus, there is difference in time and location. Secondly, the focus of the papers differs. Colombo and Grilli (2010) focus on high-tech start-ups only, while this paper zooms out to technology-based start-ups in general. The negligible difference between high-tech and low-tech supported this decision (Unger et al., 2011); this may not be the differing factor. On the other hand, the insignificant effect of technical education supports the results of Colombo and Grilli (2010). However, other scholars did find a significant outcome (Kollmann, 2006; Ratzinger et al., 2017).

In practice, this paper has the following implications. In light of Dutch technology-based start-ups, starting entrepreneurs should not undervalue the importance of prior experience, whether it is entrepreneurial experience or work experience in general. Even though entrepreneurial experience can only be learnt by doing (Delmar & Shane, 2006), it might be useful to compensate for a lack thereof by finding a business partner who does or to appeal to external advice. Furthermore, to be part of a founding team seems to improve the chances of getting funded. Thus, when funding is essential for bringing the start-up's service or product to the market, teaming up can be a good idea.

5.2 Limitations and further research

This paper has certain limitations. Firstly, the comparison between Colombo and Grilli (2010) was less straightforward due to the lack of distinction between high- and low-tech start-ups. Even though this line of research was supported (Unger et al., 2011), it would have made comparing the outcomes more parallel. Secondly, another limitation of this paper is the short-term focus. At this point, the importance of certain human capital factors can solely be framed as determinants of success in the first phase of a start-up. Therefore, research following start-ups over a more extended period would be interesting to test the long-term effects. Thirdly, this study is merely focused on the Netherlands, making it not generalisable to other countries. Thus, to correct for these two last limitations, it would be interesting to do multi-level, longitudinal research. Here, data could be collected from multiple international cities, especially those focused on supporting smart city entrepreneurship. Additionally, the distinction between high- and low-tech industries can be further explored. Even though technology research is crucial in ventures (Taylor & Greve, 2006), technology might not have a significant effect on its own. Therefore, the combination of highly educated founders in the founding team, together with experienced partners, might prove a successful line of research based on heterogeneity research in tenure (Taylor & Greve, 2006). Fourthly, the level of formal education achieved was not included as a variable; there would have been too many, based on the number of data entries. Instead, the number of years of education was used. However, including this variable would have provided a base of comparison to other studies on formal education (Bosma et al., 2004; Brüderl et al., 1992). Lastly, another limitation consists of the choice of success measure. The chosen variables for success in this thesis are often used in research (Bates, 1990; Bosma et al., 2004; Davidsson & Honig, 2003; Van Praag, 2003), although there are many more constructs to include (Eveleens et al., 2016). For example, it would have been useful to add another financial performance measure (Venkatraman & Ramanujam, 1986), such as profit or valuation of the firm.

The results of the explorative part on smart city opens the door for future research. Start-ups classified as smart city showed a significantly positive effect on investment, for which the underlying drivers are still unknow. Furthermore, while collaborating on the Smart City Index, we found not only that human capital was a necessary condition, but also social capital. Since social capital is seen as a factor of start-up success (Baron & Markman, 2003; Davidsson & Honig, 2003), it might be interesting for future research to incorporate both constructs and test their effect successful smart city entrepreneurship.

5.3 Conclusion

Conclusively, this paper argues a positive relationship of founders' experience on the success of technology-based start-ups; however, no significant effect was found for education. Furthermore, this study is an exploratory effort regarding research on smart city entrepreneurship. The added working paper can hopefully help future research by identifying some of the key elements that make a city smart and additionally illustrate to entrepreneurs and policymakers what is key in transforming the urban area.

6. References

Audretsch, D. B. (2004). Sustaining Innovation and Growth: Public Policy Support for Entrepreneurship. *Industry & Innovation*, *11*(3), 167–191. https://doi.org/10.1080/1366271042000265366

Baron, R. A., & Markman, G. D. (2003). Beyond social capital: the role of entrepreneurs' social competence in their financial success. *Journal of Business Venturing*, *18*(1), 41–60. https://doi.org/10.1016/s0883-9026(00)00069-0

Bates, T. (1990). Entrepreneur Human Capital Inputs and Small Business Longevity. *The Review of Economics and Statistics*, *72*(4), 551–559. https://doi.org/10.2307/2109594

Baum, J. A. C., & Silverman, B. S. (2004). Picking winners or building them? Alliance, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology startups. *Journal of Business Venturing*, *19*(3), 411–436. https://doi.org/10.1016/s0883-9026(03)00038-7

Baumol, W. J. (2002). *The Free-Market Innovation Machine: Analyzing the Growth Miracle of Capitalism*. Princeton University Press: NJ.

Becker, G. (1964). Human Capital. Columbia University Press, New York.

Beckman, C. M., Burton, M. D., & O'Reilly, C. (2007). Early teams: The impact of team demography on VC financing and going public. *Journal of Business Venturing*, *22*(2), 147–173. https://doi.org/10.1016/j.jbusvent.2006.02.001

Block, J., & Sandner, P. (2007). Necessity and Opportunity Entrepreneurs and Their Duration in Self-employment: Evidence from German Micro Data. *Journal of Industry, Competition and Trade*, *9*(2), 117–137. https://doi.org/10.1007/s10842-007-0029-3

Bosma, N., van Praag, M., Thurik, R., & de Wit, G. (2004). The Value of Human and Social Capital Investments for the Business Performance of Startups. *Small Business Economics*, *23*(3), 227–236. https://doi.org/10.1023/b:sbej.0000032032.21192.72

Brenna, M., Falvo, M. C., Foiadelli, F., Martiranp, L., Massaro, F., Poli, D., & Vaccaro, A. (2012). Challenges in energy systems for the smart-cities of the future. *2012 IEEE International Energy Conference and Exhibition (ENERGYCON)*, Florence, 755–762.

Brennan, E.M. (1999). Population, Urbanization, Environment and Security. A Summary of the issue. *Comparative Urban Studies: Occasional Paper Series*, *20*, 29–50. Consulted on http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.578.8102&rep=rep1&type=pdf

Brown, J. D., Earle, J. S., Kim, M. J., & Lee, K. M. (2019). Start-ups, job creation, and founder characteristics. *Industrial and Corporate Change*, *28*(6), 1637–1672. https://doi.org/10.1093/icc/dtz030

Brüderl, J., Preisendörfer, P., & Ziegler, R. (1992). Survival Chances of Newly Founded Business Organizations. *American Sociological Review*, *57*(2), 227–242. https://doi.org/10.2307/2096207

Busstra, T.J., & Verhoef, L. H. J. (1993). *Starten op z'n best; slaag- en faalfactoren van jonge ondernemingen.* Amsterdamse Academie voor Bank en Financiën, Amsterdam.

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

Cassar, G. (2014). Industry and startup experience on entrepreneur forecast performance in new firms. *Journal of Business Venturing*, *29*(1), 137–151. https://doi.org/10.1016/j.jbusvent.2012.10.002

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., … Scholl, H. J. (2012). Understanding Smart Cities: An Integrative Framework. *45th Hawaii International Conference on System Sciences*, 2289–2297. https://doi.org/10.1109/hicss.2012.615

Chowdhury, S. (2005). Demographic diversity for building an effective entrepreneurial team: is it important? *Journal of Business Venturing*, *20*(6), 727–746. https://doi.org/10.1016/j.jbusvent.2004.07.001

Chrisman, J. J., Bauerschmidt, A., & Hofer, C. W. (1998). The Determinants of New Venture Performance: An Extended Model. *Entrepreneurship Theory and Practice*, *23*(1), 5–29. https://doi.org/10.1177/104225879802300101

Colombo, M. G., & Grilli, L. (2005). Founders' human capital and the growth of new technology-based firms: A competence-based view. *Research Policy*, *34*(6), 795–816. https://doi.org/10.1016/j.respol.2005.03.010

Colombo, M. G., & Grilli, L. (2010). On growth drivers of high-tech start-ups: Exploring the role of founders' human capital and venture capital. *Journal of Business Venturing*, *25*(6), 610–626. https://doi.org/10.1016/j.jbusvent.2009.01.005

Cooper, A. C., Gimeno-Gascon, F. J., & Woo, C. Y. (1994). Initial human and financial capital as predictors of new venture performance. *Journal of business venturing*, *9*(5), 371–395.

Cooper, A. C., Woo, C. Y., & Dunkelberg, W. C. (1989). Entrepreneurship and the initial size of firms. *Journal of Business Venturing*, *4*(5), 317–332. https://doi.org/10.1016/0883-9026(89)90004-9

Coxe, S., West, S. G., & Aiken, L. S. (2009). The Analysis of Count Data: A Gentle Introduction to Poisson Regression and Its Alternatives. *Journal of Personality Assessment*, *91*(2), 121–136. https://doi.org/10.1080/00223890802634175

Dahl, M. S., & Reichstein, T. (2007). Are You Experienced? Prior Experience and the Survival of New Organizations. *Industry & Innovation*, *14*(5), 497–511. https://doi.org/10.1080/13662710701711414

Dalle, J.-M., den Besten, M., & Menon, C. (2017). Using Crunchbase for economic and managerial research. *OECD Science, Technology and Industry Working Papers*, 1–29. https://doi.org/10.1787/6c418d60-en

Davidsson, P., & Honig, B. (2003). The role of social and human capital among nascent entrepreneurs. *Journal of Business Venturing*, *18*(3), 301–331. https://doi.org/10.1016/s0883-9026(02)00097-6

Delmar, F., & Shane, S. (2006). Does experience matter? The effect of founding team experience on the survival and sales of newly founded ventures. *Strategic Organization*, *4*(3), 215–247. https://doi.org/10.1177/1476127006066596

Dencker, J. C., Gruber, M., Shah, S. K. (2009) Pre-Entry Knowledge, Learning, and the Survival of New Firms. *Organization Science, 20*(3), 516–537. https://doi.org/10.1287/orsc.1080.0387

European Commission (2019). Worldwide urban population growth. *Knowledge for policy*. Retrieved on April 9, 2020, from https://ec.europa.eu/knowledge4policy/foresight/topic/continuing-urbanisation/worldwide-urban-population-growth_en

Eveleens, C. (2019). Interfering with innovative entrepreneurship: How business incubation impacts the performance of start-ups (Doctoral dissertation). Utrecht University, Utrecht.

Eveleens, C., van Rijnsoever, F. J., & Niesten, E. M. M. I. (2016). How network-based incubation helps start-up performance: a systematic review against the background of management theories. *The Journal of Technology Transfer*, *42*(3), 676–713. https://doi.org/10.1007/s10961-016-9510-7

Field, A., Miles, J., & Field, Z. (2012). *Discovering statistics Using R*. London: SAGE Publications.

Fritsch, M., & Noseleit, F. (2012). Start-ups, long- and short-term survivors, and their contribution to employment growth. *Journal of Evolutionary Economics*, *23*(4), 719–733. https://doi.org/10.1007/s00191-012-0301-5

Gartner, W. B. (1985). A Conceptual Framework for Describing the Phenomenon of New Venture Creation. *The Academy of Management Review*, *10*(4), 696–706. https://doi.org/10.2307/258039

Gemeente Rotterdam. (2016, June 12). *Rotterdams consortium wint EU-tender van 17,7 miljoen voor Smart City toepassingen*. Retrieved on June 2, 2020, from https://persberichtenrotterdam.nl/blog/persbericht/rotterdams-consortium-wint-eu-tender-van-%C2%80-177-miljoen-voor-smart-city-toepassingen/

Gimeno, J., Folta, T. B., Cooper, A. C., & Woo, C. Y. (1997). Survival of the Fittest? Entrepreneurial Human Capital and the Persistence of Underperforming Firms. *Administrative Science Quarterly*, *42*(4), 750–783. https://doi.org/10.2307/2393656

Gimmon, E., & Levie, J. (2010). Founder's human capital, external investment, and the survival of new high-technology ventures. *Research Policy*, *39*(9), 1214–1226. https://doi.org/10.1016/j.respol.2010.05.017

Giones, F., Gozun, B., & Miralles, F. (2019). Unbundling the influence of human capital on the new venture's performance. *DLSU Business and Economics Review*, *28*(3), 47–51.

Groenewegen, G., & De Langen, F. (2012). Critical Success Factors of the Survival of Start-Ups with a Radical Innovation. *Journal of Applied Economics and Business Research*, *2*(3), 155–171.

Gruber, M., MacMillan, I. C., & Thompson, J. D. (2010). From Minds to Markets. *Journal of Management*, *38*(5), 1421–1449. https://doi.org/10.1177/0149206310386228

Gupta, P., Guha, S., & Krishnaswami, S. (2013). Firm growth and its determinants. *Journal of Innovation and Entrepreneurship*, *2*(15), 1–14. https://doi.org/10.1186/2192-5372-2-15

Haber, S., & Reichel, A. (2007). The cumulative nature of the entrepreneurial process: The contribution of human capital, planning and environment resources to small venture performance. *Journal of Business Venturing*, *22*(1), 119–145. https://doi.org/10.1016/j.jbusvent.2005.09.005

Hambrick, D. C., & Mason, P. A. (1984). Upper Echelons: The Organization as a Reflection of Its Top Managers. *Academy of Management Review*, *9*(2), 193–206. https://doi.org/10.5465/amr.1984.4277628

Harrington, K. (2017). Smart City Leaders, Champions, and Entrepreneurs – The People Part of Vibrant Smart Cities. In: Vinod, K.T. (Eds), *Smart Economy in Smart Cities. Advances in 21st Century Human Settlements*, Springer: Singapore.

Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., & Williams, P. (2010). Foundations for Smarter Cities. *IBM Journal of Research and Development, 54*(4), 1–16. https://doi.org/10.1147/jrd.2010.2048257

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

Hilbe, J. M. (2014). *Modeling count data*. Cambridge: Cambridge University Press. http://dx.doi.org/10.1017/CBO9781139236065

Hollands, R. G. (2008). Will the real smart city please stand up? *City*, *12*(3), 303–320. https://doi.org/10.1080/13604810802479126

Hsu, D. H. (2007). Experienced entrepreneurial founders, organizational capital, and venture capital funding. *Research Policy*, *36*(5), 722–741. https://doi.org/10.1016/j.respol.2007.02.022

Katz, L. F. (1994). Active Labor Market Policies to Expand Employment and Opportunity. In: *Reducing Unemployment: Current Issues and Policies,* (239–290), Federal Reserve Bank: Kansas.

Keeble, D. (1993). Small firm creation, innovation and growth and the urban-rural shift. In: Curran, J., Storey, D. J. (Eds), *Small firms in urban and rural location,* (54–78)*,* Routledge: London.

Khan, N., Li, S., Safdar, M., & Khan, Z. (2019). The Role of Entrepreneurial Strategy, Network Ties, Human and Financial Capital in New Venture Performance. *Journal of Risk and Financial Management*, *12*(1), 41–57. https://doi.org/10.3390/jrfm12010041

Kollmann, Tobias. (2006). What is e-entrepreneurship? fundamentals of company founding in the net economy. *International Journal of Technology Management*, *33*(4), 322–340. https://doi.org/10.1504/ijtm.2006.009247

Kollmann, T., Stöckmann, C., Hensellek, S., & Kensbock, J. (2016). *European Startup Monitor 2016*. Amsterdam, Nederland: Reed Business Education. Retrieved from https://europeanstartupmonitor.com/fileadmin/esm_2016/report/ESM_2016.pdf

Krueger, N. F., & Brazeal, D. V. (1994). Entrepreneurial Potential and Potential Entrepreneurs. *Entrepreneurship Theory and Practice*, *18*(3), 91–104. https://doi.org/10.1177/104225879401800307

Lasch, F., Le Roy, F., & Yami, S. (2007). Critical growth factors of ICT start-ups. *Management Decision, 45(*1), 62–75. https://doi.org/10.1108/00251740710718962

Leendertse, J. (2018). *Is new always better? The effect of technological diversity change on the performance of climate-focused start-ups* (Master's thesis, Utrecht University, Utrecht, the Netherlands). Retrieved from https://dspace.library.uu.nl/handle/1874/364068

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

Long, S. J. (1997). Regression Models for Categorical and Limited Dependent Variables*.* Sage Publications: CA.

Lussier, R. N., Corman, J. (1995). There are a few differences between successful and failed small businesses. *Journal of Small Business Startegy, 6*(1), 21–33.

McFadden, D. (1973). Conditional Logit Analysis of Qualitative Choice Behavior. In: Zarembka, P. (Ed.), *Frontiers in Econometrics*, (105–142), Academic Press: New York.

Millan, J. M., Congregado, E., & Roman, C. (2010). Determinants of self-employment survival in Europe. *Small Business Economics*, *38*(2), 231–258. https://doi.org/10.1007/s11187-010-9260-0

Mora, L., & Bolici, R. (2017). How to Become a Smart City: Learning from Amsterdam. In A. Bisello, D. Vettorato, R. Stephens, & P. Elisei (Eds.), *Smart and Sustainable Planning for Cities and Regions: Green Energy and Technology*, (251-266). Bolzano/Bozen: Italy. https://doi.org/10.1007/978-3-319-44899-2_15

Mori, K., & Christodoulou, A. (2012). Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI). *Environmental Impact Assessment Review*, *32*(1), 94–106. https://doi.org/10.1016/j.eiar.2011.06.001

Nam, T., & Pardo, T. A. (2011). Smart city as urban innovation. *Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance – ICEGOV'11*. https://doi.org/10.1145/2072069.2072100

Peña, I. (2002). Intellectual capital and business start-up success. *Journal of Intellectual Capital*, *3*(2), 180–198. https://doi.org/10.1108/14691930210424761

Ratinho, T., Amezcua, A., Honig, B., & Zeng, Z. (2020). Supporting entrepreneurs: A systematic review of literature and an agenda for research. *Technological Forecasting and Social Change*, *154*(3), 119–140. https://doi.org/10.1016/j.techfore.2020.119956

Ratzinger, D., Amess, K., Greenman, A., & Mosey, S. (2017). The impact of digital start-up founders' higher education on reaching equity investment milestones. *The Journal of Technology Transfer*, *43*(3), 760–778. https://doi.org/10.1007/s10961-017-9627-3

Rauch, A., & Rijsdijk, S. A. (2013). The Effects of General and Specific Human Capital on Long-Term Growth and Failure of Newly Founded Businesses. *Entrepreneurship: Theory and Practice*, *37*(4), 923–941. https://doi.org/10.1111/j.1540-6520.2011.00487.x

Sandberg, W. R., & Hofer, C. W. (1987). Improving new venture performance: The role of strategy, industry structure, and the entrepreneur. *Journal of Business Venturing, 2,* 5–28.

Sangen, M. (2018, November 8). *The Hague expands on smart city ambition*. Retrieved on June 5, 2020, from https://www.cbs.nl/en-gb/corporate/2018/44/the-hague-expands-on-smart-city-ambition.

Schutjens, M., & Wever, E. (2000). Determinants of new firm success*. *Papers in Regional Science*, *79*(2), 135–159. https://doi.org/10.1111/j.1435-5597.2000.tb00765.x

Shane, S. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. *Organization science*, *11*(4), 448-469. https://doi.org/10.1287/orsc.11.4.448.14602

Shrader, R., & Siegel, D. S. (2007). Assessing the relationship between human capital and firm performance: evidence from technology-based new ventures. *Entrepreneurship Theory and Practice*, *31*(6), 893–908. https://doi.org/10.1111/j.1540-6520.2007.00206.x

Spiegel, O., Abbassi, P., Zylka, M. P., Schlagwein, D., Fischbach, K., & Schoder, D. (2016). Business model development, founders' social capital and the success of early stage internet start-ups: a mixed-method study. *Information Systems Journal*, *26*(5), 421–449. https://doi.org/10.1111/isj.12073

Stam, W., Arzlanian, S., & Elfring, T. (2014). Social capital of entrepreneurs and small firm performance: A meta-analysis of contextual and methodological moderators. *Journal of Business Venturing*, *29*(1), 152–173. https://doi.org/10.1016/j.jbusvent.2013.01.002

StataCorp. 2013. *Stata Statistical Software: Release 13*. College Station, TX: StataCorp LP. https://stats.idre.ucla.edu/other/mult-pkg/faq/general/faq-what-are-pseudo-r-squareds/

Statista. (2020, March). *Netherlands: largest cities 2020*. Retrieved on May 10, 2020, from https://www.statista.com/statistics/993709/largest-cities-in-the-netherlands-by-number-of-inhabitants/

Sternberg, R. J. (2004). Culture and Intelligence. *American Psychologist, 59*(5), 325–338. https://doi.org/10.1037/0003-066X.59.5.325

Stuart, R. W., & Abetti, P. A. (1990). Impact of entrepreneurial and management experience on early performance. *Journal of Business Venturing*, *5*(3), 151–162. https://doi.org/10.1016/0883-9026(90)90029-s

Stuetzer, M., Goethner, M., & Cantner, U. (2012). Do balanced skills help nascent entrepreneurs to make progress in the venture creation process? *Economics Letters*, *117*(1), 186–188. http://doi.org/10.1016/j. econlet.2012.05.002

Taylor, A., & Greve, H. R. (2006). Superman or the Fantastic Four? Knowledge Combination and Experience in Innovative Teams. *Academy of Management Journal*, *49*(4), 723–740. https://doi.org/10.5465/amj.2006.22083029

Unger, J. M., Rauch, A., Frese, M., & Rosenbusch, N. (2011). Human capital and entrepreneurial success: A meta- analytical review. *Journal of Business Venturing*, *26*(3), 341–358. http://doi.org/10.1016/j.jbusvent.2009.09.004

Van Praag, C. M. (2003). Business Survival and Success of Young Small Business Owners. *Small Business Economics*, *21*(1), 1–17. https://doi.org/10.1023/a:1024453200297

Van Osnabrugge, M. (2000). A comparison of business angel and venture capitalist investment procedures: An agency theory-based analysis. *Venture Capital*, *2*(2), 91–109. https://doi.org/10.1080/136910600295729

Venkatraman, N., & Ramanujam, V. (1986). Measurement of Business Performance in Strategy Research: A Comparison of Approaches. *Academy of Management Review*, *11*(4), 801–814. https://doi.org/10.5465/amr.1986.4283976

7. Appendices

Appendix A: Smart City Index working paper (Hermse, Nijland, & Picari, 2020)

Classification of Smart City Startups: Smart City Index Working paper

By: Maaike Hermse (5672945), Imke Nijland (6868126) & Martina Picari (6897878)
Supervisor: Dr. Mark Sanders
Data: 26-06-2020

Acknowledgements
We would like to thank Mark Sanders, Jip Leendertse and Loek Zanders for their support and critical feedback throughout this whole process.

1. Introduction

This article develops a classification scheme for smart city startups based on 73 definitions found in the literature. 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 fast reality that will change the ways of improving the efficiency, equity, sustainability, and quality of life in cities (Batty et al., 2012). However, the literature is developing without a clear and unambiguous definition of the concept. It is essential to have a reliable meaning to ensure consistency and comparability across studies. A clear and specific definition of the concept would be helpful in a range of different applications.

In the literature, we found 20 literature review articles looking for a common thread in the numerous existing definitions. In this paper, we develop a workable definition of the concept "smart city" based on 73 definitions found in 93 academic articles. The resulting algorithm allows us to classify, e.g. projects and startups as being "smart city". We develop this classification scheme based on the methodology developed for the definition of "user innovations" in Eckinger and Sanders (2019). These authors classify the concept in two steps. After collecting a wide variety of definitions from the literature, we first identify the essential elements common to all interpretations. These make up the necessary conditions for being defined as a smart city project (0/1). We then code and count additional elements and take the eight most common ones. Scoring projects and startups on each of these (1/0) and adding these, give us an intensity score.

The contribution of this paper is, therefore, twofold. Firstly, we collected definitions of smart cities used in the emerging literature, providing an overview of the emerging concept. Secondly, we adapt the classification method in Eckinger and Sanders (2019) to classify projects and startups as a "smart city." In this way, we will facilitate data collection and future empirical research on smart city development greatly.

The remainder of the paper is structured as follows. Firstly, we present an examination of the ground of prior research and summarizing the current state of literature in reference to the smart city concept. Secondly, we present the method used for data collection and coding processing. Thirdly, we reported the results obtained by applying the coding developed to three different databases of three incubators in Utrecht, Gutemberg and Nice. Lastly, we extended the presentation of the final results by a conclusion and a discussion of the limitations of this paper.

2. Literature review

Although there is a growing interest in smart cities, there is no common definition of this concept. In some research smart cities are termed as for example intelligent city, digital city, innovative city or knowledge city (Tan, 1999; Krisna Adiyarta, 2020; Sun & Poole, 2010; Ismagilova et al., 2019; Fietkiewicx et al., 2017; Sproull & Patterson, 2004; Stolfi & Sussman, 2001). These terms are all tangential to the concept of a "smart city" but are not identical. As smart cities represent something more than those concepts (Yigitcanlara et al., 2018; Samarakkody et al., 2019). The variety of terms used to refer to the concept of smart cities makes the definition of the concept ambiguous. Definitions used are based on different themes, elements, or dimensions (Giffinger et al., 2007: Winkowska, Szpilko, & Pejić, 2019; Silva, Khan & Han, 2018). 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 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. To be able to progress with the smart city movement, entrepreneurs form an essential part (Lombardi et al., 2012). However, as mentioned, there is no readily available definition of smart city, so it is even harder to define a smart city start-up. Creating such a definition and the additional coding scheme for smart city start-ups improves the research possibilities for smart cities.

3. Methodology

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

Firstly, we looked for 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 peer-reviewed papers, excluding 20 literature reviews (see Appendix A). These 92 references were collected in an Excel file with a column for the author, publication date, title, and journal. Next, these remaining articles were ranked by the number of citations per paper, since there was a difference in relevance among them. These citations were taken from Google Scholar on the 1st of April 2020 and added 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 the European Parliament (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 an Excel sheet (See Appendix B). Afterwards, we 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 (see Appendix C1). Additionally, we also calculated the percentage of appearances based on the total amount of citations per year (see Appendix C2).

3.1 First results

Based on the percentages, the following themes and keywords are identified (see Table 3). In this table, the themes are presented as well as the keywords that are included in the particular theme. For the first results, we defined two necessary conditions - technology and city - and seven intensity conditions - ICT, citizen, environmental sustainability, quality of life, social capital, economic and human capital.

Table 3: SCI

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

Based on these first results, multiple robustness tests are carried out. In these robustness tests, our first results of the coding scheme are put into practice on the data retrieved on the start-ups of our theses. Each author individually codes the start-ups, based on their description. This description comes from the website. In most cases, the information gathered there is sufficient to be able to code the themes. Afterwards, the results are discussed. This way, we are able to validate our coding scheme. We gather information on whether the coding scheme is replicable, and whether it is even possible to code each of the variables. Changes to the coding scheme are made according to the results of the robustness tests.

3.2 Robustness tests

(1) To test the robustness of the coding scheme, we each applied it to companies from the dataset at our proposal. This dataset includes start-ups that have applied for incubation at UtrechtInc from 2014 till 2017. For each company, we coded over the nine variables - two necessary and seven intensity conditions - using the description of the company used on the website. During the discussion of our individual results, small irregularities were found. We thus decided to make the following adjustments. First, for the themes of human and social capital, we used the following definitions:

Human Capital. In Laroche, Mérette, and Ruggeri (1999, p.89), human capital is defined as the “aggregation of the innate abilities and the knowledge and skills that individuals acquire and develop throughout their lifetime”. Thus, the theme of human capital has to do with the attraction and appeal to skilled labour forces in the context of smart city. Therefore, we clustered the keywords intelligence, skilled jobs, (high) education and knowledge under this theme. Stated in Hollands (2008), human capital also has to do with creativity.
Social Capital. The Healy and Côté (2001, p.41) defines social capital as “networks together with shared norms, values and understandings that facilitate co-operation within or among groups”. Social capital entails various keywords form our definitions, namely, social, social wealth, inclusion and community.

However important they are for a smart city, we were not able to code these variables based on the descriptions of companies we looked at. In light of large databases, acquiring these variables would become too unstructured and thus not robust enough. We, therefore, decided to take them out of the intensity factors. Secondly, the definition of the themes quality of life and citizens needed some more funnelling, to make the difference between the two clearer. Finally, we decided to adjust the theme sustainability. A company would not only be seen as sustainable if products and services offered are sustainable but also if the general goal of the company is to make people more sustainable. An example here is the website Nature Today, which is not sustainable an sich, however, the information they spread awareness of nature and what has to be preserved.

(2) Since some adjustments were made in the first robustness test, we did a second test. This time, the dataset of start-ups in Gothenburg were used. These start-ups all are incubated at Chalmers Ventures between 2015 and 2020. We coded ten companies. This time we coded seven variables - two necessary conditions and five intensity conditions. The descriptions of the companies that were present on the Chalmers Ventures website are used. A downside of these descriptions is that they are fairly short and straight-forward. This made the coding of the start-ups more challenging. Although the descriptions were short, we managed to get quite similar results. During the discussion, it became clear that the variable of quality of life will only be coded 1 when the start-up has a direct effect on the quality of life of people. As incorporating the indirect effect of quality of life in this variable, would be a great source of interpretation and subjectivity. Which would make it hard to replicate the coding. Additionally, it became clear in the discussion that the definition of technology is way broader than many people have in mind. Therefore, before coding, it is important that you have a good understanding of what technology actually entails. This allows for a more accurate replication when using the algorithm.

(3) Based on our first two robustness tests, we decided that for this test, the dataset of start-ups in Gothenburg is used. Coding this dataset was more challenging because of the shorter descriptions of the start-ups. Therefore, it would be more useful to test our coding scheme after the changes using this dataset. We used twelve start-ups to check our coding. The results we individually obtained were again similar, with only a few discrepancies. This means that the coding scheme is replicable. 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 forward by this start-up. We acknowledge that this makes technology time-dependent. This can create a bias. However, it will be the most reliable way of coding technology, since it is most closely to the definition. This means that the technology should be based on new knowledge, or academic research. Besides that, it was challenging to code the variable ICT. It is a broad concept, and we agreed that it should be able to collect, store, use and send or share data electronically (ICT, n.d.). Another discussion we had was about the variable economy. After the test, we decided that economics entails both the direct effect on the start-up itself, for example cost reduction, but also the indirect effect 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. As mentioned in the previous results of the robustness test, we decided to code the variable quality of life as 1 when the effect of the start-up is directly on the quality of life. Since it is more challenging to code the indirect effect on quality of life then the indirect effect on the economic component, we decided to not include this. The indirect effect on the quality of life is more prone to interpretation, this would limit the replicability of our coding scheme. Another thing we decided is that we are only able to code the variable citizens as a 1 when we are able to code the variable city as 1. Because, these two variables are connected to each other. Lastly, we agreed that when there are terms or concepts in the definition, which we are not familiar with, we are allowed to look up the definition. One example was the word ‘biopharmaceuticals’ which was present in one of the descriptions of the start-ups. When discussing our results, we all were not certain about the definition of this. Therefore, we searched for this definition. This made it easier to code this start-up. Being able to search for terms or concepts that are unclear, makes sure the coding is done correctly according to what the start-up really entails.

4. Results

Based on the keywords and the percentages of how many times they were present, unweighted and weighted with the number of citations, we identified two necessary conditions and various intensity conditions. With the use of robustness tests, we changed our first results into our final coding scheme. First, the necessary conditions that are needed for a start-up to be defined as a smart city start-up. The necessary conditions are “technology” and “city”. We defined these themes a follows:

Technology. Defined as “the use of scientific knowledge or processes in business, industry and manufacturing” (Cambridge dictionary, 2020). Technology is the umbrella term for various terms that can be present for a smart city start-up. Some examples of these keywords included in the theme technology are “database”, “solution”, “operating system”, “sensors” and “algorithm”.

City. The city is defined as an urban challenge and “it outlines how the humanitarian community is adapting to address the challenges posed by urban areas” (Knox et al., 2012). Defined as an urban challenge, this means that

a start-up needs to be working on or creating a solution or service for an urban challenge, to conform to this necessary condition. Some keywords that are included in the term “city”, are “urban challenges”, “territory”, and “geographical area”.
Additionally, we added various intensity conditions. As a start-up complies to one or more of the intensity conditions of being a smart city start-up their intensity rating enhances. Ultimately, we defined five intensity conditions, namely ICT, citizen, environmental sustainability, quality of life and economic.

ICT. It stands for Information and Communication Technology and is defined as “the use of computers and other electronic equipment and systems to collect, store, use, and send or share data electronically” (ICT, n.d.). These technological tools and resources include computers, the Internet (websites, blogs, and emails), live broadcasting technologies (radio, television, and webcasting), recorded broadcasting technologies (podcasting, audio and video players and storage devices) and telephony (fixed or mobile, satellite, visio/video-conferencing, etc.)” as well as computer software and hardware (Unesco, 2020). Some examples that are included in the term “community” and “platform”.
Important note: as “ICT” is coded as 1, “Technology” also has to be coded as 1, since “ICT” is a part of “Technology”.
Citizen. This theme includes the keywords citizen, inhabitant and people. The implications a smart city has the need to result in practices that are beneficial in any way for its inhabitants and should improve their trust in urban institutions (Dameri, 2013). Thus, they are the beneficiaries of the solutions that a smart city offers.
Important note: "Citizen" is a condition that can only exist if “City” is coded as 1, thus also fulfilled.
Environmental sustainability. This is defined according to the definition of Gleeson and Low (2000) and Inoguchi et al. (1999) where environmental sustainability refers to the ecological and ‘green’ implications of urban growth and development. Some examples that are included in the term “energy”, “renewable”, “reduce waste”, “reduce emissions”, “bio” and “LED”.
Quality of Life. Everything that has to do with the improvement of life and wellbeing and making the environment more habitable and livable for its inhabitants was therefore put under this theme. Economic prosperity is also key to improving the quality of life (Hollands, 2008). The quality of life needs to be improved directly by the product or service offered by the start-up. Some examples that are included in the term “help”, “health”, “simplifies everyday life” and “medical solution”.
Economic. Economy is defined as the activities of production and consumption of limited resources. This theme, therefore, includes the tackling of economic challenges by using cost reductive, optimization techniques in a sustainable way. These optimization processes in terms of costs should be beneficial for its consumers, in other words, businesses that buy their product or service. Some examples that are included in the term “cost saving”, “cheaper”, “loss reduction”, “cost efficient” and “low cost”.

In Table 4 the necessary and intensity conditions are displayed, with the keywords included in each theme. For each condition, start-ups are coded a 0 or 1. After the coding, a formula (1) is used to calculate whether the start-up is a smart city start-up and what the intensity is. Within the formula, all the intensity conditions are equally weighted. The following formula is used:

SCI = (technology*city)*(1+ICT +citizen+environmental sustainability+quality of life+economic)

NC(x) = 0 if not; NC(x) = 1 if yes
IC(x) = 0 if not; IC(x) = 1 if yes

Based on formula (1), start-ups are granted a score between 0 and 6, with the following meaning per score:
0 = At least one of the NCs is = 0
1 = All the NCs, none of the ICs
2 = NCs + (ICT or citizens or environmental sustainability or quality of life or economic)
3 = NCs + MAX 2 (ICT and/or citizens and/or environmental sustainability and/or quality of life and/or economic)
4 = NCs + MAX 3 (ICT and/or citizens and/or environmental sustainability and/or quality of life and/or economic)
5 = NCs + MAX 4 (ICT and/or citizens and/or environmental sustainability and/or quality of life and/or economic)
6 = NCs + MAX 5 (ICT and/or citizens and/or environmental sustainability and/or quality of life and/or economic)

Table 4: Final SCI

Conditions	Themes	Keywords included
Necessary conditions	Technology	Technology, data, sensors, activators, internet, ICT, IT, database, algorithm, grid, digital, solar panels, smart meters, WIFI, software, hardware, smart devices)
	City	City, urban, urban challenges, territory, place, geographical area
Intensity conditions	ICT	ICT
	Citizen	Citizen, inhabitants, people
	Environmental sustainability	Sustainability, green, environmental, ecological
	Quality of Life	Quality of life, liveability, prosperity, habitable, well-being
	Economic	Economic

5. Discussion

The aim of this paper was to develop a classification scheme for smart city startups based on 73 definitions found in the literature. In the literature, there is no common definition of the concept smart city, even though there is a growing interest in the concept. Various terms are used interchangeably with the term "smart city" in the literature, such as digital city or intelligent city (Tan, 1999; Krisna Adiyarta, 2020; Sun & Poole, 2010; Ismagilova et al., 2019; Fietkiewicx et al., 2017; Sproull & Patterson, 2004; Stolfi & Sussman, 2001). However, these terms are not identical to the concept of smart city. The definitions of smart cities are based on different themes, elements and dimensions (Giffinger et al., 2007: Winkowska, Szpilko, & Pejić, 2019; Silva, Khan & Han, 2018). These various elements were used in creating the coding scheme. Following the method of Eckinger and Sanders (2019), we listed the main keywords present in each definition of smart city. Based on these keywords, we identified the most recurring keywords and overarching themes. Based on these results, we developed an index with necessary conditions for "smart city" and intensity conditions for "smart city". Ultimately, the results consisted of two necessary conditions - "technology" and "city" - and five intensity conditions - "ICT", "citizen", "environmental sustainability", "quality of life" and "economic". After each step, robustness tests were carried out to test the results of the coding scheme. Based on these tests, various changes were made along the way, finally resulting in the classification scheme stated above. There are some limitations to the paper. First, when it comes to the themes, we defined them in a way that makes sense today. However, the concept of smart city is constantly evolving, therefore making the scheme subject to different interpretations over time. Secondly, the term quality of life, which is essential when talking about smart cities, can be interpreted differently by different parties coding it. We attempted to make the definition as clear as possible, however, noticed for this theme it remained difficult. Finally, the paper lacks in certain more systematic robustness scores. These will be carried out later. Overall, with this paper, we tried to clarify the meaning of the concept smart city and find a way to code projects as smart and non-smart city endeavours. We hope it can be useful for this purpose and more, such as research in other fields than start-ups.

6. References

Adiyarta, K., Napitupulu, D., Syafrullah, M., Mahdiana, D., & Rusdah, R. (2020). Analysis of smart city indicators based on prisma: systematic review. In *IOP Conference Series: Materials Science and Engineering* (Vol. 725, No. 1, p. 012113). IOP Publishing.

Alkandari, A., Alnasheet, M., & Alshaikhli, I. F. T. (2012). Smart cities: survey. *Journal of Advanced Computer Science and Technology Research*, *2*(2), 79-90.

Anthopoulos, L., Janssen, M., & Weerakkody, V. (2019). A Unified Smart City Model (USCM) for smart city conceptualization and benchmarking. In *Smart cities and smart spaces: Concepts, methodologies, tools, and applications* (pp. 247-264). IGI Global.

Bakıcı, T., Almirall, E., & Wareham, J. (2013). A smart city initiative: the case of Barcelona. *Journal of the knowledge economy*, *4*(2), 135-148.

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., ... & Portugali, Y. (2012). Smart cities of the future. *The European Physical Journal Special Topics*, *214*(1), 481-518.

Barrionuevo, J. M., Berrone, P., & Ricart, J. E. (2012). Smart cities, sustainable progress. *Iese Insight*, *14*(14), 50-57.

Barth, J., Fietkiewicz, K., Gremm, J., Hartmann, S., Ilhan, A., Mainka, A., & Stock, W. (2017). Informational urbanism. A conceptual framework of smart cities.

Bartoli, A., Hernández-Serrano, J., Soriano, M., Dohler, M., Kountouris, A., & Barthel, D. (2011). Security and privacy in your smart city. In *Proceedings of the Barcelona smart cities congress*, 292, 1-6.

Bélissent, J. (2010). Getting clever about smart cities: New opportunities require new business models. *Cambridge, Massachusetts, USA*, *193*, 244-77.

Calderoni, L., Maio, D., & Palmieri, P. (2012). Location-aware mobile services for a smart city: Design, implementation and deployment. *Journal of theoretical and applied electronic commerce research*, *7*(3), 74-87.

Cambridge dictionary (2020). "Technology (Business English)". Accessed on May 6, 2020: https://dictionary.cambridge.org/dictionary/english/technology

Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of urban technology*, *18*(2), 65-82.

Chang, S., Saha, N., Castro-Lacouture, D., & Yang, P. P. J. (2019). Multivariate relationships between campus design parameters and energy performance using reinforcement learning and parametric modeling. *Applied energy*, *249*, 253-264.

Chatterjee, S., Kar, A. K., & Gupta, M. P. (2018). Success of IoT in smart cities of India: An empirical analysis. *Government Information Quarterly*, *35*(3), 349-361.

Chen, T. M. (2010). Smart grids, smart cities need better networks [Editor's Note]. *IEEE Network*, *24*(2), 2-3.

Chong, M., Habib, A., Evangelopoulos, N., & Park, H. W. (2018). Dynamic capabilities of a smart city: An innovative approach to discovering urban problems and solutions. *Government Information Quarterly*, *35*(4), 682-692.

Corbett, J., & Mellouli, S. (2017). 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*, *27*(4), 427-461.

Cretu, L. G. (2012). Smart cities design using event-driven paradigm and semantic web. *Informatica Economica*, *16*(4), 57.

Dameri, R. P. (2013). Searching for smart city definition: a comprehensive proposal. *International Journal of Computers & Technology*, *11*(5), 2544-2551.

David, M., & Koch, F. (2019). "Smart Is Not Smart Enough!" Anticipating Critical Raw Material Use in Smart City Concepts: The Example of Smart Grids. *Sustainability, 11*(16), 4422.

De Lima, J. P. C., Becker, L. B., Siqueira, F., Morales, A. S., & de Araujo, G. M. (2020). From a Smart House to a Connected City: Connecting Devices Services Everywhere. *Anais do VIII Simpósio Brasileiro de Computação Ubíqua e Pervasiva*, 100-109.

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

Eger, J. M. (2009). Smart growth, smart cities, and the crisis at the pump a worldwide phenomenon. *I-WAYS-The Journal of E-Government Policy and Regulation, 32*(1), 47-53.

El-Haddadeh, R., Weerakkody, V., Osmani, M., Thakker, D., & Kapoor, K. K. (2019). Examining citizens' perceived value of internet of things technologies in facilitating public sector services engagement. *Government Information Quarterly, 36*(2), 310-320.

Gascó-Hernandez, M. (2018). Building a smart city: lessons from Barcelona. *Communications of the ACM, 61*(4), 50-57.

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

Gil-Garcia, J. R., Zhang, J., & Puron-Cid, G. (2016). Conceptualizing smartness in government: An integrative and multi-dimensional view. *Government Information Quarterly, 33*(3)*,* 524-534.

Gleeson, B. and Low, N. (2000). "Cities as consumers of worlds environment". *In Consuming Cities: The Urban Environment in the Global Economy after the Rio Declaration*, Edited by: Low, N., Gleeson, B., Elander, I. and Lidskog, R.1–29. London: Routledge.

Grant (2020). "Sustainability". Investopedia. Accessed on May 6, 2020: *Investopedia*, https://www.investopedia.com/terms/s/sustainability.asp

Gretzel, U., Werthner, H., Koo, C., & Lamsfus, C. (2015). Conceptual foundations for understanding smart tourism ecosystems. *Computers in Human Behavior, 50*, 558-563.

Guan, L. (2012). Smart Steps To A Battery City. *Government News 32*, 2, 24-27.

Hall, R. E., Bowerman, B., Braverman, J., Taylor, J., Todosow, H., & Von Wimmersperg, U. (2000). The vision of a smart city(No. BNL-67902; 04042). Brookhaven National Lab., Upton, NY (US).

Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., & Williams, P. (2010). Foundations for smarter cities. *IBM Journal of research and development, 54*(4), 1-16.

Heaton, J., & Parlikad, A. K. (2019). A conceptual framework for the alignment of infrastructure assets to citizen requirements within a Smart Cities framework. *Cities, 90*, 32-41.

Healy, T., & Côté, S. (2001). The Well-Being of Nations: The Role of Human and Social Capital. Education and Skills. In: *Organisation for Economic Cooperation and Development*, OECD: Paris. Retrieved from http://www.oecd.org/site/worldforum/33703702.pdf

Heo, T., Kim, K., Kim, H., Lee, C., Ryu, J. H., Leem, Y. T., & Ko, J. (2014). Escaping from ancient Rome! Applications and challenges for designing smart cities*. Transactions on Emerging Telecommunications Technologies, 25*(1), 109-119.

Hernández-Muñoz, J. M., Vercher, J. B., Muñoz, L., Galache, J. A., Presser, M., Gómez, L. A. H., & Pettersson, J. (2011). Smart cities at the forefront of the future internet. In The future internet assembly, 447-462. Springer, Berlin, Heidelberg.

Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial?. *City, 12*(3), 303-320.

Huovila, A., Bosch, P., & Airaksinen, M. (2019). Comparative analysis of standardized indicators for Smart sustainable cities: What indicators and standards to use and when?. *Cities, 89*, 141-153.

Hussain, A., Wenbi, R., da Silva, A. L., Nadher, M., & Mudhish, M. (2015). Health and emergency-care platform for the elderly and disabled people in the Smart City. *Journal of Systems and Software, 110*, 253-263.

ICT. (n.d). Cambridge dictionary online. Retrieved May 14, 2020, from https://dictionary.cambridge.org/dictionary/english/ict

Inoguchi, T., Newman, E.and Paoletto, G. (1999). Cities and the Environment: New Approaches for Eco-societies, New York: UN University Press.

Ismagilova, E., Hughes L., Dwivedi, Y. K. & Raman, R. (2019). Smart cities: Advances in research – An information systems perspective. *International Journal of Information Management, 47,* 88-100.

Khatoun, R., & Zeadally, S. (2016). Smart cities: concepts, architectures, research opportunities. *Communications of the ACM, 59*(8), 46-57.

Knox P. & Ramalingam, B. (2012) Meeting the urban challenge: Adapting humanitarian efforts to an urban world. AlnAp meeting paper. London: AlnAp/odi

Komninos, N. (2011). Intelligent cities: Variable geometries of spatial intelligence. *Intelligent Buildings International, 3*(3), 172-188.

Komninos, N., Bratsas, C., Kakderi, C., & Tsarchopoulos, P. (2019). Smart city ontologies: Improving the effectiveness of smart city applications. *Journal of Smart Cities, 1*(1), 31-46.

Kourtit, K., & Nijkamp, P. (2012). Smart cities in the innovation age. *Innovation: The European Journal of Social Science Research, 25*(2), 93-95.

Kourtit, K., Nijkamp, P., & Arribas, D. (2012). Smart cities in perspective–a comparative European study by means of self-organizing maps. *Innovation: The European journal of social science research, 25*(2), 229-246.

Lara, A. P., Da Costa, E. M., Furlani, T. Z., & Yigitcanla, T. (2016). Smartness that matters: towards a comprehensive and human-centred characterisation of smart cities. *Journal of Open Innovation: Technology, Market, and Complexity, 2*(2), 8.

Laroche, M., Mérette, M., & Ruggeri, G. (1999). On the Concept and Dimensions of Human Capital in a Knowledge-Based Economy Context. *Canadian Public Policy / Analyse De Politiques, 25*(1), 87-100.

Lazaroiu, G. C., & Roscia, M. (2012). Definition methodology for the smart cities model. *Energy, 47*(1), 326-332.

Lee, J., & Lee, H. (2014). Developing and validating a citizen-centric typology for smart city services. *Government Information Quarterly, 31*, S93-S105.

Lee, J. H., Hancock, M. G., & Hu, M. C. (2014). Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco. *Technological Forecasting and Social Change, 89*, 80-99.

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.

Mahizhnan, A. (1999). Smart cities: the Singapore case. *Cities, 16*(1), 13-18.

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

Marsal-Llacuna, M. L., Colomer-Llinàs, J., & Meléndez-Frigola, J. (2015). Lessons in urban monitoring taken from sustainable and livable cities to better address the Smart Cities initiative. *Technological Forecasting and Social Change, 90*, 611-622.

Nam, T., & Pardo, T. A. (2011, June). Conceptualizing smart city with dimensions of technology, people, and institutions. In *Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times* (pp. 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.

Odendaal, N. (2003). Information and communication technology and local governance: understanding the difference between cities in developed and emerging economies. *Computers, Environment and Urban Systems, 27*(6), 585-607

Outlook, A. E. (2014). Early Release Overview. US Energy Information Administration.

Partridge, H. L. (2004). Developing a human perspective to the digital divide in the 'smart city'. Australian Library and Information Association Biennial Conference.

Paskaleva, K. A. (2009). Enabling the smart city: The progress of city e-governance in Europe. *International Journal of Innovation and regional development, 1*(4), 405-422.

Peng, G. C. A., Nunes, M. B., & Zheng, L. (2017). 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, 15*(4), 845-876.

Pereira, G. V., Macadar, M. A., Luciano, E. M., & Testa, M. G. (2017). Delivering public value through open government data initiatives in a Smart City context. *Information Systems Frontiers, 19*(2), 213-229.

Piro, G., Cianci, I., Grieco, L. A., Boggia, G., & Camarda, P. (2014). Information centric services in smart cities. J*ournal of Systems and Software, 88*, 169-188.

Qian, Y., Wu, D., Bao, W., & Lorenz, P. (2019). The internet of things for smart cities: Technologies and applications. *IEEE Network, 33*(2), 4-5.

Rana, N. P., Luthra, S., Mangla, S. K., Islam, R., Roderick, S., & Dwivedi, Y. K. (2019). Barriers to the development of smart cities in Indian context. *Information Systems Frontiers, 21*(3), 503-525.

Rios, P. (2012). Creating" The Smart City" (Doctoral dissertation).

Samarakkody, A. L., Kulatunga, U., & Bandara, H. M. N. D. (2019). What differentiates a smart city? a comparison with a basic city.

Schaffers, H., Ratti, C., & Komninos, N. (2012). Special issue on smart applications for smart cities-new approaches to innovation: Guest editors' introduction. *Journal of theoretical and applied electronic commerce research, 7*(3), 2-5.

Schiavone, F., Paolone, F., & Mancini, D. (2019). Business model innovation for urban smartization. *Technological Forecasting and Social Change, 142*, 210-219.

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.

Shafiullah, G. M., Oo, A. M., Jarvis, D., Ali, A. S., & Wolfs, P. (2010). Potential challenges: Integrating renewable energy with the smart grid. *In 2010 20th Australasian Universities Power Engineering Conference* (pp. 1-6). IEEE.

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.

Sproull, L., & Patterson, J. F. (2004). Making information cities livable. *Communications of the ACM*, *47*(2), 33-37.

Sussman, F. S. G. (2001). Telecommunications and transnationalism: The polarization of social space. *The Information Society*, *17*(1), 49-62.

Sun, J., & Poole, M. S. (2010). Beyond connection: situated wireless communities. *Communications of the ACM*, *53*(6), 121-125.

Tan, M. (1999). Creating the digital economy: Strategies and perspectives from Singapore. *International Journal of Electronic Commerce, 3*(3), 105–122.

Thite, M. (2011). Smart cities: implications of urban planning for human resource development. *Human Resource Development International, 14*(5), 623-631.

Thuzar, M. (2011). Urbanization in southeast asia: developing smart cities for the future?. *Regional Outlook, 96.*

Toppeta, D. (2010). The smart city vision: how innovation and ICT can build smart,"livable", sustainable cities. *The innovation knowledge foundation, 5*, 1-9.

Townsend, A. M. (2013). Smart cities: Big data, civic hackers, and the quest for a new utopia. *WW Norton & Company.*

Unesco, (2020). Information and CommunicationTechnologies. Accessed on May 6, 2020: http://uis.unesco.org/en/glossary-term/information-and-communication-technologies-ict

Van Zoonen, L. (2016). Privacy concerns in smart cities. *Government Information Quarterly, 33*(3), 472-480.

Washburn, D., Sindhu, U., Balaouras, S., Dines, R. A., Hayes, N., & Nelson, L. E. (2009). Helping CIOs understand "smart city" initiatives. *Growth, 17*(2), 1-17.

Winkowska, J., Szpilko, D., & Pejić, S. (2019). Smart city concept in the light of the literature review. *Engineering Management in Production and Services*, *11*(2), 70-86.

Winters, J. V. (2011). Why are smart cities growing? Who moves and who stays. *Journal of regional science, 51*(2), 253-270.

Xie, J., Tang, H., Huang, T., Yu, F. R., Xie, R., Liu, J., & Liu, Y. (2019). A survey of blockchain technology applied to smart cities: Research issues and challenges. *IEEE Communications Surveys & Tutorials, 21*(3), 2794-2830.

Yeh, H. (2017). The effects of successful ICT-based smart city services: From citizens' perspectives. *Government Information Quarterly, 34*(3), 556-565.

Yigitcanlar, T. (2015). Smart cities: an effective urban development and management model?. *Australian Planner, 52*(1), 27-34.

Yigitcanlar, T. (2016). Technology and the city: Systems, applications and implications. Routledge.

Yigitcanlar, T., Kamruzzaman, M., 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.

Zhao, J. (2011). Towards sustainable cities in China: analysis and assessment of some Chinese cities in 2008. *Springer Science & Business Media*.

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.

Zygiaris, S. (2013). Smart city reference model: Assisting planners to conceptualize the building of smart city innovation ecosystems. *Journal of the knowledge economy, 4*(2), 217-231.

7. Appendices
Appendix A: Review papers

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

Appendix B: Overview of definitions in the existing literature

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	City, IT, social, infrastructure, intelligence, business

						collective intelligence of the city	
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, liveability, 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.	Intelligence, innovation, technology, economic, growth, green, infrastructure, environment, interconnected, intelligence,

				Innovation Ecosystems		These aspects lead to smart city conceptions as "green" referring to urban infrastructure for environment protection and reduction of CO2 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	information, data, sensors, activators, knowledge, creative, human capital, city
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 conceptualizatio n 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	Urban, data, services, citizens, efficient, innovation, IT, monitoring, optimization, infrastructure, collaboration, economic, governance, performance, information

						different economic actors, and to encourage innovative business models in both the private and public sectors.	
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 liveability	ICT, technology, design, planning, governance, innovation, solutions, sustainability, liability, efficiency, management, city, organization
Schuurman et al. (2012, p. 51)	2012	243	27.00	Smart ideas for smart cities: Investigating crowdsourcing	Journal of Theoretical and Applied Electronic	In smart cities collaborative digital environments facilitate the development of	Innovation, improvement, development, collaboration,

				for generating and selecting ideas for ICT innovation in a city context	Commerce Research	innovative applications, starting form the human capital of the city, rather than believing that the digitalization *in se* can transform can improve cities.	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, liveability
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,	ICT, infrastructure, services (administration, education, healthcare, public safety, real estate, transportation,

						public safety, real estate, transportation, and utilities–more aware, interactive, and efficient	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	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

				between cities in developed 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, liveability, 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	Vienna: Centre of Regional Science - Vienna UT	A city well performing in a forward-looking way in economy,	Economy, people, governance, mobility,

				medium-sized cities		people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens	environment, liveability, awarenes s, 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, liveability, 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, liveability, 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	ICT, data, network, technology, software, hardware, devices

						control systems, mobile apps, big data analytical tools)	
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
Schiavone, 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	Investments, resources, sustainable, economic, growth, governance, human capital, social capital, creativity, infrastructure, business capital, technology

						system (Caragliu et al., 2011)	
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, institutional, 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 design parameters and energy performance using	Applied Energy	The main features of the smart city are smart economy, smart mobility, smart environment, smart people, smart living, and smart governance.	Economy, mobility, environment, people, living, governance

				reinforcement learning and parametric modelling			
European Parliament (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

Appendix C1: Appearances 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%

Appendix C2: Appearances in citations

#	Themes	% of appearances in total number of citations (per year)
1.	Technology (data, sensors, activators, internet, ICT, IT, database, algorithm, grid, digital, solar panels, smart meters, WIFI, software, hardware, smart devices)	74.0%
2.	City/ urban challenges (territory, place, geographical area)	72.6%
3.	ICT (if 1, also add 1 to technology)	43.8%
4.	Citizen (inhabitants, people)	42.5%
5.	Sustainability (green, environmental, ecological)	39.7%
6.	Quality of life (liveability, prosperity, habitable, well-being)	39.7%
7.	Social capital (social, social wealth, inclusion, community)	34.2%
8.	Economic (economy)	31.5%
9.	Human capital (intelligence, skilled workers/ jobs, (high) education, knowledge)	28.8%
10.	Infrastructure	21.9%
11.	Efficiency (efficient)	17.8%
12.	Innovation	17.8%
13.	Transportation (mobility, transport)	16.4%
14.	Resource management	15.1%
15.	Business (entrepreneurship)	11.0%
16.	Collaboration (participation, partnership, relational capital, coordination, stakeholder)	11.0%
17.	Network (interconnected)	9.6%
18.	Integration	11.0%
19.	Growth	8.2%
20..	Creativity	8.2%
21.	Safety (security)	6.8%
22.	Energy	5.5%

End of working paper

Appendix B: Literature review table

Table 6: Literature review on education and work experience

Study	Sample	Measures for success	Education	Significant effect of	Work experience	Significant effect of	Focus	Team -level
Bosma et al. (2004)	1151 Dutch entre-preneurs founded in 1994	Size (employees), Profitability	Higher education (0-1)	Education on profitability (+)	Experience of being an employee	Work experience on employ-ment (+)	Mixed	No
Brüderl et al. (1992)	1714 start-ups in Munich/ Bavaria founded between 1985-1986	Survival	Years of schooling (general and occupational)	Education on survival (+)	Years of general work experience	Work experience on survival (+)	Mixed	No
Gimeno et al. (1997)	1,547 entre-preneurs in US	Economic performance, Performance threshold, Exit	Formal education	Education on economic performance (+)	Not tested	/	Mixed	No
Khan et al. (2019)	196 start-ups in Pakistan	Subjective performance measures	Level of education	Not significant	Not tested	/	Mixed	No
Rauch & Rijsdijk (2013)	201 German start-ups over 12 years	Growth, Failure	Level and type of education obtained	Education on growth (+) and on failure (-)	General work experience	Work experience on growth (+) and on failure (-)	Mixed	No
Bates (1990)	21,000 non-minority male entre-preneurs from 1976 to 1982	Survival	Level of education, Years of education	Education on survival (+)	Not tested	/	Mixed	No
Dahl & Reichstein (2007)	2497 start-ups in Denmark from 1980 to 2000	Survival, Exit, Takeover	Level of education	Not significant	Not tested	/	Mixed	No
Schutjens & Wever (2000)	563 Dutch entre-preneurs	Growth	Not tested	/	Years of employ-ment	Work experience on growth (+)	Mixed	No
Davidsson & Honig (2003)	380 entre-preneurs in Sweden (over 18 months)	Size, Profit	Level of education, Business education	No significant effect	Years of work experience	No significant effect	Mixed	No
Cooper et al. (1994)	2994 start-ups in the US (followed over 3-year period)	Marginal survival, High growth	Bachelor's degree (0-1)	Education on survival (+)	Not tested	/	Mixed	Yes
Dencker et al. (2009)	436 founders in Munich	Survival, Failure	Years of education, Pre-entry knowledge	Education on firm failure (-)	Prior general work experience	No significant effect	Funded start-ups in mixed industries	No
Peña (2002)	114 Spanish start-ups (4 years into the endeavor)	Employment, Sales, Profit	College degree (0-1), Business courses	Degree and courses on growth (+)	Years of work experience	Work experience on profit (+), sales (+), and employ-meny (+)	Incubated firms	Yes
Stuetzer et al. (2012)	95 start-ups in Germany	Entre-preneurial market entry	Tertiary education	Not significant	General work experience	Not significant	Innovative start-ups	No

Lussier & Corman (1995)	216 start-ups in the US	Failure	Years of education	Education on failure (+)	Not tested	/	Low-technology firms	Yes
Giones et al. (2019)	US entre-preneurs from 2004 (followed over 3-year period)	Revenue, Employment	Level of education obtained (10-level)	Education on revenues and employees (+) – only for high tech firms	Years of work experience	On revenues (+) and employ-ment (+) – only for non-high-tech firms	High- and non-high-tech start-ups	No
Stuart & Abetti (1990)	52 start-ups in NY	Sales, Employment, Revenues, Subjective performance measures	Level of education	Education on performance (-)	Business experience	Not significant	Tech-start-ups	Yes
Shrader & Siegel (2007)	196 start-ups (under 6 years old) in the US	Profitability, Growth in sales	Not tested	/	Technical experience, marketing experience, finance experience	Technical on profitability (+)	High-tech start-ups	Yes
Hsu (2007)	149 start-ups	VC investment	Level of education	Doctoral degree on VC (+)	Not tested	/	High-tech start-ups	Yes
Gimmon & Levie (2010)	193 start-ups in Israel	Investment, Survival	Level of education,	Education on investment (+)	Not tested	/	Incubated high-tech firms, high percentage of failed start-ups	No
Colombo & Grilli (2010)	439 Italian start-ups founded between 1980 and 2000	VC investment, Employees	Economic, and technical higher education	Economic education on VC (+) and employees (+)	Technical, commercial and other work experience	Technical experience on employees (+)	High-tech start-ups	Yes
Ratzinger et al. (2017)	4953 start-ups	Investment	Business education, Technical education, General education	All types of education on investment (+)	Not tested	/	Digital start-ups	Yes

Appendix C: Operationalisation table

Table 7: Operationalisation from concept to variable

Concept	Indicator	Calculation of scores	Measurement
		Dependent variables	
Start-up success	Survival	0: the start-up is no longer operating at the moment of data collection 1: the start-up is still operating at the moment of data collection	Binary, 0 – 1
	Investment	0: the start-up didn't receive external investment 1: the start-up received external investment	Binary, 0 – 1
	Firm size	The number of employees working full-time for the start-up at the moment of data collection	Count, 0 – ∞
		Independent variables	
Technical education	Amount of higher education across founders in technical field	The average of the total number of years in technical, science, and technological higher education across all founding members	Ratio, 0 – ∞
Economic education	Amount of higher education across founders in economic field	The average of the total number of years in economic and managerial higher education across all founding members	Ratio, 0 – ∞
Work experience	Amount of work experience across founders	The average of the total number of years of work experience across all founding members	Ratio, 0 – ∞
Smart city	Smart city classification of start-ups	0: the start-up is not classified as smart city 1: the start-up is classified as smart city	Binary, 0 – 1
Smart City Score	Smart city classification and intensity of a start-up	0: the start-up is not classified as smart city 1: the start-up is classified as smart city Intensity is calculated by the number of criteria the start-up complies with +1 for every additional criterium	Categorical, 0 – 6
		Control variables	
Entrepreneurial experience	Prior experience founding a venture	0: none of the founders has entrepreneurial experience 1: at least one founder has entrepreneurial experience	Binary, 0 – 1
Gender	The percentage of males	The percentage of male founding partners in the founding team	Ratio, 0 – 1
Number of founders	The number of founders	The absolute number of founders at the moment of founding the start-up	Count, 0 – ∞
Business environment	The business environment of the start-up	0: the start-up operates in a Business-to-Business (B2B) environment 1: the start-up operates in a Business-to-Consumer (B2C) environment	Dummy, 0 – 1

Appendix D: Descriptive statistics

Table 8: Descriptive statistics including outliers of Size

Variable	Observations	Mean	Std. Dev.	Min	Max
Survival	194	0.856	0.352	0	1
Investment	194	0.330	0.471	0	1
Size	192	20.448	104.629	0	1316
Smart city	194	0.119	0.324	0	1
Smart city score	194	0.371	1.085	0	6
Economic education	194	1.733	2.169	0	11
Technical education	194	2.490	3.108	0	13.5
Work experience	194	10.386	6.360	0	29.7
Entrepreneurial experience	194	0.665	0.473	0	1
Gender	194	0.904	0.257	0	1
Number of founders	194	1.773	0.762	1	4
Market B2C	194	0.325	0.469	0	1

Appendix E: Negative binomial model

Various steps are taken to determine the appropriate regression model for the count variable *Size*. Firstly, *Size* is visualized by a histogram (see Figure 1) to see if the variable is skewed. In this case it is. Secondly, the detailed descriptive statistics of *Size* are calculated (see Table 9) to see if there is overdispersion in the data. Since the variance is substantially higher than the mean, this implies overdispersion is present. In order to do a Poisson regression, the overdispersion can't be significant. Thus, thirdly, a Poisson regression is carried out, and a goodness of fit is calculated (see Table 10). This p-value is significant; therefore, the regression model is rejected and not appropriate in this case. To conclude, the negative binomial model is the more suitable regression for the count variable *Size*.

Figure 1: Histogram of firm Size measured by number of employees

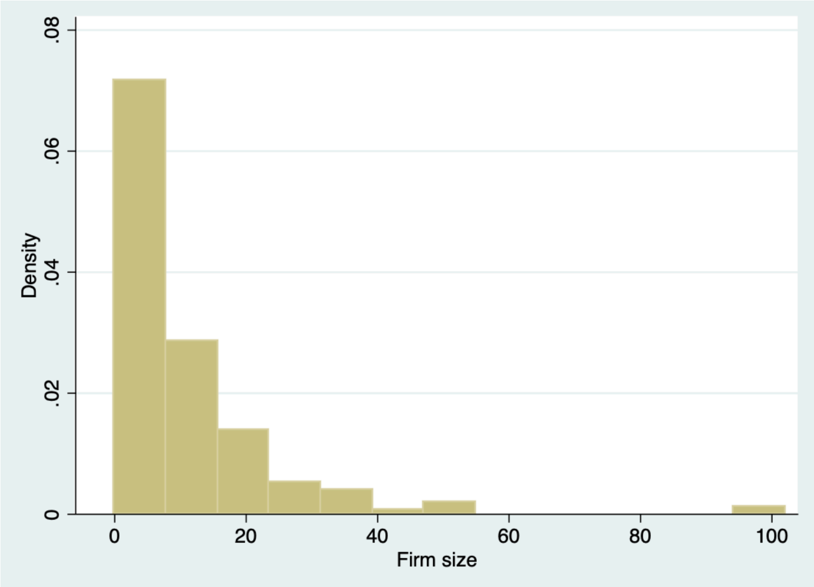

Table 9: Detailed descriptive statistics of Size

	Mean	Std. Dev.	Variance	Obs.
Size	10.495	13.813	190.785	192

Table 10: Poisson goodness of fit for Size

	$Chi^2(182)$
Deviance goodness-of-fit	2226.593***

*Note: ***p<0.001*

Appendix F: Verifying assumptions

Table 11: VIF–scores

Variable	VIF	1/VIF
Smart city score	10.79	0.093
Smart city	9.05	0.110
Interaction: technical education*smart city score	2.04	0.491
Technical education	1.43	0.699
Economic education	1.27	0.784
Entrepreneurial experience	1.14	0.876
Number of founders	1.12	0.890
Market B2C	1.10	0.906
Gender	1.10	0.909
Work Experience	1.08	0.923

Appendix G: Robustness tests

Table 12: Robustness test for Survival

	SURVIVAL				
	Logit				
	(1)	(2)	(3)	(4)	(5)
SMART -CITY		0.070 (0.048)		0.027 (0.075)	
SC SCORE			0.042 (0.031)		0.022 (0.034)
SC*TEC HEDUC				0.043 (0.053)	
SCORE *TECH EDUC					0.015 (0.022)
ECO-EDUC		0.007 (0.012)	0.006 (011)	0.006 (0.011)	0.006 (0.012)
TECH-EDUC		-0.003 (0.007)	-0.003 (0.007)	-0.005 (0.007)	-0.004 (0.004)
WORK EXP		0.007* (0.004)	0.007* (0.004)	0.007** (0.004)	0.007* (0.004)
ENTRE-EXP	0.139** (0.061)	0.104* (0.058)	0.099* (0.056)	0.094* (0.056)	0.090* (0.055)
GEN-DER	-0.124 (0.110)	-0.115 (0.106)	-0.113 (0.103)	-0.110 (0.101)	-0.107 (0.098)
NFOUD-ERS	-0.010 (0.032)	0.002 (0.030)	0.002 (0.029)	-0.001 (0.029)	0.001 (0.028)
MARK-ET B2C	-0.100* (0.057)	-0.098* (0.057)	-0.096* (0.056)	-0.098* (0.056)	-0.094* (0.054)
Cons-tant	-	-	-	-	-
Obser-vations	194	194	194	194	194
McFadd-en R2	0.065	0.104	0.110	0.112	0.115
Log Likeli-hood	-74.880	-71.724	-71.252	-71.124	-70.828
LR-test		6.31	7.26	7.51	8.10

Table 13: Robustness test for Investment

	INVESTMENT				
	Logit				
	(1)	(2)	(3)	(4)	(5)
SMART-CITY		0.312*** (0.120)		0.294** (0.148)	
SC SCORE			0.090*** (0.034)		0.077* (0.043)
SC*TECHEDUC				0.008 (0.038)	
SCORE *TECH EDUC					0.007 (0.014)
ECO-EDUC		-0.006 (0.019)	-0.001 (0.019)	-0.006 (0.019)	-0.008 (0.019)
TECH-EDUC		0.019 (0.013)	0.019 (0.013)	0.018 (0.014)	0.017 (0.014)
WORK EXP		-0.013** (0.006)	-0.013** (0.006)	-0.013** (0.006)	-0.013** (0.006)
ENTRE-EXP	0.081 (0.073)	0.119 (0.074)	0.110 (0.075)	0.116 (0.075)	0.105 (0.076)
GEN-DER	0.102 (0.153)	0.068 (0.161)	0.053 (0.161)	0.068 (0.161)	0.060 (0.163)
NFOUD-ERS	0.131*** (0.047)	0.145*** (0.049)	0.115*** (0.049)	0.145*** (0.049)	0.143*** (0.050)
MARK-ET B2C	0.046 (0.075)	-0.001 (0.000)	0.010 (0.077)	-0.003 (0.077)	0.005 (0.077)
Cons-tant	-	-	-	-	-
Obser-vations	194	194	194	194	194
McFadd-en R2	0.052	0.114	0.117	0.114	0.118
Log Likeli-hood	-116.560	-109.038	-108.617	-109.015	-108.474
LR-test		15.04***	15.89***	15.09**	16.17***

Table 14: Robustness test for Size

SIZE					
Negative binomial					
	(1)	(2)	(3)	(4)	(5)
SMART -CITY		-0.040 (0.259)		0.010 (0.318)	
SC SCORE			-0.013 (0.077)		0.008 (0.102)
SC*TEC HEDUC				-0.025 (0.090)	
SCORE *TECH EDUC					-0.009 (0.028)
ECO-EDUC		0.053 (0.041)	0.053 (0.041)	0.053 (0.041)	0.053 (0.041)
TECH-EDUC		-0.003 (0.029)	-0.003 (0.029)	-0.008 (0.030)	-0.001 (0.030)
WORK EXP		-0.002 (0.014)	-0.002 (0.014)	-0.002 (0.014)	-0.002 (0.014)
ENTRE-EXP	0.422** (0.181)	0.427** (0.186)	0.429** (0.187)	0.435** (0.188)	0.436** (0.188)
GEN-DER	0.475 (0.333)	0.421 (0.341)	0.424 (0.340)	0.425 (0.341)	0.422 (0.340)
NFOUD-ERS	0.130 (0.114)	0.127 (0.116)	0.127 (0.116)	0.128 (0.116)	0.129 (0.116)
MARK-ET B2C	0.103 (0.176)	0.101 (0.176)	0.100 (0.176)	0.185 (0.177)	0.104 (0.177)
Cons-tant	1.339*** (0.366)	1.323*** (0.400)	1.318*** (0.394)	1.306*** (0.405)	1.304*** (0.397)
Obser-vations	192	192	192	192	192
McFadd-en R2	0.008	0.010	0.010	0.010	0.010
Log Likeli-hood	-644.485	-643.371	-643.368	-643.333	-643.314
LR-test		2.23	2.23	2.30	2.34