Informational world cities
An empirical investigation of cities in the 21ˢᵗ century

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Abstract

The purpose of this dissertation is to investigate world cities that are in a network. The network is constituted by the flows of capital, power, and information. The key innovation is ICT and the acknowledgment of human capital as an important economic resource. The research approach combines urban studies, sociology, and information science. Thus, diverse hypotheses have emerged in recent years that are going to describe the knowledge, creative, digital, or smart city. In the work at hand, I will combine the approaches of diverse city types and different research fields into one investigation. According to twelve hypotheses, characteristics and best practice examples of informational world city's development will be identified. The focus is to emphasize on real world examples.

The dominating research method is grounded theory which allows to mix different approaches to gather data, e.g. interviews, field research, and statistics. In total, 31 cities are investigated regarding their digital and cognitive infrastructure, political willingness and cityness. The interviews and field studies have been conducted between June 2010 and May 2014. Literature and secondary data has been updated continuously. The focus of this empirical investigation of 31 informational world cities is to verify actual research approaches based on expert interviews. Do experts with different backgrounds and from different origins agree with general assumptions that explain the success and forecast further growth of cities in the 21st century?

In general, cities in a globalized world become more similar. Moreover, they are following the similar strategies to foster future success. Thus, for instance, city planners develop citywide ubiquitous connectivity through Wi-Fi hotspots, establish science parks and knowledge clusters in an entire neighborhood, introduce bike and car sharing, and finally push entrepreneurship and coworking spaces. All this is happening under the flagship of becoming a knowledge or smart city. But some cities are outstanding in their performance in a special sector. This could be the elite university located in or near the city as wells as an extraordinary stock exchange market. Whether it is money or talent both bring capital into the city. Thus, Boston and San Francisco Bay Area are both attracting knowledge with regard to their elite universities and New York is attracting power in terms of finance and multinational corporations. The results of this investigation present how the diverse cities meet the changing demands of the knowledge society in an increasing digitized environment.

Acknowledgement

Declaration of Authorship

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1 Informational world cities

World cities are centers of human interactions. Urbanized areas or cities are the home to more than half of human's population and till 2030, almost 5 billion people will live in cities or towns (UNFPA, 2007). According to the fact that 135 metropolises contribute 37% of the world´s total GDP, cities are important hubs within the global economy (Clark, Moonen, & Couturier, 2015). The increasing amount of people living in a dense area confronts city governments, citizens, and local business with new problems but also opportunities. What does this mean for world city development and why is it important that they are informational?

First roots of city research can be found in Webers' (1921) sociological analysis "The City." He has discussed the anonymity of cities in contrast to rural areas and the city's role as a market center in a capitalized economy. In particular, world cities have been the focus of further urban research like in Halls' (1966) "The World Cities." World cities are agglomerated areas which are not defined by their political boundaries, for example, the conurbation area Randstad Holland. Those cities are centers of governmental, economical, and human activity. According to Jacobs (1969, 1984), economic growth and as well as the development of the modern world is depending on the interaction between cities. Simplified, city interaction is defined through economic networks of firms. Thus, city researchers have emphasized the importance of world cities in a global network (Friedmann, 1986; Hall, 1966; Sassen, 2001; Taylor, 2004). How these networks are interlinked has increasingly been changed through the advent of information and communication technology (ICT). An entirely new era of economic trade, transaction, and communication has ushered. Following Castells (1989), this is the rise of the "networked society" in which spaces of flows (information, capital, and power) determine the spaces of places. He introduces "informational cities" as prototypical cities of this development.

The term "informational city" has not yet been established as a common term to describe the development of future or modern cities (Stock, 2011). In the literature terms like "digital city" (Ishida, Ishiguro, & Nakanishi, 2002), "network city" (Craven & Wellman, 1973), "ubiquitous city" (Shin, 2009), or "smart city" (Hollands, 2008) refer to cities with emerging and growing digital infrastructure based on ICT and further on the quality of life as well as green infrastructure (Mainka et al., 2013; Stock, 2011). Whereas "smart city" is a rather fuzzy term (Albino, Berardi, & Dangelico, 2015; Nam & Pardo, 2011) which is sometimes used equivalently to informational city or with reference to digital networks and enhanced sustainability which are dominant in those cities. Furthermore, informational cities cannot be observed as an isolated phenomenon based on

a high developed digital infrastructure. Yigitcanlar (2010) and Stock (2011) define informational cities as prototypical cities of the knowledge society. The essential factor here is the human being who is able to use information adequately and transform it into knowledge and vice versa (Kuhlen, 1995; Linde & Stock, 2011; Stehr, 1994; Yigitcanlar, 2010). Thus, we can refer to the importance of the cognitive infrastructure (Stock, 2011) that is observed in "knowledge city" (Ergazakis, Ergazakis, Metaxiotis, & Charalabidis, 2009) and "creative city" (Florida, 2002; Landry, 2008) research. Additionally, cities are complex constructions which today equally base on digital and physical infrastructures. Physical infrastructures as well as networks have always been the focus of world or global city research (Friedmann, 1986; Hall, 1966; Sassen, 2001; Taylor, 2004). Therefore, I refer to the term "informational world city" (Mainka et al., 2013) that combines the different types of cities and its infrastructures as illustrated in the following figure (Figure 1-1).
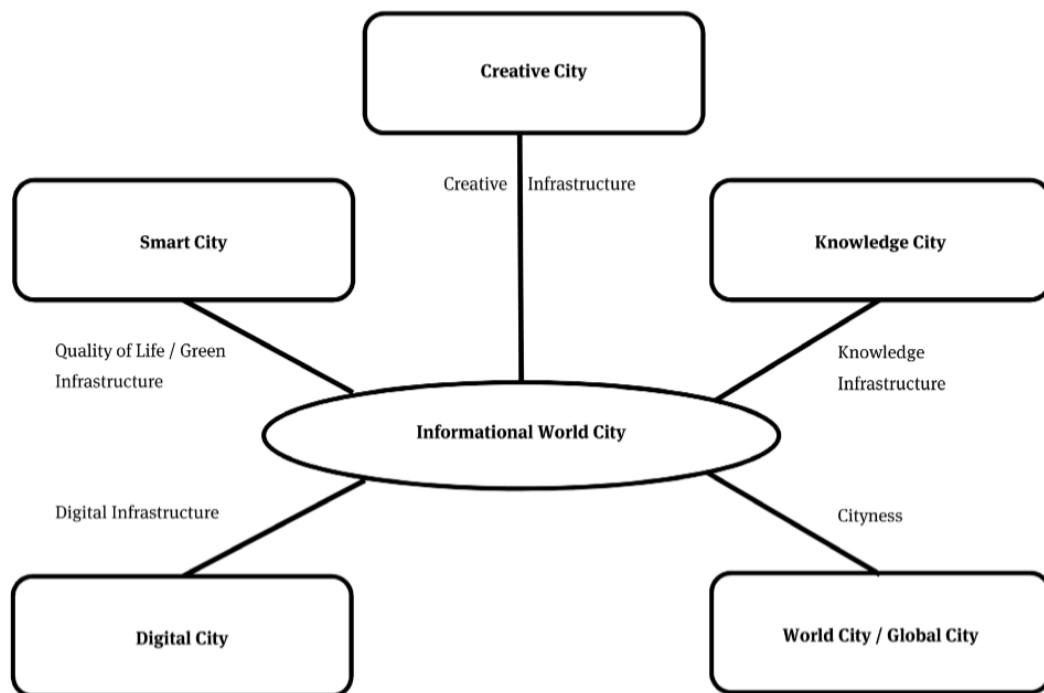
Figure 1-1: Infrastructures of an informational world city. Source: Mainka et al. (2013, p. 296).

The term "informational city" is recently defined by the researchers Manuel Castells, Tan Yigitcanlar and Wolfgang G. Stock. Yigitcanlar (2010) uses the terms "informational city" and "knowledge city" synonymously since knowledge is defined as the crucial factor of the human and economic development. Most prominent is the definition by Manuel Castells (1989), who has defined cities according to their space of flows (information, capital, and power). Accordingly,

cities are the space of places that are determined by the space of flows. For Castells the emergence of the digital infrastructure has evoked a dramatically change of economy and society. Global connectivity has been revolutionized through the new exchange of flows. Since information and knowledge have always been important, now it is possible to transform and enhance knowledge production, sharing, and consumption through these networks. This is a global trend that evolves in different cultures and places which results in a new understanding of distance. Distances do not only shrink in relation to geo locations but also in the form of communication between different parties like the civil society, business, and government. *Online* is a new space for communication, participation, and creativity (Lor & Britz, 2007). Mostly on social media or Web 2.0 platforms different parties meet to share content and to communicate (de Vries, Gensler, & Leeflang, 2012; Mainka, Hartmann, Stock, & Peters, 2014). The result is a tremendous amount of digital information and data. Finally, through digitization and online communication we arrived at the age of big data and ubiquitous computing (Bryant, Katz, & Lazowska, 2008).

Besides this technical aspect, knowledge has become an important factor of economy in relation to land, labor, and capital (Machlup, 1962). According to Yigitcanlar (2010), an informational or knowledge city is characterized by its knowledge infrastructure, including universities, as well as research and development institutes. Furthermore, a well-educated population, digital infrastructure, a global acting economy, spending on research and development, and the creation of high value-added products are basic characteristics. ICT networks and global connections play an equally important role as knowledge cluster agglomerations within the city which leads to personal contact and share of tacit knowledge.

Further, the agglomeration of talented persons is acknowledged as key driver of innovation and economic growth (Florida, 2003). The quality of life and place according to public services (e.g. health and education) are important to attract the "creative class." A wide range of cultural activities and amenities, as well as cultural heritage, attracts these talents. To build a successful knowledge city Yigitcanlar (2010, p. 395) argues that policies and visions are crucial. *"The common strategies include political and societal will; strategic vision and development plans; financial support and strong investments; agencies to promote knowledge-based urban development; an international, multicultural character of the city; metropolitan Web portals; value creation for citizens; creation of urban innovative engines; assurance of knowledge society rights; low-cost access to advanced communication networks; research excellence; and robust public library networks."*

Stock (2011) defines informational cities similar to Yigitcanlar (2010) and Castells (1989). For him, informational cities are complex constructions. Different factors have to be considered when analyzing this development. In his work "Informational Cities: Analysis and Construction of Cities in the Knowledge Society" he has defined an indicator catalogue which consist of six main aspects that influence the "informativeness" of a city: infrastructures, labor market, corporate structure, soft locational factors, political willingness, and world city (cityness). All aspects are highly correlated (Figure 1-2). For example, the political willingness to become an informational city positively influences the infrastructure. This may positively impact the labor market and so on. He calls this the positive feedback loop.
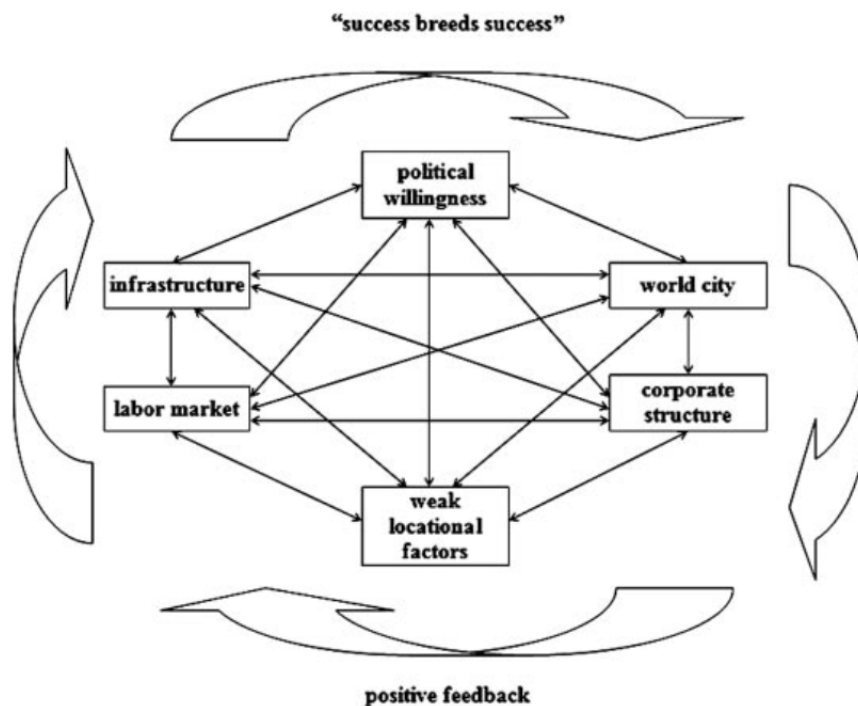
Figure 1-2: The development of an informational city from the perspective of network economies. Source: Stock (2011, p. 980).

Stock (2011, p. 966) argues, *"[w]hen Castells published The Informational City in 1989, he could not have known how existing informational cities would look like (since the Internet had not yet happened), but the theoretical foundation for dealing scientifically with informational cities had been laid. Today, we have informational cities in front of our eyes: Singapore, Seoul, and Dubai set themselves the explicit goal of creating such cities (and are very far along the way); London, New York, San Francisco (and environs), Shanghai, and Hong Kong predominantly bank on high-tech industry and services and are modifying their regions into informational cities. Today— at the beginning of the 21st century—we can fill Castells' theory with life."*

According to the indicators identified by Stock (Figure 1-2), global comparisons of cities are missing. There exist some rankings and indices on isolated aspects, like the political willingness of a city, as he mentioned Singapore, Seoul, and Dubai. But if political willingness, in general, has a positive effect on the transition towards an informational city is not demonstrated in his paper. Furthermore, he refers to findings relating to the knowledge society that is based on occasional regional data, like the comparison of the labor markets of the San Francisco Bay Area and the Los Angeles region, and on state-level data, like the Human Development Index and ICT Development Index. We miss detailed data on the state and development of concrete cities on their ways into the knowledge society all over the world as case studies. With reference to Castell's, Yigitcanlar's and Stock's theory, this thesis is a first attempt to investigate the influence of political willingness, infrastructures, and the status as a world city on the state and development of prototypical cities of the knowledge society on a global scale.

The work at hand will provide an introduction to the development of the city in the knowledge society, in particular, the economic development and innovations that have finally evolved into the knowledge society (chapter 2). Today, a lot of publications deal with the future development of our cities. In this work, I will bring them in line and investigate the main indicators of the world, knowledge, creative, digital and smart city. The focus is to identify indicators that are relevant for this development by investigating the infrastructure (ICT and cognitive), the political willingness, and finally by the cityness. Provoking hypothesizes will be developed that should animate the experts to argue for or against a characteristic feature of informational city research (chapter 3). The main method used is the grounded theroy that allows to combine literature review, online research, field study, and expert interviews (chapter 4). The investigation in this work is based on a case study of 31 cities which have been identified by literature review (chapter 5). Hence, the results will emphasize best practice examples and will be discussed within the context of informational world city development (chapter 6). Since each indicator of an informational world city has to be considered within its national and cultural context. Finally, a summary and an outlook on future work will conclude the investigation (chapter 7).

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2 The rise of the knowledge society

If we like to define the knowledge society we need to define the term knowledge in our society. According to Hack (2006), knowledge can be of different dimensions. He distinguishes between scientific knowledge and common knowledge and between lay and expert knowledge. Knowledge may be of different forms: the basis of education and training, a reservoir of patents and licenses, or it may be a form of organizational knowledge like management strategies, investment decisions, or the algorithm of search engines. Finally, knowledge may be a binding truth or a tentative interpretation. The crucial factor is that knowledge is firmly interconnected with the society (Drucker, 1993). Knowledge without human's interpretation is just information (Kuhlen, 1995). Combining with the economic resources land, capital, and labor the resource knowledge is essential for the efficiency of the other resources (Choo, 2002). Thus, the changing point from the industrial to the post-industrial capitalism is the acknowledgment of knowledge as a significant factor of economic growth (Bell, 1973; Drucker, 1993; Hepworth, 1987; Machlup, 1962; Porat, 1977). A further crucial factor is the change of status of education and learning (Stock, 2011). For Heidenreich (2002) education and life-long learning are essential drivers of our society. Knowledge institutions and an adequate educational system are needed to educate potential knowledge workers (Lim, 1999).

Hence, we cannot define the knowledge society without understanding the economic development of our capitalistic world. Economic or societal change has been analyzed for decades (Bornschier & Suter, 1992). According to Kondratieff (1926), the capitalism has experienced four cycles of economic situation[1]. For Schumpeter (1939) each economic cycle is driven by a basic innovation. Two types of innovation are acknowledged: (1) product innovation (a new consumer good e.g. the car in the 19th century) and (2) process innovation (a novel production technique e.g. assembly line production in the early 20th century) (Bornschier & Suter, 1992; Freeman, Clark, & Soete, 1982; Van Duijn, 1983). Each kind of innovation has led to a transition which also embeds the emergence of a network (Linde & Stock, 2011). The first cycle starts in the 18th century. This was the shift from the agricultural to the industrial society. The basic innovation was the steam engine which has influenced textile manufacturing. The second cycle is based on steel which evolves the rail network and allows mass transportation. In the third, the electricity networks are based on electrotechnology and chemical industry. In addition, the fourth cycle is based on

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[1] He has measured economic growth and decline starting from the 18th century (prior data has not been available (Stiller, 2005)). His findings are based on economic data (prices and products).

automobile and petrochemical industry which results in road networks that allowed independent mobility. With the upcoming of the fifth wave, a new type of society evolves (Nefiodow, 1991). Its basic innovation is information which leads to telecommunication networks particularly the internet. For Bell (1973) this is the shift from the industrial to the post-industrial society. A similar approach can be found in Toffler´s (1980) definition of "The Third Wave." The first wave refers to agriculture, the second to industry, and the third to a post-industrial society. Accordingly, the social shift is not only defined as post-industrial society but also as *informational* or *knowledge society* (Stehr, 1994; Stock, 2011; Webster, 1995, 2002). The main aspect lies on the economic transformation of knowledge which now can be stored and shared through digital networks (Drucker, 1993; Machlup, 1962; Porat, 1977). Therefore, Castells (1996) uses the term *network society*. He refers to the information and telecommunication technology network based on electronic devices e.g. phones, fax, printer, computer, and today we can add tablets, smartphones, wearables (smart watches or glasses) etc. They are building the network and allow a new kind of information sharing and communication in real time (Castells, 1996; Melzi, 2009; van Dijk, 2012). Thus, information can be shared and stored anytime and anywhere which means for Bonitz (1986) that we arrived at a new holographic and time principle. *"The entirety of human knowledge is one gigantic hologram, which consists of all storage units, databases etc. available to mankind"* (Bonitz, 1986, p. 192). Information can now be consumed simultaneous to its production (Stock, 2011).

Nefiodow and Nefiodow (2014) claim that we arrived at the end of the fifth Kondratieff cycle with the financial crisis in 2008/2009. Thus, researchers and economists started to debate about which innovation or technology could drive our future. It is assumed that future innovations will enhance the productivity of our society like prior Kondratieff cycles have always improved the productivity e.g. in the manufacturing of clothes, mobility on railways or the street, or digitization of routine work (Nefiodow, 2006). For Nefiodow (2006) the sixth Kondratieff cycle could be based on biotechnology and health. His idea bases on the growth rates in the health sector in the US and in Europe. Additionally, he suspects that sustainability, environment protection, and alternative energy supply will be growing sectors as well.

For the economist Rifkin (2014) energy supply and sustainability are both driver of our future economy. But he goes one step further and declares that the Internet of Things (IoT) will have a tremendous impact on our society and the market. He predicts the emergence of the "new smart society" (Rifkin, 2014, p. 15). His ideas are truly futuristic, but today we can already see corporations that are exploring the possibilities of the network that does not only connect information but also things in our world. Examples are General Electrics—"Industrial Internet,"

CISCO—"Internet of Everything," IBM—"Smarter Planet," or Siemens—"Sustainable Cities." Sensors on roads, in cities, or in households are connected through the internet and manageable through electronic devices like a smartphone. For Rifkin, this is the "Third Industrial Revolution" which consists of three Internets: communication internet, energy internet, and logistics internet. In the future, shared networked commons would change our lives. His main ideas are grounded on a network of sharing (sharing of information, energy, and transportation). This vision may be referred to Castells' (1996) definition of the network society in which spaces of places are determined by spaces of flows (flows of information, capital, and power). Both ideas are based on information and communication technology.

Other researchers do not follow Rifkin´s idea of the sharing society since. In contrast, they refer that we arrived at a new form of capitalism which is based on information and the knowledge labor force (Fuchs, 2012; Vercellone, 2007). Furthermore, we did not explore the whole economic wave of the fifth Kondratieff. Hence, ICT is still the driving innovation.

A further idea developed by Hall (2010) is that we arrived at the "age of the city." He has identified three main urban innovations: (1) cultural/intellectual, (2) technological-productive, and finally (3) the joining of cultural and technological. The third innovation is a new phenomenon which cannot be found in past developments. This is the new knowledge economy which brings together technological and cultural innovations especially in cities like Los Angeles, San Francisco, New York City, and London. Accordingly, Batty (2015) argues in his essay "Creative Destruction, Long Waves and the Age of the Smart City" that the next cycle could be the one of the smart city. He joins the development of IoT with innovation density of cities. For him, the further step is based on the kind of communication which develops from "anywhere at any time" in the fifth cycle to "through anything, at anytime and anywhere" in the sixth. Not everybody agree on this assumption, according to Hollands (2008), there is just a new image label, called the smart city, to sell the products of IBM, CISCO, Siemens etc. which establish many IoT projects in different cities. ICT networks are not in the spotlight but just the basic infrastructure in cities of the knowledge society.

If we refer to the new knowledge economy or to IoT, then information, knowledge, and ICT are still drivers of our economy. Hence, on a global scale we are not able to evoke the end of the fifth wave. Looking at world cities development, traditional world cities like New York and London have suffered heavily from the financial crisis around 2008 (Bassens, 2012). But there are also winners which are for example emerging cities in the Gulf region like Dubai, Doha and Abu Dhabi (Kosior, Barth, Gremm, Mainka, & Stock, 2015) or in China the cities Beijing, Shanghai, and Hong

Kong. Thus, the decrease of the fifth wave cannot be verified by a global evidence. Figure 2-1 illustrates the past and present economic cycles according to Kondratieff and the emergence of the knowledge society. The shift from the fifth to the sixth is interpreted as a smooth transition. Evidence can just be given in retro perspective.
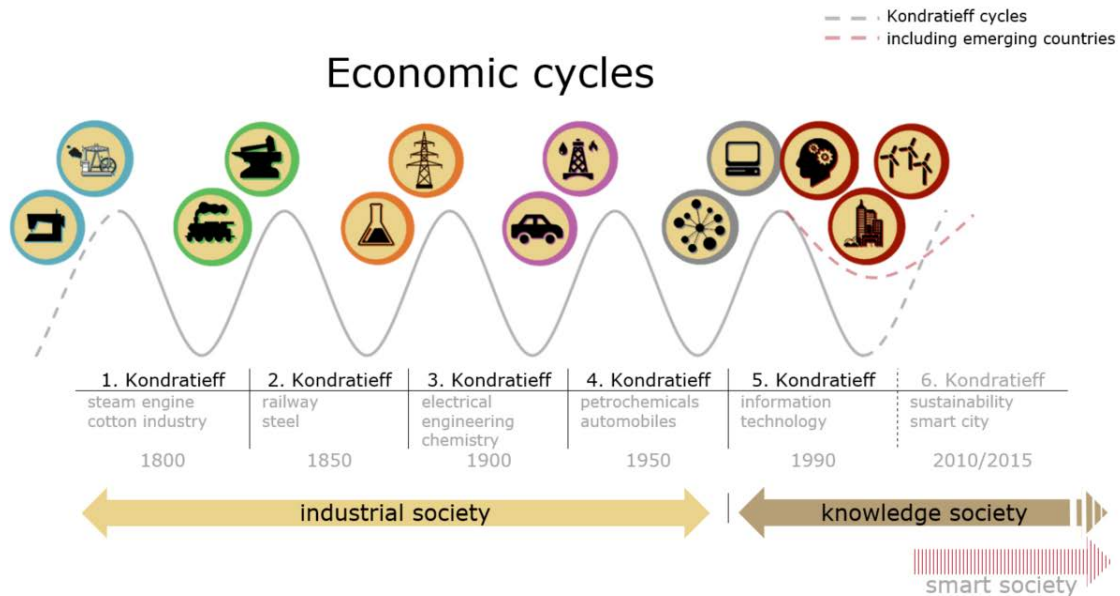
Figure 2-1: Economic cycles and the knowledge society (Own interpretation based on discussed literature).

Hence, we see a development which is not only commercially driven. In many cities and regions of the world (most in Western countries) communities start to engage with the future of their city/region to develop a more open, innovative, and democratic world (Open Knowledge Labs, n.d.). This is evident through the growing number of open data activists like the labs associated with the open knowledge foundation and the growing importance of the open data day (Akbaba, 2016). These activities are about to help citizens, government, and business in a city to create valuable engines and to become an empowered partner than just a city user. This development is based on digital networks and personal engagements of communities (physical networks). The EU, amongst other organizations, starts to speculate about the economic profit that could be gained through open data in the future (European Commission, 2015).

Summing up, the basis of our current society development is information, knowledge, and networks. Stock (2011, p. 965) has defined the factors of the information and knowledge society.

Information society:

- *"basic innovations are carried by the resource information"*
- *"computers are of great importance"*

Knowledge society:

- *"displays all the characteristics of an information society,*
    - *at which digital information and*
    - *at which computer networks play important roles"*
- *"information contents of every kind are available in any place and at any time (holographic and speed principles) and are intensively taken advantage of"*
- *"lifelong learning (including learning how to learn) is necessary"*

According to Nefiodow (2006), Hall (2010), Rifkin (2014), and Batty (2015), the productivity of the knowledge society will be pushed by further developments. Thus, we have to define the indicators of the knowledge society 2.0 or smart society.

Smart society:

- displays all characteristics of an information and knowledge society
    - in which the networks of information are increasingly growing (including the Internet of Things and Open Data)
    - with advanced holographic and speed principles which grow from "at any time and anywhere" to "through anything, at any time and anywhere"
- sustainability and health become important factors for the society and economy
- empowered citizens that engage in a more creative, innovative, and democratic future (open innovation on city level)

Finally, the concepts of the smart society are still based on the innovation "information and communication" which shows its assets through the combination of ICT, physical networks, and human capital. Because knowledge still remains the crucial factor of the society—humans transform information into knowledge—I will follow to use the term knowledge society to describe this "era" of human development in the 21st century (Stock, 2011).

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3 Measuring cities of the knowledge society

The development of the knowledge society is intertwined with many factors that impact each other. One aspect is the economic growth. An increased economic productivity results in market growth which can be statistically measured by the gross domestic product (GDP). *"The GDP is the monetary value of all goods and services produced in a nation during a given time period, usually one year"* (Brezina, 2011, p. 4). Thus, all goods and services that are bought by ordinary consumers (e.g. in a supermarket), corporations (e.g. all computers for their labor force), or the government (e.g. construction of new metro lines) increase the value of the GDP. The United Nations Development Program uses statistical data as the GDP next to life expectancy of the population at the time of birth, rate of alphabetization of adults, and ratio of pupils and students in their respective age groups to analyze the human development status on a national level. Their aim is to cover actual trends of development like mobility, climate change, and gender and ethnic inequality (UNDP, 2014). Depending on the topic of investigation different indicators are included in studies and finally compared in most cases with the GDP growth rate.

On city level, different terms and approaches exist to describe the measurement of the knowledge society. Depending on the type of city (digital, smart, knowledge, or creative) different indicators are used. As already explained in the first chapter I will bring different approaches in line with the definition of an informational world city. Figure 1-2 in chapter 1 Informational world city represents an overview of the main characteristics which are identified by Stock (2011) and are used in several case studies as well as in development reports. Some indicators like the GDP are established as growth value but others are not and just used experimentally. For those that are not established, I will formulate hypotheses that will be investigated further on.

3.1 Infrastructures

Referring to the development of the knowledge society two main infrastructures have evolved: "ICT infrastructure" and "cognitive infrastructure." The first one is allocated to the technical development of the fifth Kondratieff. It is the basis innovation of this economic cycle. The cognitive infrastructure is not new but has grown in importance. It refers to the knowledge and creative institutions and their output.

3.1.1 ICT infrastructure

ICT is the infrastructure which has become central in everyday life and essential for many businesses. The approach of being connected everywhere and anytime is mostly investigated under the topic of ubiquitous computing or ubiquitous cities (Schumann & Stock, 2015). Internet connectivity does not only include private persons and businesses. We arrived at the age of the Internet of Things and have to add sensors and things with Wi-Fi connections to this ubiquitous environment (Hollands, 2008; Rifkin, 2014). However, cities are still the center of human interact (Sassen, 2001). Therefore, physical mobility has not to be ignored.

With the advent of ICT, investigations in relation to human development have been referred to the information society. Bruno, Esposito, Genovese, and Gwebu (2011) have examined the progress of different indices that measure the ICT access, use, and skills on a national level. *Access* is related to fix telephone lines per 100 inhabitants, mobile phone subscriptions per 100 inhabitants, internet bandwidth (bit/s) per internet user, and proportion of households with a computer and with internet access at home. ICT use is calculated by the number of internet users per 100 inhabitants, fixed broadband internet subscribers per 100 inhabitants, and mobile broadband subscribers per 100 inhabitants. Finally, ICT skills are related to adult literacy rate and to secondary and tertiary gross enrollment rate. The indicator ICT skills is underdeveloped since a direct connection between the education obtained by the citizens and the ability to use ICT is not evident. Media or information literacy should be the right indicator instead but it is almost impossible to be evaluated on a global scale (Beutelspacher, 2014; Henkel. & Stock, 2016).

In the early stage of the fifth Kondratieff cycle in 2003, the ITU starts to publish their "Digital Access Index" (ITU, 2003) and Orbicom has published the "Infostate" index, which was established to explore the digital divide on a national level (Sciadas, 2003). For a future publication, Orbicom and ITU merged their indices and published the "ICT Opportunity Index" (ICT-OI) for the years from 2001 to 2005 (ITU, 2007a). Other indices that analyze the ICT development on national level are the "ICT Diffusion Index" (ICTDI) published by the United Nations Conference on Trade and Development (UNCTAD) for the year 2005 (United Nations, 2006) , the "Digital Opportunity Index" (DOI) published by ITU for the years 2005 and 2006 (ITU, 2007b), "ICT Development Index" (IDI) which is continuously published by ITU since 2007 (its recent publication is ITU (2010)), the "E-Readiness Index" published annually by the Economist Intelligence Unit and IBM from 2000 till 2009 (Economist Intelligence Unit, 2009), the "Digital Economy Rankings" published by the Economist Intelligence Unit and IBM in 2010 (Economist Intelligence Unit, 2010), and finally, the

"Networked Readiness Index" published annually by the World Economic Forum (World Economic Forum, 2015).

According to a study by Paparwekorn (2015, p. 385), ICT indices generally can be grouped into five categories:

1. *"infrastructure and accessibility"*
2. *"national regulatory agency (NAR) and ICT policy"*
3. *"business environment"*
4. *"education and innovation"*
5. *"usage and security."*

Paparwekorn (2015) argues that indices are important to disclose the degree of development of a certain region or nation. Especially when it comes to development plans, it is favorable to benchmark its own development against others to be able to set realistic goals for further ICT strategies. However, a comparison of a certain set of variables always bears with limitations like missing data or methodical assumptions that are not applicable for every region on a global scale. Thus, indices have to be read and interpreted very carefully.

Nevertheless, Bruno et al. (2011) have identified that ICT indices are highly correlated with the GDP of a nation. Thus, the ICT-OI has a correlation of +0.946 and IDI of +0.916 (Bruno et al., 2011, p. 27). This implies that national growth and wealth impacts ICT access, use, and skills and vice versa. A similar trend was analyzed by Stock (2011). He has identified a high correlation of +0.90 (Pearson) for the Human Development Index (HDI) and the ICT Development Index (IDI) for 112 countries.

In a further study, Jin and Cho (2015) have used different variables like PC adoption rate, internet use rate, profit rates of ICT supplier, ICT trade, the amount of ICT workers, policies and governmental investments, to evaluate the impact of ICT on national growth rates. In total, they have investigated 128 countries. According to their findings, the adoption rate of PCs has no significant correlation. This is not surprising since many more devices exist through that the internet is accessible. Thus, they argue that the adoption rate of multiple devices with internet access has a positive effect on economic growth. Further, evidence of a statistically significant correlation was provided through the variables internet use, profit of telecommunication suppliers, and governmental investments. No correlation could be found for the variables amount of ICT workers and ICT trade. In addition, they investigated the effect of education and literacy rates on economic growth and conclude that both variables do not have that strong impact as for

example ICT use. What they did not discuss is the limited significance of the characteristics used (school enrollment rates and literacy rates) which do not tell us anything about the information literacy (Spitzer, Eisenberg, & Lowe, 1998) of the population or quality of the educational system. *"Other moderating variables are national corruption and the consumer price index; both are shown to affect national economic growth positively, with significance levels of 95% and 99%, respectively. The positive effect of CPI (corruption perception index) on economic development is consistent with the assertions that emphasize good governance as a critical factor for economic development"* (Jin & Cho, 2015, p. 258).

All in all, we see a complex mix of indicators that are used to measure the degree of the knowledge society prevalent on national level. Summarizing, the knowledge society has been investigated on national level since the early 21st century. Its development is highly related with economic growth and information and communication technology. Technological innovations have changed rapidly and have influenced which kind of technology infrastructure is needed for such a society. One example is the indicator "wireless broadband subscription" which has replaced "fixed internet subscription" since slow internet access via modem is no more relevant. Education has gained in importance as well as freedom of information and access to public information. In addition, the gross enrolment and literacy rate of adults are used as indicators of ICT-skills and HDI. In the following, I will use these indicators and bring them into line with investigations on city level, since cities can be defined as the hubs that are the cause of the development of the modern world (Jacobs, 1969, 1984). According to Hall (1985) cities are part of the "geography of the fifth Kondratieff." Furthermore, Stock (2011) emphasizes that there always existed typical cities of a societal era as for example Manchester was a typical city of the industrial society or Manhattan of the service society. Accordingly, he is convinced that prototypical cities of the knowledge society are represented by informational cities in the 21st century.

One index, which focuses on ICT and the development of smart cities, is the Networked Society City Index 2014 which has been investigated by the Swedish IT Corporation Ericsson. Because Ericsson is a private corporation their index has to be read with caution. Further indices by independent agencies are underway, for example by the ITU. A report on "Smart Sustainable Cities" will be developed by the ITU-Study Group 20. According to the "Smart cities—Preliminary Report 2014" (ISO/IEC JTC 1. InformationTechnology, 2015), city indices like "Global City Indicators" or the "Green Cities Index" use variables that do not reflect or relate to the ICT infrastructure in cities. Accordingly, smart cities have different demands which can be defined under technical, market, and social needs. Those require standardization to facilitate interoperability. The established indicators of ICT developments on a national level as well as the

discussion on ICT indicators to compare city developments are never isolated ICT infrastructure measurements. For example, the investigation of European medium sized cities as smart cities uses the ICT infrastructure as a sub indicator of "smart mobility" (Giffinger et al., 2007). Economic and social factors have to be considered as well. These have been included, for example, by Nesta (2015). They have established a "European Digital City Index" with the aim to compare entrepreneurship in the digital economy. The missing of ICT city indices on a global scale and the approach to define standards of smart cities indicates the need for further research in this field.

For example, one indicator that is valuable only on the city level is accessibility through Wi-Fi hotspots. Those are especially important for tourists, business travelers, but as well for people who cannot afford (mobile) broadband contracts. Ergazakis, Ergazakis, Metaxiotis, and Charalabidis (2009) define low-cost access to Wi-Fi networks as one of their criteria of a knowledge city. Furthermore, low-cost access to broadband networks is assumed to be present in most global cities (Ergazakis et al., 2009). The amount of Wi-Fi hotspots is useful for a comparison of dense areas like a city or touristic hubs at which a lot of people will use this access. This was acknowledged within the E-Readiness Ranking, a national index, in which Wi-Fi hotspots are not compared due to concerns about the data comparability on a country level (Economist Intelligence Unit, 2009).

The ICT infrastructure underlies different quality and availability options depending on the market conditions. Quality and availability of internet access are influenced by the interplay of government development (plans) and the economic businesses. Taking a look at the Unite Arab Emirates (UAE), with the two big cities Dubai and Abu Dhabi, it could be observed that the telecommunication market was monopolistic and the only provider has been Emirates Telecommunications Corporation (Etisalat) (Kosior, 2013). Since 2007, a second provider, namely Emirates Integrated Telecommunications Company (du) is able to offer universal ICT support like Etisalat. Further corporations have been entering the market since 2009, but they are just allowed to support niches. The main providers are under governmental control. Due to this oligopolistic or governmental owned market share the prices are relatively high. They range from 1% (starting with 1 Mbps) up to 8% (for 100 Mbps) of the GDP on a per-capita basis in fiscal year 2013. In contrast, the ICT providers on a polypolistic market in Scandinavian cities—Oslo, Helsinki, and Stockholm—offer comparably cheap contracts which are between 0.5% – 0.7% of the GDP per-capita in 2011 (Stallmann, 2014). In both cases, the majority is using broadband connection if it is available. On the one hand, the government as monopolist at the market can keep prices at an artificially high level. On the other hand, governments can also help to provide broadband access

to all areas if they are working as a provider like in the case of UAE or offer incentives for providers of the private economy e.g. through subsidization or other reward systems.

The increasing importance of ICT regarding to city development and planning is already a common topic for IT firms, for science, for city majors, as well as for citizens. Cities became data-driven hubs like it is drawn in any science fiction film (Hollands, 2014). Recent studies on future city development refer to the term "Smart City" (Hollands, 2008). Cisco and Gale International (two IT corporations) share a common vision: *"… in cities of the future urban services will be delivered more innovatively, and cities will be managed more efficiently using technology that enables newer models of managed and hosted services within public-private partnerships"* (Songdo IBD, 2009). They are involved in building the Smart City Songdo in South Korea. Furthermore, IBM is solving urban problems through technology as well (IBM, 2010). Hence, not to build a whole new city but to develop smarter cities projects for different urban problems, e.g. health care or traffic. Hollands (2014) criticizes the development of "Smart Cities," as they are built by IT firms. The huge amount of data will be produced by citizens and owned by corporations instead of the cities themselves.

However, IT firms located in a region may bring further advantages as they are in need of an excellent ICT infrastructure by their own. One example is the IT Corporation Nokia. Nokia is located in Espoo which is located near the Finnish capital Helsinki. It has been one of the leading global providers of cellular phones of the first generation. Today, Helsinki is a city with an enhanced developed ICT infrastructure. A further example is Google. Google has implemented a lot of Wi-Fi hotspots around Palo Alto (residence of Google headquarter). Not only IT firms but other businesses as well depend on a high developed ICT infrastructure and therefore are the potential funder of it.

The connection of physical space, digital data, and citizens enables new modes to solve urban problems which arrived through the increasing urbanization. To mention one example, we could think about traffic jam warnings which are calculated through the traveling speed of car drivers using a smartphone with GPS connection (Herrera et al., 2010). That kind of services are possible with enhanced ICT infrastructure, where its users generate the data and retrieve real-time data through mobile IT devices.

A further example, how ICT changes our lives is the way we communicate, work, and retrieve information. In many cases emails, messengers (e.g. WhatsApp or Facebook Messenger), group discussion apps (e.g. Slack), video calls (e.g. Skype or Hangout), social media platforms (e.g. Facebook or Twitter) have opened a lot more opportunities than telephone calling or letter

writing. If we are looking for information, we are going to use Google (Rowlands et al., 2008). For more profound information deep web databases are at our disposal through digital libraries (Mainka et al., 2013). These possibilities are as well based on ICT. The innovation is that we can use this access anytime and anywhere through our mobile devices. Most importantly, the ICT infrastructure is the basis for future economic development and represents the fifth Kondratieff cycle which has evoked the network of ICT, namely the internet and outpaced the network of the 4th Kondratieff, namely automotive traffic in cities. Smart city developments always concern about efficiency and sustainability (Hollands, 2008). Climate change and new modes of mobility are in the focus (Nam & Pardo, 2011). Car and bike sharing has entered the mobility market in metropolises next to green buses and (underground) trains to enhance sustainable public transport.

Summing up, the ICT infrastructure of a city or region is measurable through hard factors like the broadband speed, -accessibility, and -quality as well as the amount of internet users counted by the number of broadband subscribers and Wi-Fi hotspots. Political willingness to improve the ICT infrastructure or support businesses of the ICT market are understood as advantage. The ICT infrastructure conquers the city and automotive traffic is increasingly reduced. Finally, information literacy needs more attention and adequate investigation.

Which technical factors are crucial in an investigation of informational world cities? The fact that ICT access, use, and skills are important is already evident through the high amount of indices on national level that are using them in their calculation. From the economic perspective, it is still controversial if ICT companies have to be located in a city to improve the city's ability to become an informational world city. Thus the following hypothesis will be proved:

H1   *Informational world cities are hubs for companies with information market activities, e.g. telecommunication companies.*

The importance of the ICT infrastructure regarding an informational world city development may dispose old traditions. According to Stock (2011), motorways have to be abandoned in favor of more space for recreation, like in the case of Seoul where the motorway in the city center has been demolished in favor of open the space for walking and leisure. Seoul is a leading city regarding to its ICT industry. Contrasting these two development paths the following hypothesis will be investigated:

H2   *The ICT infrastructure in an informational world city is more important than automotive traffic infrastructure.*

3.1.2 Cognitive infrastructure

Humans are in the focus in the investigation of informational world cities. In an economy at which knowledge is understood as crucial growth factor (Machlup, 1962) humans are important to transfer information into knowledge and vice versa (Kuhlen, 1995). As already described in the first chapter, it is often referred to the topic knowledge city or creative city when it comes to the investigation of the knowledge society. The infrastructure of these city types can be joined as "cognitive infrastructure" (Stock, 2011). It is a soft infrastructure as it is not measurable according to hard facts like the ICT infrastructure (Setunge & Kumar, 2010). According to Stock (2011, p. 970), the cognitive infrastructure of informational cities could be investigated by two types of activity:

- *"Scientific–technical–medical activities and the results thereof ('knowledge city'),"*
- *"Creative–artistic activities and the results thereof ('creative city')."*

As activities need a place of origin I will add institutions of the knowledge and creative city as further part within the cognitive infrastructure. In particular, libraries have inherited a special role in the 21st century as meeting, learning, and creative space but as well as knowledge provider. In the following I will discuss the key factors that are defining a knowledge as well as a creative city and the role of libraries within this context.

Knowledge city

The knowledge city infrastructure includes institutions like universities, enterprises of the knowledge economy, as well as research and development. Kunzmann (2004), for example, defines the knowledge city as home for knowledge institutions like public and private universities, public funded research institutions (e.g. Frauenhofer Institute or Max Planck in Germany), and research institutes or centers operated by private corporations. This agglomeration of these institutes is also called the "triple helix" (Kunzmann, 2004). Universities and enterprises in those cities benefit from each other. Corporations have the money to invest in research or pay for professors and universities educate knowledge workers, which are needed in corporations, and help knowledge workers to open innovative startups (Van Winden, 2009). According to Carrillo (2004, p. 44): *"[Knowledge cities] are becoming the scenario for probably the most substantial development in human evolution."*

The basis of knowledge is education. Education has a positive impact, hence it is related to the status and income of a person in our society (Heidenreich, 2002). Thus, secondary enrolment and tertiary enrolment are part of the HDI and the rate of alphabetization of adults are included in several ICT indices as well. In addition, life-long learning as well as an adequate educational system is seen as part of the continuously development of the knowledge society (Lim, 1999). Therefore, institutions like universities and libraries are needed (Stock, 2011). Hence, libraries are able to offer life-long learning.

Referring to the education level, scientific and technical competencies could be used as measurement value of knowledge flows. Stock (2011, p. 970) emphasizes that *"[t]he knowledge society may be concerned with all sorts of knowledge."* Amongst others scientific knowledge of STM—science, technology, and medicine—because economic development is based on scientific innovations, e.g. in biotechnology. For example, the work of scientists on new bio fuels, that could release us from our dependency on limited oil and gas (Department of Energy, n.d.), will have an impact on future economic growth. Another aspect is scientific innovations in medicine that increase for example the live expectancy of the population (Nefiodow, 2006). Therefore, the HDI includes the indicator "life expectancy at birth" (UNDP, 2014).

Stock (2011) proposes to use informetric investigations to analyze scientific output by the number of patents and scientific articles and its impact by the number of citations of these publications. These are the information flows from a scientific point of view. Powell and Snellman (2004) have shown that a patent investigation reflect the development of the economy, as proved by the evaluation of patents granted in the US. *"The upsurge in overall patenting activity is driven by the emergence of new industries, highly fertile in terms of generation of novel ideas and new products. In tandem, there is a decline in traditional sectors"* (Powell & Snellman, 2004, p. 203).

Summarizing, on city level the investigated infrastructure according to the knowledge city is based on places, education, and information flows. Places refer to institutions of higher education, science parks, libraries, and enterprises of the knowledge economy (Carrillo, Yigitcanlar, García, & Lönnqvist, 2014; Kunzmann, 2004). Education plays a significant role, as secondary and tertiary enrolment are both part of the HDI. Finally, information flows refer to scientific articles, patents, and citations (Powell & Snellman, 2004; Stock, 2011).

Thus, the question arises how to measure the knowledge infrastructure? As knowledge institutions are the origin of knowledge output and are physically visible in the city they could be understood as basis of the knowledge output. This should not mean that all knowledge institutions produce the same output. The trend in informational world cities is to agglomerate science and

development at one place e.g. at science parks or university clusters (Kunzmann, 2004). Thus, the following hypothesis will be investigated:

H3   *Science parks or university clusters that cooperate with knowledge intensive companies are important in an informational world city.*

The investigation of information flows according to informational cities should also be considered in further investigation but would exceed the actual thesis and therefore will not be included. However, quality rankings of knowledge institutions include indices like the number of patens and scientific publications as indicator to which I will refer in the following.

Creative city

According to Florida (2003b, p. 40) there exist three types of creativity: *"(1) technological creativity or innovation, (2) economic creativity or entrepreneurship, and (3) artistic and cultural creativity."* Creativity is a driver of economic growth. Thus, Florida (2003a) refers to the "creative capital," which is a type of the human capital, that, if can be found in places, e.g. in cities, will be a magnet for further creative people, since they prefer open, tolerant and diverse environments. Further, he has defined the "3 T's" of the creative class that are crucial factors of economic growth: technology, talent, and tolerance (Florida, 2002). He has investigated this by correlating high-tech places with places with the highest concentration of gay people according to the "Gay Index" and his "Bohemian Index," which count the penetration rate of artists, writers, and performers in a region (Florida, 2014). Florida (2003a) has defined the *creative class* on a broader spectrum not only artists, writers, performers, but also includes occupations like scientists and engineers, university professors, non-fiction writers, editors, think-tank researchers, and analysts.

From the economic perspective the creative class is often referred to the "creative industry," "cultural industry," or "creative economy" (Flew, 2013; Howkins, 2001; Pratt, 2008). Until now, there is no common standard which sectors belong to the creative industries or even about which term should be used; creative or cultural industry (Hölzl, 2006). Singapore, for example, uses a classification framework for the creative industries which consists of three parts: arts and culture, design, and media. The British Council (Collis, Felton, & Graham, 2010) argues to relate the creative sectors to the four domains: (1) books and press, (2) audio visual, (3) performance, and (4) visual arts and design. For Stock (2011), the creative class overlaps with the definition of knowledge workers. Accordingly, Florida (2003a, p. 8) argues: *"(T)he creative class also includes 'creative professionals' who work in a wide range of knowledge-intensive industries."*

Thus, a clear separation of the knowledge and creative city is not practicable and both parts are best joined as cognitive infrastructure of a city.

Even as there are differences in the terminology and classification of cultural and creative industries, they also have a diverse impact, if we compare this development on a global scale. Murugadas, Vieten, Nikolic, Fietkiewicz, and Stock (2015) have analyzed the impact of creative industries (including culture and arts, and innovation in the sense of publications and patents) on the GDP on city level. Their results show that creative industries in the analyzed American cities have a higher correlation with the GDP than in European or Asian cities. Thus, they argue that Florida's results on the impact of creativity and economic growth is true for American cities but cannot be generalized as a global phenomenon. Further research on the relevance of Florida's creative class theory was undertaken by Hansen, Asheim, and Vang (2009). Accordingly, not all hypotheses of the creative class are true for Europe. Nevertheless, tolerance and attractive environments attract the creative class and have a positive impact on the regional development. They argue to simplify the theory to 2T's theory: talent and tolerance and that a more diverse investigation of occupations would give a better understanding of the creative class. To identify patents in the field of ICT, fashion design, music and other creative sectors could help to identify locations of creative/competitive cities, in addition (Boulton, Brunn, & Devriendt, 2012).

The creative city, in its physical representation, is dedicated to creative industries. Most evident are bohemian neighborhoods in which creative talents and industries are settled down (Collis et al., 2010). They are established in creative quartiers near the city center. Very important is the proximity of talents and industries of the creative class within a city. Interlinking is not based on ICT but on face-to-face communication (Storper & Venables, 2004). Thus, places in the city at which creatives can meet each other become crucial (Stock, 2011). Local creatives can build the bridge between the space of flows and the space of places (Castells, 1996). Therefore, local creative clusters which bring together local creatives and authorities are important for the development of a "milieu of innovation" (Camagni, 1995; Hitters & Richards, 2002).

Open Social Learning is a new form of the knowledge market of the 21st century which can be dedicated to a new form of innovative milieu. *"OPEN SOCIAL LEARNING … [includes] spaces for action and entities (Public Private Partnerships, PPP), that use digital technology as a resource to offer LEARNING (focusing on the learner) that is SOCIAL (co-creation and collective use of knowledge) and OPEN (based on the reusability of the learning object). These new organizations "labs" co-create, collaborate, and build alternative roads to bring about real change in the way we learn, innovate, work, enjoy, live..."* ("OSL crowdmap," n.d., para. 1). Carrillo et al. (2014) mention

for example Citilabs as spaces for collaborative learning. Learning initiatives are initiated by citizens and are often related to technology. Furthermore FabLabs, HackLabs, living lab, Tech Shops or Innovation Boot camps are events or spaces for an open community that is likely to participate and to create something. Cities that are home to creatives need to offer space that can be used accordingly.

To summarize, the creative infrastructure includes creative talents, creative industries, proximity and face-to-face interaction. The correlation of the creative class and GDP growth rates are evident for US American cities but cannot be proved on a global scale. Thus, it is questionable if Florida is right with his assumption of the high impact of creative city indicators on the development of cities in the 21st century. Accordingly, the following hypothesis will be investigated:

H4   *An informational world city needs to be a creative city.*

Further, the agglomeration of creative industries and talents are important to foster innovation. The creative class (including creative talents and knowledge worker) need space within the city to meet and interact. Therefore, following hypothesis will be investigated in addition:

H5   *Physical space for face-to-face interaction is important for an informational world city.*

Libraries in informational world cities

According to Hall (1997), access to information even via ICT or face-to-face is one of the main indicators of cities of the 21st century. And this is exactly the role of libraries in informational world cities. Library services are dedicated to two spaces: digital and physical (Mainka et al., 2013). Following Ergazakis et al. (2009), libraries offer a tremendous amount of collections through digital access. Thus, a main characteristic of the knowledge city is the digital library that serves the needs of citizens and companies. Access is mostly cheap or even free of charge. Furthermore, the access is not restricted to reference information, e.g. through the libraries catalogue, but inherits a lot of full text materials (Stock, 2011). This access to information via library networks is just able due to the enhanced ICT infrastructure. A precondition of this service is that citizens and companies located in the city need access through the internet and own devices. Stock (2011) emphasizes the idea of library networks as service provider independent of their location. One mentioned example is the digital library in Reykjavik that offers access for the whole population of Iceland to all scientific publications published in specialized journals on Elsevier's Science Direct (van de Stadt

& Thorsteinsdóttir, 2007). A further example is the nation state Singapore. The library network there offers a wide range of access to selected resources of general interest through private and library devices for registered users and access to specialized resources and databases through devices located at any library branch, e.g. the National Library in the city center (Chellapandi, Wun Han, & Chiew Boon, 2010; Sharma, Lim, & Boon, 2009). Both models are very cost-intensive. In comparison, the model of Singapore is less expensive since specialized materials are not provided through the digital network but access is given through devices at the library building (Stock, 2011). The available media is not only dedicated to scientific or specialized materials, fiction as well is part of the library collection. According to Stehr (2003), the consumption of knowledge should be of interest in research on the knowledge society in addition to the knowledge output.

Libraries and public libraries are further investigated according to their economic value (following Mainka et al. (Mainka et al., 2013) this is evident through the studies of (Aabø, 2005; Ferreira dos Santos, 2009; Ko, Shim, Pyo, Chang, & Chung, 2012; Koontz, 1992; McCallum & Quinn, 2004; Missingham, 2005; Morris, Sumsion, & Hawkins, 2002; Poll, 2003; Saxena & McDougall, 2012)). In the business sector public libraries are an important service for small and medium-sized companies that do not have own libraries or information centers (Ferreira dos Santos, 2009). Libraries act as document supplier and also serve as push information provider, e.g. according to mergers and acquisitions in the business sector (Yimin & Zhong, 2008). Public libraries are dedicated to the "soft" location factors as they could not be investigated through "hard" facts like infrastructures or wage structure (Mainka et al., 2013). Soft location factors are important in attracting and binding companies as well as the creative class (Florida, 2003a; Umlauf, 2008). Mainka et al. (2013) argue that public libraries, even if they are just a soft location factor or a cultural institution, are important as physical space within the city. This fact is already evident through investigations of cultural amenities and libraries (Evans, 2009).

The economic value of a public library is able to be investigated according to the willingness of costumers to pay for the service but as well comes to light if a public library needs to be shut down and the citizens start to protest (Aabø, 2005; Hummel, 1990; Ko et al., 2012). As physical place the library can also act as a "place maker" (Skot-Hansen et al., 2013). New library buildings with an attractive architecture are further used as urban planning instrument to revitalize city space. Public libraries as well vitalize their community by inviting citizens to interact with their library or publish content produced by the community. Public libraries offer space for working, meeting, and learning (Mainka et al., 2013). As public library buildings are public space they offer room for the community and are understood as basic infrastructure of the creative and knowledge city (Florida, 2003a; Landry, 2008; Stock, 2011).

Summarizing, the libraries' infrastructure role is dedicated to its physical and digital services. The digital library is referred to information support including access to full text content. According to Dehua and Beijun (2012), knowledge in an informational world city is understood as service that is ubiquitous available through digital networks and devices. Therefore, following hypothesis will be investigated according to the support of digital content:

H6   *A fully developed content infrastructure, e.g. supported by digital libraries, is a characteristic feature of an informational world city.*

According to the physical space, Mainka et al. (2013) conclude their study with the question, how creative talents and knowledge workers could be attracted to library buildings? Space within the library is changing from being a big archive of printed material towards more space for the community. Thus, I will investigate this changing role of the library according to following hypothesis:

H7   *Libraries are important in an informational world city as a physical place for face-to-face communication and interaction.*

3.2 Political will

The political willingness of a city can be observed by its achieved goals and future master plans which are related to the cities' development e.g. in economy, society, and infrastructure. According to Yigitcanlar (2010, p. 395) the following activities are crucial in regard to political and societal will of an informational city:

- *"strategic vision and development plans,*

- *financial support and strong investments,*

- *agencies to promote knowledge-based urban development,*

- *an international, multicultural character of the city,*

- *metropolitan Web portals,*

- *value creation for citizens,*

- *creation of urban innovative engines,*

- *assurance of knowledge society rights,*

- *low-cost access to advanced communication networks,*

- *research excellence,*

- *and robust public library networks."*

Political willingness goes hand in hand with societal will. Thus, for example a multinational character of a city can just be reached by an open minded society. All of the prior mentioned factors by Yigitcanlar (2010) to become an informational city are investigated by the "Knowledge-Based Urban Development" (KBUD) framework which covers four pillars of development namely: economical, societal, spatial, and institutional (Carrillo et al., 2014). This framework helps to detect good governance towards a knowledge society.

It is observable that city mayors have recognized the importance of information and communication as a driver of economy and wealth and start to push their city with governmental future plans. One of the early adopters is Singapore. They developed a master plan in 2005 where they described their goal to become *"An Intelligent Nation, A Global City, Powered by Infocomm"* in 2015 (IDA, n.d.-a). Today they follow a "Smart Nation Vision" which equally refers to the further development of the ICT sector (IDA, n.d.-b). Another example is Barcelona. Their vision is *"to become: self-sufficient, with productive neighborhoods, living at a human speed and producing zero emissions. A productive, open, inclusive and innovative city; a living city with enterprising people and organized communities"* (Dameri & Rosenthal-Sabroux, 2014, p. 14). For citizens the potential of living in a "Smart" or "Informational City" shows its assets in their everyday life. Services become gadgets in their pockets like in smartphone applications based on city data or services (Mainka, Hartmann, Meschede, & Stock, 2015a). Furthermore, citizens are able to add value to the tremendous amount of data that smart cities are generating. *"[T]he role of sensors/information providers is the only role citizens can play that is specific (not to say exclusive) to smart cities"* (Castelnovo, 2015, para. 4).

To have the technological equipment is not a guarantee for having access to information. Thus, Lor and Britz (2007) rise the question if a knowledge society is possible without freedom of access to information. Access to information should be affordable for the society. This implies a fair regulation by the government and the market. *"The development of a knowledge society requires freedom. It therefore requires a social system that allows critical thinking, encourages access to the ideas of others, and promotes the freedom to communicate and participate in the sharing of the global body of knowledge"* (Lor & Britz, 2007, p. 395). They conclude that it is possible to be an information society but not a knowledge society without freedom of information, content, and human capacity. Freedom of information is understood as a human right. Thus, the United Nations report that freedom of information is essential for a transparent, open, and democratic government and may help to avoid corruption (La Rue, 2011). The freedom of information is analyzed e.g. by Reporters without Borders (n.d., para. 5) who develop the World Press Freedom Index using the following indicators:

- *"Pluralism*
  Measures the degree to which opinions are represented in the media

- *Media independence*
  Measures the degree to which the media are able to function independently of sources of political, governmental, business and religious power and influence

- *Environment and self-censorship*
  Analyses the environment in which journalists and other news and information providers operate

- *Legislative framework*
  Analyses the impact of the legislative framework governing news and information activities

- *Transparency*
  Measures the transparency of the institutions and procedures that affect the production of news and information

- *Infrastructure*
  Measures the quality of the infrastructure that supports the production of news and information

- *Abuses*
  Measures the level of violence and harassment during the period assessed"

In addition to the freedom of press, the freedom of the internet is a basic indicator of the free flow of information. Accordingly, this is measured by the Freedom House (2016, para. 10) with the following indicators on national level:

- *"**Obstacles to Access** details infrastructural and economic barriers to access, legal and ownership control over internet service providers, and independence of regulatory bodies;*

- ***Limits on Content** analyzes legal regulations on content, technical filtering and blocking of websites, self-censorship, the vibrancy/diversity of online news media, and the use of digital tools for civic mobilization;*

- ***Violations of User Rights** tackles surveillance, privacy, and repercussions for online speech and activities, such as imprisonment, extralegal harassment, or cyberattacks."*

However, mass media information as well as government information should be open for the public regardless if online or offline (Yu & Robinson, 2012). Next to government services and online initiatives, governments have started to make public data available through open data portals in the last few years (Mainka et al., 2015a; Mainka, Hartmann, Meschede, & Stock, 2015b). Those portals can be on national level (e.g. data.gov in the U.S., or data.gov.uk in the United Kingdom), regional level (e.g. data.qld.gov.au for the federal state Queensland in Australia or open.nrw/de/dat_kat for the federal state North Rhine-Westphalia in Germany) or city level (e.g.

nycopendata.socrata.com for New York in the US, or data.gov.hk for Hong Kong). These kind of development is often part of an open government strategy which should involve different stake holders to participate in policy-making and decision-making processes (Bingham, Nabatchi, & O'Leary, 2005; Harrison, Burke, Cook, Cresswell, & Hrdinová, 2011). What needs to be added is that the understanding of the governmental role has changed. With the advent of information and communication technology topics like e-governance and open government arose which should reflect new modes of government to business, government to citizens, and government to government interaction (Harrison et al., 2011; Palvia & Sharma, 2007). This is more than the digitization processes within or between governmental agencies. It is referred to an open discourse between all stakeholders in the city.

That an adequate e-government is of importance in a knowledge society is stressed by the e-government survey by the United Nations. Since 2003, they generate a global survey on national level. Their recent publication is their ninth edition from 2016 (United Nations, 2016). For their measurement of the "E-Government Readiness Index" they combine the "Telecommunication Infrastructure Index" (TII), "Human Capital Index" (HCI), and "Online Service Index" (OSI). Similar to the presented ICT indices the TII is based on the amount of mobile-cellular subscriptions, fixed-telephone subscriptions, and fixed and wireless-broadband subscriptions each per 100 inhabitants. In addition, the amount of individuals using the internet as a percentage of the whole population is calculated. For the HCI they count the adult literacy ratio, the gross enrolment ratio, the expected and the mean years of schooling. These components should reflect the importance of an adequate educational system. The last part is the OSI. The results for this part are based on the e-government survey undertaken by the United Nations. The survey focuses on the following topics (United Nations, 2014, p. 191):

- *"the rising importance of a whole-of government approach and integrated online service delivery;*

- *the use of e-government to provide information and services to citizens on environment related issues;*

- *e-infrastructure and its increasing role in bridging the digital divide, with a particular emphasis on the provision of effective online services for the inclusion of disadvantaged and vulnerable groups, such as the poor, the disabled, women, children and youth, the elderly, minorities, etc.;*

- *the increasing emphasis on service usage, multichannel service delivery, 'open government data', e-procurement;*

- *the expansion of e-participation and mobile government."*

Referring to Nam and Pardo (2011) political willingness in the sense of smart or informational city initiatives include citizens engagement. Citizens are not only the users of the smart city infrastructure but they are able to engage smoothly which reshapes the authority's awareness of the citizens' needs (Pimbert & Wakeford, 2001). It is crucial that government development plans should care about the people and their lifes (Orofino, 2014). An open governmental strategy or e-governance should include new ways of e-democracy (Palvia & Sharma, 2007). E-democracy and e-participation in particular through social media channels help to enhance the transparency and flow of information but is still in its infancy (Bonsón, Torres, Royo, & Flores, 2012).

Summing up, different governmental issues are of importance when characterizing an informational city. First, from the political point of view it is not evident if an informational city is able to establish itself within the global network only due to economic market activity—through the invisible hand of the market—or if political willingness and more important governmental support to establish such a city is needed (Chandler, 2002). An example that has become an informational city without a master plan is Silicon Valley whereas Singapore has made a tremendous transition based on governmental future vision plans (Stock, 2011). Thus, accordingly I will investigate the following hypothesis:

H8   *Political willingness is important to establish an informational world city especially according to knowledge economy activities.*

Second, governmental services have changed due to the enhanced ICT infrastructure. Information and services become ubiquitous available. Through online participation and an open governmental culture, we arrive at a new democratic level within a city. Therefore, I will investigate if these opportunities are established in informational world cities with the following hypothesis:

H9   *An informational world city is characterized by e-governance (incl. e-government, e-participation, e-democracy).*

Third, the ability to share information through different media and digital networks does not implicate that there is a free flow of information. Critical thinking and a free flow of information is understood as human right and essential to become a knowledge society. Thus, the following hypothesis will be further investigated as part of the political will:

H10   *A free flow of all kinds of information (incl. mass media information) is an important characteristic of an informational world city.*

3.3 World city

The corporate structure of an informational world city is the essential basis for the space of flows as defined by Castells (1989). Flows of information, capital, and power are not delegated by administrative city borders but by the interplay of city networks. Thus, for some researchers the world city network is related to the economic development of cities. Taylor, Firth, Hoyler, and Smith (2010, p. 2814), for instance, argue that *"world cities do not make the world city network, advanced producer service firms do."* The firms located in a city build the relations to other cities that form the network of cities. World city networks are often related to the finance sector. Sassen (2001) sees finance, insurance and real estate (FIRE) as the advanced producer service sector with main impact on globalization.

According to the economic development Egedy, von Streit, and Bontje (2013) describe cities as beeing recognized as "multi-layered." Multi-layered cities are complex constructs which are formed by the interplay of phyisical, socio-economic, and socio-culltural processes. This concept is related to the concept of historic development paths of a city according to Musterd and Murie (2010) and is as well highly correlated with the world city and global city concept by Taylor (2001) or Sassen (2001). Egedy, von Streit, and Bontje (2013) see Amsterdam, Milan, and Munich as examples of those cities due to the variety of branches located there. The opposite of those cities are "one-company" towns. According to Stock (2011, p. 979) the coporate structure of an informational world city covers four types of companies:

1. *"Capital-Intensive Service Providers"*
2. *"Knowledge-Intensive Companies (high-tech industry)"*
3. *"Companies in the Information Economy"*
4. *"Creative Companies."*

In history cities have played key roles if they were located in a hegemony state (Jacobs, 1969). Hegemony states lead in production, commerce, and finance (Taylor, Hoyler, & Smith, 2012). Finance is seen as important factor for cities to obtain an important status within the world network. Following Sassen (2001) finance is part of the preeminent advanced producer service firms in global cities. Cities like London or New York are important world cities because of their location in hegemony states. Taylor, Hoyler, and Smith (2012, p. 29) have shown that *"hegemony-making occurs in specific vibrant regions."* Cities in a specific region are leading in economic growth which is referred to the countless new work encouraged through their networking with each other. Thus, current cities, recognized as world city, play a key role in finance, commerce, and business (Friedmann & Wolff, 1982). Let me explain this by an example. From the European

perspective London is a financial center which covers the global market and Frankfurt as the hub to serve the European market (Taylor, 2012b). This is evident for example through the fact that the European Central Bank is placed in Frankfurt rather than in London. Indicators to analyze international finance centers may vary slightly between different research approaches (Lizieri, 2012). The "Global Financial Centers" ranking by Z/Yen for examples uses a combination of different quantitative indicators of market share, qualities, e.g. quality of the labor market and quality of the infrastructure, and openness, e.g. transparency, regulatory and tax structure among others. Furthermore, Stock (2011) suggests to use the turnover of the regional stock exchange as indicator of the flow of capital with reference to the flows of spaces (capital, power, and information). Hence, every financial center, e.g. New York, London, or Tokyo, has an own stock exchange market to enable those capital flows.

Summing up, the corporate structure of an informational world city is characterized by a mix of companies that cover diverse economic industries (capital intensive, knowledge intensive, information market activities, and creative companies). They cooperate and compete in a global market. To be successful within the global network the finance sector plays a crucial role. First, being located in a hegemony state and second, being a leader according to advanced producer service firms (finance and insurance companies) are both advantages in becoming a global hub within the network of cities. Therefore, I will set the focus on the financial sector and proof the following hypothesis:

H11   *An informational world city has to be a financial hub with a lot of banks and insurance companies.*

To describe the formation of a world city network the term "cityness" is used in diverse ways. For Jacobs (1969) "city-ness" is the relation between cities that form the network of cities. In contrast, local processes that happen within a city are understood as "town-ness." It is related to its local economy and civic society (Taylor, Firth, et al., 2010). Cities that have a high number of inter-city relations are referred to as world or global cities (Friedmann & Wolff, 1982; Taylor, 2001). They are the hubs within the world/global city network. A further definition of "cityness" by Sassen (2001) refers to local urban space. In her definition "cityness" is the process in a city that happens when all instances interact productively. Thus, the core concept of cityness is *"complexity, incompleteness, and making"* (Sassen, 2013, p. 209). Cityness is not given just because of built housing, offices, or factories at one place and it is not just related to the understanding of the western kind of urbanity. It can be a different kind of cityness which we do not see immediately. She refers to the cultural differences between cities in different regions and that western researchers need to be more open to all kinds of urbanity. Finally, both aspects of

cityness are of relevance when investigating informational world cities: First, the inner city processes and second, the inter-city relations or in other words the formation of the global/world city network.

Castells (2001) combines inner and inter-city relations within his theory. For him "glocal" connectivity is a special characteristic of informational cities. Locally, enterprises connect with each other, and globally they are connected through digital networks with the rest of the world (Stock, 2011). The physical connection plays a significant role since the development of cities. Inner city processes as well as their relations and influence on other cities are regarded. They are connected through "asymmetric power relations" which are determined by cities' domination over other cities through offered services like *"food, raw materials, cheap industrial goods and labour"* (Taylor, 2012b, p. 65). Cities in history have always been in a network of cities and they are not world cities because of their size even someone could assume that larger cities lead to larger inter-city flows, e.g. trade. Jacobs (1969, 1984) defines cities in a network as the hubs that are the cause of the development of the modern world. She argues that economic growth is depending on the interaction between these cities. Taylor et al. (2010) are arguing that the development of world city networks is referred to as "central flow theory" in that the economy, merely the firms located in a city and building networks through branches in other cities, are the main actors of this constitution.

For the investigation of world or global cities it is important to acknowledge that cities are not static. They are understood as processes (Castells, 1996; Taylor, 2012a). *"Every city is constituted of myriad urban processes represented by a particular outcome at the point of study. Thus, the world city process is very strong in London and New York and this is reflected in their network measurements and the fact that they are often applauded as 'global cities' (Sassen, 2001)"* (Derudder, Hoyler, Taylor, & Witlox, 2012, p. 3). The term world is also understood as contemporary world according to historical systems as the "Roman World" (Taylor, 2012c). Thus, the contemporary cities are in the focus of world city or global city network analysis. In the following I will refer to Jacobs and Taylors definition of "city-ness" which is derived from inter-city flows that are as well used in Castells (1996) theory of spaces of flows (capital, power, and information). Furthermore, the economic definition of a city is not referred to political-administrative boundaries (Stock, 2011), e.g. Greater London or City of London according to its two authorities. Following Castells (2010), this is due to the fact that we arrived at the network society and networks have no boundaries. Thus, Friedmann (1995, p. 23) defines world cities as *"large, urbanized regions that are defined by dense patterns of interactions rather than by political-administrative boundaries."*

Popular city researchers of world cities or global cities are Peter Hall—The World Cities, 1966, John Friedmann—The World City Hypothesis, 1986, Saskia Sassen—The Global City, 2001, and Peter Taylor—Director of the Globalization and World Cities (GaWC) Research Network. According to Hall (1966) the term world city is now used for more than 100 years and is preferably used to define cities that act as centers for government, economy, and human activity. Taylor (2012a, p. 11) defines a world city as a city within a network of cities. For him this term does not refer to worldwide but to a *"distinctive fragment of the myriad societies in the world."* Therefore cities are understood as "cities in globalization" (Taylor, Derudder, Saey, & Witlox, 2007). Because of this global process and its connection Sassen (2001) prefers to call those cities *global city*. Nevertheless, the status of a world city is measured according to different approaches. In the following, I will present some popular methods and highlight those who are characteristically for an informational world city.

According to the analysis of economic flows a hierarchical order of world cities has been identified (Friedmann, 1995). In the literature there is a difference in the analysis of cities according to the used terms world city or global city. World cities traditionally are analyzed through information on multinational corporations and global cities through information on producer services firms (Derudder, De Vos, & Witlox, 2012). Since both approaches refer to the emergence of a global network based on economic processes it is useful to combine both ideas for further investigations. Derudder, De Vos, and Witlox (2012) have done it and identified that both approaches have outputs that are correlated. Nevertheless, their results show us as well that cities with a high producer service firm value do not always have a high multinational corporation value. In the following, I will refer just to the term world city as there is no reason to distinguish between both terms since both methods are based on economic data.

The method to analyze world cities based on multinational corporations starts from existing lists or entries of firms, e.g. "Fortune's Global 500" for the largest firms in the world, or "Polk's World Bank Directory" for international bank offices (Alderson & Beckfield, 2012). The network can be built with hierarchical orders, e.g. headquarters get higher values in the coding schema, or vertical connections, e.g. the relation between headquarters and subsidiaries are interpreted as collaborative. Advanced producer service firms cannot be found in a structured list. Taylor, Ni, and Derudder (2010) use website information of those firms and code them according to their office size respectively importance, e.g. headquarters are coded with the highest score. Their investigation results in a network that is based on three layers. The net level refers to the space of flows of the world economy, the node level represents the cities, and the third level is called sub-nodal level which refers to advanced producer service firms. They call it the interlocking

network model (Taylor, 2012c; Taylor, Derudder, Hoyler, & Witlox, 2012; Taylor, Ni, et al., 2010). It is an investigation of contemporary world cities since advanced producer services firms expand after 1990 (Taylor, Derudder, et al., 2012). From this time, they start to build their economic world city network.

A similar investigation was undertaken by Wall and van der Knaap (2012). They have analyzed companies starting with the top 100 headquarters of the Fortunes 500 list in 2005. They analyzed city networks according to the company's ownerships to subsidiaries in more than 2000 cities worldwide. Their results show *"that 84 per cent of the network occurs between and not within cities and that 70 per cent of European and North American ties extend beyond their supra regions, it is shown that cities have become dissociated from their local geographies (Friedmann, 1986)"* (Wall & van der Knaap, 2012, p. 225). According to Friedmann's (1986) definition of city hierarchies, they argue that cities link hierarchical and horizontal between different city levels.

A world city network may as well be built by other economic players. Thus, for example the giant firms which provide the internet infrastructure are not part of the advanced producer service sector but they are important for the construction of informational world cities (Malecki, 2012). According to Graham (1999) world cities are providers of telecommunication infrastructure due to their agglomeration of financial service firms and transnational corporations. Thus, both kind of firms are located in world cities. To investigate ICT network flows between cities no measurable data is available, e.g. emails between employees (Taylor, 2004). However, it is possible to identify global internet hubs as it is done by *"Internet backbone capacity (Townsend, 2001b), number of internet domain names (Zook, 2001; Sternberg and Krymalowski, 2002), and internet exchange points (IXPs) (Malecki, 2002; Devriendt et al., 2010)"* (Malecki, 2012, p. 117). Malecki (2012) argues that it is important to include content providers such as Google and cloud computing according to their co-location facilities (co-location facilities host servers, storage, and networking equipment for content providers).

Taylor (2012b) states that city hierarchies do not exist on a global scale. Hierarchies are limited to political processes. One example for him is the relationship between London and Paris. London is often listed higher in city rankings than Paris. This does not mean that London may tell Paris "what to do." This indicates that London for instance has more headquarters. However, Paris as well has headquarters with branches in London. Thus, there exists a horizontal relationship in that Paris headquarters instruct branches in London and vice versa. On a political level London stands higher in a hierarchical order within other cities in the United Kingdom because of decisions which are taken in London on other cities. That there is no evidence for a hierarchy on a global

level is also reflected in Friedmann's (1986) world city system where world cities are classified in primary and secondary world cities with horizontal relations. From an economic perspective a city like London also stands higher in a hierarchy comparing to its hinterland. Taylor, Hoyer, and Verbruggen (2010) describe this phenomenon as "central place theory." Furthermore, they introduce the "central flow theory" with reference to Castells theory of the importance of the space of place as well as space of flows which are both prevalent in a network of cities.

Cities are also defined as world cities because of their political power. Important to a political world city is that the city plays a significant role in a global network. This could be a city that is home to political actors with a global reach or because of a global reach of decisions that are taken in such a city, e.g. Washington or Brussels (van der Wusten, 2012). Another aspect could be the presence of diverse non-governmental organizations and universities that are globally oriented. They are referred to as "civil society hubs," e.g. The World Economic Forum which aims to foster public-private cooperation worldwide (van der Wusten, 2012). A third aspect is the "symbolic significance" of a political city, e.g. the White House in Washington (van der Wusten, 2012).

Networks also can be created through political decisions to join a network of nations, e.g. like the European Union (Taylor, 2012b). The aim is to build relations of sharing "best practice" expertise and enhanced transparency on policy information within this network. Inter-city relations also play an important role when it comes to infrastructure investments, e.g. building new airports. But Taylor (2012b) sees the economy, furthermore the agents who are the important actors in inter-city relation networks, as the main users of new infrastructure. For him the inter-city network is built through intra-firm relations of service firms.

A further measuring method of world cities bases on the physical inter-city connectivity calculated e.g. through airline networks. A high level of accessibility is analyzed by the number of direct originating or destined flights for a city respectively metropolitan region (Derudder & Witlox, 2005). For Grubesic and Matisziw (2012) direct connections indicate an important role of a city in the world system. They argue that further calculations can be derived from airline networks, e.g. minimum cost of travelling by calculating the minimal number of steps (e.g. Shimbel distance calculation) or minimum distance (e.g. L-matrix calculation). Airline connectivity reflects the actual need of consumption and is changing by demand (Grubesic & Matisziw, 2012). According to Budd (2012, p. 151), airports bring nations closer together in "time and space." Airports that offer direct flights every day to global airport hubs should also be considered within those calculations (Budd, 2012). Therefore, airline connectivity is used to analyze the physical

inter-city connections of contemporary cities. It is questionable how important airports will remain in the future. Budd (2012) suspects that increasing pain of terrorism and fluctuating oil prices can conclude in less flights which could lead to that flying will be a luxury good in future. Nevertheless, most global cities are harbor cities because of the historical importance of shipping goods which leads to global flows according to trade and commerce (King, 2012). Thus, alternative flows could be detected through traditional physical connections.

In addition, entrepreneurship can be seen as a globalizing phenomenon. Bayrasli (2015) report in her book "From The Other Side of The World" about entrepreneurs from the seven countries Mexico, Nigeria, China, India, Russia, Turkey, and Pakistan. Young entrepreneurs who have learned how to be an entrepreneur (for example in Silicon Valley) go back to their home country and develop startups to solve place related problems (Bayrasli, 2015). Unfortunately, flows of knowledge cannot be investigated like the flows of power of producer service firms, by counting headquarters and their branches. The early stages of entrepreneurs are not countable in that way, but later, if the business idea was fruitful, branches may go global. Cities which are following the trend of entrepreneurship can be identified through their amount of enterprise births and self-employment rates (Murugadas et al., 2015). Many cities like to push the entrepreneurship through diverse initiatives, but Bayrasli (2015) argues that the implementation of a "Silicon Anything" like the Silicon Alley in New York or Silicon Cape in South Africa will not be the next Silicon Valley. Furthermore, an investigation of the impact of entrepreneurship on the GDP in metropolitan regions have shown that there is no significant correlation which could indicate the positive effect of the economy (Murugadas et al., 2015). This may be due to the still small amount of enterprises births or self-employment rates in comparison to cities population growth. The globalization of entrepreneurship as described in Bayrasli's (2015) report opens the market and space for competition, which may result in fruitful ideas and economic growth in future.

Accordingly, to measure knowledge flows from an economic perspective, Faulconbridge and Hall (2012) have identified three forms of flow and interconnectivity. First, city related knowledge production is evident through clusters and universities in a city; second through flows between cities as by trade fairs or conferences; and third knowledge is produced in space between cities like in organizational communities of practice where firm members located in different cities share their knowledge through calls, meetings, and other methods.

Further, the cultural economy has gained in importance as employer and economic actor in many places. For instance in London it increased to the third largest component of the economy

in the 21st century (Pratt, 2012). As Pratt (2012) argues, the cultural economy is very complex and its actions and flows are not easy to analyze as for example the investigations of headquarters and its subsidiaries. Sufficient and sensitive tools are needed to determine the impact of the cultural economy of world cities and globalization. One idea is to analyze global networks of huge media firms. Watson (2012) has investigated transnational media corporations (TNMCs) because they belong to the largest firms in the world and serve a global market—which is borderless due to digital connection through the internet. It is not easy to identify true indices that make TNMCs global. Watson (2012, p. 284) adapts the idea of global investigations of advanced producer service firms (see Taylor, 2001) and analyzes the *"transnational office networks of 25 of the world's largest TNMCs."* He refers to Castells (2009) theory, that the network of this multinational companies makes them global. Thus, the investments, labor, production, and distribution interlock these organizations. Watson (2012) has identified that the two largest media fields are the Pacific Rim and the US according to media production. Thus, he argues that TNMCs are not truly global they are rather regional focused, e.g. considering the total sales of TNMCs which are extremely domestically. Finally, he argues that the combination of TNMCs and smaller media organizations located in cities make the city global and interlock the city in diverse levels of global flows and networks. He calls those cities "global media cities."

The hitherto presented research methods force us to question: What leads to the existing network? Is it "city networks" or a "network of cities"? According to Allen (1999), Sassen is concerned with the city as place—therefore referring to the city networks—and Castells puts the flows between cities in the focus of his theory—thus he refers to the network of cities. Both have been investigated according to connectivity between different instances. Thus, the space of flows is "glocal." Secondly, we have to ask: *what* flows? Following Stock (2011, p. 981), informational world cities can be measured by three types of flows: *"(a) the amount of capital flows (stock exchange turnover), (b) the amount of power flows (as indicated by the sum of profits of their companies), and (c) the amount of information flows (the connectivity of the city with regard to business and STM publications/citations)."* According to Boulton, Brunn, and Devriendt (2012) world cities networks can exist of more than just flows and acknowledge that there exists a big research gap to analyze cities beyond flow theories. They conceptualize smart world cities in three dimensions of cyber infrastructure: physical, human, and soft. The physical infrastructure refers to airlines, visitor facilities like hotels and conference halls, and include the high-tech fiber optic technologies which are the basis of telecommunication. The second refers to the traditional human capital (labor) and soft refers to informational "cloud" Web domains, cyberspaces, and user-generated and geo-referenced spatial data. Referring to King (2012) further categories need

to be add: (1) political and cultural criteria, (2) infrastructural criteria, and (3) visual and architectural criteria (Table 3-1).

Table 3-1: World city categories by King (2012, p.32).

Political and cultural criteria	Infrastructural criteria	Visual and architectural criteria
- Presence of international organizations of governance and administration - A minimally large and diverse population - Media - Communications and publishing activities - Museums - Theatres - Educational facilities - Religious sites for pilgrimage and tourism - The capacity to sponsor global sporting or cultural events	Major airport and transport hub	- Skyscrapers - Distinctive skyline

Thus, King (2012) merges many criteria to describe the constellation of a world city. Finally, to identify criteria of a world city is very controversial. Many different factors like multinational corporations, advanced producer service firms, giant internet firms, media corporations, entrepreneurs, physical connectivity through air or water, and many more are considered. At least, it is not defined whether to talk about global cities or world cities. Nevertheless, combining world city and informational city theory both have in common to investigate the space of flows, even if they are digital, economical, or knowledge flows. The essential characteristic is the produced network which is genuinely a feature of the network society. Summing up, I will investigate if being a world city is a necessary characteristic of an informational city according to following hypothesis:

H12   *An informational city is supposed to be a global city ("world city").*

3.4 Hypothesis Overview

Based on the investigated literature the following hypothesizes have been derived. All will be investigated through methods used from grounded theory (see chapter 4 Methods). The motivation is that measuring cities according to the amount of people living in a city, internet access per household, GDP, etc. are not easy to scale equally. For instance, there are different educational systems in Asia and Europe. In Asia for nearly every profession you need to have at least a Bachelor degree (SH 1, personal communication, July 13, 2012) and in Europe, you may learn professions through craft training and get a degree of the Chamber of Industry and Commerce. The numbers do not reflect the culture or the identity of a city, which is equally important whether we want to detect cities of the knowledge society. According to the following hypotheses the main characteristics of informational world cities in the 21st century will be determined:

H1   *Informational world cities are hubs for companies with information market activities, e.g. telecommunication companies.*

H2   *The ICT infrastructure in an informational world city is more important than automotive traffic infrastructure.*

H3   *Science parks or university clusters that cooperate with knowledge intensive companies are important in an informational world city.*

H4   *An informational world city needs to be a creative city.*

H5   *Physical space for face-to-face interaction is important for an informational world city.*

H6   *A fully developed content infrastructure, e.g. supported by digital libraries, is a characteristic feature of an informational world city.*

H7   *Libraries are important in an informational world city as a physical place for face-to-face communication and interaction.*

H8   *Political willingness is important to establish an informational world city especially according to knowledge economy activities.*

H9   *An informational world city is characterized by e-governance (incl. e-government, e-participation, e-democracy).*

H10   *A free flow of all kinds of information (incl. mass media information) is an important characteristic of an informational world city.*

H11   *An informational world city has to be a financial hub with a lot of banks and insurance companies.*

H12   *An informational city is supposed to be a global city ("world city").*

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4 Methods

This work is part of a research project on informational cities conducted at the Department of Information Science at the Heinrich-Heine-University Düsseldorf (Germany) since 2010. Therefore I will refer to prior publications on informational world cities in which I have been involved, like the case studies of Singapore and London as prototypes of informational world cities (Khveshchanka, Mainka, & Peters, 2011; Murugadas, Vieten, Nikolic, & Mainka, 2015), case studies of emerging informational world cities in the Gulf Region (Kosior, Barth, Gremm, Mainka, & Stock, 2015), the investigation of public services like public libraries and e-government services in informational world cities (Mainka, Hartmann, et al., 2013; Mainka, Fietkiewicz, Kosior, Pyka, & Stock, 2013), the analysis of social media activities by public authorities and citizens in these cities (Förster, Lamerz, Mainka, & Peters, 2014; Förster & Mainka, 2015; Mainka, Hartmann, Stock, & Peters, 2015), and the investigation of the use of open data in mobile applications for city services (Mainka, Hartmann, Meschede, & Stock, 2015). Furthermore, I will refer as well to publications which have been investigated by my colleagues like the case study investigation of the labor market in informational world cities (Dornstädter, Finkelmeyer, & Shanmuganathan, 2011), the case study investigation of indicators of the "space of flow" (Nowag, Perez, & Stuckmann, 2011), the investigation of entrepreneurship and creativity on a global scale (Murugadas, Vieten, Nikolic, Fietkiewicz, & Stock, 2015), and the case study of informational world cities in Japan (Fietkiewicz & Pyka, 2014; Fietkiewicz & Stock, 2015). Wolfgang G. Stock (2011) has laid the foundation of all this work with his article "Informational Cities: Analysis and Construction of Cities in the Knowledge Society" in which he has defined first indicators of informational cities and raises the question how to investigate prototypical cities of the knowledge society. The intention of this dissertation is to evaluate prototypical cities of the knowledge society on a global scale according to the indicators infrastructures, world city, and political willingness.

Research on informational world cities is based on an interdisciplinary approach and uses methods that are established in information science and in social science. I will combine qualitative with quantitative approaches and as well use secondary data to analyze cities of the knowledge society in a broader spectrum. The methods used in this research project can be subsumed under the grounded theory which includes literature review, semi-structured interviews, field study and statistical data investigation methods. In the following, the methods used are described. Hence, the research project was a process of identifying adequate research methods and evaluating data. In the following, the methods used will be presented.

4.1 Grounded Theory: Combination of research methods to investigate new fields

As a common qualitative approach, the grounded theory defined by Glaser and Strauss (1998) is used in social science studies worldwide (Strauss & Corbin, 1996). According to Strauss and Corbin (1996) the combination of interviews, field research and statistics can be used to define a new data-driven theory; the grounded theory. This research approach does not start with a theory which should be proved but with a research field that should be investigated based on data and analytical methods. Furthermore, the focus and important aspects of the investigated object will come to light during the research process. Based on the grounded theory defined by Glaser and Strauss (1998), Oktay (2012) has formulated four core components that have mutual effects of the developing theory:

1. *Theoretical sensitivity:* This ability refers to the researcher's ability to think analytically. It implies that the researcher is able to develop an understanding of the research field or object and to identify crucial characteristics of it. Adhering to this concept helps the researcher to conceptualize and formulate a theory based on the investigated data.

2. *Constant comparative method:* This is the basic method used in grounded theory. Here the researcher may conceptualize theories by a constant comparison of empirical data. This helps the researcher to build concepts by identifying similarities and differences in the data.

3. *Theoretical sampling*: This is not one of the first steps in grounded theory since the developing theory is a process. Thus, sampling may change during the research process e.g. after an interview. A sampling may become irrelevant or help to define the final theory.

4. *Theoretical saturation*: This means that the researcher has analyzed all data which may be relevant for defining new concepts. More data would not result in further findings. Saturation is the point that the researcher has met after a process of data evaluation and data analysis.

Thus, the basic research method used in this work is the grounded theory and combines the different approaches of qualitative and quantitative methods. The first step was to analyze the literature of informational cities and related fields to formulate first samplings. The samplings were used to formulate first theories which then have been adopted to evolve questions for interviews with experts. Further questions that arose from the data gathered in the interviews

have been added individually and field related, e.g. librarians were interrogated with additional questions about citizen's participation and engagement in library activities. Besides, further theories could emerge through the interview evaluation which also led to an additional literature review during the research process. Therefore, the grounded theory is a helpful method to disclose further hypothesizes based on emerging topics, problems, or challenges. This approach is flexible and allows researchers to combine mutual methods like literature reviews, interviews, field studies and statistical data analysis as it is done in this work to gain complementary and fruitful results. Figure 4-1 visualizes the process of investigation.
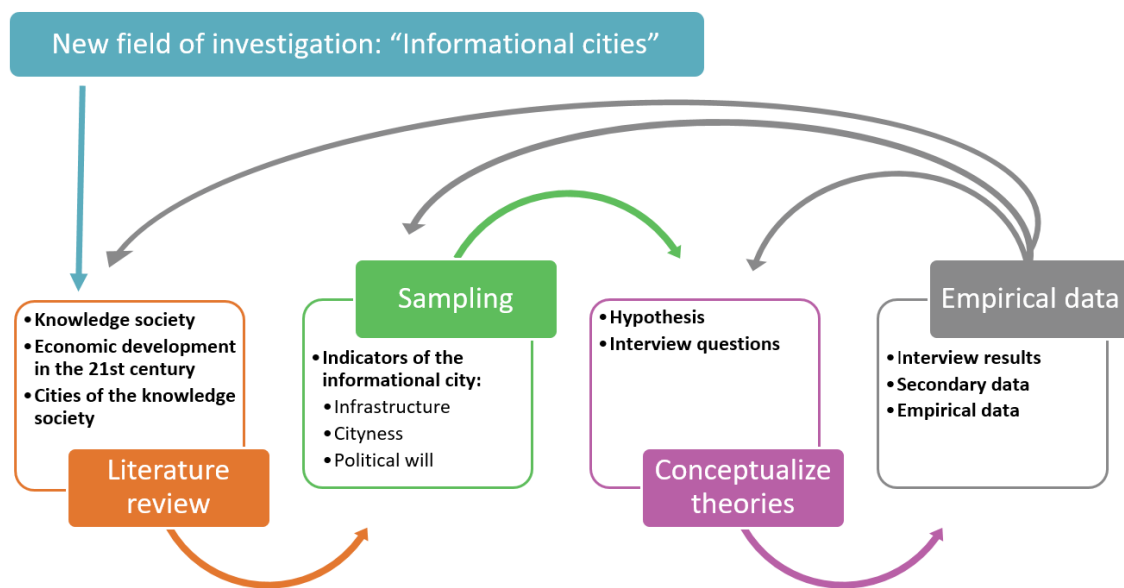
Figure 4-1: Grounded theory cycle representing the investigation process of the work at hand.

4.2 Literature review: Identifying prototypical cities of the knowledge society

To identify potential cities of the knowledge society a literature review was undertaken on the platforms Web of Science®, Scopus, Google Scholar, and Wiley Online Library. All platforms are multidisciplinary databases which can be used for bibliometric investigations (Moed, 2009). It is possible to search e.g. for topics, titles, abstracts, keywords, authors, etc. They differ in their amount of covered journals, due to different authority regulations for journal integration. Thus, it is recommended to use more than one database to enhance the recall.

To add a city to the potential investigation corpora two conditions have to be met. The first requirement is that the city has to be referred to as a world city in the literature in the sense of

world city and global city definitions of the researchers John Friedmann (1986), Saskia Sassen (2001), or Peter J. Taylor (2004). For them, world or global cities are not defined by a number of people living in a city but through the city's position in a global economy. The second precondition is that the city has to be investigated in at least one aspect of the development of an informational city according to the research of Manuel Castells, Tan Yigitcanlar, or Wolfgang G. Stock. As those cities are complex and serve as a hub for economic, government, and human interaction further search terms had to be included which represents the cities' development towards a knowledge city, digital city, creative city, or smart city. Additionally, bibliographic databases do not offer full-text research, a manual investigation of proper literature is necessary. The identified cities and their characteristics will be described in chapter 5 Identifying prototypical cities of the knowledge society. A short version of the process was published in Mainka, Hartmann, et al. (2013). The literature review has been updated and does include literature published till June 2016. This approach does not aim to set the full list of prototypical cities of the knowledge society, which would exceed the costs of this research project. Thus, only prominent cities have been chosen by the research group to be investigated deeply and are scrutinized in this work.

4.3 Interviews: A qualitative approach

Besides the literature review, own empirical data have been gathered through interviews. We choose expert interviews as method since those interviews are recommended if the researcher's approach is to get an orientation in a field (Flick, 2009). The investigated field in this research project cannot be dedicated to only one field since informational world cities are very complex structures (Stock, 2011) and a lot of different aspects like culture, infrastructures, economic market, knowledge institutions, etc. have to be considered. Therefore, the interviewed experts are from different fields like universities, government authorities, public libraries, urban planning, or cultural institutions. These individuals are *"highly knowledgeable informants who can view the focal phenomena from diverse perspectives"* (Eisenhardt & Graebner, 2007, p. 28). Appendix I provides a list of the cities and date of the interviews. The approach was to interview three to five experts in each city to get an overview of the city and its strengths and weaknesses according to different indicators of an informational city. In total 158 experts have attended the interviews.

For the interviews, a prepared questionnaire was used. The questionnaire contains 18 questions which are semi-structured. The questions are inspired on the one hand on the SEVQUAL method which is used to measure the quality of products, but on the other hand, the questions

are qualitative as well, since the interviewee has the option to add his or her thoughts and knowledge to each question.

The SERVQUAL method is established by Parasumaran, Zeithaml, and Berry (1988) to analyze the quality of services and goods. Traditionally a questionnaire that bases on SERVQUAL includes 18 questions and covers five dimensions: reliability, assurance, tangibles, empathy, and responsiveness. All questions have to be answered for two components "expectation" and "perception." The evaluation is based each on a scale with marks from one (strongly disagree) to seven (strongly agree). The difference is the degree of the quality value (Q) of the analyzed good or service. Thus, the quality of an item can be calculated as follows:

Quality value = Perception - Expectation

As Parasumaran, Zeithaml, and Berry (1988, p. 17) argue *"[t]he skeleton, when necessary, can be adapted or supplemented to fit the characteristics or specific research needs of a particular organization."* Therefore, their approach to investigating the quality of the development of an informational city is used in this work. Furthermore, the prepared questionnaire for the present work consists of 18 questions with the two components expectation, to reflect the personal assumption of an interviewee, and experience, to reflect the interviewees' perceptions and observations. According to Stock´s (2011) definition of informational world cities the dimensions infrastructures, labor market, corporate structure, world city (cityness), political will, and soft locational factors are covered. The questions are based on the interview questions used by our research group to investigate Singapore as a prototypical informational world city (Khveshchanka et al., 2011) and have been adjusted to fit into the SERVQUAL method.

As mentioned before, the interviews are based on quantitative and qualitative approaches. The quantitative data from the SERVQUAL scales have to be accumulated and can be analyzed statistically. The results are not statistically significant since the number of respondents is small and does not represent a cross-section of the society, but the results can give us a first hint about the investigated city. In the results section, the evaluation will be presented in one figure covering the expectation, perception, and the quality value. The SERVQUAL scores are scaled from one to seven and the quality vale from plus seven to minus seven which needs to be considered while interpreting the results.

Furthermore, we may evaluate the interviews qualitatively. The experts were allowed to give as much information on each questioned topic as they were able to. Thus, the interview is based on a semi-structured method which offers space for open answers by the interviewee

(Diekmann, 2014). The evaluation of the qualitative part of the interviews is done according to the case- and group comparison method introduced by Mattissek, Pfaffenbach, and Reuber (2013). Therefore, the interviews have to be transcribed. If I were allowed to I have recorded the interviews and transcribed them in the subsequence. Otherwise important statements by the experts have been noticed during the interview[1]. In the following, the interview results have been categorized in types of homogeneity (statements that are very similar) and of heterogeneity (statements that differ greatly). This has been done according to each question separately. The goal of this method is to identify parallels and differences between the interviewees which could lead finally to a generalized statement on each topic.

The interviews have been conducted between June 2010 and May 2014 in German and in English language (depending on the interviewee preference). The duration of the interviews varies between 15 minutes and two hours. The time spent for each interview has depended on the contact person's willingness to provide much information, his or her schedule for the day, and how many persons have attended one interview. As the interviews have been conducted during a period of four years it should be acknowledged that interviews always represent a retro perspective (Diekmann, 2014). Thus, the interviewees could always just report on the state of the art at the time of the interview. Accordingly, this is not a significant limitation according to the political willingness since city projects towards a knowledge society often need many years starting with a master plan and finishing with its realization.

Using interviews in research has some further limitations. Thus, the researcher depends on the willingness of contact persons to take some time for an interview. As the research group, of course, do not have colleagues around the world persons of interest had to be contacted e.g. via email or phone. This is not always fruitful and unfortunately, we were not able to arrange any interview in Beijing. On the opposite, we had 8 interviews in Vienna and 9 in Barcelona. A further problem was caused by the standardized SERVQUAL interview. Not every expert was satisfied with this research method. Thus, alternative and more open questions have been asked in those interviews, which nevertheless have led to fruitful conversations and information that have enhanced the work in this research project. In addition, it was not possible to conduct only individual interviews thus we had individual and group interviews in the investigated cities depending on the availability of the contact persons. According to Diekmann (2014), the attendance of other persons during the interview may have a manipulative effect on the response.

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[1] The transcripts need undergo a cleaning process before they could be published. Data will be made available to all interested researchers upon request.

This is evident for intimate questions about person's private life which are not part of this research. My experience during the interviews with groups was that interviewing more people at once have led to very productive conversations related to the investigated topics. A further limitation is the personal interest and experience of the interviewee. If he or she is not interested in one topic or service, the quality of this object could be evaluated as poor. For instance, a male senior professor is not the right person to assess the quality of shopping malls as important consumer temple.

4.4 Gaining first-hand experience through field studies

A further method used in this research project is the ethnographic field study. To gain fist hand experience and to do the interviews face-to-face my colleagues and I have visited all cities that will be investigated in this work[2]. Ethnographical field studies originated from ethnography and anthropologies and became a popular method of social science at the end of the 19th century (Lichtman, 2013). The basic idea of this research method is based on the observation and participation of a given research field (Malinowski, 1922). Thus, the main aspect is the description of ethnographical and cultural characteristics of groups of people (Fischer, 2003; Meier, 2001). Ethnographical field research is further used to investigate smaller communities like a neighborhood or employees work together in one office (Fischer, 2003). There are many ways how the ethnographical field study is applied in practice (see for further readings Melhuus, Mitchell, and Wulff (2012)). Nevertheless, main characteristics of this method can be identified.

According to Meier (2001) the ethnographical field research is a process of readjusting research questions according to the field and dependent on the research task; it allows the detailed investigation of specific cases (e.g. ethnic groups or business enterprises); it enriches the investigation through the mutual complementary of interviews and observations as well as unsystematic observation and attendance of situations in everyday life; and finally induces the researcher to put the focus on the understanding of observations of actions rather than verify own hypothesizes about actions. It is obvious that the researcher has to spend some time personally in the space of his or her investigated field to observe the habitat of the research object(s) (Schmitz, n.d.). A timely specification is not given. Additionally, Schmitz (n.d.) adds that

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[2] Melbourne in Australia is the only city I have not conducted the interviews by myself. In addition, further interviews have been made in Tokyo by another research group with the same questionnaire which I have added to the interview results in the work at hand.

quantitative data collections of facts and data of the investigated field are of relevance, e.g. photographic- and audio documentation as well as interviews.

The ethnographic field work can be used to open many perspectives which show the investigated field from the point of different views, e.g. communities or authorities (Geertz, 1983). The researcher's task is, therefore, to be open minded since he or she has to investigate the field from the different perspectives (Meier, 2001). The perspective depends on the data that is used to investigate the field. Accordingly, Schmitz (n.d.) has prepared descriptions with examples of data evaluations of possible perspectives based on Geertz (1983) definitions. According to Fietkjewicz (2013) and Stallmann (2014) the following are of relevance for the informational city research:

- The perspective of the administration (e.g. through the investigation and analysis of statistical and demographic data),
- the perspective of the locals (e.g. through interviews and own documentations like photos or videos)
- the perspective of experts in the field (e.g. through expert interviews and their corporation to share relevant documents), and
- the perspective of analytical social science (e.g. according to the published literature in the field).

To investigate informational world cities the ethnographical field research was used as a further aspect of the grounded theory. Thus, all investigated cities had to be visited. Since the research project had to be finished in a reasonable time the time spend in each city was limited to a maximum of five days. The cities have been visited between June 2010 and May 2014. In total 30 cities have been visited by me and one (Melbourne, Australia) by my colleague Katrin Weller. Except for Frankfurt always a second person has attended the interviews to help with notices and the transcription. During the stay, interviews with experts have been conducted as described in the subchapter above. Hence the ethnographic field work includes further methods of data acquisition, own photographs were taken to visualize observations. Furthermore, statistical and demographic data, as well as field related literature, and online publications complete the work.

4.5 Measuring cities and nations on secondary data

A lot of city comparisons can be found in reports and other publications from organizations, corporations, and academics. They investigate cities, regions, or nations in different aspects and often present a timely development if they are published regularly. They are concerned with actual topics of the economy, government, society, or environment. Prominent examples of reports are the "Human Development Index" by the United Nations (UNDP, 2014) or the "Global City Index" by A.T. Kearny. An academic research group is, for example, GaWC (Globalization and World Cities). They publish many case study investigations and approaches to analyze world cities. They also offer many open datasets which are available online (www.lboro.ac.uk/gawc/data.html). Actual and relevant city comparisons, as well as academic publications, and their data will be used to identify the most recent indicators of the knowledge society and the informational city. Hence it is a very extensive work to gather first-hand data, other researchers tend to reuse the data, for example, to compare the cities on different levels or to identify interconnections of indicators (see for example Bruno, Esposito, Genovese, and Gwebu (2011) or Stock (2011)). In this work, I will also reuse data collections of existing reports and investigations.

Even the existing city indices cover a lot of important indicators, which are useful to investigate the knowledge society and prototypical informational world cities, an online content investigation of official city websites, institutional websites and business websites (if they are in any relation to the investigated topic) will be taken into account, as well. The web data will be retrieved through simple online search engines like Google or Bing. The languages that are used for this data gathering are German, English, and Spanish. In consequence, this will lead to better results for cities which have one of these languages as lingua franca and hinder to find information that is only available, for instance, in Chinese. In contrast to academic publication or official reports, online content is dynamic and multidimensional (it contains text, links, audio data, and videos) and therefore need to be investigated qualitatively (Volpers, 2013; Welker et al., 2010). Thus, it is possible to identify actual topics which are of interest in the field of the knowledge society or informational world city which have not been published till now in academic research or official reports. The presented methods, content analysis as well as data and document investigations, are part of empirical sociological research methods (Atteslander, 2010).

4.6 Retrieval of patents and scientific publications

Informetric as the main field of information science will be used to identify the knowledge and innovation output of informational world cities. Accordingly, an own data corpus will be created. As innovation indicator patents will be used. Following van Winden, van den Berg, and Pol (2007) patenting is one of the drivers of the knowledge economy. Hence, within information science "patent informetrics" can be used to investigate the productivity (Stock & Stock, 2015). The productivity can be measured according to the number of granted patents within a certain time period. Thus, to identify the innovation productivity of informational world cities patent information of the Derwent World Patent Index (DWPI) have been retrieved using the host STN International. This host offers the possibility to adjust the retrieval according to the country name (/PAA.CNY) and the city name (/PAA.CTY). Thus ambiguous city names like London in the UK and London in the US can be separated. However, the DWPI is covering 52 sources from around the world but no patent information is available for the United Arab Emirates (Thomson Reuters, n.d.-a).

In addition, the knowledge output of informational world cities has been retrieved according to science, technical, and medicine (STM) publications. Informational cities offer an enhanced knowledge infrastructure like knowledge institutions, research centers, and universities. They all produce scientific publications and according to Stock (2011) cities of the knowledge society dominate those publications in quantity. Further, a knowledge flow can be investigated based on the citation of this publications. However, in this study, I will concentrate on the investigation of informational world cities as centers of knowledge and therefore the productivity will be measured based on the knowledge output. For this investigation, Web of Science will be used which is a citation database that is covering more than 12,000 journals and 150,000 conference proceedings (Thomson Reuters, n.d.-b). Similar to the patent information database, it is possible to search for city and country names within the address field and the year of publication.

4.7 Limitations of the results

The results presented in this investigation are subject to several limitations. Hence, not for every hypothesis own data and statistics will be gathered, the investigation is based on secondary data and its reliability. Thus, if possible data investigations by independent researcher and organizations have been used. In addition, more than one data survey will be compared to discuss

probably diverse findings. Not all data is available on the city level and not all data is available for the same investigated time period. Thus, in some studies only a comparison on the national or regional level is practicable. However, the subject of reference should not be mixed within a data survey. Therefore, some investigations do not base on all 31 cities. In addition, the presented figures, indices, and surveys are mostly based on a data evaluation of a certain time period or of a snapshot of the time of the investigation. To identify the development and trends the presented research findings and methods used should be investigated for longer time periods on bigger data than only on 31 cities.

Further, the presented case studies and examples of projects are limited to those which have been mentioned by the interviewed experts, identified through own experience or already have been described in other publications. Thus, for example, the online participation platform "Frankfurt gestalten" is mentioned, however other cities will have introduced similar projects. In addition, the interviews have been made in a time span of June 2010, started in Singapore till the end of April 2014, finalized with a telephone interview with an expert from Vancouver. Hence, the own experience and the statements of the experts are always in retrospect. Further, the interviews have been conducted in English and in Germen. Language barriers during the interviews and research may result in further limitations.

At least, the corpus of investigated cities is limited to world cities that have already been mentioned in the literature as creative, knowledge, digital or smart city. Therefore, cities that are not recognized yet by another study or of medium or small size are not considered in the work at hand. Hence, the results are not reflecting the development of those cities.

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5 Identifying prototypical cities of the knowledge society

Urban researchers have investigated many cities with regard to different characteristics and published their findings in journals, conference proceedings, or reports. These publications build the basis of the identification process of prototypical informational world cities. Informational cities may be defined as prototypical cities of the knowledge society. According to Stock (2011), those cities are a complex phenomenon that is determined by diverse characteristics. Many of their indicators are inherited from the world or global city research. Therefore, the literature review starts with the definition of world cities that are not considering the amount of people living in a city but their status in a global system according to the world and global city researchers John Friedmann, Peter J. Taylor, and Saskia Sassen. Following Friedmann (1986) cities are not defined by political-administrative boundaries but through their economic interactions with other cities. A similar approach can be found in Taylor's (2004) definition of world cities. For him, world cities are never isolated but characterized through their linkages with other cities and regions. According to Taylor (2004) cities interlinking with other places is referred to "cityness." Sassen (2001, p. 209) refers to the term "cityness" as the process happening within a city with the components*: "complexity, incompleteness, and making."*

The status of a city can change over time. Therefore, the formation of global or world cities is referred to as processes (Derudder, Hoyler, Taylor, & Witlox, 2012). Accordingly, the cities **New York**, **London**, and **Tokyo** belong to the group with the highest amount of interactions or in other words, have the highest degree of cityness in the late 20th century which turns them, referring to Sassen (2001), into true global cities. Friedmann (1986) has identified cities within a global network which he has announced as primary or secondary world cities based on investigated economic flows. Of course, New York, London, and Tokyo belong to the primary world cities. Like Friedmann, Taylor (2004) also investigates economic flows of cities to define the network of world cities. According to his research group GaWC world cities can be categorized as alpha, beta, and gamma world cities (GaWC, 2014). They also identified which cities have the potential to become a world city in the future. Finally, the basic idea of informational cities is referred to Castells` (1996) theory of the network society and his definition of prototypical cities in which spaces of flows inherit a central role. Hence, the flow of power can be represented through economic flows (Nowag, Perez, & Stuckmann, 2011). World cities that are defined through their economic flows and their interlinking connectivity are a good starting point for further investigation. Further on,

all cities that are going to be investigated in this thesis have been identified as a world or global city at least by one urban researcher (see Appendix II Literature Review Cities).

Moreover, informational world cities have to serve as prototypical cities of the knowledge society. Therefore, further conditions have to be met. According to Stock (2011), informational cities are characterized by their combination of further characteristics as they are investigated in knowledge-, creative-, digital-, and smart city research. Those topics are of interest in academic research as well as in economic analysis and furthermore may impact political decision-making. Therefore, cities that are prominent for a special development towards an informational world city can be detected in the literature, e.g. in journals like Urban Studies, or be presented at conferences e.g. at the IEEE International Smart Cities Conference (ISC2-2015). Further, they may result in projects e.g. in a project for Horizon 2020 "Smart Cities and Communities." The main problem is that there exists a lot of different terms which are used to describe this process. In the following, I will present the identification process of prototypical informational world cities using literature review to highlight trends, examples, and studies. For this, I separate the findings into two topics: digital and smart cities, which are both focused on ICT infrastructure and sustainability, and second, creative and knowledge cities, both are characterized by the cognitive infrastructure. The characteristics and definitions of the city types have many overlaps and therefore the definition as informational world city will be the umbrella term to combine them all.

Following the method to identify prototypical informational world cities, two conditions have to be fulfilled (see chapter 4 Methods): First, the investigated city has to be identified as a world city according to the flow theory and second the city has to be investigated as a knowledge, creative, digital or smart city. All in all, 138 publications have been investigated. Figure 5-1 presents the amount of publications found in each year according to the investigated city types. Using this method in total 31 cities have been identified as prototypical informational world city (see Table 5-1). The identified cities represent metropolises around the world (Figure 5-2). Further on, the literature review will be presented in this chapter in detail. This will give an overview first, on the identified cities and second, on the topics investigated hitherto in research regarding the investigated city types.
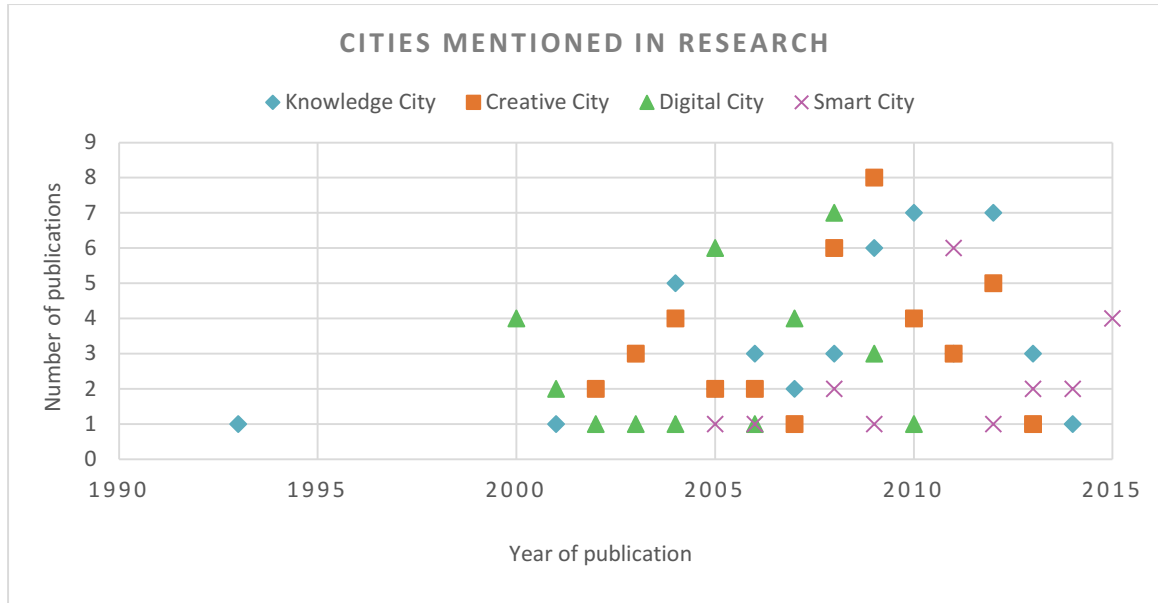
Figure 5-1: A Literature review on city research which uses at least one of the 31 informational cities as a case study or example (n=138).
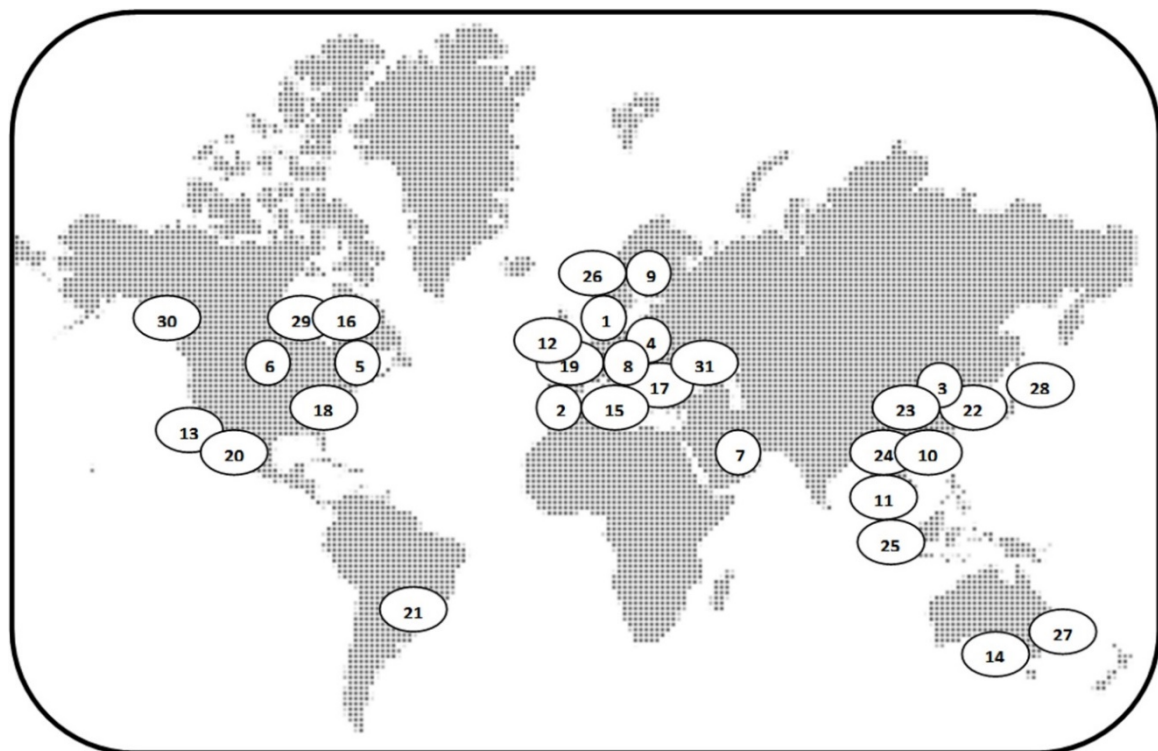
Figure 5-2: Informational world cities on the world map. Cf. numbers in Table 5-1. Source: Mainka et al (2013, p. 298).

Table 5-1: A literature review on city research which uses at least one of the 31 informational cities as a case study or example (n=138).

	Knowledge City	Creative City	Digital City	Smart City
1. Amsterdam (The Netherlands)	✓	✓	✓	✓
2. Barcelona (Spain)	✓	✓	✓	✓
3. Beijing (China)	✓	✓	✓	✓
4. Berlin (Germany)	✓	✓	✓	✓
5. Boston (USA)	✓	✓	✓	✓
6. Chicago (USA)	✓	✓	✓	✓
7. Dubai (UAE)	✓	✓	✓	✓
8. Frankfurt (Germany)	✓	✓	✓	✗
9. Helsinki (Finland)	✓	✓	✓	✓
10. Hong Kong (China, SAR)	✓	✓	✓	✓
11. Kuala Lumpur (Malaysia)	✓	✓	✓	✗
12. London (UK)	✓	✓	✓	✓
13. Los Angeles (USA)	✓	✓	✓	✗
14. Melbourne (Australia)	✓	✓	✓	✓
15. Milan (Italy)	✓	✓	✓	✗
16. Montréal (Canada)	✓	✓	✓	✓
17. Munich (Germany)	✓	✓	✓	✗
18. New York (USA)	✓	✓	✓	✓
19. Paris (France)	✓	✓	✓	✗
20. San Francisco (USA)	✓	✓	✓	✓
21. São Paulo (Brazil)	✓	✓	✗	✗
22. Seoul (South Korea)	✓	✓	✓	✓
23. Shanghai (China)	✓	✓	✓	✓
24. Shenzhen (China)	✓	✗	✓	✓
25. Singapore (Singapore)	✓	✓	✓	✓
26. Stockholm (Sweden)	✓	✓	✗	✓
27. Sydney (Australia)	✓	✓	✓	✓
28. Tokyo (Japan)	✓	✗	✓	✗
29. Toronto (Canada)	✓	✓	✓	✓
30. Vancouver (Canada)	✓	✓	✓	✓
31. Vienna (Austria)	✓	✓	✓	✓

5.1 Digital and smart cities

According to the relevance of ICT in a city different terminologies arose in research investigations and in city projects. Anthopoulos and Fitsilis (2013) have analyzed the historical evolution of ICT related city projects and set up a list of the terminology used. Thus, we have to extend the search of "digital cities" with the terms "broadband cities," "wireless cities," "u-cities," and "web-cities." Furthermore, they refer to the terms "eco-city" and "smart city." Both terms have to be used with caution since there are different approaches behind these terms. A smart city is amongst others referred to sustainability and a green infrastructure (Abdoullaev, 2011). This includes, of course, parts of the knowledge, creative, and digital city but is not necessary related to world city characteristics. According to an interview with Saskia Sassen (Meister, 2012), the city Songdo in South Korea, which was built as a smart or u-city, based on ICT networks and business solutions, is not a world city because it lacks in cityness. In the following, world cities that are investigated in digital- and smart city case studies and analysis will be presented.

5.1.1 ICT infrastructure

To become a digital city the basic infrastructure has to be established. Events like the Olympic Games or the World Expo, have a positive influence on the ICT infrastructure development. Thus, for example, **Beijing** has established a "Metropolitan Area Network (MAN)" which offers broadband connectivity to public information services and free Wi-Fi for residents (the Wi-Fi network was planned to be available for three years) (Anthopoulos & Fitsilis, 2010). Song, Zhang, and Zeng (2009) have investigated governmental wireless city strategies and stated that **Beijing** and **Shanghai** already have finished the implementation of wireless hot spots which will open a public network for tourists and citizens alike. Free Wi-Fi access has become an important aspect of public spaces. Efforts have been made by different stakeholders e.g. by the municipality in **Toronto**, by communities like **New York** Wireless, or Île Sans Fil in **Montréal** (Hampton & Gupta, 2008). However, the accessibility and quality vary in each city (own experience).

So-called "ubiquitous cities" (u-City) are one step further. A u-City is a fully connected city in which all things, institutions, and services are embedded. D. Shin, Nah, Lee, Yi, & Won (2008) identified the topics home, work, education, traffic, health, environment, and government as actual projects in u-City plans. Cities that adopt those plans are, for example, **Hong Kong**, **Dubai**, **Seoul**, **Singapore,** and **Amsterdam**. Their approaches differ from each other but all are grounded

on ICT networks. In **Seoul**, for example, we can find an enhanced ICT infrastructure with traffic sensors and a high smartphone penetration rate (J. H. Lee, Hancock, & Hu, 2014). More than 97.5% of the population is connected to the national broadband network and about 57% use the fiber connection (J. H. Lee et al., 2014). According to Al-Hader and Rodzi (2009), the implementation of smart ICT infrastructure to manage waste, water, electricity, etc. is the basis of a smart city as we can find it in **Dubai** or **Singapore**.

5.1.2 ICT networks

From the cities government perspective, the ICT infrastructure was used to enable communication between the municipal institutions or additionally to connect themselves with citizens, organizations, and the economy. Thus, in many cases, the term "digital city" was used to describe online platforms for communication between different stakeholders. Examples are the "digital city **Amsterdam**," "Virtual **London**," "Rete Civica di Milano" (**Milan** community network), "virtual **Helsinki**," or "Digital City **Shanghai**" (Aurigi, 2000; Benini, Cindio, & Sonnante, 2005; Ding, Lin, & Sheng, 2005; Ishida, 2000). Buzzwords as "cyber cities," "virtual cities," or "civic networks" amongst others have become popular (Ishida, Aurigi, & Yasuoka, 2005). Another aspect of digital city networks is 3D representations of the city's physical space. Early adopters of 3D representations are **Chicago** (developed by a private consulting agency) and **Melbourne** (developed in conjunction with the virtual design studio and the University of Melbourne) (Deren, Qing, & Xiafei, 2000). Further visualization models have followed e.g. in **Amsterdam, Berlin, Boston, Dubai, Frankfurt, Helsinki, Hong Kong, London, Los Angeles, Munich, New York, Paris, San Francisco, Singapore, Sydney, Tokyo, Toronto, Vancouver, and Vienna** (Horne, Thompson, & Podevyn, 2007). According to Horne, Thompson, and Podevyn (2007) the use of these visualizations can be categorized under "planning and design," "infrastructure and facility service," "commercial sector and marketing," and "promotion and learning of information on cities."

Initiatives that bring together citizens, business and government are often investigated under the topic e-government or e-participation (Palvia & Sharma, 2007). Digital space has been opened in some cities to stimulate political interest and debates. One example is the 2006 municipal election in **Milan** with the portal ComunaliMilano2006.it. This platform has offered profile pages and open forums to discuss and inform about the candidates (De Cindio, 2009). A further example is **Shanghai**. The IT industry in Shanghai has opened the way for an enhanced information infrastructure within the city and the government. This has resulted in better public

service, e.g. healthcare, fire departments, or public security, by developing one elaborated e-government system (Lagerkvist, 2010).

One of the pioneers of open innovators according to its digital city developments is **Amsterdam**. In 1994, a free internet network was launched by the DDS (De Digitale Stad) (Besselaar, 2001; Couclelis, 2004; Riemens & Lovink, 2002). This initiative opened the access to the net for the public. According to Riemens and Lovink (2002, p. 327) the aim of this initiative *"was to democratize the use of the Net and create a digital public domain."* DDS was initiated by a grassroots project with funding by the city government. The idea was to bring communities together and as well to open space for political debates. The digital city approach was used to help users to identify themselves with this virtual communication platform and to enhance the orientation using city metaphors. In other cases, the digital city was a digital simulation of the physical city. Nevertheless, due to the lack of ongoing funding, the foundation was not able to survive, thus it became a business and has lost its independent character.

The intention of many digital city initiatives was to build communities. Those "virtual communities" should not replace the physical communities but extend the space for communication. According to Schuler (2005), this is the case for many cities and towns in Europe. The EU has funded these communities in order to stimulate the communication between citizens, institutions, the government, and economy. According to Couclelis (2004), best examples are the digital city **Amsterdam** and **Helsinki**. Schuler (2005) emphasizes community networks in **Milan** (wrcm.dsi.unimi.it), Amsterdam (www.dds.nl) and **Barcelona** (www.bcnet.upc.es/ravalnet) as successful examples. Further, Ishida (2000) mentions "Virtual **Los Angeles**" with its communicative approach and aim to involve the community in decision-making processes as a successful example from the US.

The European Union has established a funding for digital initiatives called "TeleCities support program" (Ishida et al., 2005). The aim was to enable partnerships between European cities and to enhance government to citizens' communication. These projects have often been implemented as top-down approaches and lacked in social inclusion. Thus, the projects were not able to establish themselves and failed. One of the few successful exceptions of TeleCity project was **Vienna**. In their approach, the citizens and the government got responsibilities of the project and both had to work in cooperation. Similar projects and activities have started in the years between 1990 and 2000 in many European, American, and Asian cities. According to Ishida et al. (2005), these initiatives have served the needs of the information society since most digital city platforms have been more information than communication oriented.

The idea behind those initiatives is to re-design decision-making processes. Citizens should become a partner in policy and city debates. **Montréal** is a city that has started to use open innovation processes (Leydesdorff & Deakin, 2011). Open innovation on city level means to learn from all parties and stakeholders. In a city, these are citizens, private businesses, universities, organizations, and all others who live or work in the city. In a creative city, like in Montréal, open innovation can build creative communities, that are able to develop new strategies and policies which are not only depending on economic indicators. This is a further form of human capital, which is an important factor in a smart and sustainable city (Leydesdorff & Deakin, 2011).

5.1.3 Strategic master plan

To become a digital city or a smart city is for many cities the key point in their visionary plans for future development. For example, Malaysia's vision 2020 which was set up in 1991 (Yigitcanlar & Sarimin, 2010). This vision includes the development of the "Multimedia Super Corridor" (MSC) which is located near the capital **Kuala Lumpur** and the international airport. The main objective was to establish a competitive knowledge economy based on an enhanced ICT infrastructure. Another early adopter in Asia is **Singapore** with its IT2000 Master Plan called "Singapore One: One Network for Everyone" (Ishida et al., 2005). Furthermore, **Singapore** has launched its iN2015 masterplan in 2006 which aim was to foster the digital infrastructure and to turn **Singapore** into a global and intelligent nation (Zhu, 2011).

Seoul has benefited from the early established nationwide ICT plans in Korea. Beginning with the Cyber Korea master plan in the late 1990s followed by the plans E-Korea and U-Korea (S.-H. Lee, Yigitcanlar, Han, & Leem, 2008). The key goals have been high-speed internet nationwide, the establishment of e-government and e-commerce, and a virtual city as a communication platform between different stakeholders. In the U-Korean plan the ICT network and physical space had to be joined. For this reason, Wi-Fi hotspots have been established in large and metropolitan areas. The actual plans focus on the development of U-cities with advanced U-infrastructures which should enhance urban planning and urban life within an ubiquitously connected environment. In the past, Seoul was determined by car manufacturing and known as street and cemented city. Its shift towards a knowledge society, with leisure time facilities and public involvement, is manifested through the redevelopment of the Cheonggyecheon highway which had to be demolished in favor of public space along the Cheonggyecheon creek in central Seoul (Choi & Greenfield, 2009). Today, **Seoul** has set itself the goal to become a ubiquitous city

with the highest rate of broadband penetration, with multimedia boards/touch screens, LED streetlights including hotspot functionality for Wi-Fi connection (Choi & Greenfield, 2009).

Asian cities as **Beijing**, **Shanghai**, Chengdu, Hangzhou, and Wuhan as well establish master plans with the goal to become a smart city (Zhu, 2011). Beijing includes smart home, digital life, smart healthcare, smart traffic, dynamic navigation, mobile payment in its future visions. For Shanghai high-end industry, e-commerce, e-government, intelligent city management, information safety, and wireless broadband connectivity are major topics in its smart city master plan. In addition, due to its big port, **Shanghai** has gained in importance as China's center for import and export in the 19th century (Lagerkvist, 2010). This has positively affected further physical connectivity, foreign investment, and governmental intervention which has pushed the cities' ICT sector and the whole economy. Today, many of the "Fortune Global 500" companies have offices in Shanghai.

A further example is **Shenzhen**. The city has implemented a science and technology development plan to become a hub for high-tech industries and R&D with the aim to improve its competitiveness and to meet the needs of the future (de Jong, Yu, Chen, Wang, & Weijnen, 2013). The master plan of Shenzhen is called "Eco-2-Zone" and refers firstly, to the Special Economic Zone with benefits for business and industries and secondly, to the Ecological Zone which represents the cities initiatives towards a green city (de Jong et al., 2013; Kang et al., 2014). The ambition of Shenzhen is to attract knowledge workers with their knowledge-eco-city initiatives. One of their main strategies is to promote Shenzhen as "living laboratory" for knowledge workers who are likely to develop a smart city. Furthermore, a government to government cooperation was established to implement green technology together with the expertise of *"Dutch Ministries of Infrastructure & the Environment and Economic Affairs, Agriculture & Innovation, the cities of Amsterdam and Eindhoven and a number of research institutes"* (de Jong et al., 2013, p. 217). In China, it is a common practice to enable special economic zones or "sweeteners" like tax reduction in the first years of business to become an attractive space for the desired industry. **Beijing**, for example, has established the Capital Recreation District (CRD) which is already known as Cyber Recreation Industry due to its offered benefits for the ICT industry and its workforce (Keane, 2009). **Dubai** as well is following this approach in several economic districts, e.g. Dubai Internet City (Vanolo, 2013).

To focus on establishing the knowledge economy by enhanced activities in ICT and related fields is as well emphasized in other cities through the development of digital media city districts *"—for example, Poblenou (Barcelona @22), Fashion City and World Jewelry Centre (Milan),*

Orestad (Copenhagen), Digital Corridors (Malaysia), [and] Digital Media City (Seoul)" (Evans, 2009, p. 1007). Hospers (2003a) defines, for example, the fashion districts of **Milan** and **Paris** as cultural-technological cities. For Gdaniec (2000) the cultural/technology district Poblenou in **Barcelona** has resulted in a positive image in which the city is represented as a successful cultural and innovative place. The knowledge-intensive economy and the ability to attract talents is for Bakıcı, Almirall, and Wareham (2013) an argument that **Barcelona** is a prototype of a smart city. Further policies and reforms according to smart city initiatives in Barcelona are based on its political willingness (Cohendet, Grandadam, & Simon, 2011).

In many other cities, clusters of related business firms have evolved due to strategic master plans but as well due to the economic motivation of firms. This is true for knowledge, digital and creative based industries, financial sectors, and as well for educational institutions. Evidence for this development in the digital sector gives the investigation by Kotkin and DeVol (2001). Firms of the digital or information economy have to stay where the talents are. In the US those cities are for example **Boston** with its Fort Point Channel called "cyber district," Lower Manhattan (Silicon Alley) in **New York** City, **San Francisco** with its "South of Market" district, and **Chicago**'s neighborhood "Bucktown." In these areas, companies of the information age as well as creatives and knowledge workers have settled down and reshaped the district or neighborhood. The reasons are the same as in the evolution of creative clusters: cheap rents, much space, and a vibrant community. Further examples are the "digital media city" in **Seoul** and **London**'s developing a digital hub at Queen Elizabeth Olympic Park which should cluster business, technology, media, education and data at one place to improve innovation (Angelidou, 2015; S.-H. Lee et al., 2008). Other cities do not establish a whole district but build a "high-tech park" for ICT industries and R&D. One example is **Shanghai**'s "Zhangjiang Hi-Tech Park" (Sigurdson, 2005).

New York City as well has developed a smart city master plan which focuses on its human and social capital (Angelidou, 2015). In its "Digital Roadmap," they focus on the four topics industry, open government, engagement, and access. Their approach is to humanize technology. Further on, **London** focuses on creativity and technology in its smart city development plan (Angelidou, 2015). Their main topics are "collaboration and engagement," "open data and transparency," "technology innovation," and "efficiency and resource management" with the overall goal to "improve the lives of Londoners."

According to Ben Letaifa (2015), smart city strategies depend on actual circumstances in a region or city. Thus, **London** is concerned most about smart transportation and mobility due to the increasing attractiveness of the financial sector located in the dense city center. **Montréal** is

working on smart health, due to its aging population, smart transportation, because of its poor transport infrastructure, and smart grid technologies that are driven by the major ICT providers which are located in the city. Finally, **Stockholm** builds on a smart traffic management which should replace the 100-year-old infrastructure.

Some cities call themselves "smart city" because they embed ICT in their developing process. Hollands (2008) has identified **San Francisco**, **Amsterdam**, and other cities which are the forerunner of this trend. Further adopters are **Vancouver** and **Montréal**. For Hollands (2008) the main aspects of a smart city are the ability of learning and innovation, a creative population, institutions of knowledge production and digital networks for communication.

5.1.4 Economy and labor

Digital cities are as well defined as hubs of the information and communication technology economy. One example is **Helsinki** which has become an important player in the global network of ICT firms due to the success of Nokia (Roper & Grimes, 2005). In 2001 Nokia's global market share was 31%. The firm was active in R&D and on the global trade market. Because of the telecommunication giant Nokia Helsinki has earned the title "the telecommunication capital'' of Europe (Yigitcanlar, 2009). But a more diversified strategy in ICT markets than just investing in mobile phones is important for the future (Roper & Grimes, 2005; Van den Berg, Braun, & van Winden, 2001). A further example is **Los Angeles'** digital city development which is highly correlated with the film industry. According to Kotkin and DeVol (2001), Los Angeles is dominating the film production for the internet. Furthermore, it is a hub for animation and future films and as well for video games.

According to Blythe (2005), increasing e-commerce and innovative solutions like the electronic signature, which allows verifying online transactions in the private sector as well as for government interaction, have made **Hong Kong** to one of the "most wired" cities in the world. In addition, Hong Kong's neighbor **Shenzhen** has made a rapid development towards a global player in the ICT industry as well (C. C. Wang, 2013). It was Chinas first established "Special Economic Zone" which has open Shenzhen as a marketplace for global cooperation. This and further governmental plans have pushed the growth of ICT manufacturing and software developing industries in Shenzhen. Nevertheless, Shenzhen cannot be compared with Silicon Valley or other high performing and innovative cities of the IT industry, since it lacks in educated and creative talents (C. C. Wang, 2013). Ding et al. (2005) have investigated the digital city initiatives in

Shanghai. One reason why Shanghai lacks behind Hong Kong or the US is the complicated procedure to register a corporation, e.g. startups which are very common in the IT industry especially in IT service and software development are less represented in Shanghai.

To become an important player in the digital or smart economy Glaeser and Berry (2006) argue that a high percentage of educated adults are one important growth factor. They indicate that **Boston** or the **San Francisco Bay Area** are examples which had a high percentage of highly skilled workers and hence higher income rates. This as well positively influences the incomes of low-skilled workers in that region. They identified that cities with a lower percentage of educated adults had a far less growth and income rate till the year 2000. Glaeser and Berry (2006) argue that in most industries that emerged from the 1980's till today, human capital has become an important resource. They claim that educated managers and entrepreneurs tend to hire a high-skilled workforce. Two examples represent this tendency. First, the founder of Apple, Steve Jobs, has started his high-tech company in Cupertino, California, which is located in Silicon Valley. Till today Apple is located in Cupertino. The second example is the founder of Gateway, Ted Waitt, he started his firm in Sioux City in Iowa. He had to move with his company to a place with a higher amount of highly skilled workers.

According to Glaeser and Berry (2006), it is important for a city that wants to become an attractive smart city and to "stay smart" to offer an excellent school system and to invest in education. This attracts educated parents and educates the next generation for the future. In addition, the city should invest in safety. One example is **Boston** which has rapidly reduced crime rates till 1990 and in consequence this could have attracted workers with colleague degree. Affordable housing for young educated people and students are necessary as well as limited tax rates to encourage economic growth.

5.1.5 Smart and sustainable city

Abdoullaev (2011) has defined the "trinity city" as a real smart city which combines the three features "Information Cyber City, Intelligent/Knowledge City and Ecological/Clean city." This merges the ICT network, the human, and ecologically sustainable cities at one place. According to his investigation, cities that focus on a smart environment are **Amsterdam**, **Stockholm**, and **Sydney**. Further, new cities that follow a smart city master plan have been built from the scratch as for example **Dubai** Waterfront, Dubai Central, Putrajaya (next to **Kuala Lumpur**), Songdo and Incheon next to **Seoul**, and Langfang located south of **Beijing** (Abdoullaev, 2011; Zhu, 2011).

Another definition is claimed by Komninos (2011). He joins the enhanced ICT infrastructure and the rise of the knowledge and innovation economy under the term smart city. In his point of view, examples are the Cyberport **Hong Kong** and Smart City **Amsterdam**. *"Cyberport should not be seen as the usual technology district or technology park. It is an ecosystem that nurtures talent in the media industry, turning skills and talent into start-ups. It amplifies the skills and creativities of the Hong Kong population using experimental digital infrastructure and open platforms. The objectives are technology diffusion, up-skilling and the enhancement of human capabilities. Cyberport is a creative community supplied with advanced communication and media infrastructure and digital connectivity"* (Komninos, 2011, p. 184). **Amsterdam** as well has established an advanced ICT infrastructure. Smart devices (crowd data) and sensors in the city help to analyze and enhance the citizen's everyday life and organizational practices (Komninos, 2011). The government has opened its doors and minds to establish open innovation processes in decision-making processes. Finally, the main goal for Amsterdam is to become a sustainable city that is able to reduce CO_2 emissions constantly.

Amsterdam is a green city which is not exclusively built on ICT. Their transportation infrastructure is focused on bicycles. There are more bicycles in the city than inhabitants which could be counted as sustainable since the city is indipendent of petroleum (Gilderbloom, Hanka, & Lasley, 2009). Further, plans to make the city more sustainable and livable are made by the Municipality of Amsterdam. According to Gilderbloom et al. (2009), they are concerned amongst others with noise pollution, air quality, climate change, green space, and place for recreation. Further steps are made by Amsterdam Smart Meter Service which helps to reduce energy consumption (J. H. Lee et al., 2014). The reduction of emissions is as well the aim of the Urban Eco-Map in **San Francisco** (J. H. Lee et al., 2014). On this map, citizens can visualize the produced emissions in their neighborhood and compare them with other neighborhoods. In addition, they can learn about actions to reduce their ecological footprint. J. H. Lee et al. (2014) identified that more than 44% of **San Francisco** services (smartphone applications or websites) have a direct or indirect impact on the environment. Many services combine technology like sensors and civic participation. In **Vienna**, for example, the project "Smart City Wien" has developed the "Smart Energy Vision 2050" which should advice how the climate goals could be met step by step to become a smart and sustainable city (Hofstetter & Vogl, 2011).

In the case of **Seoul,** a participatory approach has helped to reduce 10% of CO_2 emissions annually (C40 Cities, 2011). They introduced a one-day-no-driving campaign (J. H. Lee et al., 2014). Citizens could participate by registering online at no-driving.seoul.go.kr and choosing a day between Monday and Friday on which they will only use public transportation. Afterwards, they

get an e-Tag based on RFID which monitors if the car is not driving in the city. This campaign was introduced in 2003 and includes monetary tax incentives for participating citizens (Seoul Solutions, 2015). Further real-time monitoring is used in other public sectors like *"the public drainage system, Han River bridges, the fire service, public parking, garbage trucks, some public buildings and SMC air pollution"* (J. H. Lee et al., 2014, p. 94). GPS and real-time information are as well considered in **San Francisco** e.g. for real-time public transportation navigation (Routesy San Francisco) or parking space sensors to adjust parking fees in dependence of actual demand (J. H. Lee et al., 2014). Furthermore, metering systems are integrated into water, energy, and gas networks. Sensors have also been implemented in the Royal Seaport of **Stockholm**. Real-time consumption of energy and material production are monitored by a "Smart Urban Metabolism" framework (Shahrokni, Lazarevic, & Brandt, 2015). This analyzes and visualizes energy flows within the seaport.

Different rankings announce nations and cities as digital or smart. Smart communities are for example nominated by the Intelligent Communities Forum (ICF) since 2006. Accordingly, cities have to be considerted for the "ICF's annual Intelligent Community Award." Each year, 21 finalists are chosen by a committee. The finalists are scored according to an indicator framework which bases on a questionnaire. Finally, the top seven cities are announced as best practice examples *"in broadband deployment and use, workforce development, innovation, digital inclusion and advocacy that offer lessons to regions, cities, towns and villages around the world. They are charting new paths to lasting prosperity for their citizens, businesses and institutions"* (Intelligent Community Forum (ICF), 2014, para. 2). Actually, they have identified cities that show the political willingness to become smart e.g. **Hong Kong**, **Shanghai**, **Seoul**, **Singapore**, **Stockholm**, **San Francisco**, **Toronto**, **Vancouver** and much more. The case of **Singapore** is rather unique. Singapore is a city-state island with the strong political willingness to become an intelligent island. That Singapore is catching its own objective is evident through international surveys where Singapore is high ranked because of the e-government status and due to its ambitions to make IT accessible and available at the whole island (Baum, Yigitcanlar, Mahizhnan, & Andiappan, 2008).

5.1.6 Smart city applications

Many cities use ICT and sensors around the city to implement innovative city services. In recent years, user generated data has been involved. In combination with open data, offered by the government, smart city applications have been developed by citizens as well as the private sector (Mainka, Hartmann, Meschede, & Stock, 2015b). The different types and approaches to

develop smart city services in **Seoul** and **San Francisco** have been investigated by J. H. Lee et al. (2014). They identified that Seoul has implemented services for diverse topics like health, welfare, and education. San Francisco is more focused on public administration and transportation. Most applications in **Seoul** are built by the cities IT department but since 2011 they have launched an open data portal and try to follow a more participatory development strategy (J. H. Lee et al., 2014). Due to the early adoption of open data by San Francisco MTA (public transportation) many transportation applications have been developed till today (J. H. Lee et al., 2014).

Mobile applications are getting more and more into the focus in smart city development. Therefore open data portals and hackathons are the ideal backbones for innovative solutions (Mainka, Hartmann, Meschede, & Stock, 2015a; Mainka et al., 2015b). Thus, for example, the City of **Chicago** offers an open data portal but does not develop own mobile apps. According to John Tovla, chief technology officer of Chicago*, "volunteers and private sector will probably innovate quicker and certainly at a scale that government cannot match"* (Walravens, 2015, p. 219). The aim of those applications is called public value. Walravens (2015) has prepared a business model grid to identify and to compare the public value of apps. Apps that are of higher public value are for example "I **Amsterdam** QR spots," "**London** Bike App," and "**Berlin** Neighborhood." All three apps are of different aims but can be identified as apps that enhance the quality of living in a city.

5.2 Creative and knowledge cities

According to Lor and Britz (2007), "usable content" and "human capacity" are pillars of the knowledge society. Referring to both we have to determine the cognitive infrastructure in a city. For Stock (2011, p. 970) the creative city—with its *"[c]reative-artistic activities and the result thereof"*—as well as the knowledge city—with its *"[s]cientific-technical-medical activities and the result thereof"*—represents characteristics of this infrastructure. Knowledge and creative activities are part of the development of soft infrastructures but are not easy to measure through hard facts as roads or ICT (Setunge & Kumar, 2010; Stock, 2011). Etzkowitz and Klofsten (2005) see the academic facilities, municipal institutions, and enterprises as responsible towards the development of the needed infrastructure. Accordingly, content and shared knowledge are of high importance as well. Thus, lifelong learning has to be add as part of the cognitive infrastructure and is equally important for institutions as well as the municipality (Stock, 2011). For Evans (2009) and Foord (2008), the creative economy can be subsumed under the knowledge economy. In the following, I will highlight the topics which are investigated in the literature according to both city types in case studies and investigations.

5.2.1 Historic development

Different historical backgrounds may positively influence a city's development towards a creative or knowledge city. For instance, cities that are historically known as cultural hubs have now a high potential to become creative cities. Accordingly, Musterd and Gritsai (2009) have investigated European cities and identified this potential e.g. for **Amsterdam**, **Munich**, **Milan,** and **Barcelona**. Further, the capital function of a city is seen as an advantage to become a creative or knowledge city but this is not a limitation. *"Capitals are often culturally rich, with major museums, art galleries, universities and other important seats of research and learning located there"* (Brown, Redmond, & Miquel, 2013, p. 62). According to Hospers (2003a) the creativity of a city increases during unstable times, for instance during the two World Wars in **Berlin**, or in 1600 in **Amsterdam**, or during the nineteenth century in **Vienna**, **London**, and **Paris**.

Nevertheless, historically established creative cities will not lose their role. Hospers (2003a) mentions, for example, **Los Angeles**, **New York**, and **London**. Those cities have been the first to agglomerate cultural and creative activities and gain success through this. For Hospers, this is the Mathew effect which follows the principle "success breeds success." Further cities with a cultural/creative background are **Vienna** and **Berlin** (Hall, 2004). **Vienna**, for example, has established itself as a knowledge hub with excellent universities, a high amount of scientists and students, and an increasing number of patents (Trippl, 2012).

5.2.2 Economic transformation

A further factor is the past economic specialization of a city. Cities that are characterized through industrialization have to overcome bigger challenges to restructure their economic orientations. Musterd and Gritsai (2009) indicate that a good starting point for the establishment of the creative- and knowledge industry are high-skilled activities, engineering, and high-tech activities but also a service oriented economy has this advantage. Within Europe the cities **Amsterdam**, **Barcelona**, **Helsinki**, and **Munich** are examples.

For instance, **Amsterdam** has become a creative and knowledge city because of the city's open and tolerant image and due to the creative industry which now is located there (Gilderbloom et al., 2009; Musterd, 2004; Pethe, Hafner, & Lawton, 2010). *"A tradition of innovative economic talent, combined with a high degree of openness, has resulted in the distinctive Amsterdam atmosphere, a major pull factor for knowledge workers and creative individuals"* (Musterd & Deurloo, 2006, p. 81). This has resulted in a high metropolitan quality of life and an international

atmosphere which attracts the talents (van den Berg, Pol, van Winden, & Moets, 2005). Other cities are prominent because they are known to be diverse and tolerant as well, e.g. **Barcelona** and **Munich** (Musterd & Gritsai, 2009; Pethe et al., 2010). Those cities are a home for the creative class. In North America, for example, 14% of the nation's artists live in the cities **New York** and **Los Angeles** (Kotkin & DeVol, 2001). To attract creatives and talents a city's tolerance can be an indicator. Florida and Gates (2001) have identified an increasing correlation between the Gay Index and the growths of regional ICT clusters. This does not mean that all talents work in the ICT industry but that talent from abroad who may represent a minority feel comfortable (Florida, 2014). Those tolerant and creative regions are e.g. **San Francisco**'s **Bay Area**, **New York**'s Greenwich Village, semi-autonomous **Hong Kong**, Greater **Amsterdam**, **Toronto** and **Vancouver** (Heywood, 2008).

A further city that has made a transformation from a car manufacturing place (dominated by SEAT) to a vibrant, creative, and knowledge driven city is **Barcelona** (Edvinsson, 2006, 2011). Today, the city benefits from *"newly constructed and remodeled city areas, positive image, attractive world-class events, and high performing schools and research organizations. What might be the most interesting is the explicit focus and vision of shaping the context for the new workers of tomorrow rather than the present focus groups of politics. The artists, designers, food and restaurant entrepreneurs, biomedical researchers, educational entrepreneurs, all working with intangible and intellectual capital have been attracted to this city"* (Edvinsson, 2006, p. 8). An extreme transformation of the cities economic orientation, like in the case of Barcelona, can help to flourish the creative and knowledge industry. Other prominent examples are **Singapore**, **Hong Kong** and **Dubai** (Edvinsson, 2006). Further cities that Edvinsson (2006) recognizes as hubs of talents of the creative and knowledge economy are for example **Boston**, **New York**, and **Stockholm**. In an investigation of European cities van Winden, van den Berg, and Pol (2007) have identified **Amsterdam**, **Munich**, and **Helsinki** as cities that are able to attract talents and the knowledge-based industry. According to van den Berg et al. (2005) **Munich**, which is mostly known for its car manufactory BMW, has a very diversified economic base and a large number of knowledge-intensive companies and institutions—They call it the "Munich Mix." This kind of business landscape shapes the base of the knowledge economy which is the employer for a high amount of workers with high qualifications. In the case of **Helsinki,** Inkinen and Vaattovaara (2010) argue that the city's advantages are the welfare, excellent educational system, and the development of the ICT infrastructure which has helped Helsinki to come out of the Nordic periphery. Hu (2012) has investigated **Sydney**'s transformation towards a knowledge city. Accordingly, Sydney is a hub for advanced producer service firms, which is the main aspect of

global cities, but creative industries, cultural and media services are located in Central Sydney as well. This characterizes Sydney as a knowledge city. Rocco (2012, p. 391) argues that *"providers of services are providers of knowledge."* He has investigated the knowledge economy of **São Paulo**, which as well has attracted national and international producer service firms. A prominent example of the creative economy is **Berlin**. According to an investigation by Kunzmann and Ebert (2007), branches of the cultural or creative economy are represented above average in 43 of 192 districts in Berlin. They also identified a higher concentration of creative economy activities near the city center. Another example is the development of the knowledge economy in **Dubai**. Dubai has benefitted from the oil boom and became able to rebuild its landscape into a prosperous and vital city. According to Alraouf (2008), Dubai has built up a successful mix of the knowledge economy and service industry.

Some cities are acknowledged as a digital city although their economic orientation is not prominent in IT and engineering fields. This is true e.g. for **New York**. Currid (2006) has investigated the distribution of occupations according to different economic sectors for the years 2000 and 2004. The results show that New York has just a marginal proportion of occupations in IT and engineering. Currid (2006) argues that New York's ongoing status as a global center is perhaps the effect of its vital and diverse industries. The most important is the creative economy in New York. Occupations in arts and culture dominate and have a higher potential to grow than the financial sector (Currid, 2006).

5.2.3 Strategic master plan

In the literature many cities that are on their way to become a knowledge city or already gain the status of a knowledge city are investigated according to their "Knowledge-Based Urban Development" based on the three pillars: environment, economy and society (Yigitcanlar, O'Connor, & Westerman, 2008). This includes many and diverse strategic decisions and the inclusion of the industry and society in governmental urban planning. The result of this kind of planning is usually the manifestation of a master plan or a vision for the future of the city. In addition, a strategic master plan for a city with the goal to become a creative or knowledge city may have a positive effect to face future challenges. As positive examples, **Barcelona** with its vision for 2015 and **Melbourne**'s City Plan 2010 are highlighted by a report from Price Waterhouse Coopers—Cities of the Future (Bolz et al., 2005). Both action plans are concerned with a wider range of critical aspects, e.g. environmental quality, social equity, education, economy, culture etc. Today, it is observable how successful these plans have been implemented and manifested,

e.g. Melbourne has received the "Most Admired Knowledge City Award" (MAKCI) by the World Capital Institut regarding their outstanding city development (World Capital Institut, 2012). Currently, Melbourne is working on their plans for 2030 (Victorian Government Department of Sustainability and Environment Melbourne, 2003).

As a further example, Edvinsson (2006) mentions the impressive transformation of Malaysia and its capital **Kuala Lumpur**. Today, the city has taken many steps towards their 2020 vision which includes becoming an attractive place for living, working, and services on a world class level. Edvinsson (2006) calls **Kuala Lumpur** a prototypical intelligent city which is able to attract the creative class. A strategic plan to develop a knowledge city is acknowledged as fundamental to be successful (Yigitcanlar, 2009). Following Yigitcanlar (2009), cities, next to **Kuala Lumpur**, that endeavor to become a knowledge city are e.g. **Dubai** and **Shanghai**. Further cities, like **San Francisco**, **Seoul**, **Shanghai**, and **Singapore**, have as well set themselves the goal to become a knowledge city with the focus on "people's skills and abilities" (Reffat, 2010). **Berlin** is mentioned as a city which has also established a master plan to encourage the city's development towards a knowledge city. According to Franz (2009), **Berlin** is a city which is rich in knowledge and poor in capital. World cities that are mentioned in the literature that have already made a successful transition towards a knowledge city or creative region due to its strategic plans and visions are **Barcelona**, **Berlin**, **Beijing**, **Boston**, **Dubai**, **Helsinki**, **Hong Kong**, **Kuala Lumpur**, **London**, **Melbourne**, **Montréal**, **Munich**, **Seoul**, **Shanghai**, **Shenzhen**, **Singapore**, **Stockholm** and **Vancouver** (Carrillo, Yigitcanlar, García, & Lönnqvist, 2014; Durmaz, Yigitcanlar, & Velibeyoğlu, 2008; Dvir & Pasher, 2004; Foord, 2008; Heng & Low, 1993; Hospers, 2003a, 2003b; Kong & O'Connor, 2009; Lange, Kalandides, Stöber, & Mieg, 2008; Y.-S. Lee & Hwang, 2012; Metaxiotis & Ergazakis, 2012; D. Wang, Wu, Li, & Wang, 2012; C. Wong, 2008; C. Y. L. Wong, Millar, & Choi, 2006; Yigitcanlar, 2009, 2012; Yigitcanlar et al., 2008; Yusuf & Nabeshima, 2005; Zhao, 2010).

Master plans that endeavor to establish the knowledge economy and set in addition a focus on cultural activities are acknowledged as important for the creative city development. According to Evans (2009), many cities start to replicate successful creative city or creative economy approaches. For example, the "Creative **London**" commission was adopted by the councils/commissions: Creative **New York**, Creative **Amsterdam**, Create **Berlin**, Design **Singapore**, and Design **Toronto.** Landry (2008) emphasizes the cities **Barcelona** and **Frankfurt** as a creative city because their visionary plans are highly focused on cultural development. In some master plans the creative city development includes the formation of "creative clusters" which *"helps to shape places or urban sites as 'creative milieu'"* (Chen, 2012, p. 439). The development of new urban space in relation to special economic zones (SEZ), reuse of industrial estates and

warehouses for artistic activity, and strengthening the development of links to universities and traditional creative institutions are core implementations of the creative cluster in **Shanghai** (Chen, 2012). According to Wu (2005), the political interventions to build clusters, e.g. creative or R&D cluster, actively contribute to developing local creative hubs. A further example is **Boston,** according to its creative growth in software and biotech which is university-based and located there as well. Those clusters emerge in many Asian cities as well, examples are **Singapore** and **Beijing** which have been developed as top-down initiatives by the government (Keane, 2009; Kong, 2009). In **Singapore**'s master plans the explicit development of the creative economy belongs to the key innovations (Hornidge, 2007). According to Porter (1990), the cluster theory is not new. Industries have always tended to cluster. The aim is to link vertical (supplier to the buyer) or horizontal (host, vendors, and suppliers—business to business). Formal as well as informal interactions are seen as a generator of innovation because of the direct or indirect idea and knowledge share.

Landry (2008) mentions further examples of governmental plans that have been established years ago, e.g. the "pedestrianization" of **Munich** in the 1970s or the regeneration of the waterfront in **Barcelona** in the 1990s. Both re-inventions have been made as preparation for the Olympic Games and are helpful factors for the development of the creative city. Landry and Bianchini (2006) emphasize **Montréal**, **Singapore,** and **Milan** due to their pedestrianization and car congestions which exclude cars from the city center as forerunners of a livable city. These programs have made the redesigned places to a magnet for citizens and tourists alike which enhance the quality of life.

The city's shape and design is as well a part of urban planning. A positive example which is mentioned by Landry and Bianchini (2006) because of its creativity is **Melbourne**, for its skyline which looks like a metropolitan one but has no high rising buildings e.g. as Manhattan. A further example includes the Metro Stations in **Stockholm**. The stations have been decorated and designed by artists. Landry and Bianchini (2006) argue that this transfers a positive feeling in relation to public transportation and in addition offers another tourist attraction.

The strategic master plan "22@**Barcelona**" focuses on the IT sectors but is as well important for the establishment of the creative city because it attracts creative talents to work in Barcelona (Cohendet et al., 2011; Marti-Costa & Miquel, 2012). The redevelopment of the city district Poblenou has become a vital creative neighborhood which is a positive result of the knowledge city master plan by the government. For Barcelona's government, cultural and creative activities are embedded in their knowledge city ideology.

Landry (2008) has investigated the development of creative cities. For him, many creative innovations have been established because of its necessity or scarcity without any master plan. Examples are the high-rise buildings in **New York** which have been developed due to the increasing immigration or the floating car parks in **Amsterdam** which have been established because of the city's limited space. Another innovation, he mentions, is the car sharing initiative in **Berlin** called "STATTAUTO" which could be translated with "instead of car." Compared to the average car use the shared cars have driven twice as many kilometers and have mostly carried two persons instead of 1.4. For Hospers (2003a) the underground train system was a creative solution for the traffic in **Paris**, **Stockholm**, or **London**. This has had a positive effect on the further growth of these cities.

5.2.4 Face-to-face facilities

Communication is as well a major aspect of the creative city. People have to meet each other physically. Therefore a diversity of locations has to be spread throughout the city. One example which has a lot of those facilities is **Vienna**. There are countless "Kaffeehäuser" which are open from early morning till late evenings and give space for a meeting. Hospers (2003a) has called this the "café factor." According to Landry (2008), the café culture was a common feature in Central Europe, e.g. as well in **Berlin** or **Munich**.

For Landry (2008) communication and partnerships between cities are also important in creative cities. *"Networking and creativity are intrinsically symbiotic, as the greater the number of nodes in a system the greater its capacity to reflexive learning and innovation"* (Landry, 2008, p. 126). Communities can come together physically or virtually. He is focused on community networking. Examples are Virtual **Helsinki**, Copenhagen, **Amsterdam**, or Manchester.

Network communities which focus on urban development within a city are a further example for creative cities. Landry (2008) describes the case of **Chicago** in which a partnership of organizations and volunteers have developed ideas for the future of the city. The project is called "Imagine Chicago." Furthermore, Chicago has the advantage of being geographically centralized (Reffat, 2010). Therefore, it is a good place for conventions and conferences where people can meet. This is as well a magnet for professionals of the knowledge economy. Accordingly, Chicago is the place for knowledge exchange.

In his discussion on human capital on the national, regional, and business level, Pawlowsky (2011) has emphasized cities that have established knowledge centers which enhance the communication between politics, business, and citizens. One example is **Dubai** which has passed

Singapore in 2003 competing as a knowledge city due to projects that have foster education and human capital. For Pawlowsky (2011) the establishment of the high-tech campus with its impressive architecture has been an asset in this regard. Perhaps the most noted city for its scientific development and education is **Boston** with its globally known universities MIT and Harvard (Evans, 2009; Reffat, 2010). For Hospers (2003a) those hubs may also be referred to as cultural-intelligent cities. As an example, he mentions **Boston**, Toulouse, and Heidelberg. In addition, **Barcelona** has been mentioned as a developed knowledge city according to its orientation towards a knowledge economy (Pawlowsky, 2011; Walliser, 2004). In **Helsinki** a university-government corporation called the "Culmitaum Innovation Oy Ltd." aims to increase the collaboration between universities and firms and to foster the production of technological innovations (Stachowiak, Pinheiro, Sedini, & Vaattovaara, 2013). A similar approach is followed by **Frankfurt** (am Main). The city has established the "House of Finance" located at the Goethe University which concentrates on public-private partnerships focusing on science, politic, and business (Szogs, 2011). In **Milan,** the "Politecnico di Milan Acceleratore d'Impresa" supports the establishment of startups based on academic research and services for enterprises (Stachowiak et al., 2013). Further knowledge centers, for example, are established in **Hong Kong** (Future Nest), **Tokyo** (KDI Future Center), **New York** (Metrotech), **Singapore** (One-North), **Shanghai** (The Zhangjiang Hi-Tech Park), **Amsterdam** (Amsterdam Science Park ASP), **Sydney** (The Macquarie Technology Business Precinct), **Melbourne** (The LaTrobe Research and Development Precinct), **Toronto** (MaRS) and **Helsinki** (Helsinki Science Park) (Bugliarello, 2004; Edvinsson, 2011; Evans, 2009; Pawlowsky, 2011; Sigurdson, 2005; van den Berg et al., 2005; Yigitcanlar & Martinez-Fernandez, 2010). Those centers are often called "Knowledge Innovation Zone," "Science Park," or "Knowledge Park."

5.2.5 Knowledge output

Focusing on science and knowledge output in terms of academic papers, the cities **Tokyo**, **London**, **San Francisco**, **Boston**, **New York**, **Paris**, **Los Angeles**, **Amsterdam** (including region), **Beijing**, Moscow, and Osaka are leading the city ranks in the last two decades according to the bibliometric investigation of Matthiessen, Winkel Schwarz, and Find (Matthiessen, Winkel Schwarz, & Find, 2006) (listed in descending order). A further research hub is **Berlin**. According to Franz (2009), **Berlin** has a high concentration of public and private funded research institutions with a high quality pursuant to the number of graduate students and the ability of professors to apply for funding.

The role of universities is not limited to academic output. They are important as a teaching institution as well as a mediator between different stakeholders to develop a knowledge city (Powell, 2012). Examples are the "UN Global Cities" program invented by the RMIT in **Melbourne** or the "Camp for Social Innovation" by the Alto University in **Helsinki**. Those initiatives try to meet the actual needs of urban and social development.

Research output may also be used as an indicator of "knowledge flow" which represents the connectivity between knowledge cities (Haustein, 2012). According to the investigations of Matthiessen et al. (2006) the cities **London**, **New York**, **Los Angeles**, the **San Francisco Bay Area**, **Boston**, Baltimore, and Philadelphia are the seven major research nodes.

5.2.6 Knowledge economy and labor market

For Kotkin and DeVol (2001) scientists as well as professionals working in IT jobs belong to the group of knowledge or creative workers. In their investigation of the North American labor force, they identified an increase of IT professionals in the cities **San Francisco**, Seattle and **New York**. To attract highly skilled professionals the city has to emphasize the quality of life. In **Amsterdam**, for example, the strategic plan includes the improvement of amenities for culture, arts, leisure, tourism, education, etc. (Romein & Trip, 2012). Accordingly, an attractive living climate improves the business climate in a creative city. Strategic plans or a campaigns may help to attract talents to the city as for example **Barcelona**'s initiative `Talencia' (Wesselmann, Meyer, & Lisowski, 2012).

Pareja-Eastaway, Chapain, and Mugnano (2013) have investigated the "city branding" initiatives by **Barcelona** and **Amsterdam**. Both cities aim to attract foreign talent by setting the focus on their creative- and knowledge-intensive economy. An important aspect is that these efforts are made in cooperation with citizens, institutions, and economic actors. This can also be promoted by established networks in a city. Streit and Lange (2013) mention, for example, the network "CREATE **Berlin**" which helps to connect creative people in the city. The City of **Amsterdam** has constituted the "Bureau Broedplaatsen" which is a service that helps artists and creative folks to find affordable space for their activities (Streit & Lange, 2013). Own cultural activities or tourist attractions as well play a role for creative cities. **Helsinki** was emphasized as one example of cultural innovative by Landry (2008). The city is known for its lightening festival "Vailon Voimat" which takes place during the winter term to overcome the dark time of the year

and furthermore, it has resulted in cultural cooperation with other cities, e.g. Barcelona and London.

According to Landry (2008), city brandings are also related to unique creativity. For him, examples like the creative interventions in the public space, e.g. by the artist Miro in **Barcelona,** and its world-class architecture, built by prominent artists like Serra, Pollock, and Ellsworth create an unique image. Barcelona is a living art city with a lot of design and beautiful architecture (Landry, 2006).

Amenities of higher education may attract many young people which are the next creatives and knowledge workers. Pareja-Eastaway, Bontje, and d'Ovidio (2010) have investigated the potential of **Amsterdam**, **Milan** and **Barcelona** to attract young and high-skilled workers. They see these three cities as creative knowledge centers which are recognized internationally, with a high offer of higher education but as well with a high cost of living. Similar findings are described by Baum, Yigitcanlar, and O'Connor (2008) for the cases of **Sydney**, **Melbourne,** and Canberra. All cities have a creative industry which is concentrated in the city center and all cities have the same problem of too expensive costs of living for the creative class.

To investigate the knowledge workforce in **Melbourne,** Johnson (2012) has analyzed the 2006 ABS Census data for industry and deployment in Melbourne. He has counted 244,000 people as knowledge economy workforce (Johnson, 2012, p. 280):

> *"1. Telecommunications, IT and Media (around 31000 jobs or 13 percent)*
>
> *2. Finance and Banking (111000 or 45 per cent)*
>
> *3. R&D/Higher education (71000 or 29 per cent)*
>
> *4. Design-related industries (e.g. architecture) (27000 or 11 per cent)*
>
> *5. Cultural industries (e.g. performing arts) (6000 or 2 per cent)."*

Accordingly, the data shows that just a small part (13%) of the workforce has a job in design related or cultural industries but a high amount of people is working in knowledge-intensive jobs like R&D and higher education as well as in the finance sector. The case of **Los Angeles** shows another aspect of the creative economy. Los Angeles is known for its film and entertainment production activities. For Landry (2008) this is the best example for a successful match of cultural and technological creativity.

5.2.7 Creative milieu

It is not always possible to promote or plan the knowledge or creative city. Looking back to the years around 1900 so-called "creative" or "bohemian milieus" evolved in city areas which have former been dedicated e.g. to the industrialization or commerce (Bontje & Musterd, 2009; Wojan, Lambert, & Mcgranahan, 2007). Old manufacturing spaces have been rent or occupied by artists, like for example in the city district Soho in **New York** (Vivant, 2010; Zukin & Braslow, 2011). During the deindustrialization of Manhattan, artists started to reuse the space for artistic activities. This has turned Soho into a flourishing neighborhood, but in consequence commercial galleries, luxury shops, cafés and restaurants have entered this district and banished the artists who could not afford this lifestyle. Today, we still see examples of those squatters or cheap buildings for rent, e.g. Squat Chez Robert and Electron Libre in **Paris**, a former film academy, parts of harbour and shipyards areas, the Westergasfabriek (Western Gas Factory) in **Amsterdam**, the former village of Gracia in **Barcelona**, the Cable Factory in **Helsinki**, the Domagk (a former army barrack) in **Munich,** the art district TianZiFang in **Shanghai,** or the recently closed art house *Tacheles* in **Berlin** (Bontje & Musterd, 2009; Brake, 2012; Hitters & Richards, 2002; Uitermark, 2004; Vivant, 2010; Wei & Jian, 2009). For Evans (2009) creative quarters evolved from prior bohemian quarters as in the cases of **London**, **Paris** or **New York** or as well from the garages of **Silicon Valley**. In the case of Canadian cities (**Montréal**, **Toronto,** and **Vancouver**) as well "bohemians" have occupied inner city districts which have been prior industrial warehouses or inner city neighborhoods (Gertler, 2004; Ley, 2003). Today, we can still find creative neighborhoods e.g. in **Barcelona** (Bairro de Grácia Bairro do Raval) or **São Paulo** (Vila Madalena) (Costa & Oliveira, 2009). Evans (2009) adds new districts of commerce like the Fashion City in **Milan** to the category of a creative milieu. Further creative clusters which arose due to policy interventions are Dashanzi art's district (yishu qu) in **Beijing**, m50 art district in **Shanghai**, West Kowloon Cultural Centre in **Hong Kong**, Creative Gateway at King's Cross **London**, Liberty Village in **Toronto**, or Wicked Park in **Chicago** (Catungal, Leslie, & Hii, 2009; Foord, 2008; Henry, 2010; Kong & O'Connor, 2009; Lloyd, 2002; J. Wang, 2009). Accordingly, others arose without policy intervention e.g. film/TV production in **Los Angeles**, fashion and furniture in **Milan**, and fashion in **New York**. For Evans (2009) hubs of design are located in **London** and **New York**.

It is not unusual that those creative milieus grow up to creative clusters or districts (Cinti, 2007). If there is for example one successful creative site, e.g. the cable factory in Helsinki, other creative, innovative, cultural or artistic amenities settle down in the neighborhood as well. To create or to flourish a creative district may have following goals: reuse degraded space, enhance the city image, attract tourists, or conserve heritage and culture. Different approaches and best

practices of how to establish a creative cluster have been discussed in the literature (see for a review Cinti, 2007).

Cohendet, Grandadam, and Simon (2010) have investigated the layers of a creative milieu in a city for the case study **Montréal**. In this city, for example, the circus Cirque du Soleil and the game developer Ubisoft are important for the city's creative milieu. The Cirque du Soleil has established a National Circus School and is the initiator of the International Circus Festival. Ubisoft is as well an initiator of a festival, namely the Ubisoft Street Festival and additionally organizer of the International Game Summit. Schools and educational amenities for creatives as well attract the creative class. In Montréal the National Circus School recruit artists from around the world (Cohendet et al., 2011).

In a further investigation Cohendet et al. (2011, p. 154) analyzed **Barcelona**'s creative cluster and identified five main institutions: *"(i) the Pompeu Fabra University, focusing on communications related training, research and production; (ii) the Engineering schools of UPC-Barcelona and the new School of Industrial Engineering of Barcelona; (iii) the Barcelona Media Innovation Centre (CIBM), which conducts research, innovation and experimental production projects in the field of communications and audiovisual production; (iv) the new Barcelona Digital ICT Technology Center, which aims to contribute to the development of the Information Society and the growth of the ICT sector; and (v) the 22@Living Lab, led by 22@ and the Barcelona Digital Foundation, which forms part of a network of different urban laboratories operated by the public and private sectors, aimed at developing new ICT based mobile technology products and service."*

Creativity, culture, and heritage are as well important for the tourism and visitor economy (Evans, 2009). But cities today are confronted with a new type of tourists (Maitland, 2010). This type of tourist wants to learn more about the daily life of citizens. One example is **London**. The London Eye and Big Ben are the main tourist attractions but some tourists make their own way through the city e.g. to get in touch with locals. According to Maitland (2010), especially gentrified areas, where the "yuppies" live, are the new tourist spots for the "cosmopolitan consuming class" and "transnational elites." Thus, **London**'s new hot spot is Islington which is a neighborhood of the wealthy middle class with a lot of shopping opportunities.

Another way to express the creativity of a community in a city are events which are organized by autonomous groups. One example mentioned by Landry and Bianchini (2006) is from **Shanghai**. Families living in houses in Putuo district, sing from their balconies in a competition and are judged by a jury staying in the courtyard. This event has become a festival which is now celebrated with special lightning and food in the district near the estate.

5.2.8 Knowledge city benchmarks

E. Ergazakis, Ergazakis, Metaxiotis, and Charalabidis (2009) present in their research paper a framework of characteristics which should be met by successful knowledge cities, e.g. political support, an advanced library network, tolerant and open society, e-government services etc. Prosperous examples for them are **Barcelona**, **Montréal**, **Munich**, **Stockholm**, **Singapore**, Dublin, and Delft. In a prior publication K. Ergazakis, Metaxiotis and Psarras (2004) have emphasized the cities **Melbourne**—according to its City Plan 2010 which has focused on knowledge as economic driver—and **São Paulo**—with regard to its developed research network and its role in connecting the knowledge community virtually.

Another benchmark for knowledge cities is the Most Admired Knowledge City Award (MAKCi) which was established in cooperation with the World Capital Institute and Teleos in 2007. They have established a framework based on eight categories: (1) identity, (2) intelligence, (3) financial, (4) relational, (5) human individual, (6) human collective, (7) instrumental-material, and (8) instrumental-intangible (World Capital Institut, 2008). Experts with expertise in knowledge management or knowledge-based development nominate cities and finally vote for the most admired knowledge city. Cities that have been elected by 10% or more belong to the finalists. Because cities are of different scopes and sizes since 2009 cities can be nominated as knowledge metropolis or knowledge city region.

Following finalists have been detected in the last awards:

Table 5-2: Finalists of MAKCi 2007-2012. Source: World Capital Institut (2007, 2008, 2009, 2010, 2011, 2012).

2012	Austin	Bilbao	Brisbane	**Melbourne**	**Montréal**	Ottawa	**Seoul**	**Singapore**
2011	Austin	Bangalore	Holon	Manizales	**Melbourne**	Nuremberg	**Singapore**	
2010	**Barcelona**	Manchester	**Melbourne**	Ottawa	**Singapore**			
2009	**Barcelona**	Boston	Istanbul	Manchester	**Melbourne**	**Montréal**	**Shenzhen**	Valencia
2008	Bangalore	Manchester	**Montréal**	Ottawa	**Singapore**	Valencia		
2007	**Barcelona**	Bilbao	**Boston**	Ottawa	**Singapore**			

In 2012 the last report was published online. More actual information can only be found at a Wiki run by an independent knowledge management group ("Most admired knowledge cities," 2016). Accordingly, further awards have been given to **Boston** and **Melbourne** in 2013, Ottawa in 2014, **Montréal** and **Vienna** in 2015, and to **Melbourne** and Dublin in 2016. Further finalists in 2016 have been **Tokyo**, **Seoul**, and **Vancouver**. Hence, that the information about the MAKCI Award and the investigation process of the winning city and region are not available since 2013 is downgrading the awards trustworthiness. Nevertheless, the initiators of this award are highly

cited researchers in the field of knowledge cities (e.g. Francisco Javier Carrillo, WCI President, Blanca Garcia, WCI Executive Director Awards Program, Tan Yigitcanlar, WCI Executive Director Events Program, and Kostas Metaxiotis, WCI Executive Director Editorial Program).

5.3 Conclusion of the identification process

In this chapter, the investigated literature review has been described in detail. The aim was to identify a corpus of cities that are on their way to becoming an informational world city. Hence, the initial precondition of this investigation was that the city had to be mentioned as a hub in world city research. This condition is fulfilled by all cities listed in Table 5-1. In consequence, all cities that may be as well a good example of an informational city will be excluded from this investigation. Therefore, the term informational world city is used in the work at hand.

Additionally, the cities had to be mentioned at least in one of the following research topics: knowledge, creative, digital, or smart city. The literature investigated here was retrieved from Web of Science, Scopus, and Google Scholar. All retrieved publications have been evaluated manually and therefore are limited to the researchers' language skills (German, English, and Spanish). Whereby the majority of the publications are in English. Accordingly, all of the cities have been identified as knowledge city or developing knowledge city. Further, all cities except for Shenzhen and Tokyo have been investigated according to be a creative city. This, exclusion can be due to the language limitations. Further, all cities except for São Paulo and Stockholm have been mentioned in the literature as digital cities. This does not reveal that both cites are disconnected from the internet. They just have not been mentioned as examples of a digital city or investigated in a case study on a related topic. Finally, 23 out of the 31 cities have been mentioned or investigated in the literature as a smart city. This may be caused by the inconsequent use of the term smart city (Hollands, 2008) whereas topics like sustainability and mobile applications based on urban data have been considered.

The literature review has reflected that many of the topics that are part of the city's development towards an informational city are hard to be segregated only to one category. Hence, there are always interrelations. Thus, for example, the gaming industry belongs to the category entertainment and therefore is calculated within the creative economy. But it is as well increasingly related to ICT which could be counted as value added in the technology sector. However, each city type has gained a lot of attention in research during the last years as represented by the literature review in this chapter. Therefore, all of them have to be analyzed in

an investigation that is considering to identify interrelations of city development in the 21st century.

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6 Case study investigation of 31 informational world cities

Many theories and case studies exist on the development of cities of the knowledge society. As already discussed I call those cities informational world cities which are defined by diverse characteristics. How these characteristics could be measured is described in chapter 3 Measuring cities of the knowledge society. Nevertheless, cities are not all the same. Thus, in Asia for example politics have much more influence on economic development than in western countries (Chow, 2004). Also religion and leisure time have different significance in different cultures (Haller, Hadler, & Kaup, 2013). Finally, as there are many differences on the one hand, on the other hand globalization has led to a loss in identity especially in world cities—just a hand full of architects build the cities shape and shopping malls offer all the same brands (Madanipour, 2013). In addition, cities of the 21st century are confronted with a continuously increasing density at one hand and with a shift in economic values at the other. Production and manufacturing is increasingly replaced by creative and knowledge industries, especially in informational world cities.

In the chapter at hand, I will fill the theory of informational world cities with life. The main data collection bases on expert interviews and first-hand experiences. The interviews are split into quantitative data (SERVQUAL) and qualitative statements. As described in the chapter 4 Methods 31 cities are investigated. Unfortunately, no interview partner has been found for Beijing. Furthermore, the quantitative data has to be read with caution since the data represents only the personal meaning of the experts and is not representative for the whole society. In addition, data from articles, websites, reports and rankings will complete the investigation of the cities. The aim of this chapter is not to identify "the best" informational city but rather to identify best practice examples according to different developments. The findings are structured according to the twelve hypothesis developed in chapter 3 Measuring cities of the knowledge society which is grouped as "Infrastructure," "Political will," and "World city."

Additional note: To offer a better reading flow in this chapter the references for the expert interviews are shortened by an abbreviation for each city following by a number for each interview partner, e.g. for a personal communication in Amsterdam with the first expert (AM 1). The associated reference in APA style (AM 1, personal communication, Month Day, Year) is listed in Appendix I.

6.1 Infrastructures

The infrastructures discussed in this chapter are divided into two main aspects: first the digital infrastructure and second the cognitive infrastructure. The first one is described by mainly hard location factors for instance by the internet connectivity and the number of users. The second one is acknowledged as soft location factor since the focus lies on the human capital – the creative class.

6.1.1 ICT infrastructure

The investigated cities (31 in total) are highly diverse and in different stages of their development. Following the development of the fifth Kondratieff, the ICT infrastructure should be more important than the past infrastructure (automotive traffic). Thus, many companies of the information market have probably settled down in informational world cities. During the field study and interviews hints and arguments of the growing importance of companies of the information market and ICT infrastructure have been investigated according to the first two hypotheses:

> H1 *Informational world cities are hubs for companies with information market activities, e.g. telecommunication companies.*

> H2 *The ICT infrastructure in an informational world city is more important than automotive traffic infrastructure.*

H1 Hub of companies with information market activities

The first hypothesis is closely related to the investigations of world city networks in which the presence of headquarters (HQ) and branches of an economic sector are counted. This has already been adapted by researchers e.g. through the investigations of internet backbone capacity, the number of internet domain names, internet exchange points (IXPs), amount of content providers such as Google and of cloud computing provider, e.g. Dropbox (Malecki, 2012, p. 117). Thus, a city with many company HQ with information market activities (called ICT in the following) is a hub of this economic sector on a global scale. This is the theory. But if this is an important factor for a city on its way to become an informational world city will be investigated according to the following hypothesis:

H1 Informational world cities are hubs for companies with information market activities, e.g. telecommunication companies.
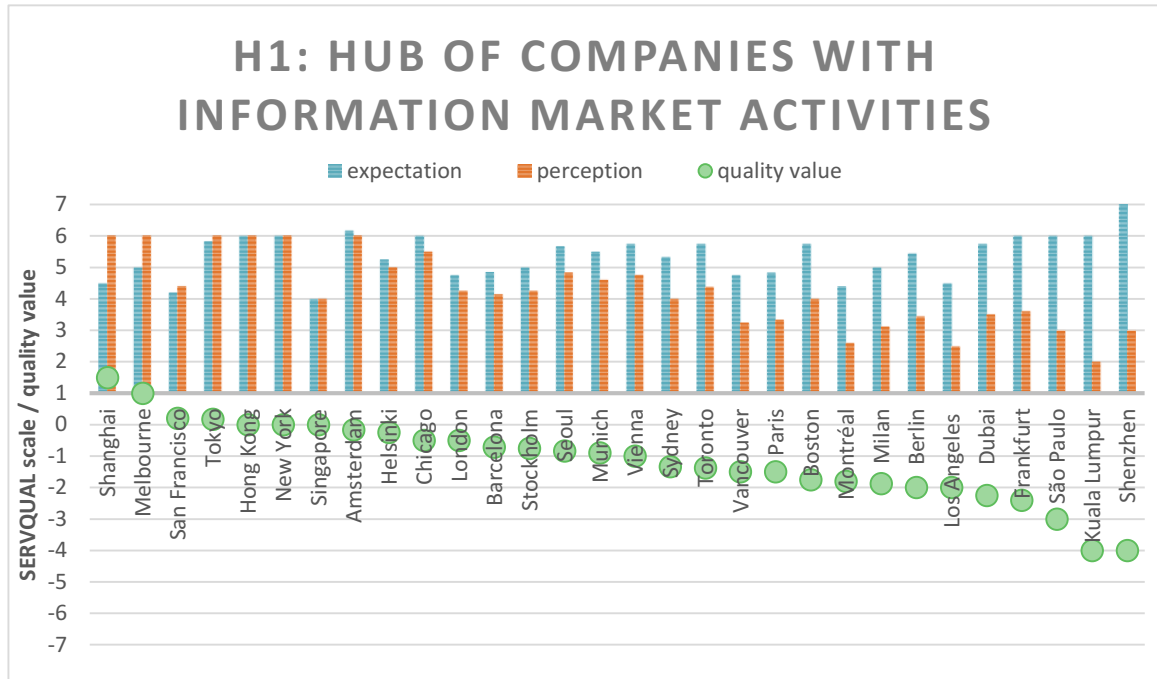
Figure 6-1: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the first hypothesis: "H1 Informational world cities are hubs for companies with information market activities, e.g. telecommunication companies."

Based on the interview findings, several factors influence the importance of being an ICT hub in relation to becoming or being an informational world city. Most of the interview partner agreed that being an ICT hub is of advantage. 37 interviewees have stated that it is "important" for becoming an informational world city, 15 that it is "helpful" and 20 experts do not see the necessity to be a physical hub of the ICT market. Further, relational aspects have been stated as important, e.g. research and development in ICT, creativity, and synergy effects with other sectors. Furthermore, startups within the ICT sector empower innovation and are seen as more important as big telecommunication HQ (stated by nine interview partners). Experts which stated that it is not important to be an ICT hub argued that the presence of an enhanced ICT infrastructure is the driving factor of economic growth. This will be discussed according to the second hypothesis in this chapter. The SERVQUAL evaluation reveal that most experts, accumulated per city, have a higher expectation that an informational world city have to be an ICT hub than the actual perception is for the particular city (Figure 6-1). The overall quality value is Q = -1.12. This indicates that the ICT sector in most cities is not acknowledged as developed to such an extent as it could be. Cities that are stated as advanced ICT hubs are Shanghai, Melbourne, San Francisco, Tokyo, Hong Kong, New York, and Singapore.

ICT hub

Prominent ICT hubs are e.g. San Francisco Bay Area including Silicon Valley or Singapore according to its vast development driven by ICT. Many facts and studies are evident for this popularity. For example, following the investigation by Forman, Goldfarb, and Greenstein (2016), the number of patents according to computers and communication has increased from 10% to over 30% annually between 1980 and 2005 in the San Francisco Bay Area. Furthermore, the Bay Area is more active in patenting than other US cities, e.g. New York or Boston (Forman et al., 2016). Many firms of the information and communication economy are headquartered in this region, e.g. Adobe, Apple, Facebook, Google, Twitter, and others. San Francisco's information economy evolved bottom-up. In contrast, in Singapore policies and governmental willingness to establish an "Intelligent Island" based on ICT was decisive for its success (Choo, 1995). As early as in the late 1970s Singapore's government acknowledged the importance of ICT for economic growth (Hornidge & Kurfürst, 2010). One figurehead of Singapore's success is its port which is aimed at being the world's most busiest one (Pike & Tomaney, 2010). According to Qiang, Rosotto, and Kimura (2009), this success story is based on the enhanced ICT infrastructure and its constant improvement, e.g. the implementation of a wireless broadband infrastructure.

Based on the interviews, many experts of the investigated cities mentioned that their city is an ICT hub at least for the continent or region. Thus, Vienna was mentioned as the third biggest IT location in Europe (VI 5). The experts stated that the ICT industry is more important than the tourism even most people would know Vienna because of its sightseeing spots. A special example is Paris. One interviewee stated that Paris ICT hub is globalized within the French-speaking world due to the language preference of the most French people (PA 2). Helsinki is another example for profiting of the ICT market. The city has benefited from the mobile phone producer Nokia. Today, Nokia is in trouble but the city is not. Hence, the ICT infrastructure is highly advanced due to former activities of Nokia. An important economic part is now the gaming industry which as well is technology driven (HE 4). Consequently, information market activities are not only related to telecommunication but are based on information and communication technology.

A study of information market activities within the OECD countries has revealed that the focus has changed from industries of the computer, electronic, and optical products to industries of IT and other information services (OECD, 2014) (Figure 6-2). Since the demand for ICT goods has not decreased it is obvious that production of physical goods is outsourced to other countries. In contrast, the increase in employment and value added in IT and other information service industries indicates the further economic growth of the IT sector.
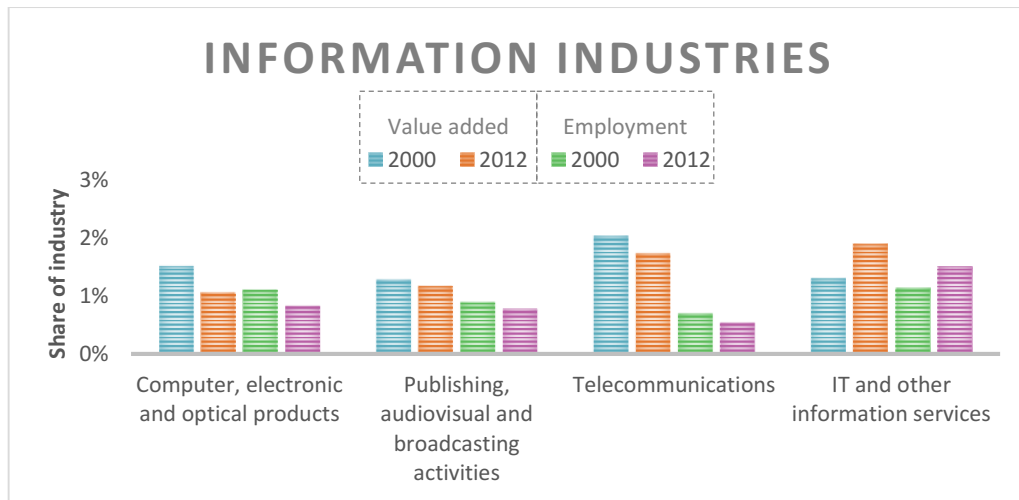
Figure 6-2: The relative size of information industries in the OECD. Percentage points of total value added and employment calculated. Source: OECD (2014).
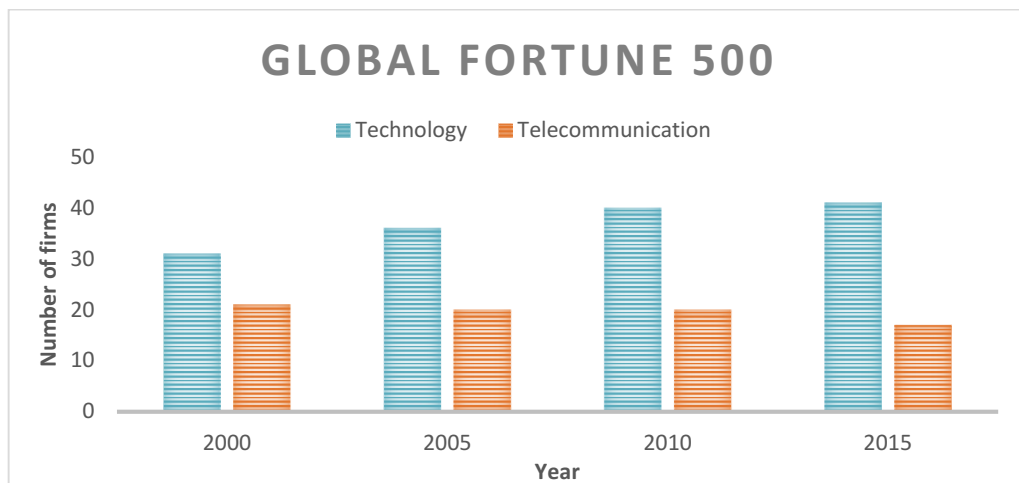
Figure 6-3: Amount of firms listed as Global Fortune 500 by industry "Technology"* and "Telecommunication." Data source: Global Fortune 500. *Technology industry was not available for 2000 and 2005, therefore the sectors "Computers, Office Equipment," "Computer services and software," "Information Technology Service," "Internet Service and Retailing," and "Electronics" have been accumulated.

According to investigate a hub within the global network a starting point can be the list of the Global Fortune 500 (Alderson & Beckfield, 2012; Wall & van der Knaap, 2012). Looking at the listed corporations in the years 2000, 2005, 2010 and 2015, the number of telecommunication companies has declined from 21 in 2000 to 17 in 2015. On the other side, there is an increase of firms of the technology industry from 31 to 41 firms as displayed in Figure 6-3.

Taking a deeper look at the companies with the highest revenues in the world both sectors are still playing a role. Thus, the headquarter location of those companies could acknowledge the city or the entire region as a hub within the technology or telecommunication sector. Which cities are home to these companies is displayed in Figure 6-4 ordered by revenue.

TELECOMMUNICATION HUB

< 3%
- Paris
- Shanghai
- London
- Milan
- Melbourne

Tokyo 18%
Beijing 15%
Dallas 13%
New York 11%
Bonn 7%
Philadelphia 6%
Newbury 5%
Madrid 5%
Mexico City 5%

TECHNOLOGY HUB

< 3%
- Hong Kong
- Dublin
- Stockholm
- San Diego
- Boston region
- Singapore
- Walldorf

Beijing 3%
Shenzhen 3%
Osaka 3%
New York region 4%
Tokyo 8%
Seattle region 10%
Seoul region 13%
San Francisco Bay Area 29%
Taipei region 14%

Figure 6-4: Telecommunication and technology hub according to headquarter locations of companies listed in the Global Fortune 500 in 2016 within the sector telecommunication or technology.

Synergy effects

It is possible to empower synergy effects in combining different sectors. One example is Frankfurt. The city is known for being a hub of the finance sector and not for being an ICT hub. Finance service and the stock exchange are highly dependent on ICT and fast internet connections.

Thus, it is of major advantage for Frankfurt that the internet exchange hub (DE-CIX) is located there. Many banks have HQs or branches in Frankfurt. Finally, this economic situation has an impact on tech companies and developments related to the finance sector. For example, the bank "Deutsche Bank" has outsourced its IT services to IBM (FR 4). In the following, IBM has opened a branch in the Frankfurt region (Sossenheim) and at the same time, they established their main data center for the whole federal region (Hessen). Thus, the capital to establish the IT sector came in Frankfurt from the financial sector due to its high dependency on IT services (FR 4). Today, most IT services have clustered around Eschborn and Sossenheim which are neighboring cities of Frankfurt.

A further advantage is to offer the adequate education at the same place where highly skilled personnel is needed. In Paris for example, the France Telecom (now renamed to Orange) is the most important telecommunication company in France. *"[I]t's situated in Paris and it's also linked to the polytechnic school, so the company can recruit new brains, new young people, freshly educated in the polytechnic school"* (PA 3).

Barcelona is another example that is not known for big ICT firms. Nevertheless, it is the World Mobile Congress Capital and hosts the Smart City Congress (BA 3). The World Mobile Capital Barcelona is an initiative to enhance the ICT development of the city. They are fostering *"the digital empowerment of new generations, professionals and citizens; the digital transformation of industries; and the acceleration of digital innovation through entrepreneurship"* ("Mobile World Congress," n.d.). Telefonica is one major company which performs R&D in the ICT sector in Barcelona whereas the HQ is located in Madrid (other branches of Telefonica are e.g. in London or São Paulo). Another big player is Cisco which is also involved in the smart city campus in Barcelona (BA 6). Starting projects under the flagship of being or becoming a smart city always include the increase of ICT whether to increase society skills, R&D, government or industry (Albino, Berardi, & Dangelico, 2015). The driving force is the innovation and the positive economic impact that is estimated according to the ICT economy.

Further, ICT may influence or revolutionize creative work and culture, e.g. the gaming industry and animation pictures which are both parts of the entertainment sector and will be further investigated as part of the creative city. Nevertheless, cultural and creative activities can profit from synergy effects between themselves and firms of the ICT market. For example, *"[i]n Paris, Google opened a cultural institute where artist can meet with computer scientist"* (PA 5). 3D painting is one of the innovations that have been developed at this Google Cultural Institute (n.d.).

It is a difficult task to measure the synergy effects between different sectors even if it is between the finance and the ICT sector, or the impact of ICT in educational and cultural institutions and vice versa. To identify those synergy effects an investigation on a deep case study level for each city is needed. Some examples have been described in this thesis but they cannot be counted as numbers in a global comparison since every city has different cultural and economic requirements.

Entrepreneurship

As important for innovation within the ICT sector entrepreneurship and startups have been mentioned. This is as well the driving source of economic growth in Silicon Valley. Accordingly, the innovation industry in the San Francisco Bay Area grew 174% whereas the rest of the economy grew 57% between the years 1994 and 2014 (B. L. Herrmann, Gauthier, Holtschke, Bermann, & Marmer, 2015). Startups are as well important job creators in North America. Kane (2010, p. 2) investigated the impact of startups related to the labor market and stated that *"without startups, there would be no net job growth in the U.S. economy."* Following Murugadas, Vieten, Nikolic, Fietkiewicz, and Stock (2015) in a global investigation the impact of entrepreneurship has not been identified as significant as in the US.

Nevertheless, there is a global trend that cities tend to be entrepreneurial friendly, especially for tech startups. Thus, today many cities start their own "Silicon Anything" to join this global development. For example, Silicon Alley in New York which is not only a place but a name that joins the tech industry and entrepreneurship (NY 1). First reports have ranked the best cities to start a business according to the given policies and environment in diverse cities, e.g. the Global Startup Ecosystem Ranking 2012 and 2015 (B. L. Herrmann et al., 2015; Bjoern Lasse Herrmann, Marmer, Dogrultan, & Holtschke, 2012), or City Initiatives for Technology, Innovation and Entrepreneurship (Gibson, Robinson, & Cain, 2015). Table 6-1 records all cities ranked by these reports for the year 2015. Interestingly, San Francisco is not the winner according to the report by Gibson, Robinson, and Cain (2015). They rank the top five cities which are despite New York all located in Europe. However, San Francisco does not need to implement innovative initiatives for technology since it is the best practice example. Following the report of Herrmann et al. (2015) the top four cities for startups are located in the US followed by Tel Aviv in Israel. Other rankings as well exist but they are not globally oriented like the European Digital City Ranking (Nesta, 2015) or investigated on a country level like the Global Entrepreneurship Index (Ács, Szerb, & Autio, 2016).

Table 6-1: Startup rankings according to Global Startup Ecosystem Ranking 2015 (B. L. Herrmann et al., 2015) *on the left and* City Initiatives for Technology, Innovation and Entrepreneurship (Gibson et al., 2015) *on the right.*

The Global Startup Ecosystem Ranking 2015		City Initiatives for Technology, Innovation and Entrepreneurship 2015	
City	Rank	City	Rank
Silicon Valley	1	New York	1
New York City	2	London	2
Los Angeles	3	Helsinki	3
Boston	4	Barcelona	4
Tel Aviv	5	Amsterdam	5
London	6		
Chicago	7		
Seattle	8		
Berlin	9		
Singapore	10		
Paris	11		
São Paulo	12		
Moscow	13		
Austin	14		
Bangalore	15		
Sydney	16		
Toronto	17		
Vancouver	18		
Amsterdam	19		
Montréal	20		

Conclusion: Hub of companies with information market activities

Summing up, that Informational world cities are hubs for companies with information market activities has not been totally agreed by the interviewed experts. Nevertheless, the SERVQUAL investigation has revealed that there is still space for improvement within the ICT sector in the most cities. During the interviews has been emphasized that there are different components of the information and communication technology market that play a role according to economic growth and thus as well for becoming a successful informational world city. ICT corporations are not only telecommunication companies but as well technology firms and information service corporations. As investigated in the OECD countries, telecommunication activities declined but on the other hand, IT and information services increased (OECD, 2014). A similar development can be investigated looking at the Global Fortune 500 firms filtered by industry. In 2015, 41 companies of the technology sector and 17 companies of the telecommunication sector belong to the Global Fortune 500. In Addition, synergy effects of different sectors, as well as the impact of education and culture, have been mentioned during the

interviews. A positive impact of ICT on education has been identified, for instance, by a study from the telecommunication company Ericsson (2016). However, more independent research in this area is needed. Special attention has got the overall flourishing startup scene according to technology. Actually, two rankings on a global scale are published (Global Startup Ecosystem Ranking, and City Initiatives for Technology, Innovation and Entrepreneurship) which are diverse in their methodology. Nevertheless, they reflect those cities that are entrepreneurship-friendly and represent a new kind of hub within the global ICT sector.

H2 ICT Infrastructure vs. automotive traffic

With the second hypothesis, I will investigate whether the infrastructure of the fifth Kondratieff (ICT infrastructure) will displace the automotive infrastructure. In fact, no infrastructure has been completely eliminated in favor of another. For example, today railways are an important part of mobility. But the focus has changed. Therefore, the following hypothesis will be investigated in accordance with the expert interviews and secondary data:

H2 The ICT infrastructure in an informational world city is more important than automotive traffic infrastructure.
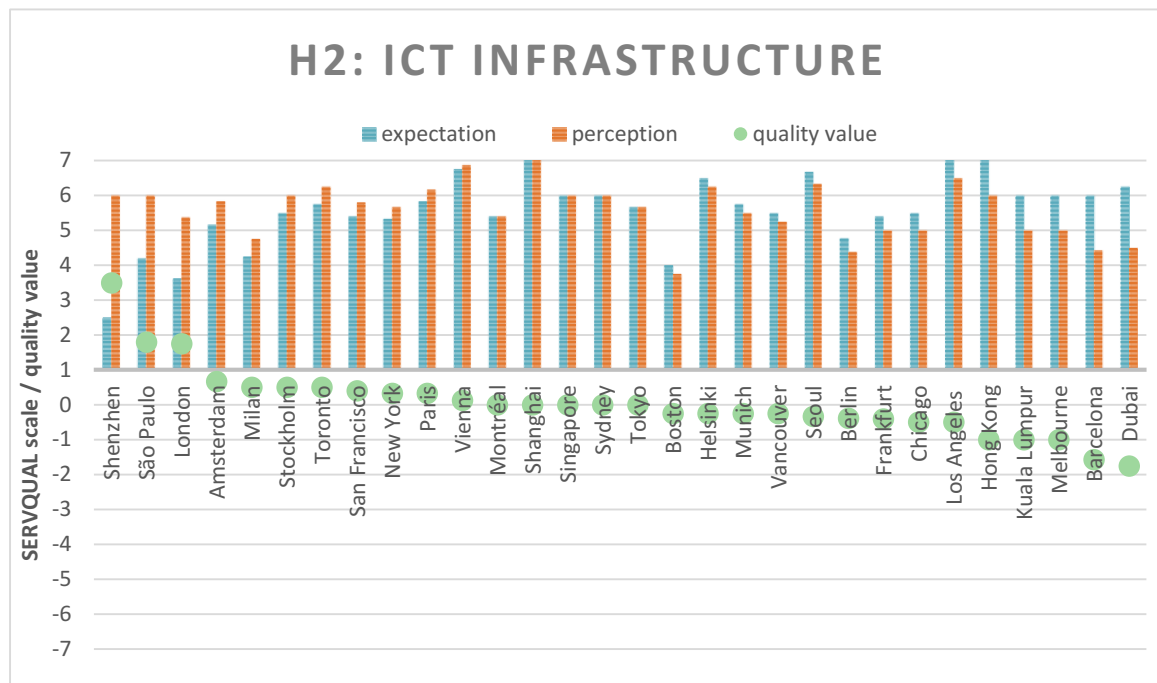
Figure 6-5: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the second hypothesis: "H2 The ICT infrastructure in an informational world city is more important than automotive traffic infrastructure."

According to the experts, the expectation and perception are very diverse across the cities (Figure 6-5). The mean quality value according to SERVQUAL is near zero (0.03). Which

infrastructure is in the spotlight is depending on the current demand. For Shenzhen, São Paulo, and London the interviewed experts have marked their perception very high in contrast to their expectation. São Paulo and London are both financial hubs that are in need of an advanced ICT infrastructure for the every-day business. And Shenzhen is a city that has been built nearly from the scratch and therefore includes from the early beginnings an enhanced ICT infrastructure. One expert stated that if you live in a city like Montréal where many streets are cracked due to the extreme climate (-30 degree in the winter and +30 degree in the summer) then everybody cares about road and street problems (MO 2). All in all, 38 interviewed experts stated that the ICT infrastructure is more important, 13 have emphasized that cars are becoming less important and 15 that cars are very important for mobility in the city. Contrasting the digital infrastructure of ICT and the physical of cars has encouraged many of the experts to discuss the importance of Wi-Fi hot spots in the city and further the influence of ICT on mobility. Thus, I will follow to debate the maturity of the ICT infrastructure, Wi-Fi connectivity, and mobility in the city and finally the influence of ICT on mobility.

ICT infrastructure maturity

According to the maturity of the ICT infrastructure, many rankings and indicators have been developed to compare e.g. the "ICT Development Index" on a national level (see chapter 3.1.1 ICT infrastructure). On city level, Ericsson has published the "Networked Society City Index" (NRI) for 2014 and 2016 (Ericsson, 2014, 2016). Indices by autonomous institutions are occurring step by step e.g. by the International Technology Union (ISO/IEC JTC 1. InformationTechnology, 2015). Referring to actual indices and studies, ICT maturity calculations will base on broadband speed, accessibility, and quality, the amount of internet users counted by the number of broadband subscribers, amount and quality of Wi-Fi hotspots, political support, and information literacy. Hence, it is evident that a positive correlation between the human development and the ICT maturity (Bruno, Esposito, Genovese, & Gwebu, 2011) as well as between the GDP and ICT indicators (Jin & Cho, 2015) exists on national level, it can be concluded that a city's economic success is positively related to its maturity of the ICT infrastructure. Furthermore, Ericsson (2016) has identified positive correlations between the ICT maturity and health and education. And according to the economic success, ICT maturity has a higher correlation with productivity (GDP per capita) than with economic competitiveness (R&D expenditure, patents, business startups, knowledge-intensive employment, and higher education attainment).

In order to ensure the relation of the national development and a cities ICT maturity I have correlated the Human Development Index (HDI) with the NSCI by referring the national score to cities (Figure 6-6). For example, São Paulo is related to the HDI score of Brazil. In total, only 16 scores are available in both indices. The cities are presented inverted ranking scores e.g. Stockholm is ranked first amongst 40 cities, thus Stockholm got the value 40 in the NSCI. As already assumed, the cities located in nations with a high HDI are ranked high in the NSCI (Pearson correlation R=0.74). The cities on top in both indices are New York, Singapore, and Stockholm and at the bottom are the cities São Paulo, Beijing, and Shanghai. What needs to be considered in this comparison is that the calculation is made with only 16 cities and that the NSCI is developed by the telecommunication corporation Ericsson headquartered in Stockholm – the city that is ranked first in the NSCI. However, the ICT infrastructure of the 31 cities that built the corpora of this work would probably result in high scores of maturity for all, since all cities in the corpora are located in a high human development nation.
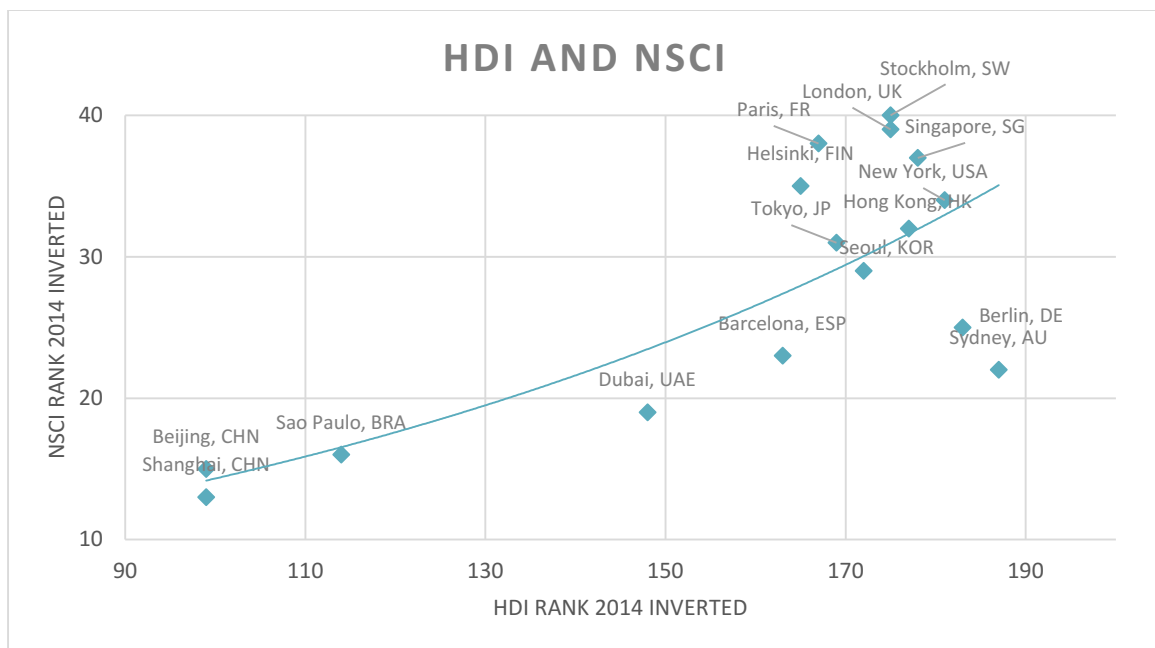
Figure 6-6: Correlation of the Human Development Index (HDI) and Networked Society City Index (NSCI) for the year 2014 with inverted ranking scores. Data source: Ericsson, 2014; UNDP, 2014.

One problem that has come to light during the interviews is accessibility. A world city has not a population that solely consist of wealthy people. Social inequality as well results in inequalities of access to ICT which is called digital divide (Ravi S. Sharma, Ng, Dharmawirya, & Keong Lee, 2008). To bridge this divide is a challenging task for every city. One remarkable initiative comes from Boston. My interview partner there, Deb Socia, leader of Tech Goes Home (at the time the interview, 2013) and now the leader of Next Century Cities, told me: *"We are wiring the poorest neighborhoods of the city by our Tech Goes Home initiative"* (BO 1). She is the

winner of the NATOA Community Broadband Hero in 2013 and other awards for her work to connect all neighborhoods and to close the technology gap. The Tech Goes Home initiative connects people with low-income, unemployed and underemployed, people who do not speak English, and individuals with disabilities (TGH, 2016). People like Deb Socia and initiatives like Tech Goes Home are needed in this changing society to help not to lose disadvantage people.

Public institutions like libraries are as well important in bridging the gap between the information poor and the information rich. Libraries in the 21st century have to identify their new role as an information hub for the society and at the same time to face diverse problems like budget cuttings (see chapter H7 Library as physical space). Thus, libraries are not all the same. *"If you have the money the technology is phenomenal. [In Los Angeles] Beverly Hills and West-Hollywood have state of the art libraries with good broadband connection"* (LA 1). In addition, the central library in Los Angeles offers a free Wi-Fi hotspot that is available continually and is accessible 24 hours even the library is closed, e.g. on Sunday's people are hanging around the library with their private devices (LA 3). Referring to a former investigation of public libraries in informational world cities, in 30 out of the 31 cities public libraries do offer Wi-Fi, but there are differences in e.g. charging and log in barriers (Mainka, Hartmann, et al., 2013). Thus for example, in Singapore the Wi-Fi access is offered in all public institutions and not especially in the library. Whereas Dubai does not offer many public libraries and the one we visited was more a kind of a reading room for international newspapers without Wi-Fi access.

The digital divide is not only caused by high costs for technology devices and telecommunication contracts. The adoption rate of ICT as well shrinks with the personal ability to use the technologies (SG 5). In Singapore, for instance, classes for the elderly and for the youngest are introduced to help the society to call attention to information technology and to become information literate (Mainka, 2011). Today, no standardized measure of information literacy do exist on a global scale (Beutelspacher, 2014). Thus, on city level courses in schools, libraries or other public institutions give us a hint if the city is willing to bridge the digital divide. The Vancouver Public Library has for example introduced a special program for illiterate adults (VA 3). The library has acquired e-reader which should animate the adults to learn to read and at the same time to learn how to use the technological equipment. In addition, *"[o]ne advantage of an e-reader is that nobody around you will see which book you are reading"* (VA 3). Thus, a further barrier could be abolished.

As I mentioned prior, all investigated cities are located in well-developed countries and offer an enhanced ICT infrastructure. Nevertheless, having the problem in mind that cities will grow and

increase in density, the quality of all infrastructures has to be ensured according to the needs of the population. Thus, a further problem of ICT access could be due to too slow connectivity rates through the internet which will at least hinder some functionalities or in the worst case exclude citizens from the network. Therefore, the political willingness to support the digital infrastructure, if it is through financial incentives of the private provider or through own investments, is essential. To support the ICT infrastructure is in most cases not regulated by municipalities but by national or regional governments. Therefore, a direct comparison of a cities expenditure for ICT would not reflect the real investments that are made. One exception is Singapore which is a city-state. The government authority for ICT "Infocomm Development Authority" (IDA) states on their website: *"IDA actively engages various stakeholders in collaborative efforts and initiatives to ensure that our work is closely aligned with the needs of the infocomm industry, business sectors and end-user communities"* (IDA, n.d.-b). The IDA as well develops continually future master plans that emphasize the increasing importance of ICT—currently, they are working on realizing their smart nation vision (IDA, n.d.-a). In a speech at the annual Industry Briefing in Singapore, Ms. Jacqueline Poh, Managing Director of IDA, has stated that the government will make a $2.82 billion expenditure for ICT. The core investments will be in infrastructure related programs like data centers and storage, cloud networking, routers, new PCs and laptops for government agencies, and enhancing Wi-Fi coverage at schools. As Singapore is a nation state the governmental decisions and expenditures are made by one authority. In comparison to other countries Singapore is ranked first in the Network Readiness Index (NRI) in 2015 followed by Finland and Sweden. The NRI covers amongst others the indicators political and regulatory environment, business and innovation environment, ICT infrastructure and usage. Finally, the NRI has a high correlation with the HDI which as well indicates the positive correlation of ICT indicators and economic success (Peña-López, 2006).

Ubiquitous connectivity through Wi-Fi hot spots

One indicator of the ICT infrastructure that is not considered in comparisons on a national level is Wi-Fi hotspots. Hotspots for public internet connections are then useful when many people are able to access them. Thus, today many cities start to offer public or private supported Wi-Fi hotspots in city centers, metros, or in other busy areas. The approaches how public Wi-Fi is implemented varies between the cities. In some cases, the municipality is involved in other cases private initiatives evolved through the public demand.

According to my own experience with an Android smartphone, many of the offered hotspots are disillusioning. Too slow internet connectivity, bugs, and connection errors have often hinder me to use the public Wi-Fi. For example, in Paris, to login via a smartphone, a button needs to be pushed within a mobile website at which the conditions of use have to be accepted. Most open Wi-Fi hotspots offer that kind of entry pages as the providers are liable for illegal internet activities like copyright infringement. In the case of Paris free public Wi-Fi, the entering button has not worked and due to this login bug, I was not able to connect (Own experience, December 12, 2013).

Another aspect of public Wi-Fi is the comfort of use. In Barcelona, the famous market street "La Rambla" offers approximately every 250 meters a public Wi-Fi hotspot. It is easy to connect to it and the entry page works sufficiently. However, to access the internet connection constantly while walking down the more than one-kilometer street is not possible. At each hotspot a new login is necessary. The best connectivity was reached of course directly in front of a hotspot (Own experience, December 4, 2013). Generally, Barcelona has made a lot of investments to improve their ICT infrastructure and offer for instance about 590 Wi-Fi hotspots all around the city (Ajuntament de Barcelona, n.d.). Nevertheless, Wi-Fi hotspots in a walking area invite people to use the internet connection for e.g. navigation tools or augmented reality functionalities with their smartphone. Due to login permissions, a continuous connectivity is not possible today. As wearables, navigation systems, and other functions of mobile devices will increasingly enter our every day life the legal constraints of public internet access need to be passed.

In some cities, as well the public transport provider offers free Wi-Fi, like for instance in New York City. According to an actual report, the Metropolitan Transport Authority will offer Wi-Fi in all 278 subway stations until the end of 2016 (Hawkins, 2016). Considering, offering public hotspots are not equated with high-quality access. However, my own experience in August 2014 was not satisfying. It was hard to connect to the internet through the offered hotspots in New York City's metro stations. They have been very slow or even not connectable with my Android phone. Nevertheless, it is no standard today that free Wi-Fi is available at public transportations. As Wi-Fi hotspots in public areas do not only serve the needs of tourists and visitors some telecommunication providers offer hotspots for their clients and in addition chargeable use for non-costumers. This is the case e.g. in Paris (as in other parts of France) where the hotspots are provided by the biggest telecommunication provider Orange and in Berlin, Frankfurt, and Munich (as in other German cities) by the provider Telekom. However, the Telekom hotspots are available in most rail stations in Germany which will probably hinder the integration of free public Wi-Fi.

Wi-Fi connectivity in the city could also be managed by private persons. Such an initiative can be found in Berlin. It is called "Freifunk" and encourage all citizens to open their personal Wi-Fi hotspot for the public ("Freifunk - Berlin," n.d.). Since mid-2016, private persons that offer an open internet connection have been as liable as other providers (BER 2). Actually, the German telecommunication law has been transformed with the goal to offer more opportunities for open Wi-Fi hotspots (BMWi, 2016). However, in the future, private internet sharing could enhance public Wi-Fi infrastructure in urbanized areas (BER 2).

There are still many municipalities that do not offer public Wi-Fi or not to the same extent like Barcelona. For instance, in Milan, there is free Wi-Fi for the first 30 minutes (MI 3) and in Munich, there is only one place in the city center where free public Wi-Fi is available (MU 1, MU 4). Nevertheless, cities where the municipality does not offer public Wi-Fi the private economy meet that needs to some extent. Thus, there are open Wi-Fi hotspots in countless Starbucks cafés, McDonald's and also smaller restaurants and cafés that make municipal Wi-Fi ostensibly obsolete. Hence, to use an internet connection in London you do not need to enter a café. Often the hotspot could be reached from the street (Own experience, June 24-30, 2013). One example which offers both to a high extent is Singapore. Next to a lot of public hotspots, private provider like shopping malls, cafés, and restaurants offer nearly ubiquitous connectivity. During my stay in diverse cities, in most cases, the private provider like shopping malls or restaurants have offered a more satisfying internet connection than public hotspots at outdoor places. Though, according to public institutions internet connection in public libraries have most been acceptable.

Figure 6-7: Media Poles in Seoul. A u-city street project. Left: One media screen in use by Prof. Wolfgang G. Stock. Middle: Street in Gangnam Districts with 22 media poles. Right: One multimedia information totem in Milan. Photos by: Agnes Mainka.

Finally, another idea to offer free public internet connectivity on the go is media poles (Schumann & Stock, 2015). According to the investigated cities, Seoul and Milan have installed media poles experimentally. The idea is that pedestrians can use the touch screens at the poles

like a huge smartphone with diverse applications, e.g. a restaurant guide or travel assistance. In Seoul, the screens can be switched between the languages Korean, Japanese, and English. 22 media poles that are twelve meters high each have been installed every 35 meters along the 760-meter long street Gangnam daero in 2009. They are as well used as an advertising platform and Wi-Fi hotspot (see Figure 6-7). According to my own experience in July 2013, the media poles are largely ignored by pedestrians. In addition, the screen was working very slow and at least disconnected after a few minutes of use. In Milan, the media poles are called "multimedia totems" which offer first of all a smart navigation system for public transportation, and in addition Wi-Fi connection, power sockets to recharge own devices, and NFC technology to purchase additional services. They have been installed according to other smart city initiatives as preparation of the upcoming Expo 2015 (Morandi, Rolando, & Di Vita, 2016). Like in Seoul, I have not seen any person who was interested in these poles (Own experience, November 5-7, 2013). These experiences are similar to the findings of an investigation of media screens in Oulu, Finland (Schumann & Stock, 2015). Due to the nearly ubiquitous penetration of smartphones, media screens are less used and will probably become obsolete like public phone boxes. Therefore, media screens need to identify their niches with additional features which are not served by a smartphone to become popular.

Mobility

That ICT is growing in importance in our everyday life has been described by one interview partner as follows: *"In the future, the blood system of the city will not be the streets but the information networks. Because when you have information you could act and maybe you don't need to move by transport"* (BA 6). Even if the ICT infrastructure will be highly developed, it is not supplementing mobility at all. Further, the advantages of the ICT infrastructure are not recognized as important part for the whole society. For example, in São Paulo, *"[t]he ICT infrastructure is better developed than the automotive infrastructure, but the most Paulistas care more about their cars"* (SP 5).

With the growing density within cities, a problem of mobility aroses. Dargay and Gately (1999) have shown a disproportionate relation between economic growth and the amount of car owners per capita for the years from 1970 till 1990. In their study, published in 1999, they forecast an 18% annually car ownership growth rate e.g. in China. Finally, in nearly all cities around the world, the growing number of cars resulted in traffic jams, especially during the rush hours. Today the problems are crowded cities, pollution, and high costs. Thus, many cities have to face these problems and develop ideas how to reduce the negative effects of cars in the city, e.g. congestion

fees for entering the city, high parking rates in the center, and finally governmental incentives or requirements. The reallocation of the road network to sustainable modes of traffic has already been discussed in the early 2000's (Cairns, Atkins, & Goodwin, 2002). Today, while diverse smart city initiatives are facing the problems of climate change, approaches of sustainable transportation become true.

According to Kenworthy (2006), three types of mobility modes are acknowledged to cities: "auto city," "transit city," and "walking city." He has investigated the correlation between population density and the preferred mode of mobility. As a result, he identified that thinly populated cities are "auto cities," cities with 30 to 100 persons per hectare are "transit cities," and with 100 or more are "walking cities." He concludes that being a transit or walking city makes the city sustainable and livable. A similar result has been identified by the "Mobility in Cities Database. Synthesis Report" (UITP, 2015). In this report, the share of sustainable transport modes (walking, cycling, and public transport) has been correlated with the population density. Accordingly, a positive correlation is the result (Figure 6-8 6-8). Nevertheless, in most world cities traffic is still a problem. According to investigate the effect of the fifth Kondratieff which is dedicated to the growing importance of ICT rather than to automotive traffic different cases of car traffic reduction will be introduced in the following.
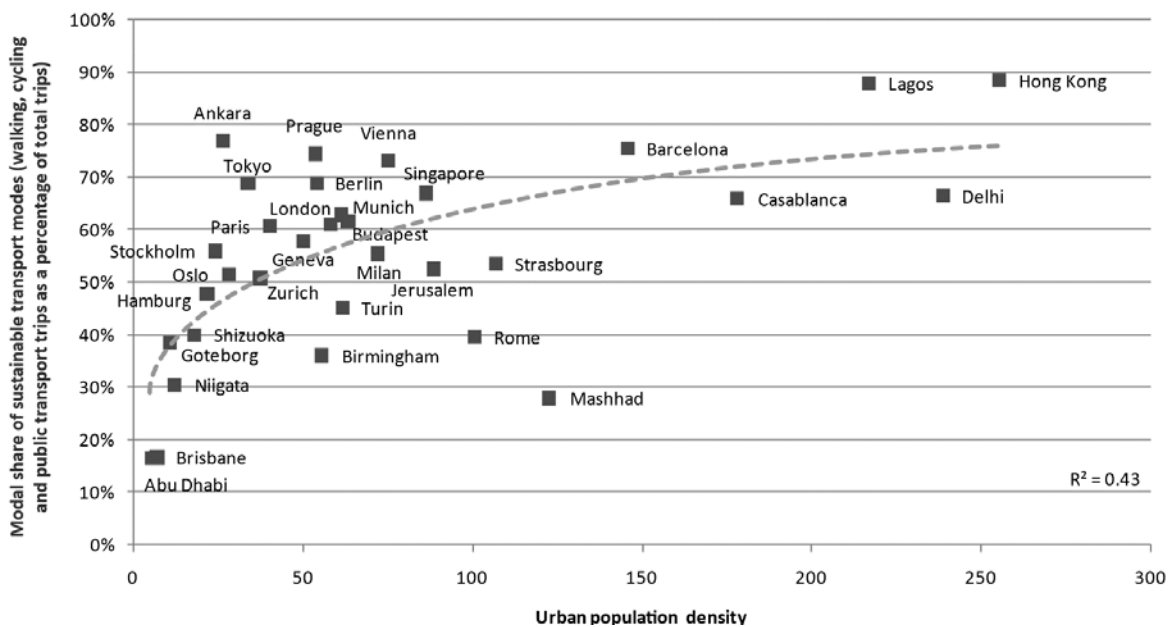
Figure 6-8: Share of total daily trips undertaken by sustainable modes – walking, cycling, and public transport – out of the total number of daily trips (vertical axis) explained by urban population density in the metropolitan area (horizontal axis). Source: UITP (2015, p. 2)*.*

In Europe, many cities have introduced a green zone to reduce dust pollution in city centers. Thus, many cars that do not fulfill the modern standards are not allowed to enter the city center

("Die Umweltplakette/Feinstaubplakette," n.d.). Other cities like London or New York have introduced congestions fees. In many other cities, the parking fees are exorbitantly high, which would prevent many people automatically to enter the city by car (LA 1). As high costs exclude people from driving a car, Singapore has introduced a tremendous high registration fee that is nearly the price of a new car (SG 12). Seoul has introduced the "No Driving Day" with monetary incentives for participating citizens. In the case of São Paulo, the municipality had to establish a "No Driving Day" without any incentives for the citizens, due to the overcrowded streets around and in the city center (SP 1). However, this could mislead people to buy a second car instead to use the public transportation. Another approach was chosen in Helsinki where *"slow driving zones kill the car driving fun factor"* (HE 1). Finally, to reduce car use in the city alternative transportation modes need to be offered which in conclusion could be interpreted as the loss of importance of cars in the city.

The investigated informational world cities are all off different size and dense. Nevertheless, all are "global cities" that have to deal with many people that enter the city center even for business, leisure, or as a visitor. Today, all of the 31 cities have a rather dense population and offer any kind of public transportation. Therefore they all are at least "Transit cities" (Kenworthy, 2006). Due to the need of mass transport opportunities diverse mobility modes from omnibuses on streets, subway railroad systems, up to driverless metro trains on high rise levels have evolved (Post, 2007). Figure 6-9 shows examples of the trams in Barcelona and Hong Kong and of the self-driving high rise metro in Dubai. According to the interviewed experts, many have stated that public transportation is only well developed in the city center and to a lesser extent in the whole metropolitan area or region.

In Los Angeles, the main public transportation mode is the bus. Buses have to share the road with the cars and thus they are very slow especially during the rush hours (LA 2). Further, LA's autonomous urban development has resulted in a car-oriented city in which most places are reachable best by any freeway (Bratzel, 1995). Hence, due to the overcrowded streets in the core of the city, a lot of smaller centers have evolved everywhere in the LA metropolitan area. Today, the city is a very widespread area and offers a subway system only for the interior city center. However, *"[t]he majority of the City of Los Angeles is considered a High Quality Transit Area. These areas have frequent access to some form of transit, whether it is light rail, bus, BRT [bus rapid transit], or subway"* (Chamberlain & Riggs, 2016, p. 54). According to Chamberlain and Riggs (2016), the inhabitants of LA are not likely to live in walking distance of metro stations but 97% live at least in a "bikeable" distance to any public transit station. Referring to a report of the United States Census Bureau (Wilson et al., 2012), LA is second after New York City according to the

average dense of population per square mile which definitively characterizes the city as "transit city."

Figure 6-9: Public transportation modes. Examples of Dubai Metro (upper pictures) and trams in Hong Kong (bottom-left) and Barcelona (bottom-right). Photos by: Adriana Kosior (top-left), Agnes Mainka (both right), Carsten Brinker (bottom-left).

To make public transportation attractive a seamless infrastructure is important. An example how an infrastructure should not be established is Kuala Lumpur. In this city, two light rail provider and one monorail provider coexist. Each is independent and this has resulted in an uncomfortable commuting (own experience). Thus, assuming that a person needs to change the train, it can happen to that a train change could include a longer walk since the providers do not share metro stations. Furthermore, pedestrians are not integrated into the road infrastructure what makes it difficult to cross the street in some parts. Thus, missing traffic lights for pedestrians makes the use of public transportation dangerous and inconvenient.

As there exist a lot of different modes of transportation today, it becomes possible to banish automotive traffic in city centers in favor of reusing this space as public space. This is a rather seldom phenomenon in real life. One prominent example is the demolished highway Cheonggyecheon in Seoul in 2003. The highway that has crossed the city center was demolished in favor of revitalizing the former river underneath the street (Figure 6-10). Today, this space is an attraction for pedestrians which offers a light entertainment in the evening. This was not the only

step of Seoul towards a more sustainable city. Amongst others, since 2002 in total 15 highways have been banned which has resulted in a decrease of 3.6°C in the summer terms (Mesmer, 2014).

Figure 6-10: From highway to greenway. Photos by: Carsten Brinker (bottom-left), Agnes Mainka (others).

In contrast, there are two examples that would as well have the potential to redevelop a riverside. First, Kuala Lumpur have two rivers crossing the city (Sungai Klang and Sungai Gombak) which are in need of improvement according to water quality and furthermore could be redesigned (Shaziman, Usman, & Tahir, 2010). And second, Singapore has built a four-lane expressway along a canal in the city center. Nevertheless, in Seoul as well the space next to the river is still a high used motorway and Singapore has a lot of recreated public space along the Singapore River. Another example is New York City. At the famous entertainment area "Time Square" a pedestrian plaza was realized which has reduced the space for cars (NY 1). In both cases (Seoul and New York), the government was the main planner and decision maker. In other cities, the government is the biggest challenger according to those development plans. *"The habit in the administration is the problem"* (MO 6). The creation of car free zones needs the acceptance of the citizens, too (MU 1). For instance, in Munich, which is home to the leading automobile manufacturer BMW, has already started a discussion on establishing a car free zone in the old town area but till today no decision has been made. In other cities like Frankfurt the *"[a]utomotive traffic is important for local and global logistic. [As] Frankfurt is a logistic hub"* (FR 2). Looking at Vienna, the city development plan is to reduce 20% car traffic by offering new pedestrian zones and enhancing the number of journeys with public transportation up to 40% (VI 5). One incentive

is the cheap price of an annual public transport ticket which is available for 356 €. This is half of the price compared to Frankfurt (VI 5). But as well in Vienna *"there is a clash between the car driver fraction and the car free zone fraction"* (VI 5, own translation). Thus, there are also experts that state that *"the city wouldn't function without cars"* (LO 1). Milan's government goes one step further and offers free public transit vouchers for commuters leaving their vehicles at home (Peters, 2015). Further cities have already made some goals according to car reduction rates, e.g. in Paris the number of car owners has reduced from 60% in 2001 to 40% of inhabitants in 2015 (Peters, 2015). In Hong Kong *"80% of people use public transport, only 20% own cars"* (HK 1). At least, *"[t]he city should be a meeting place for people and not for traffic"* (ST 1).

Besides pedestrianization we can additionally see that there is a change in behavior as one expert from Toronto stated: *"The younger generation is less car oriented. In addition, an own car is too expensive for most inhabitants"* (TOR 2). As well in New York, most people do not own a car since the fastest way of commuting is via the Metro (NY 1). Further, not all cities are developed for cars, e.g. *"Vancouver has no freeway going through the city center. Compared to other North American cities this is unique. Some streets are designated only for bicycles"* (VA 1). Equal examples are Amsterdam or Boston. However, in some situations a car is of advantage, e.g. to make a bigger shopping at the supermarket (whereas the number of delivery services is growing as well). To satisfy such short time needs, car sharing has established in many cities. In many cases, the cars are very small and are powered electrically (Figure 6-11).

Figure 6-11: Sharing services. Left: Car-sharing in Berlin. Right: Bike-sharing in Milan. Photos by: Agnes Mainka.

An equivalent system has been introduced for bikes in nearly all investigated cities except for Amsterdam, Hong Kong, Kuala Lumpur, and Sydney (Appendix III Bike sharing). However, *"Amsterdam is not famous for fast connections via cars"* (AM 1). The city is a bike friendly city and due to this fact the city is sustainable and has fewer emissions by its nature. Amsterdam offers bike rent for a much longer time than bike sharing was launched. Figure 6-11 shows a typical

bike-sharing station in Milan. According to the numbers of bikes in use and stations available, China has the largest bike sharing systems (EWContributor, 2015). Amongst the top cities, Shanghai offers 19,000 bikes and 600 stations. Paris has one of the most successful bike sharing systems in Europe (EWContributor, 2015). They offer almost 20,000 bikes in around 1,800 stations ("Paris - Vélib'," n.d.). New York City is the first in introducing a bike-sharing system in the USA. Most bike share programs are a joined effort by local businesses and municipalities. But in New York, the bike sharing program is developed only by private parties. Thus, this service is the most expensive compared to other global cities (EWContributor, 2015). Paris and New York have to suffer with vandalism which results in negative revenues for the investors (EWContributor, 2015). However, only a sufficient amount of bikes and stations all over the city makes the sharing system successful. Accordingly, a bike sharing density of 10 bike stations per square kilometer is ideal (NACTO, 2015). Following, an interview partner from Berlin, the increasing importance of bikes and bike lanes in a city results consequently in a losing importance of cars (BER 7). According to an interview partner from Boston: *"People always have ridden bicycles, but now there is much more support for bicycles, like bike racks for bike sharing. It's the second or third year that they are in the city. It's very popular in Boston. … [B]eyond the automobile Boston is a great city for walking"* (BO 4).

Reffering to car reduction rates in cities there are also some constraints that need to be considered. Thus, one interviewee stated: *"It depends on what class you are living. If you are a worker and you have to get to work you need to be able to use transportation. If you are a knowledge worker and you are flexible and you make lots and lots of money then ICT infrastructure is more important"* (LA 3). Public transportation is as well seen as a transportation mode for the mass and not for e.g. the rich and royals. In Dubai for example, there is a big gap between the rich and the poor. But, to make public transportation attractive for all societal groups a "first class" cabin at the metro has been established. In addition, a forward-looking urban planning is needed. For example, in Vienna, the city planning of the new neighborhood "Aspern" has directly integrated a metro line from the early beginnings. Thus, people who would like to live in Aspern in future do not have to wait till the neighborhood gets crowded before the infrastructure will be built according to the demand. The infrastructure is already there (VI 5). Finally, the increasing success of bike sharing systems is not wholly integrated into the most cities as a secure alternative to public transportation. In many cities, additional bike lanes are planned or under construction. Some cities like Barcelona are not entirely bicycle friendly due to its hilly landscape or the weather conditions are unfavorable for riding a bike e.g. in the freezing winter terms in Toronto and Montréal. Thus, the weather is not manageable but geographical conditions like a hilly landscape

in Barcelona could be overcome e.g. by offering e-bikes instead (BA 3). Problems are, for instance, accidents while riding a bike. Thus bike lanes should be established that help to reduce this worry. In the case of Paris, the user of the bike-sharing systems indeed is less involved in traffic accidents than other cyclists. *"In 2009, … Vélib' riders were responsible for one-third of all bike trips in Paris but were involved in only one-fourth of all traffic crashes involving a bicycle"* (Kazis, 2011).

Summing up all interviews, there is a twist between the assumption if cars are important or not. Most have stated that you need the car if you do not live in the city center since outside of the core public transportation is not developed enough. In London for example two experts mentioned independently that the ICT and the automotive traffic needs improvement (LO 2, LO 3). Finally, if the city is a "Walking City" does not depend only on the ratio of commuters that are using a sustainable mode of transport. According to a study by Duncan, Aldstadt, Whalen, Melly, and Gortmaker (2011), a "Walk Score" is a valid measure to investigate certain aspects of walkability in a city. This score was calculated for major cities in the US which are online free available. However, two indices already use the amount of sustainable modes of transport as part of their indicator catalog according to the development towards a sustainable city: "The Green City Index" by Siemens (2012) and the "Sustainable Cities Index" by Arcadis (2015). According to The Green City Index the greenest European city is Copenhagen, in Asia Singapore, and in North America San Francisco. And Following the Sustainable Cities Index the top three cities are Frankfurt, London, and Copenhagen. In their ranking (which is not segregated per continent) San Francisco owns the 27th and Singapore the 10th ranking position.

Internet of Things – Smart mobility

The examples above show, mobility is still important within a city and will not be replaced by ICT. However, ICT does enhance the efficiency of the use of e.g. physical space and mobility. For instance the usage of sensors in the city that are connected to the internet is referred to as "Internet of Things" (IoT) (Kamel Boulos & Al-Shorbaji, 2014). This technology is used e.g. in Amsterdam where smart mobility initiatives are under development, for example in the actual cooperation of HERE (a software developer for navigation systems) and the Dutch Ministry of Infrastructure (Nokia, 2015). They test a new road messaging system to improve road safety and traffic flow. Data of mobility or physical space at all origins from installed sensors and as well from citizens that are using their smartphone and different kind of apps (Castelnovo, 2015).

According to the most used type of mobile apps that base on urban data, navigation systems are the top downloaded (Mainka, Hartmann, Meschede, & Stock, 2015a). Through mobile apps,

costumers are able to request departure times of trains and buses. Though, this is not introduced in every city as for example in Montréal no real-time transit information is available via an app (MO 3). In addition, smartphones can replace ticket vending. For instance, Munich is a very conservative city and is very cautious in introducing new things. Therefore, the city is not a forerunner, for instance, in e-tickets. The city has waited for the technology until it was successfully tested in other cities and now it is available in Munich, too (MU 1). However, there are many providers of public transportation in each city—bike sharing, car sharing, metro, and buses. ICT as well increase the ease of use for instance in offering a one stop paying system (through an app) for all transport modes (Regio IT, n.d.). Furthermore, the combination of all public mobility modes in one app could in the future bridge between the different providers to offer a nearly seamless public infrastructure. Such a service is e.g. offered in Helsinki in the development stage with the ambitious to make it obsolete to own a car (Peters, 2015).

Citizens as sensors and open urban data will have an impact on urban planning decisions in future. Thus, it might be possible to identify the main bike routes and meet the demand if additional bike rakes or lanes are needed. One example is the running and biking app Strava (Davies, 2014). Originally this app was built to monitor the personal tracking of the costumer's training like distance and time. Therefore, a lot of data has been tracked of when and where the app user rides. Today, Strava is cooperating with cities, amongst others with London, and sell the data to urban planners who can now, for instance, identifying routes where new bike lanes are needed.

According to Vekatraman (2014), a shift in managing traffic conditions is needed. Since in 2013 about 101 billion US $ have been spent to make cars more efficient and only 3.56 billion US$ to make traffic more efficient. He argues, it will not help the driver to own a car equipped with all kind of technology. He will not become more efficient because the traffic management does not work sufficient. Thus, using data, e.g. from apps, may help to track routes from cyclist as well as from commuters that are using any other kind of transport. One example that evolved in Boston is the "Street Bump" app (www.streetbump.org). While driving a car the app automatically tracks if the car is passing a pothole and records that data. The stored data can be used to help the government agencies to identify where the streets conditions are the worst. Finally, accumulating all real-time data (traffic data, transit service data, routes and city maps, weather data) could in future be used to support citizens with information about which mode of transport would be most efficient, e.g. sharing a taxi with other persons at the one morning and perhaps to commute by bike on the other (Busher, Doody, Webb, & Aoun, 2014). And from the urban planning perspective, this data may be used to enhance the efficiency in urban transit by identifying the mobility

demands in more detail. Nevertheless, neighborhoods with poor data provision by citizens should not be ignored in future city development plans.

Conclusion of ICT infrastructure

Following the theory of economic waves by Kondratieff the 21st century is the century of information and communication technology (fifth Kondratieff). Accordingly, a new network has evolved—the internet. As economic development and innovation are concentrated in cities of the knowledge society the impact of ICT will be enormous (Castells, 1989). Therefore, the question arises if the importance of ICT has increased in contrast to the former economic wave driven by automotive traffic including the network of streets. Following the interviewed experts this question is very controversial. Some see the opportunities that are given to enhance sustainability in the city but the inclusion of the whole region is missing. Most of the public mobility options are developed for the inner city center and not for the surrounding area. Therefore, the change in behavior which was acknowledged as an important step towards a sustainable city could not grow without a sufficient offer of alternatives to automotive traffic.

Today, many indices exist that use core indicators of the digital infrastructure like internet broadband speed, accessibility, and quality. Thus, the digital infrastructure is seen as a fundament for economic innovation and success. Finally, cities located in a nation that is highly ranked by the Human Development Report and the Networked Readiness will generally offer a good ICT infrastructure. In addition, a higher GDP rate indicates an enhanced ICT infrastructure. Public institutions are bridging the digital divide in the society by supporting information literacy programs for citizens, inclusive the poor, disabled, youngsters, or seniors. Thus, political willingness to support the ICT market and the social inclusion of the information poor are of advantage.

In addition, continuous access to the internet is envisaged even for the people through Wi-Fi hot spots or to add things through IoT technology. Diverse opportunities emerged in cities how to access free Wi-Fi. From the view of the municipality, the cheapest way is if the free market like restaurants and cafés offer access to internet hotspots. Private companies like Telekom in Germany or Orange in France offer additional hotspots for their customers. Providing a lot of free hotspots like in Barcelona or investing into media poles like in Seoul and Milan can additionally add a smart city image (Morandi et al., 2016), even if the technology is not totally satisfying. According to the increasing sharing economy, Wi-Fi hotspots can be shared by private persons like

in the case of "Freifunk" in Berlin. Nevertheless, the open access to internet hotspots has not reached its limits and could, if efficient included, enhance the ICT infrastructure in cities.

Additionally, ICT is used to open new opportunities in managing urban traffic. That too many cars in the city cause high pollution, costs, and traffic jams is not new but with the upcoming of smart city initiatives sustainable modes of transportation are in the focus of urban planners. A special role is acknowledged to the increasing amount of sharing services and to real-time information services (based on IoT). ICT in combination with public transportation services can make commuting via sustainable modes of traffic more comfortable. The possibilities of using technology in improving transit conditions are still in its infancy, e.g. tracking common cyclist routes to adjust the construction of bike lanes according to the demands of the user, or enhance the ease of use, e.g. by introducing a one-stop payment system for all kinds of public transportation including bike and car sharing services. Finally, governmental incentives may enhance the public willingness to switch from the car to sustainable transportation modes.

6.1.2 Cognitive infrastructure

As informational world cities are prototypical cities of the knowledge society the cognitive infrastructure is related to institutions of the creative and knowledge city. Hence, in this subchapter, I will investigate if the aspects of both city types are preeminent in the 31 analyzed cities. Knowledge flows are represented through the scientific-technical output, e.g. scientific articles published and patents granted. Both are the output of knowledge institutions and knowledge intensive companies. Synergy effects and innovation will be encouraged foremost by their cooperation. Therefore, the following hypothesis will be investigated:

H3 *Science parks or university clusters that cooperate with knowledge intensive companies are important in an informational world city.*

According to attract the "creative class" that is the workforce of the knowledge and creative economy the city's ability to become a creative hub is acknowledge as an advantage for the economic success. Thus, the 31 cities will be investigated if they are characterized as creative city:

H4 *An informational world city needs to be a creative city.*

Cities that are recognized as creative cities are home to so-called "creative milieus." They offer space for face-to-face communication and collaboration:

H5 *Physical space for face-to-face interaction is important for an Informational world city.*

In addition, the main resource of the knowledge society is the human capital. To encourage life-long learning and to offer access to all kinds of information is a special role of digital libraries:

H6 A fully developed content infrastructure, e.g. supported by digital libraries, is a characteristic feature of an informational world city.

Due to the digital access of information in the 21st century libraries as space inherit a new role. They shift from being archives of publications to a place for cooperation and thus offer additional space for face-to-face meeting:

H7 Libraries are important in an informational world city as a physical place for face-to-face communication and interaction.

In the following, I will investigate each hypothesis separately as part of the cognitive infrastructure.

H3 Science parks and university clusters

Following Stock (2011), the knowledge city can be investigated according to their output of scientific and knowledge work which he dedicates to the amount of STM publications and registered patents. Hence, the origin of these publications are knowledge institutions. Those can be defined as the infrastructure that is needed to be successful in knowledge related activities. In addition, today's economic success bases on the human capital. Thus, private R&D in cooperation with scientific institutions can contribute to this. To identify the importance of science parks and knowledge clusters in informational world cities the experts have been interviewed according to following hypothesis:

H3 Science parks or university clusters that cooperate with knowledge intensive companies are important in an informational world city.

Thus, taking a look at the SERVQAL results the quality value in sum is slightly negative Q = -0.44 (Figure 6-12). Nevertheless, the overall expectation on this indicator is rather high but only in four cities the experts are convinced that the perception of science parks and universities overtake the expectation. *"[T]his [question] does go to the heart of an informational city … But really the question is, 'Do you have that added proportion to your size of city?' That, to me, is the issue. And Vancouver probably leans towards maybe having them slightly more"* (VA 1). But in average all experts in Vancouver reveal that there is still space for more university clusters and science parks. In addition, it is not surprising that a city like Boston has got a positive quality value with the maximum perception score (7) since some of the best universities are located within the Greater Boston Area (e.g. Harvard and MIT). In contrast, a city like Melbourne got a negative

quality value whereas the city is acknowledged as knowledge city according to the Most Admired Knowledge City award (City of Melbourne, 2013). Accordingly, in this city more science parks and university clusters should be developed. Furthermore, a physical agglomeration of the private economy and universities is seen as important to have a good partnership between them (77 experts). For instance, in Seoul, all three interview partner agreed that the existence of science parks or clusters are not as that important. The Universities in Seoul, as in whole South Korea, produce a high number of qualified people but the economic system is not comparable to the innovation production in western countries (SE 2). Most academics are looking for a job at Samsung or LG after they graduate. That university clusters have a low contribution to economic development in South Korea has further been reviewed by an scientific investigation by Sohn and Kenney (2007). Concluding, the expectation that science parks and university clusters are an important characteristic is rather high.
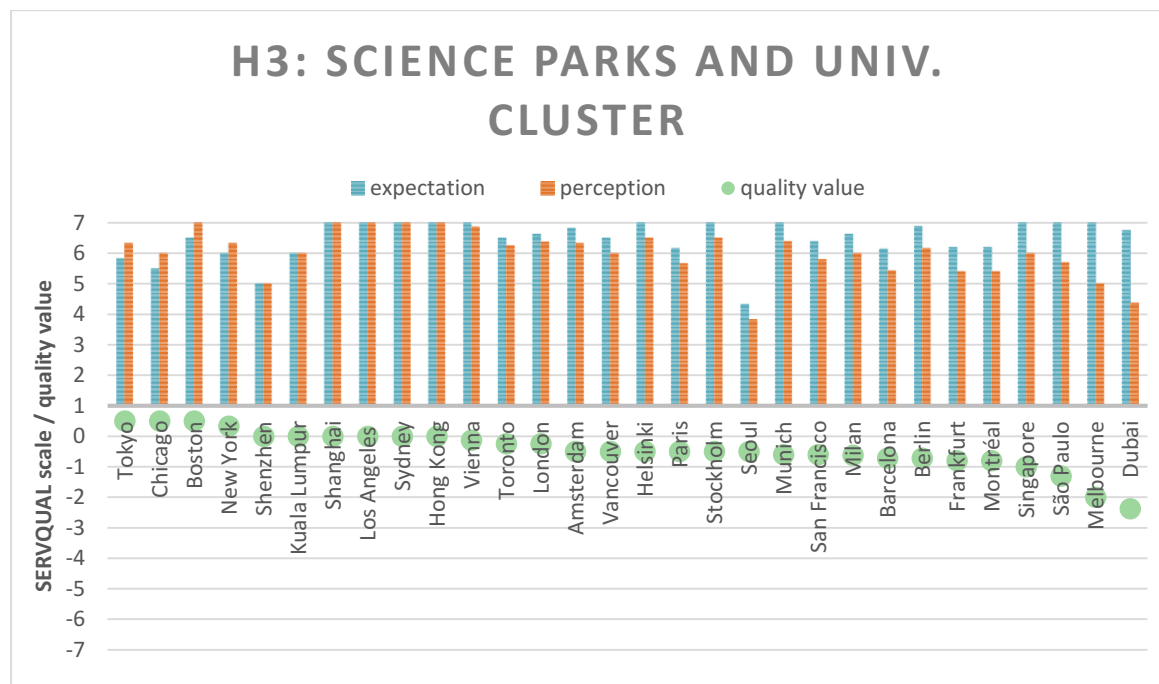
Figure 6-12: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the third hypothesis: "H3 Science parks or university clusters that cooperate with knowledge intensive companies are important in an informational world city."

Finally, the interview partners have argued that the base for R&D is education (16 experts). Following the interviewed experts, it is important to be a strong university city (MO 2). Thus, many experts stated during the interview the number of universities and colleges that are located in their city or region (18 experts). Additionally, the city should attract students to graduate and finally to settle down in the region (mentioned by 6 experts).

Boston, for instance, is a successful example of institutions of higher education. The institutions are not located in the city center but are easy and fast to reach from there. The metro from Boston city center to Harvard University needs approximate 15 minutes. MIT and Harvard for instance are both located in Cambridge and both are the world leading universities in several rankings (O'Neill, 2016). Following the investigation of Von Zedtwitz and Heimann (2006) the neighborhood Cambridge is acknowledged as the knowledge cluster of Boston with about 50 institutions of higher education and a medical center. The high number of scientists and engineers in Greater Boston attracts further corporations to set up an own R&D center or to collaborate with local research institutes. In addition, the established culture of promoting entrepreneurship, e.g. student startup competitions, enhances the growth of the economy and consequently the number of startups in that region. Von Zedtwitz and Heimann (2006) conclude that especially network events and the personal character of the networks (everybody knows everybody) is an important driver of the regional competence of Boston. A further advantage of Boston is that Harvard and MIT are globally known universities which attract people from all over the world.

Considering the link between the knowledge institutions and the cities, science parks and universities are not as interconnected as for instance other global institutions like museums or national libraries. One expert from Paris stated: *"Let's give some examples, … Bibliothèque de France is a world institution with very strong functionality to knowledge. So yes, I would put it at the same level as the British Library or library Grand Basque… The Louvre, the museum, I would put it the same, it's really a global institution, which spreads over information and more than information—exhibitions, like national gallery would do it in London. … I think it's the same kind, but then if you start with universities, … I don't think the universities are yet really linked enough to the city. There is a link between universities, but it's not yet what I would call knowledge intensive institution. It's not like … in the Netherlands, for example, where the university is part of the city and share information with the people. No, I don't think we are that far. I don't want to say that there's nothing done, but we [in Paris] are not at the age of sharing knowledge between university and the city"* (PA 2).

Thus, becoming a knowledge hub is related above all to the presence and quality of universities and then the science parks and university clusters can be built around those institutions. Therefore, in the following I will focus the discussion on the city's performance as place of institutions of higher education. In addition, the trend of building clusters will be highlighted.

Knowledge hubs and education

In Munich, for example, the history of the two universities LMU and TU is going back until the time as Kings have governed Bavaria (MU 1). The LMU was established in 1472 and the TU in 1868 (LMU, n.d.; TUM, n.d.). Both are a hub on national but not on an international level (MU 2). After the Second World War, in addition, the cooperation of the German Army has pushed the success of the scientific location Munich as a knowledge hub (MU 1). Interventions with the military are as well the roots of Silicon Valley (Dembosky, 2013). In comparison, other cities cannot look back on that long history because they are rather young like cities in Canada (TO 4).

Others have developed in recent years from a fishing village to a knowledge city, e.g. Dubai and Shenzhen. Thus, Dubai has imported the knowledge to educate their society: *"There are 26 international universities in Dubai. Nearly all of the international universities are international branch campuses, which provide an accredited degree from the home institution. These institutions are from ten countries (Australia, UK, USA, India, Russia, Iran, Pakistan, France, Ireland, and Lebanon)"* (Dubai private education landscape, 2014, p. 15). In total Dubai counts 57 institutions of higher education. Shenzhen is probably a unique example of a city that has grown rapidly due to governmental plans (SH 1)—from a population of 2.39 million in 1995 up to 10.75 in 2015 (Statista.com, n.d.). The city is neighboring Hong Kong and will grow up to be as competitive. To reach this goal Shenzhen has opened special economic zones in the 1980's with incentives for free market activities. According to a documentation about the city's rapid development, Shenzhen is called the "Silicon Valley of Hardware" (WIRED, 2016). The advantage of starting a tech startup business in Shenzhen is that it is quicker and cheaper to do research and to produce the products. Thus, the city is the perfect location to develop new products which could be underlined by the number of patents granted. However, patents are investigated as indicator of innovation which will be discussed in chapter H4 Creative city.

A true success story of becoming a knowledge hub is Singapore (Khveshchanka, Mainka, & Peters, 2011). The city's economic development has started as a port hub for the shipping industry. Simultaneously, the governmental plan has focused on the development of a knowledge society, today driven by ICT (IDA, n.d.-a). Since the people in Singapore have been less educated at their beginnings they were in need of the expertise of expats (SG 12). This is as well the case for Dubai which has become a world city based on their oil resources. Today, Dubai is focusing on importing knowledge and the knowledge economy to succeed in future (DU 3).

The degree of education is acknowledged as an indicator of the knowledge society (UNDP, 2014). Hence, just to count the amount of people e.g. with a Bachelor degree and to compare

them across cities and nations would not reflect the quality of the educational system. Globally the growth rates of higher education enrollments are continually increasing (British Council, 2012). Thus for example, in São Paulo the amount of people with an academic degree has grown as well. This development is the result of a special student credit that has made universities more accessible for lower income groups (SP 1). Nevertheless, the education quality is very poor, especially in many private universities (SP 1). Instead, public universities and expensive private universities are acknowledged as being of a better quality.

The main problem in São Paulo is that the best universities are the public universities (SP 1). To apply for the public university, students have to pass an entry examination which contains questions about general knowledge. But most public schools do not prepare the students adequately to succeed this examination and thus students of wealthy families that are able to pay for private education are privileged. Therefore, a few years ago the entry examination was adjusted to offer students from the public school and ethnic minorities special conditions to pass the test. In addition, many offers exist to acquire special qualifications after school instead of visiting a university. Thus, a lot of people educate "after work" to reach a qualification (SP 1). There is no program like a dual curriculum like in Germany, where the students get trained in practice at the firm and in theory at the university.

Rankings of higher education institutes

Income inequality leads to unequal access to higher education (Bond Hill, 2015). Therefore, cities in which the living costs are too high will exclude students and creatives (BO 3, MU 1). Accordingly, the Quacquarelli Symonds (n.d.-b) ranking of the "QS Best Student City 2016" acknowledges further criteria in their ranking like the "Global Livability Ranking." the "Mercer Cost of Living rank" or the "Cost of a Big Mac." In this ranking, Paris is the leading student city mainly caused by the high amount of universities (18 universities that are ranked in the QS top university ranking). *"… [W]hile Paris does have a reputation for being an expensive place to live, relatively low tuition fees mean that for students, it actually represents a more affordable destination when compared to many other popular student cities—though of course enjoying all the delights of life in this iconic European capital is certainly likely to demand quite a substantial student budget"* (Quacquarelli Symonds, n.d.-a). Nevertheless, an informational world city should be a place that attracts talents. This as well includes students that will become knowledge worker in future. But to be an attractive student city, measured by the position in the "QS Best Student Cites" ranking, shows a negative correlation with the number of students as a percentage of the city's population

either with the number of international students as a percentage of all students (Table 6-2). For example, in Paris, only 18% of the total students are from abroad. Within the QS ranking, London has the highest amount of international students (42%). Language barriers may cause the rather small percentage in Paris in contrast to London. Interestingly, Dubai, not measured by QS, shows a high amount of international students (62%) which are coming e.g. from India (30%), Egypt (8%), Nigeria (6%), or Pakistan (6%). Hence, Dubai is not (or not yet) attractive for students from western countries since only in a few cases institutions of higher education meet the standards of western educational systems (Kosior, Barth, Gremm, Mainka, & Stock, 2015; Schröder, Kuta, & Haidar, 2010).

To visualize the distribution of students as percentage of the population and the percentage of students from abroad all cities that are investigated in the work at hand are listed in descending order from left to right according to their position in the QS ranking in Figure 6-13 (Dubai, Shenzhen, and Frankfurt are added manually as they are not a part of the QS ranking).

In addition to the affordability of a student city, the quality of the university is important. Diverse rankings exist that compare universities on a global scale (Academic Ranking of World Universities, n.d.) (*Abbreviations introduced here will be used in the following)*:

- Academic Ranking of World Universities (Shanghai Ranking Consultancy) – *SRC*
- Center for World University Rankings - *CWUR*
- THE World University Rankings (Times Higher Education) - *THE*
- QS World University Rankings (Quacquarelli Symonds) - *QS*
- Performance Ranking of Scientific Papers for World Universities (Higher Education Evaluation and Accreditation Council of Taiwan)
- Ranking Web of World Universities (Cybermetrics Lab (CCHS), a unit of the Spanish National Research Council (CSIC))
- CHE-Excellence Ranking (Center for Higher Education)
- UTD Top 100 Business School Research Rankings (The UT Dallas' School of Management)

Table 6-2: Pearson correlation of the cities ranking position within the QS Best Student City and the number of students as % of total population and with the number of international students as % of total students. Source: Dubai Statistics Center (2015), Goethe Universität Frankfurt am Main (n.d.), Quacquarelli Symonds (n.d.-a).

PEARSON CORRELATION	QS Best Student City rank
number of students as % of the total population	-0.40
number of international students as % of total students	-0.61
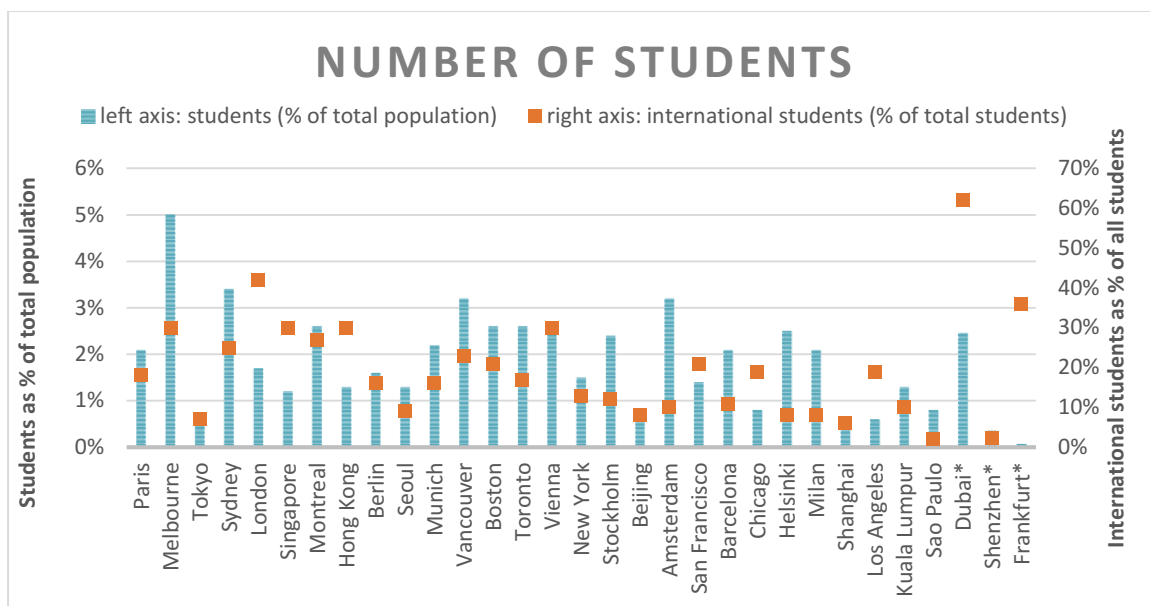
*Figure 6-13: Number of students as a percentage of total population per city (left axis) and number of international students as a percentage of total students (right axis). Cities are ordered in descending order according to their rank as "QS Best Student City." *Not available in "QS Best Student City. Data source: Dubai Statistics Center (2015), Goethe Universität Frankfurt am Main (n.d.), Quacquarelli Symonds (n.d.-a).*

Indicators of those rankings are for example the number of publications, citations, patents and additionally award measures as for example the number of alumni and staff winning Nobel Prizes as an indicator of the quality of education. The ranking position bases on a score which is calculated for each ranking according to the underlying indicators. For instance, comparing the scores of the CWUR, SRC, THE, and QS rankings the overall university scores show a positive Pearson correlation (Table 6-3). The QS shows the lowest correlation with other rankings. In general, universities that reach a high score within one ranking will as well reach high scores in the other rankings. According to the visualization of the ranking's correlation this becomes evident (Figure 6-14). Interestingly, there are rather few universities that are able to reach very high scores (higher than 60). In addition, a high number of institutions only reach scores between 40 and 60 in total. Accordingly, those could be interpreted as the standard and universities with scores above 60 as elite.

Table 6-3: Pearson correlation of university scores in the rankings CWUR, SRC, THE, and QS for the fiscal year 2015 for 90 universities. Data source: CWUR, SRC, THE downloaded from (O'Neill, 2016), and QS from (Quacquarelli Symonds, n.d.-b).

PEARSON CORRELATION	SRC	THE	QS
CWUR	0.93	0.93	0.68
SRC		0.83	0.67
THE			0.83
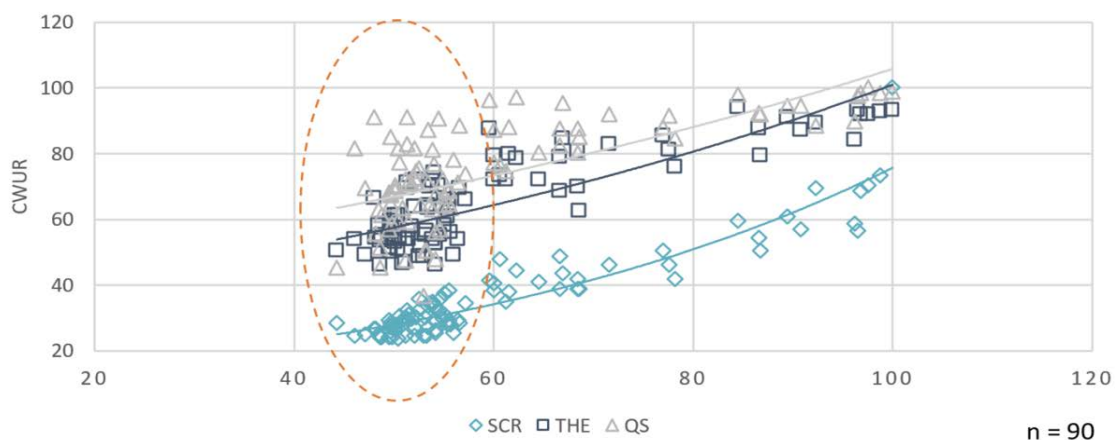
Figure 6-14: Correlation of university scores in the rankings CWUR, SRC, THE, and QS for the fiscal year 2015 for 90 universities. Data source: CWUR, SRC, THE downloaded from O'Neill (2016)*, and QS from Quacquarelli Symonds* (n.d.-b)*.*

Nevertheless, the reached scores in any ranking seldom serve as a figurehead for a cities or universities self-marketing. The ranking position is a more powerful argument, for instance, "we are the best university in the world" sounds better than "we reached 100 points in the university ranking." According to the example of the cities that are investigated in the work at hand, in the following the cities' performance in higher education will be investigated based on the best QS ranked university for each of the QS Best Student Cities (only 29 out the 31 cities are available for the year 2015). Figure 6-15 visualizes the ranking position (CWUR, SRC, and QS) for the investigated universities. The bubble size (ranking position in QS) and position (x = SRC position, y = CWUR position) reflects that the cities rank cannot be revealed by one ranking only. The different methodologies of the rankings result in slight variances of a universities position in a global comparison. This is becoming clear if we just take a look at the ranking positions of the University College London (Table 6-4).

Table 6-4: Position of University College London in three global university rankings for the fiscal year 2015.

Institution	SRC	CWUR	QS
University College London	18	27	7

In the QS top university ranking the University College London is placed under the top ten universities but in the others not at all. Thus, looking at the average performance Boston and San Francisco are both at the first, Chicago at the second, and New York at the third place (out of 29 cities). It is striking that the first positions are dominated by US cities. The first European city is following at the fourth position—London. Taking into account that this calculation reflects only one institution per city, this ranking is not eligible to reflect the landscape of higher education in informational world cities. Accordingly, all institution should be considered in the comparison on

the city level. Furthermore, it is important to choose criteria that reflect the quality of education and of the university in total. This is for instance attempt within the methodology of CWUR in which the number of awards and Nobel prizes as an indicator is used. Finally, *"… achieving a higher ranking does not necessarily correlate with providing better education and research opportunities"* (Holmes, 2016)*.*
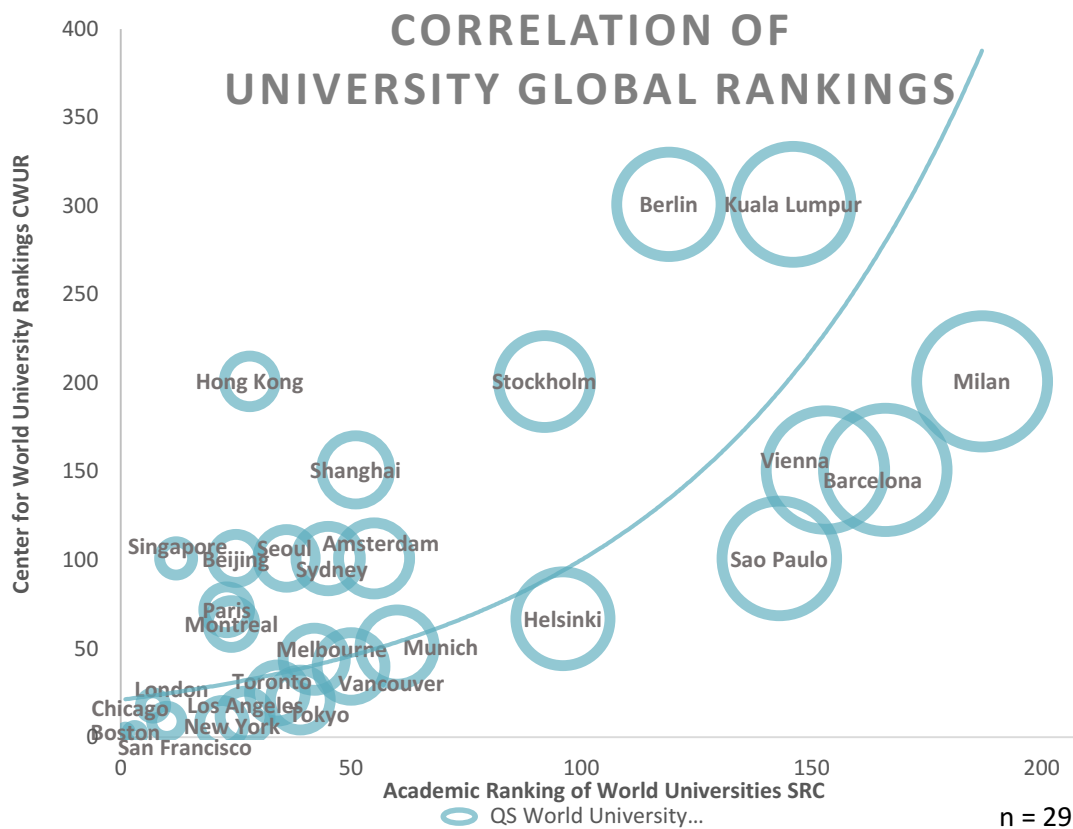
Figure 6-15: Correlation of the ranking positions within the three rankings: CWUR (x-axis), SRC (y-axis), and QS (bubble size). Universities = 29. Appendix IV "Best ranked university in city" lists all investigated universities.

Impact of universities

Ranking positions and the numbers of national and international students are not equated with attracting the talents to stay: *"Harvard and MIT physically draw people from all over the world... The trick is to hold on to them here—to hold some percentage of them here to staying here to create industries for the future. Boston has all these things but for various reasons we don't hold on to people very well-the cost of living, the cost of office space. The whole US have a serious immigration problem of knowledge workers. Students from all over the world come to the US. The colleges and the state invest a lot into those people but when they are finished with their study and they want to have a job they are not welcome"* (BO 3). According to the expert, Boston does attract students but is not able to hold the people to settle down. This is possibly true for the Boston Area but following the investigation by Roberts and Eesley (2009, p. 3) *"[m]ore than 38*

percent of the software, biotech and electronics companies founded by MIT graduates are located in Massachusetts, while less than 10 percent of arriving MIT freshmen are from the state. More than half of the companies started by MIT's foreign-student alumni are located in the U.S., creating their primary employment and economic impacts here." Finally, the region is acknowledged as a global hub for R&D and tech startups which is linked first to the personal network concentrated in Cambridge and second to the strong financial community with the ability to raise adventure capital (Von Zedtwitz & Heimann, 2006).

This success is as well acknowledged for other regions. The world's most known is Silicon Valley which attracts talents from all over the world. Their cluster is not concentrated like the example of Cambridge in Boston but in the whole San Francisco Bay Area. Historically this knowledge hub has evolved around the Stanford University which developed the "Stanford Industrial Park" (n.d.). Other regions adapt the idea and demonstrate their intentions by establishing clusters which are called "Silicon Anything," e.g. Silicon Alley in New York or Silicon Roundabout in London (Pancholi, Yigitcanlar, & Guaralda, 2015). If those initiatives will be equally successful remains to be seen.

Minguillo, Tijssen, and Thelwall (2015), have investigated publication activities of science and business parks in the UK for the time span from 1975 till 2010. According to their findings, science parks and research parks have a higher impact in fostering cooperation and in scientific production than science and innovation centers, technology parks, incubators and other parks. *"Finally, regarding the industry-academia interaction, the public research base developed in the country represents a more relevant source of knowledge and technology than those located abroad and in particular within the same region due to the fact that on-park firms tend to collaborate with partners beyond their local region. The reason for this could be the lack of relevant and top quality universities nearby (Laursen et al. 2011). … Furthermore, only the regions with great agglomerations have access to many international links"* (Minguillo et al., 2015, p. 721). Accordingly, science clusters are in need of collaboration with universities. Following an expert from Vancouver this is the success story behind their cluster formation: *"Here at the Center for Digital Media, we do a lot of collaborations and it's kind of unique in that sense, it's owned by four universities and … our curriculum is a two-thirds collaboration with industries… I think there's a fair bit of that going on here in Vancouver, that universities are all quite engaged with working with their communities. I guess another example would be all of the work that's done at UBC and connecting to medical research companies or BCIT working with aerospace industry and another sort of electronics kind of companies, and my university, Simon Fraser, working closely with, well,*

just one example but Boeing and other aerospace companies on user interfaces and visualization…" (VA 4).

According to urban planning activities in the diverse cities, many new projects are under construction which focuses on the cooperation of university, R&D, and the free market. Examples that are under construction are:

- *WESTERN Sydney's Innovation Corridor which will establish new "smart" jobs and homes (Paterson, 2015).*

- *In the neighborhood of Stockholm "Kista Science City" which is already the largest ICT cluster in Europe. The hub is still in its development to become a real city (ST 4).*

- *The new suburb of Vienna—"Aspern" a former airport will become a place for a new science park in Vienna (a library is planned as well) (VI 1).*

- *Paris has now introduced a new mega university "Paris-Saclay" with the ambitious to become as excellent as Harvard, MIT, Oxford and Cambridge (Thoening, 2015). It is called the French Silicon-Valley and will bring together 19 institutions of higher education and a business cluster at the outskirts of Paris.*

Conclusion science parks and university clusters

According to one expert from Vancouver (VA 1), scientific activities and universities are *"the heart of an informational city."* Nevertheless, the question about the importance of science parks and university cluster has led the interviewees to discuss the importance of universities, education and the quality thereof. Hence, the universities are the important infrastructure to educate the future scientists and engineers. Comparing the universities' performance according to already established global rankings (e.g. CWUR, SRC, THE, and QS), only a few universities reach very high scores and the majority remain as middle class (Figure 6-15). Due to the different methodologies used in those rankings, the absolute position can differ gravely. This is revealed, for example, by the ranking positions of the University College London which is ranked 7th in the QS and 27th in the CWUR global index. To determine the city's environment as student friendly, additional factors like the livability and cost of living are acknowledge as further indicators. The winning cities are not to be equated with the global university rankings. Hence, the best student city in 2015 is Paris but the best universities according to QS are both located in Boston.

Accordingly, it is acknowledged by the interviewees and by the literature that a friendly environment for R&D and entrepreneurship are of advantage. Thus, the goal of a student city should be to convince the students to stay in the region after they graduate. If we look at the

examples of Cambridge in the Boston Area and of Silicon Valley in the San Francisco Bay Area the agglomeration of universities and knowledge intensive companies in clusters and science parks demonstrates the success of physical concentration. Other cities all around the world adapt this idea and start to build own hubs of knowledge institutions. Having in mind that within the region of Boston and San Francisco the world best universities are located—Harvard, MIT, and Stanford University are ranked at the first three positions in the SRC, CWUR and in QS—it will be interesting to see whether the knowledge cluster in other cities will reach the same success on a global scale as these both cities do.

Finally, the cooperation between the free market and universities is acknowledged as a driver of the future economy which is best shown by the countless examples of science city, silicon anything and innovation incubator developments. Most of them do not build isolated science silos. Space for living and meeting is integrated into the planning to encourage the effects of networking and clusters as they are found in Boston Cambridge. Thus, the importance of physical space for face-to-face interaction will be further discussed according to the fourth hypothesis in this chapter.

H4 Creative city indicators

As already discussed in chapter 3.1.2 Cognitive infrastructure, a clear separation of the knowledge city definition and creative city definition do not exist. Hence, the creative class, as it is defined by Florida (2003), is represented through the workforce of the knowledge-intensive economy and the creative economy. He includes for instance occupations like scientists and engineers, university professors, non-fiction writers, editors, think-tank researchers, and analysts additionally to the traditional ones like artists, writers, and performers. In all knowledge-intensive occupations creativity grows in importance. Nevertheless, in city's economic development plans the importance of the "creative industries" like design, media, culture, and arts grow as well. The economy and environment of a creative city should attract talents, in addition. As an underlying indicator, the tolerance of the society is acknowledged as important in European cities (Hansen, Asheim, & Vang, 2009). Furthermore, in US-American cities technology completes the conglomeration of Floridas 3T's hypothesis that a creative city is determined by technology, talent, and tolerance (Florida, 2003). Thus, an open community of collaboration and learning that network in so-called "labs" extend the presence of "creative milieus" to so-called "milieus of innovation." Hence, face-to-face interaction is a crucial factor of innovation. According to Florida's hypothesis of the creative class, the interview partners have been asked if an informational world

city needs to be a creative city. To identify the importance of creativity within an informational world city the following hypothesis will be investigated:

H4 An informational world city needs to be a creative city.
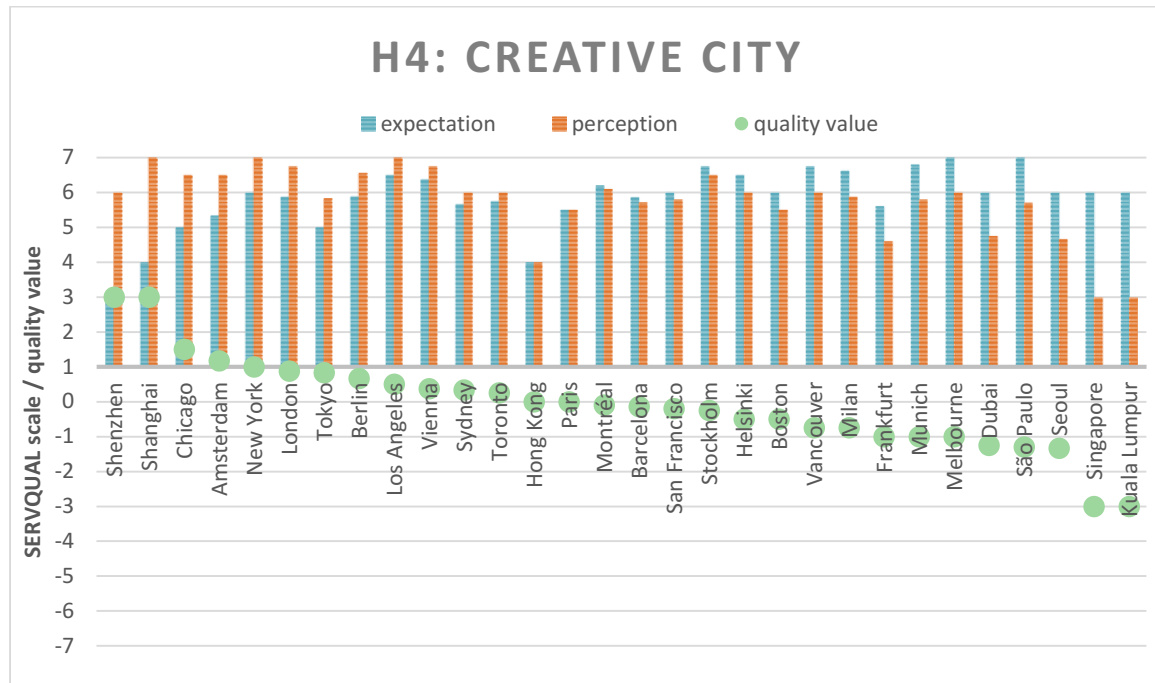
Figure 6-16: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the fourth hypothesis: "H4 An informational world city needs to be a creative city."

Summing up the SERVQUAL evaluation in average, the interviewed experts have a high expectation of the importance of being a creative city (Figure 6-16). During the interviews 39 experts mentioned explicitly that it is important, 10 that it is at least of advantage and only 3 that it is not important to be a creative city. Interestingly, the interviewed experts in Shenzhen mentioned that they have a high experience of the city as being creative but nevertheless they do not see the necessity of an informational world city to be a creative city. This twist of understanding can be reasoned by the "traditional" way how a creative city is acknowledged. Thus, for example, most people would say that Paris is a creative city because of all the cafés where the artists and writer have met and the bunch of museums, galleries, and performing arts in the city. But in the 21st century creativity is not only writing, painting, and performing it is as well about innovation and technology-based development. Hence, *"Shenzhen is a field of experimentation that goes hand in hand with creativity and innovation. It is a testing ground for new ideas, computer programmers, and architecture"* (SHE 1).

Following Landry (2011b) it is not the same to be creative and to be innovative. Thus, just counting the number of patents does not reflect the creativity of a region but its innovation output. Whereas, downstream innovations and imaginative behavior are creative for him.

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Accordingly, there are already diverse indices and frameworks how to measure the creative city. A research group of the ARC Centre of Excellence for Creative Industries and Innovation (CCI) has investigated and compared the recently published indices to develop a composite index, namely the CCI Creative City Index, which captures the core definitions of a creative city (Hartley, Potts, & MacDonald, 2012). Accordingly, the indicators are grouped as follows:

1. Culture, Recreation & Tourism
2. Creative Output & Employment
3. Cultural Capital & Participation
4. Venues, Resources & Facilities
5. Livability & Amenities
6. Transportation & Accessibility
7. Globalization, Networks & Exchange
8. Openness, Tolerance & Diversity
9. Human Capital, Talent & Education
10. Social Capital, Engagement & Support
11. Government & Regulations
12. Business Activity & Economy
13. Entrepreneurship
14. Innovation & R&D
15. Technology & ICT
16. Environment & Ecology

The indicators above show that there is a mixture of world city indicators, e.g. "7. Globalization, Networks & Exchange," as well as political willingness, e.g. "11. Government & Regulations," which are often used in combination with other creative city aspects. Both will be discussed in further chapters in the work at hand. Thus in the following, I will concentrate on indicators of creativity according to its definition as "creative economy" and the "creative people." In addition, the importance of space for face-to-face interaction will be discussed separately according to the fifth hypothesis in the next subchapter.

Creative economy

According to the question of being a creative city some interviewees started to count the "creative sectors" that are of relevance for the city. Many have mentioned traditional sectors like art (13 experts), culture and design (each by nine experts), museums (eight experts), fashion (seven experts), the film industry and music (each by six experts), and finally galleries, architecture, and tourism (each by five experts). Further have been mentioned rarely: media, printing, writing, performing art, ballet, orchestra, opera and theater. With reference to Florida's 3T's, technology has been mentioned by 14 interviewees, advertising and gaming industry by five, animation by three, and conferences and boot camps by two experts. Additionally, green city initiatives and research have been mentioned as creative, too. To bring together creatives with citizens, festivals have been indicated as important for a creative city (four times). Whether the festivals are for instance related to performing arts like the International Circus Festival or related

to engineers and programmers like the Ubisoft Street Festival is obsolete (see chapter 5.2.7 Creative milieu).

Both, the traditional understanding as well as technology and talents, are part of the creative city. In addition, the growing importance of innovation has been described as the natural result of the financial crisis in 2008/2009. Innovation and startups are rising due to the proximity of many production industries in the investigated cities. Hence, *"[h]unger makes the people creative. We are on the entrepreneurship way because there are no other jobs"* (BA 3). Equally, statements have been given by two other interviewees. Another expert mentioned: *"I think that in future the question will be: What can I do and create with the information at hand? This is in need of creativity. And if you understand the creative city as the sum of all art, graphic design, music, and culture, then it is of course of an advantage because it creates a more beautiful habitat. It creates attention for further projects and impacts the society"* (BE 6, own translation).

Finally, the term creativity has been widened from culture and arts towards technology and innovation. This can be as well observed by the categorization of the creative sector by the Creative Cities Index CCI (Hartley et al., 2012):

1. Music and performing arts
2. Film, TV, and radio
3. Advertising and marketing
4. Software and interactive content
5. Publishing
6. Architecture, design and visual arts.

According to the investigation of the CCI, London has the biggest creative economy, calculated by the total revenues and number of jobs, compared to Brisbane, Melbourne, Bremen, Berlin, and Cardiff. The investigation of revenues and amount of employment is a traditional measuring method of an economic sector (Hall, 2000). In the overall index of CCI London is the most creative city, followed by Berlin and Melbourne. Further indices on a global scale have been developed by Florida, Mellander, and King (2015). These findings are on a national level at which Australia, the United States, and New Zeeland are the top three nations.

Places for music and performing arts as well as for visual arts are acknowledged as having a positive effect of attracting the creative class. According to one expert, New York is a creative city because it has galleries and is a hub for design and advertising. This is what is missing in Silicon Valley (NY 1). In contrast, a creative city like Paris has to struggle with their galleries, as the artists are moving to other places (PA 2). To get an idea of the offer of cultural amenities the World Cities Cultural Report 2015 (BOP Consulting, 2015) has investigated 21 out of the 31 cities of the work at hand. Figure 6-17 shows the number and share of cultural and creative facilities in these cities.

Paris is, as assumed, the city with the highest number of galleries. Even the interviewees stressed that the future of Paris as continuing global creative hub is uncertain. Nevertheless, the city offers as well more theaters and museums than any other. The second most facilities are found in London and the third highest number is found in New York. Interestingly the report has not identified galleries or theaters in Shenzhen. However, one famous gallery in Shenzhen is the OCT ART & Design Gallery which has been opened in 2008 in a renovated warehouse. Summing up, the number of cultural amenities varies gravely between the cities. Furthermore, to identify the correct numbers is not easy because there is a high fluctuation of opening and closing galleries (PA 2).

Calculating the number of cultural amenities as a percentage of the total population Paris is not the top of the list (Figure 6-18). Interestingly, San Francisco with its 323 cultural amenities and a population of roundabout 800,000 has the highest number per capita. These numbers are only revealed for the city and not for the region which has been criticized for their rare offer of cultural attractions (NY 1). In contrast, the number per capita for Paris is based on the metropolitan region (population = 12,005,077 and sum of cultural amenities= 1,821). However, the number of citizens does not correlate with the amount of offered cultural facilities. Further, the number of tourists is used as an indicator by the World Cities Culture Report 2015 (BOP Consulting, 2015), since cultural activities are a main attraction. Nevertheless, comparing the data of this report no correlation between the number of international tourists with the number of cultural amenities or with the number of average art gallery visits could be found. Neither, a relation of the GDP and the number of international tourists. Finally, cultural amenities are not useful as a basis for the calculation to identify the most attractive city. At least the data provided by BOB Consulting do not allow reliable conclusions.
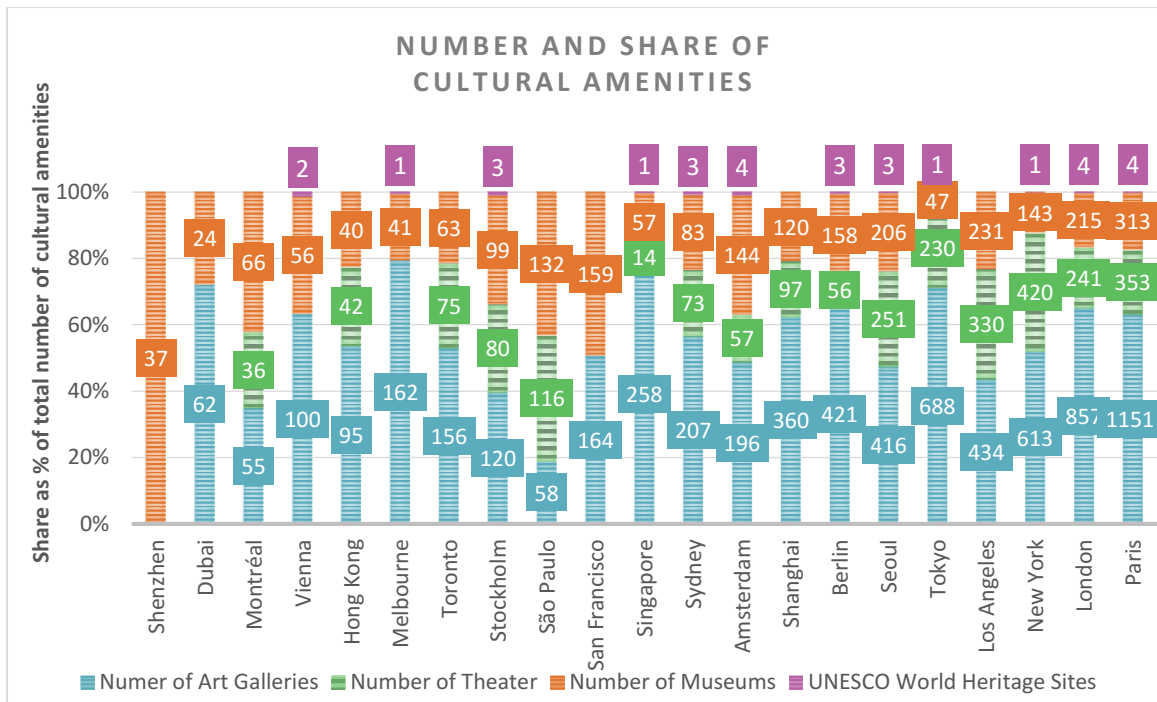
Figure 6-17: Cultural amenities of informational world cities in numbers and shares. Cities ordered from left to right in ascending order according to the total sum of cultural amenities. Data source: BOP Consulting (2015).
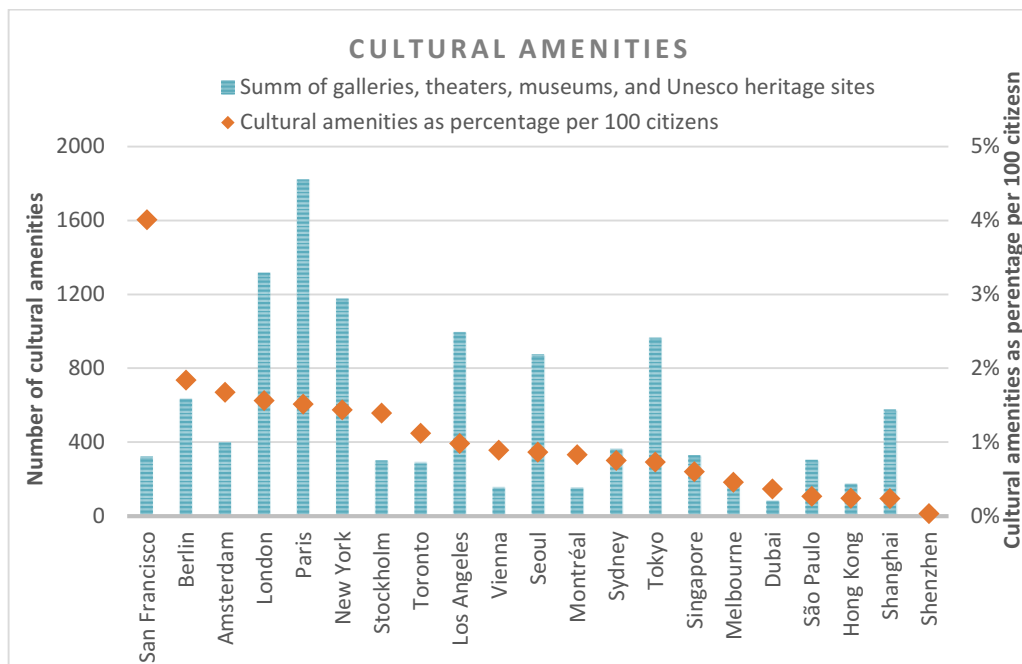
Figure 6-18: Cultural amenities as a percentage per 100 citizens (right axis) and the total sum of cultural amenities for each city (left axis). Data source: BOP Consulting (2015).

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A further index is provided by to the MasterCard Global Destination Cities Index. Accordingly, the most visited cities in the world are London, Bangkok, and Paris (Hedrick-Wong & Choong, 2014). Hence, London and Paris offer the most popular museums which are the Louvre in Paris and the British Museum in London. Furthermore, it is not proved how the creative class, which as well includes the knowledge workforce, interacts with cultural institutions or even if they use or visit them at all (Comunian, 2011). Cultural sectors like art and performing art are state-protected and supported. Therefore they are not as market-driven as others and are mostly stable during economic downswings but benefit from upswing phases (Dapp & Ehmer, 2011). Thus cultural amenities are acknowledged as part of the creative infrastructure and are often included in city development plans (Comunian, 2011). Opera houses, theaters, and galleries serve as iconic symbols of the city and in addition, constitute a cosmopolitan lifestyle feeling for the creative class. Examples are for instance the Walt Disney Concert Hall in Los Angeles, the Shanghai Grand Theater, the Sydney Opera House, or the Louvre in Paris (Figure 6-19).
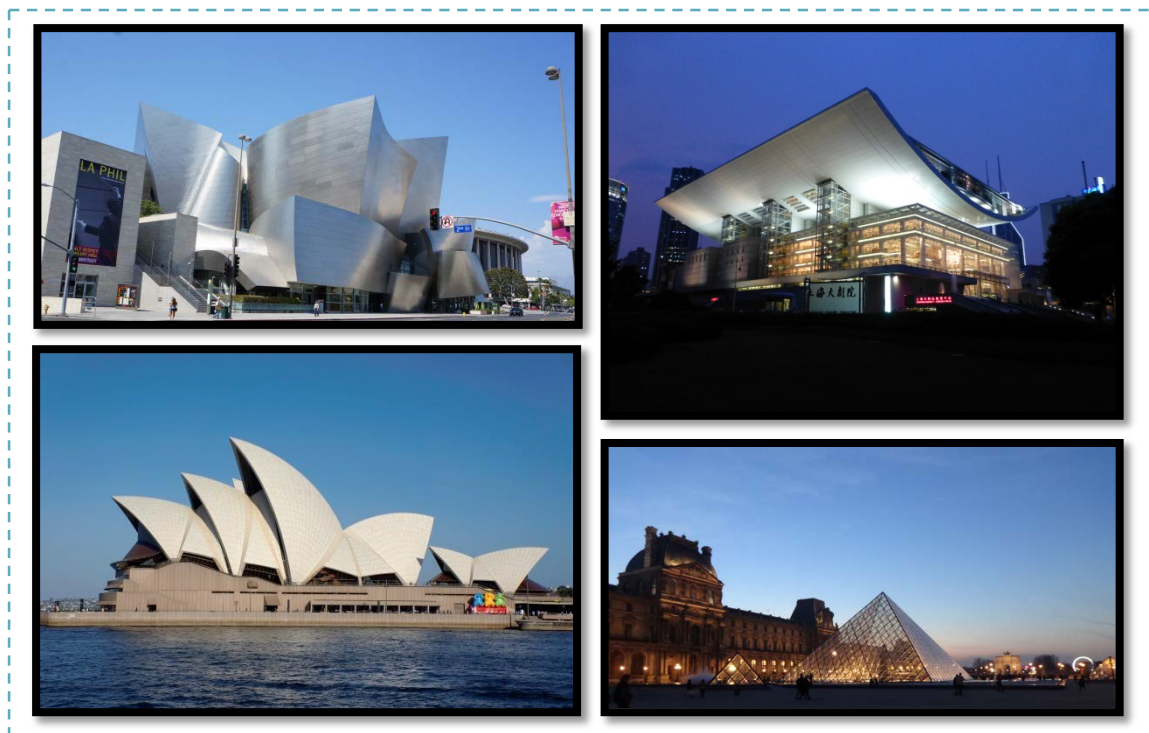
Figure 6-19: Top-left: Walt Disney Concert Hall in Los Angeles. Bottom-left: Sydney Opera House. Top-right: Shanghai Grand Theater. Bottom-right: Louvre in Paris. Photos by: Carsten Brinker (top and bottom-left), Wolfgang G. Stock (top-right), Agnes Mainka (bottom-right).

Furthermore, the creative industry impacts the digital economy (EY, 2015a). Hence, digital and physical goods sold on the internet, e.g. books, music, games, and videos, as well as online advertising are part of the creative sector. Today, the majority of creative and cultural content is still consumed offline. Nevertheless, an investigation by EY (2015a) has revealed an overall growth in the EU for online sales of Amazon (+44%), subscribers of Netflix (+61%), and the amount of

collected money by entrepreneurs on Kickstarter (+81%) in the time span from 2011 to 2014. Furthermore, the advanced technology and increasing broadband connections have widened the spectrum of devices from PC and consoles to smartphones, tablets and smart TV's for gaming (Newzoo, 2016) and as well for further consumption.

Combining the creative class and the digital economy entrepreneurship and as well tech startups are part of the creative economy. The discussion about entrepreneurship in informational cities as part of the ICT sector can be found in chapter H1 Hub of companies with information market activities. As already described, being a city with a high amount of creatives and entrepreneurs does not correlate with the GDP growth (Murugadas et al., 2015). One interviewee has tried to figure out this relationship as follows:

"[In Vancouver there is a] constant build up and collapse of companies in this region. [F]or example, Pixar set up a studio here and three years later closed it… You can tick off thousands of companies that go through this cycle in this location. The only explanation that I can offer for Vancouver, this comes out of another cluster that we studied, that we did on biotechnology where exactly the same thing happens. [T]he University of British Columbia is very good at doing basic research. So, entrepreneurs start by taking a piece of basic research and developing it… Now, that applies more to locally grown companies that the entrepreneur built the company up to a point where it can then be sold to a much larger, usually, multi-national [company]. It still doesn't explain Pixar… and so on… There is a marginal explanation of what they are really doing is there are lots of independent, particularly, digital animation has us around here. And in effect, Pixar comes along, buys one, puts a nameplate on the door… Particular, as they start trying to apply large corporate management systems on them, everybody has walked out the door. But… there are some parts… that you still don't really understand" (VA 1).

The case of Vancouver shows an interesting phenomenon of entrepreneurs. Hence, being entrepreneurial friendly is not to be equated with being market friendly for big firms. Finally, innovation and startups are driven by the creative class. To figure out the innovation potential of a city the number of granted patents within a selected time period is used as calculation base (Florida et al., 2015). Looking at the 31 cities investigated in the work at hand the numbers vary gravely (see Appendix V Patents granted 2000-2012). The database used for this investigation is the Derwent World Patent Index (the method of patent investigation is described in chapter 4.6 4.6 Retrieval of patents and scientific publications).

Accordingly, Seoul is the city with the highest amount of patents in total numbers but in relation to the number of citizens, the most innovative city is, as assumed, San Francisco (Figure

6-20). Per annum, the most patents have been granted in 2006. Afterwards, a downswing can be recognized in the number of patents for the majority of the cities except for San Francisco. Munich has the second most granted patents for the whole investigated time period but in 2010 Boston has passed Munich in the number of granted patents per 1,000 citizens. The underlying data is only evaluated on the city level and does not include the region or surrounding area like the San Francisco Bay Area. However, in a composite index that include amongst others indicators like R&D, education, and high-tech companies next to the number of patents South Korea is the most innovative nation on a global scale (Jamrisko & Lu, 2016). The US is following at the 6th rank.
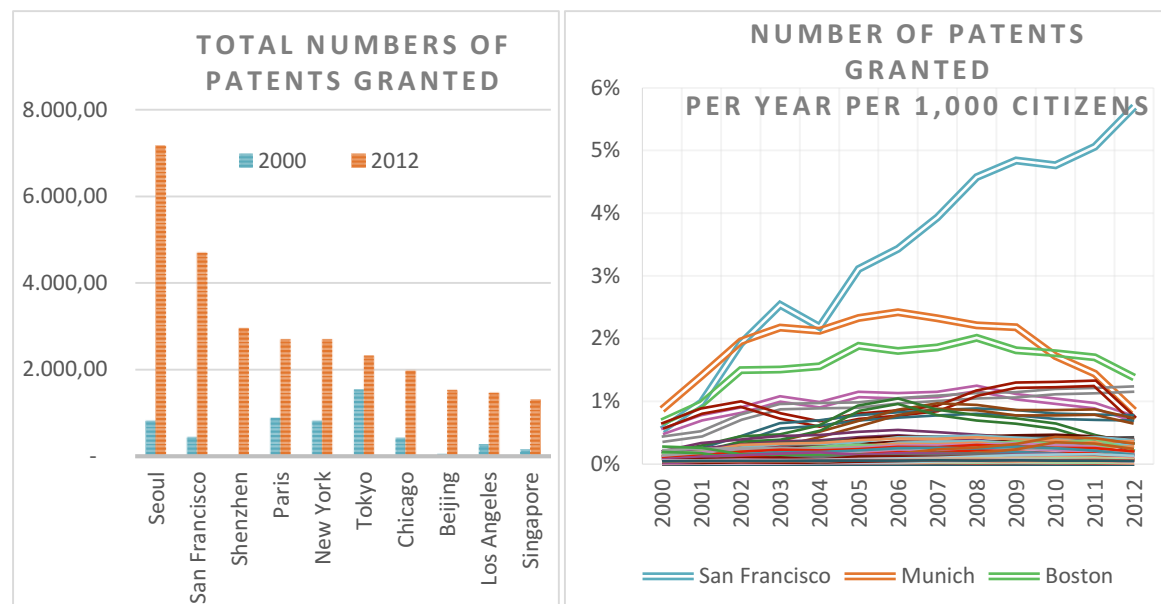
Figure 6-20: Left: Total numbers of granted patents in 2000 and 2012. Top ten informational world cities listed in descending order according to the number of patents granted in 2012 from left to right. Data source: Derwent World Patent Index (retrieved in 2013). Right: Number of patents granted as percentage per 1,000 citizens for 31 informational world cities. San Francisco, Munich and Boston are the top three of the list. Data source: Derwent World Patent Index (retrieved in 2013).

Creative people

In accordance to the 3T's (tolerance, talent, and technology) one interviewee asked: *"What is the creative city? People with their smartphones?"* (MO 2). He is not wrong since many of the smart and tech startups are building businesses by reusing data in a new way which eventually may result in smartphone applications. To do this, it is of advantage to be in a "milieu of innovation" with other creatives and like-minded people. Hence, openness and tolerance have been identified as indicators of the creative class with a positive impact on the economic growth (Florida & Gates, 2001). According to Florida (2003), tolerance, in addition, positively influences the flow of talents. Since talents are not a static number, they are variable and therefore should be attracted by a city. Tolerance as attractor has been revealed for US-American cities and as well

for European cities (Hansen et al., 2009). Looking at the most tolerant cities identified by Florida for the US, the majority are not acknowledged as a world city (see Table 6-5).

Indicators of a tolerant population are the openness to people independent of their gender, race, nationality, sexual orientation, or "geekiness" (Florida, 2012, p. ix). The Global Creativity Index uses the indicators of openness to ethnic and racial minorities and openness to gay and lesbian people (Florida et al., 2015). This indicator is available on national data and is based on a poll survey. The global index is constituted of the three T's and ranks Australia, United States and New Zeeland on the first three positions. A regional index of tolerance has been developed by The Daily Beast on the state level for the US (2011). In addition to the race and sexual orientation, further indices are determined, like the percentage of hate crimes, discrimination complaints, and laws that support and protect legal rights for religious minorities and same-sex couples. The "winners" of this investigation are Wisconsin, Maryland, and Illinois.

Table 6-5: Top ten metros of the Tolerance Index. Data source: Florida (2012).

Rank	Metro	Tolerance Index Score (0-1)
1.	San Diego-Carlsbad-San Marcos, CA	.751
2.	Napa, CA	.747
3.	Santa Rosa-Petaluma, CA	.739
4.	Santa Cruz-Watsonville, CA	.738
5.	Santa Fe, NM	.726
6.	Ithaca, NY	.723
7.	Oxnard-Thousand Oaks-Ventura, CA	.708
8.	Cape Coral-Fort Myers, FL	.702
9.	Boulder, CO	.701
10.	Ann Arbor, MI	.693

On the city level, just a view indices are developed and they are not on a global scale. One index that is similar to the used indicators by The Daily Beast is the LGBT-Friendly Cities comparison (LGBT = lesbian, gay, bisexual, transgender) (Miller, 2015). Accordingly, San Francisco is the most LGBT-Friendly city. Within the top 10, only Los Angeles has reached the 9th place out of the investigated cities in the work at hand. Being a gay-friendly city is as well revealed by offering gay neighborhoods and gay parades to celebrate this tolerance (see Figure 6-21). Nevertheless, those neighborhoods are not representing the whole gay community within metropolitan areas (Kelly, Carpiano, Easterbrook, & Parsons, 2014).
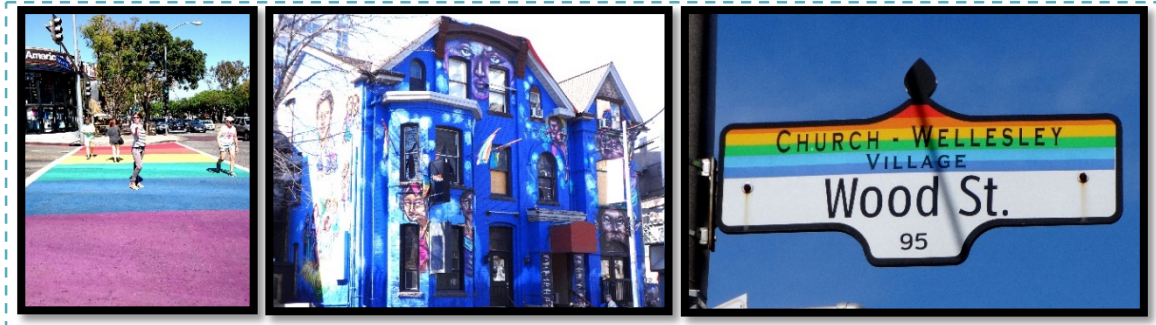
Figure 6-21: Gay neighborhoods. Left: Los Angeles - West Hollywood. Middle and Right: Toronto Church Street. Photos by: Agnes Mainka.

The tolerance indicators of a society are used to identify the openness. Hence, the more tolerant a society is the more talents feel welcome no matter of their religion, skin color, or sexual orientation. Finally, this results in an enhanced flow of talent. This openness is more related to western-oriented countries e.g. North America, Europe and Australia (Florida et al., 2015). Nations in Asia and Africa show a lesser tolerance with respect to religious and sexual orientation. However, talents in the US are more likely to flow between places and creatives in Europe are more likely to choose destinations near their family or friends (Murugadas et al., 2015). All in all, tolerance is one indicator to attract talents. Further indicators of an attractive city are amongst others the livability, cost of living, and creative networks (Wright, 2016). Hence, the creative class is not only referred to the software developer or researcher with an adequate income. Creatives are as well the painters and performers that are mostly not that wealthy. In a creative city ideally, both are present. Two interview partner from Paris and from Berlin stated that they do not believe that their city will keep the status of a creative city as it is known today:

- Berlin is acknowledged as "poor but sexy." The city had to struggle with the authority, especially in East Berlin. Many buildings, even whole street sections, remained empty and no one was aware of the owner. This has boosted the creative redesign of these places which led to a "creative milieu." But this explosion of open space has been unique in history and therefore it is not clear if Berlin will be able to keep the role as a creative city in future (BE 6).

- *"Paris is a paradox because it has a large amount of creativity. Of course, … there is a lot of artists, a lot of companies that do art or design in different stages, in these fields—architecture, fashion, cinema etc. So, in this aspect, it is a very creative city. It has the potential of a creative city—the human and the intellectual and the financial potential of a creative city. But then the paradox is that Paris is a very conservative city. The danger of Paris is that it becomes a museum and it is in some part becoming a museum—lots of museums, beautiful city, in fact, a small city in comparison … to New York, London, [or] Berlin. … [T]he people that live in Paris are pretty rich people, lots of foreigners, and lots of people coming… So, those*

people are very conservative, they want no change. They don't want to be like this and this is the paradox. They have a huge potential and sometimes a big amount of conservatism. That maybe explains the fact that Paris has lost somehow this leadership in creativity in the last 50 years" (PA 2).

Theses qualms mentioned by the interviewees should not mean that art and culture are becoming less important. Since *"quality of life is an important location factor and one aspect of quality of life is culture"* (MU 1, own translation). One main reason for the uncertain development is that citizens are confronted with changing circumstances. *"Before World War II, Paris was obviously the capital of art... Today it's not anymore. French artists are much underestimated in the market and the so-called good artists or well-known artists … go away. They go to London, … New York… [or] Berlin. Lots of my artist friends live in Berlin because it's more creative, … more innovative galleries, … there are more crazy exhibitions… [and] space for artists. You very much cannot find here, because [Paris] can't expand"* (PA 2). The rising density and the high cost of living have been mentioned by five interview partners as the bouncer of the creatives and young people, e.g. for London, Boston, and Munich. In other cities, like Vienna and Barcelona, the experts are optimistic and consider that the creativity in the city is growing. Furthermore, cultural behavior like the tacit to avoid risks is mentioned by on interviewee from São Paulo: *"the people are afraid of risks, e.g. afraid cycling to work or so and all kind of risks hinder Brazilians to be creative"* (PA 3)

Accordingly, to attract talents in spite of the high costs of living, jobs in the creative economy and educational institutions of art, performing, fashion or else are needed. To support innovative projects for instance the Munich municipality is awarding locals in diverse categories like art, design architecture or comics. Other interviewees mentioned that there need to be done more with regard to keeping the creatives and not only the technology talents. Today, we can see that in diverse parts technology and creativity is merged. For instance, the Google Cultural Institute in Paris or the increasing gaming and animation industry (Newzoo, 2016).

Consequently, the creative class is an umbrella term that is used for diverse groups of people with diverse needs and ambitions. Hence, on the one hand, the creative class are creative people working in the culture and art sector and on the other hand, creative people working in innovation industries like tech startups (Cohendet, Grandadam, & Simon, 2011). Both are creative in their own way but the big difference lies in their income. This finally results in different needs in their everyday life. Nevertheless, both groups are attracted by cities and especially a creative

or innovative milieu. The importance of networks and space within an informational world city will be discussed in the following subchapter.

Conclusion: Informational world cities need to be creative cities

According to the interviewed experts, the creative city is widely recognized as the sum of economic sectors that could be counted as creative. Hence, most experts started to list the institutions and organizations that are present in the respective city. Interestingly the ratio of named cultural and art related institutions are equally often mentioned as technology and innovation related developments. Finally, the investigation of cultural amenities as well as the analysis of granted patents has revealed the already known hubs of the creative economy. Paris is the iconic city for culture in total numbers and San Francisco is leading the list of the investigated cities based on the per capita calculation. Nevertheless, both have to struggle with critics, e.g. even San Francisco has many cultural amenities the whole Silicon Valley is not known to offer many of them (NY1) and Paris is acknowledged as too conservative and thus could become a museum in itself (PA2). According to the most innovative city calculated by the number of granted patents, Seoul is leading the list of the 31 cities. San Francisco is the hub of technology and innovation if the numbers are calculated as a percentage of the population. In this investigation, the city was used as a basis and not the whole San Francisco Bay Area. According to Landry (2011a) it is not necessary to top the list but it is of importance to find a niche in which the city is outperforming. Furthermore, it is still questionable in which relation the knowledge workforce and cultural amenities are (Comunian, 2011). Hence, many interview partners have argued that they would not have the time to visit cultural attractions. Additionally, no relationship between cultural amenities and tourism or the GDP could be revealed. Nevertheless, cultural amenities that are iconic symbols, like the Louvre in Paris or the Opera House in Sydney, transfer a metropolitan lifestyle. Thus, not the quantity of cultural amenities but the quality of them make the difference.

Furthermore, a creative city is attractive due to the creative people living there. This has been investigated by Florida (2014). Referring to his creativity index, creative places are determined by the three T's: technology, talent, and tolerance. In his definition, the openness towards minorities attracts further talents. Florida is using the gay index as the main resource to investigate the tolerance of a region. Additional indices have been developed that are measuring the tolerance of a specific region or city. Those are based on crime rates against immigrants and minorities or by the existence of laws to protect the rights of minorities or females. Nevertheless, in the majority of these investigations "world cities" are not at the top ranking positions. However,

mid-size cities are the leader of "attractive city" rankings for creatives hence they are less expensive, offer more space and are more secure. Especially space is seen as a booster of creativity as mentioned e.g. in the case of Berlin's rise of creativity which was driven by open space after the city's reunion. And the lack of space is acknowledged as the problem of Paris which has to struggle not to become a museum in itself.

H5 Physical Space for face-to-face interaction

In a creative city, not the whole city is recognized as creative. Most common are so-called "creative milieus" or creative quarters near the city center (Collis, Felton, & Graham, 2010). Talents, industries or galleries tend to cluster in a physical place that foster interaction and innovation. Conglomerations of like-minded people pop up in diverse city labs to co-create or to co-learn something (Carrillo, Yigitcanlar, García, & Lönnqvist, 2014). Those clustering effects are as well according to entrepreneurs and the startup scene. They are going to share coworking space or work in so-called incubators. Thus, they are in proximity with other people with diverse educational background and occupations which encourage a "milieu of innovation" (Camagni, 1995; Hitters & Richards, 2002). As creative cities tend to offer space for face-to-face interaction the following hypothesis will be investigated:

H5 Physical space for face-to-face interaction is important for an Informational world city.
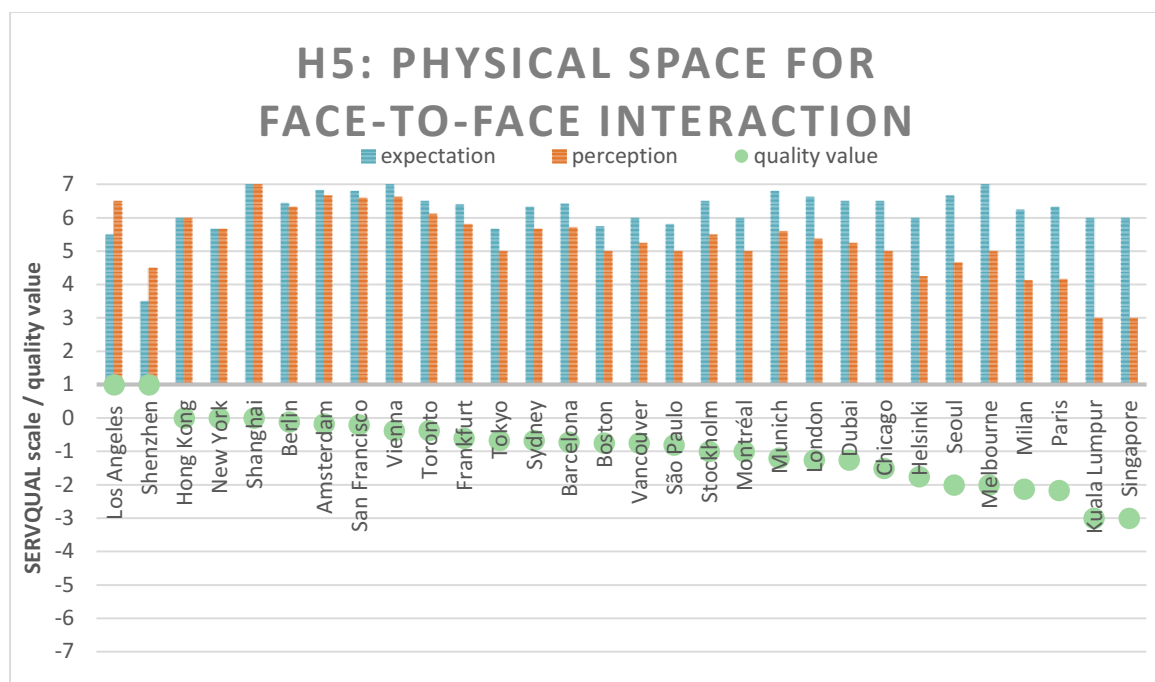
Figure 6-22: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the fifth hypothesis: "H5 Physical space for face-to-face interaction is important for an Informational world city."

According to this hypothesis, 53 of the interviewed experts mentioned explicitly that it is very important to have physical space for face-to-face interaction. The SERVQUAL evaluation reveals this statement (Figure 6-22). The average expectation for all cities has a score of +6.2. Additionally, it displays that in most cities the availability of those spaces is lacking. Hence the average quality value is negative (-0.9). In fact, people are going to sit more and more in front of their monitors and do need those places (FR 1). *"Knowledge does not emerge from reading only. Knowledge does not emerge from intelligence. Knowledge appears especially through the exchange, through inspiration, through reflection and for this you need fellow human beings. For sure there are people that are able to do all that by themselves, but the most people need external inspiration to reflect certain circumstances in a new way. And for them, this interaction is very important. It is necessary to step out of the box"* (MU 1, own translation). Hence, *"[t]o do a project only online is hard. To meet face-to-face and to discuss things is very important"* (AM 6). Only two experts mentioned that they do not see the necessity of those places. Others have mentioned some concerns about the importance. For instance, one expert from Hong Kong (HK 2) has stated that *"[t]here is no real reason for the Silicon Valley clustering. Technically, if we are all connected and it's all about the flow of information you can live everywhere… but people will cluster anyway."* In addition, physical places for face-to-face communication should not be established only for creatives and knowledge workers. Those people should meet with other people with diverse backgrounds (BE 6). Interestingly, most of the interviewees have associated those places with knowledge workers and entrepreneurs only. Thus, they have discussed the availability of coworking spaces or other places of knowledge sharing like universities rather than creative clusters or creative milieus in their city. The discussions have most been dedicated to the culture of communication and the availability and importance of an architecture that should enhance the interaction between creatives and knowledge workers. Both aspects will be investigated in the following.

Architecture of face-to-face interaction

Interviewed experts from London, Milan, and Paris mentioned that there is a lack of places for face-to-face communication in the city. For 13 experts cafés, restaurants, and bars are those places. In addition, several interviewees mentioned as well informal spaces like museums, galleries, and parks. In London, for instance, people working in the finance sector meet at weekends in pubs to relax and for conversations at Canary Wharf (LO 3). In Munich, beer gardens are famous places to meet each other. Those places should as well offer a Wi-Fi internet

connection (MU 1). Thus, the architecture of the city is important to offer space for an informal meeting at diverse places with heterogeneous people (Rantisi & Leslie, 2010). One expert from Boston (BO 3) explains the impact of a city's architecture as follows: *"It's the way like their office buildings are structured, the way how street culture works, coffee culture and that sort of thing. If you go to California it feels completely different. Harvard Square is a kind of European feeling. It's lots of small shops and cafés, restaurants that have seats along the sidewalk, book stores etc. Candle Square is where Microsoft Research, Google Research, and the Computer Science Complex at MIT is—very cold! You walk blocks, nothing but glass windows from the front of offices buildings facing you [(*Figure 6-23*)]. No place to sit. And then they try to plant a café every now and then but it just doesn't feel the same way at all. We have some disadvantages for knowledge workers where they can meet face-to-face by our architecture and weather."*

Figure 6-23: Boston - Cambridge office buildings with glass front. Photos by: Carsten Brinker.

Thus, if your city is not located in a warm climate zone then the most common opportunity is to meet at any commercialized place. For one interviewee from Frankfurt, this has become a common standard but there are as well other possibilities: *"So I would say there is a lack of free indoor meeting spaces where you can bring your own thermos of coffee or whatever. I think that most people just expect these days, when they have a meeting that they have to buy something. I mean, I always do. I don't even think about a free meeting space. But in Fremantle, where I come from, in the Perth region, Fremantle has a place called 'The meeting place.' It's free. It's a community facility where you wanna have a meeting with a group of people, then you can go to 'The meeting place.' You don't have to pay. You can use the kitchen"* (FR 3).

Furthermore, formal places have established for face-to-face meeting. For instance, one expert from Los Angeles (LA 2) has stated that *"[i]n LA there are increasingly very interesting spaces where people do meet to collaborate. Renting small offices. There is an open office concept. Not necessarily people working for the same company but where they dump together in the break room and that is very popular in the software industry. So when there are people who doing consulting they can bump into each other have companionship and exchange ideas. So that's become pretty popular throughout the city."* Hence, coworking spaces enhance the opportunity to meet people spontaneously and get in contact by accident. According to one interviewee from San Francisco (SF 2) libraries are those places since many years: *"People who are more in the digital technology than me are often talking about how important it is to have these human interactions… Workspaces are more and more being designed that people working around a big table or they working collaboratively in a coworking space. I think the library is for some people a surprising place which is fulfilling their needs and they are excited when they see that they can come here and work here and see other people and they think that they discover it before anybody else. It's funny, too, because of the coworking, it feels like some of our branches, they have been doing this for years. The people come in and take out their desktop and punk it on the table and then they put out the big monitor and put it there and you just look: 'Aha?'"* (SF 2).

Unconventional working spaces have already been introduced in tech firms like in California. *"When you visit Google or Facebook. It's all fluent and open and there is food everywhere. This is what we want. The west coast has this much more than the east coast has"* (BO 3). Consequently, people tend to meet at places where they have space to (co-)work and to meet like-minded persons no matter if it is at any working spaces or in the open kitchen of their company. As one of the early adopters, Berlin has been mentioned for its popular coworking spaces by several experts. One expert from Berlin (BE 7) has recognized a rapid growth of such spaces. In 2012 they had about 50 of those spaces and two years later more than 100. The success of coworking spaces goes hand in hand with the changing business models that are becoming more and more open. According to Chesbrough (2003), innovation models at the economic market have changed from closed to open innovation processes. Hence, the process of research, development, and selling of a product do not follow anymore just the principles of doing everything alone and with own capacities. Further, a flow between stakeholders, technology, and capacity opens the way for new markets and enhances the innovation process. For example, face-to-face communication in an organization can be described as knowledge transformation process (Nonaka & Takeuchi, 1995). Tacit knowledge plays a significant role and is best transferred through physical social relation. Coworking spaces enable both principles, open innovation and tacit

knowledge transformation. They bring people together, most are entrepreneurs or freelancer, which could contribute to the innovation process of each other's product or service. For example, you are working on a smartphone app as a programmer but you have no idea how to develop a beautiful design or even how to sell this product. Per accident, you will meet a designer or a marketing person at the café of your coworking space and get some insights about how it works. And in turn, you are able to solve some WordPress bugs for them. It is a win-win situation for both parties. Hence, coworking spaces *"are defined as localized spaces where independent professionals work sharing resources and are open to share their knowledge with the rest of the community"* (Capdevila, 2014, para. 7). In the first stage, this trend came up due to the changing labor market of knowledge workers. They are able to work and live anywhere where they have access to the digital infrastructure (Beyers & Lindahl, 1996). In the second stage, the emergence of coworking spaces is dedicated to the financial crisis 2008/2009 since many office buildings have become empty. To enliven these buildings, shared spaces are used as a new renting model. For instance, *"[t]he first [coworking space] CWS in Barcelona was launched in 2007 and currently, more than a hundred spaces in the city define themselves using the term 'coworking'"* (Capdevila, 2014, para. 17). This development is related to the upcoming spaces of the creative industries. Creatives reused empty industrial spaces as galleries or performing places due to their relatively cheap availability (Collis et al., 2010).

In practice, not all coworking spaces are innovative. Capdevila (2014) has undertaken a qualitative investigation of coworking spaces in Barcelona and divide them into three groups: "no innovative communities," "innovative communities," and "highly innovative communities." The typology of this investigation is fuzzy but at least it demonstrates that unconventional handling is understood as innovative. For instance, *"[t]he CWS managers avoid sponsorship understood as getting free products or putting a visible logo at the entrance. Instead, they propose challenges and innovative approaches to reach win-win agreements"* (Capdevila, 2014, para. 59).

Looking at the 31 cities investigated in the work at hand, in all cities this kind of spaces is available. Of course, the number of spaces is varying and a definite list of all coworking places does not exist. In Figure 6-24, the number of spaces for each city found are listed in descending order. The numbers were found through Google search at the 18th of November, 2016, using the search terms "[city name] coworking space." There are some websites and blog posts that are trying to help people to find those places and are constantly updating their list of coworking spaces. For instance, a blog post about coworking space in Tokyo (tokyocheapo.com/business/drop-in-coworking-spaces-tokyo), the coworking wiki (wiki.coworking.org), or the matching platform Coworker (www.coworker.com) do offer overviews about available coworking spaces. Those lists

have been additionally used to identify the number of coworking spaces. The numbers are not finite because coworking spaces are popping up and shutting down constantly. The full list of identified spaces and sources are available in Appendix VI Coworking spaces. Interestingly, Berlin, which is the city that has been mentioned by the most interviewed experts as the pioneer of coworking spaces, is not at the top of the list. Hence, this could be due to the diverse definitions of coworking spaces. Some spaces are just shared work spaces or offices with short time rental options. Other spaces are acknowledged as cafés with a good Wi-Fi connection and many plugs for Laptops. Nevertheless, the city with the most identified coworking spaces in relation to the number of citizens is Amsterdam. The city is rather small and offers 60 coworking spaces by having a population of smaller than one million. In Beijing or Shanghai, it is rather difficult to find coworking spaces. There are first attempts to offer innovative spaces for entrepreneurs and freelancers, where sharing of resources and knowledge can happen, but in relation to the size of the cities there are just few of them. In addition, the language barrier could be the reason that just a few of those spaces were found via Google search. Interestingly, one blog post about coworking spaces in Amsterdam lists the public library as a place for people looking for a desk. The importance of public libraries as physical space for face-to-face communication will be investigated in a further subchapter of the cognitive infrastructure of informational world cities.
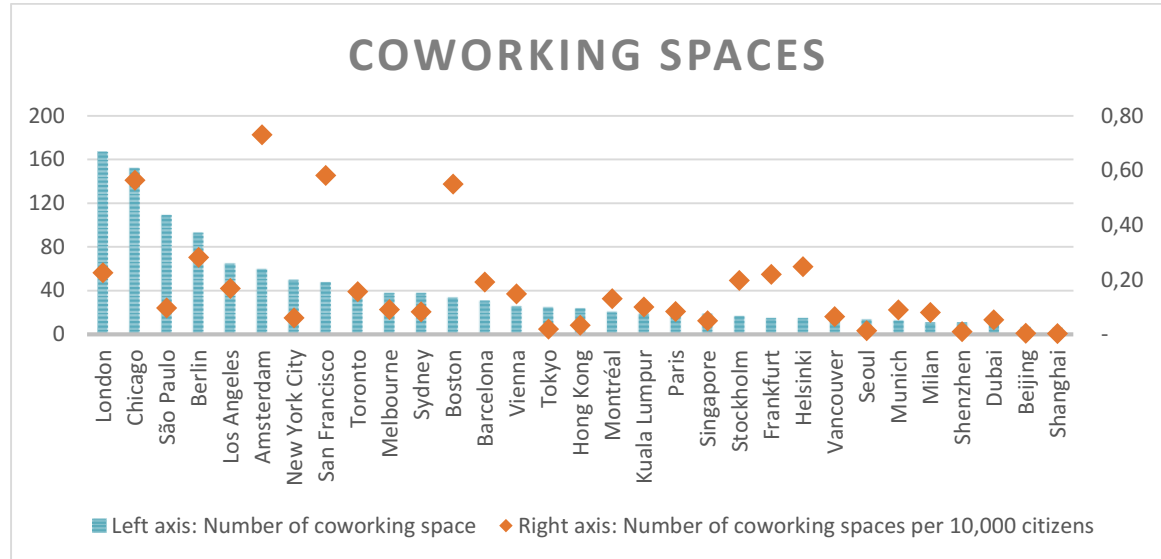
Figure 6-24: Total number of coworking spaces per city and the number of spaces in relation to the population.

Not every interviewee had experience with coworking spaces or did even know that those spaces exist in the city. Hence, many told that this might be due to their professions and community which have no contact with the startup and freelance scene. The culture of communication and work practice can exclude some citizens from this community because they

are not aware of those spaces. Therefore, I will discuss cultural diversities in communication according to the 31 cities in the following.

Culture

Something that everybody will find in the city are cafés and bars at which people can meet. In Amsterdam for instance, the cafés and restaurants are trying to attract knowledge workers, e.g. by offering Wi-Fi (AM 2). One interviewee from Berlin (BE 6) has mentioned that their newspapers are full of cartoons that are making fun of all the people with their laptops sitting in cafés. For him, this is indeed an indicator that the knowledge workforce is meeting there. In São Paulo, for instance, the people meet foremost for lunch or dinner. During lunch it is more informal, hence the people working in the same neighborhood meet accidentally at lunch restaurants. This offers opportunities to exchange with people that work in another office then you (SP 4). In Barcelona, one expert (BA 6) stated that it is important to offer free Wi-Fi at public spaces because open spaces are the meeting places. This is indeed possible in a city like Barcelona which has a Mediterranean climate. Finally, to get into a community is more important in some regions. In Los Angeles one interviewee has reported how important the personal contact is to become successful: *"It is the story of legends. It's the people here in the entertainment industry. They will go to a club to hear a new performer. Then there are sitting two very famous people from the entertainment industry look at this new performer. That person is unknown. They decide they are going to mentor that person and that person becomes very famous. So that face-to-face. Getting to know somebody here. That is what makes the industry"* (LA 1).

The personal contact and to meet the community are very important for other businesses as well. *"In Asian cities like Hong Kong, Singapore, or Beijing it is difficult to find those places. It is kind of a 'speakeasy' concept, e.g. in the Hutong area in Beijing. In Beijing, places are not public. It is very hard to find those places; you need to be in the community"* (SHE 1). And this is the key as well in Tokyo. To make a business in Japan you need much time of investing in personal contact (TOK 2). It is necessary to create confidence through office meetings and in addition get together for dinner or at a bar before any business happens. This is similar to Dubai, where the businessmen meet at bars to get in contact with each other and make their business. To meet at conference rooms is old fashioned for them (DU 2).

Summing up, the community is the key to identifying the best spots to meet with other people to do a business or to create creative things. For instance, Frankfurt is a city that is not

acknowledged as being very creative. One expert mentioned that this is due to the community which is not so strong in Frankfurt (F3). The people are moving in and out and there is no feeling of belonging to the city. But to do creative or innovative things, communities and networking are very important. *"You can't have that kind of technology revolution that we are having here [in Chicago] without a social component. People don't talk about that very much but it's hard work to organize the meetups, even things like getting people to go. Getting people to mix. Because these communities often times don't like for instance urban planners and architects and technologists. I do a lot of that. Mixing people, inviting them to meet at a restaurant or something like that"* (CH 2). Finally, this impacts the creativity (F3).

Especially in the tech scene collaboration is important if it is face-to-face or digital. They are sharing code and experience to support each other. One example from Boston reveals the importance of open source and sharing within this community: *"[T]he local group had broken up the flu in January here. The mayor was like everybody gets a flu shot. 'Here is the location where you can get for.' And it was just a list. 'Ok, what we can go with that?' This group was like: 'That's not very user-friendly. I can't say what's the closest location to me'. Chicago gets a similar thing. So the local group got the Chicago code. We set up on a server here… Within like 40 hours we had working app with maps. Having that kind of structure in that community that collaborative ability made providing a good solution. So much faster than it would be without that infrastructure. Without that community, it's like 'forget to build that ourselves'"* (BO 2). Hence, this community is productive due to local coworking and global digital exchange. The important factor is that they are sharing their knowledge in an open source format to help each other. This is a kind of co-learning that is as well described according to upcoming social learning or hack labs in many cities (Carrillo et al., 2014). One of the most known communities is the Open Knowledge Foundation that is organized as head of OK Labs in cities all over the world. They have built a community of people that are using open data and open source code to develop new tools to solve local problems and to share their results with the global community similar to the case in Chicago and Boston. Hence, they work globally on a digital level and meet face-to-face in each city lab.

One expert from Toronto reported about an interesting phenomenon of communities in the music industry: *"Some of my post docs did some work looking at the music industry… And comparing those industries, how the kind of music and musicians and how they work in Toronto vs. how they work in Halifax. And one of the things that was a really interesting one, is that musicians who are working in Halifax actually do more stuff. They have a broader scope. Because there are fewer of them. So if you are a bass player. You might play with a jazz trio one day, you may play with a heavy metal band a couple days later and you might be working on a documentary*

film the other. That is because there are not so many bass players in Halifax. In Toronto, when you play with a jazz trio, you only play with jazz trios. You will never ask about or even know about the other options. Because Toronto is large enough and actually silos more. If it gets bigger people tend to focus on the one thing they do and ... the music industry ... is a good proxy for a lot of the kind of creative industries. What you see is that people tend to silo up and they are competing more against each other and they don't tell each other about opportunities. Whereas in a smaller market like Halifax the people have to collaborate more than to compete. In a city like Toronto, you have this siloing. People who are working in IT, doing stuff and meeting other people from IT, but they are not really meeting with designers if you would think about industrial design or whatever. The larger places become the harder those things become... But I also think, because Toronto is so large it has the siloing even if you have more spaces that are kind like that it is hard for them to be effective" (TOR 1).

Anyway, many of the interviewed experts have related the fifth hypothesis to knowledge workers, the tech scene, and coworking spaces. According to Saskia Sassen (NY 5), next to coworking spaces, there is as well a trend towards small performance spaces in the art and entertainment industry. *"What we see is the return of the small performance space as the hottest space. So when you go to the Bowery which is a totally degraded place. If you go at certain times at a day, mostly late at night. It is full of people. You know, they dance, they do sound poetry, all kinds. It`s not just to dance or to rave. It's also the performance of arts of theatrical etc. This area has really grown… Once that full Madison Square they probably came from the suburbs. The typical hip New Yorker is not going there. They are going to small performance space. So it is a sense of also yourself representing, it's a form of creative zone than sitting in an audience applauding the best-selling musician of blabla… But the performance festival in New York is the hottest festival and it's all counter it's not in the center"* (NY 5).

Conclusion: Physical space for face-to-face interaction

Regarding hypothesis: "H5 Physical space for face-to-face interaction is important for an Informational world city." the results definitely do confirm that face-to-face interaction is a main requirement. Informational cities should not be cold places like the Candle Square in Boston where Microsoft Research, Google Research, and the Computer Science Complex at MIT have built their glass complexes. A culture of meeting and meeting places should be established. The infrastructure of a city is important. Thus, Wi-Fi at cafés or at open spaces extends meeting places to working spaces. Hence, people can work or get in touch with people at informal places. As in

the case of Berlin, where so many people connect to the Wi-Fi of cafés to do their work, or the special lunch restaurants in São Paulo that offer the opportunity to get in touch with people working in other offices.

Further, the labor market has changed in the last years. There are many people that are working as entrepreneurs or freelancer and are able to work at any place with internet access. Nevertheless, they are going to use shared offices or coworking spaces. Each city that is investigated in the work at hand offers coworking spaces. They vary in their innovation profile but at least offer a place that opens the ability to get in touch with other people. Globally, the tech communities and coworking spaces follow a very open culture. Networks and workspaces are easy to find online through a simple Google search but to become involved with the community is rather difficult, e.g. in the music industry in LA or with businessmen in Asia. This is more of a 'speak easy' principle or a VIP circle that includes new people by invitation only. Additionally, the size of a city results in a siloing effect. Only selected people are able to get in touch with each other and probably work together.

Finally, the examples show that places tend to become smaller with a more familiar climate. This is true for innovative coworking spaces that explicitly invite the people not only to share hardware but as well their knowledge and experience. In the creative sector small performance spaces are locally organized and in the case of New York, do attract the hip New Yorkers more than the mainstream bestseller musicals do. Nevertheless, it is not clear if the informational world city accelerates this movement of smaller and more familiar meeting places or not. The interviewed experts mentioned that those places are not known if you are not into that community. Hence, the SERVQUAL evaluation revealed a lack of those places, though the simple Google search showed that interested persons can find them. The interviewees mentioned that an infrastructure like Wi-Fi connectivity and coffee house culture are important. Some have mentioned the example of the public library which can serve as a meeting and working space. Additionally, the library offers access to a huge content infrastructure. To which extend the public library is acknowledged as a service of content infrastructure and as space for face-to-face communication will be investigated in the two following hypotheses.

H6 Fully developed content infrastructure provided through digital libraries

Libraries in informational world cities inherit a special role as a content provider even through digital access or as physical space for face-to-face communication. Hence, to foster lifelong learning access to digital and physical libraries is crucial. Therefore libraries are acknowledged as part of the cognitive infrastructure of a knowledge society (Stock, 2011) in addition to the knowledge output which was investigated in the prior chapter. The use and access of digital libraries represent the consumption of knowledge resources (Stehr, 2003). Furthermore, digital libraries do not only meet the needs of the knowledge society but beyond that, they are information service providers for companies. To review the importance and state of the art of digital libraries in the 31 cities the following hypothesis will be investigated:

H6 A fully developed content infrastructure, e.g. supported by digital libraries, is a characteristic feature of an informational world city.
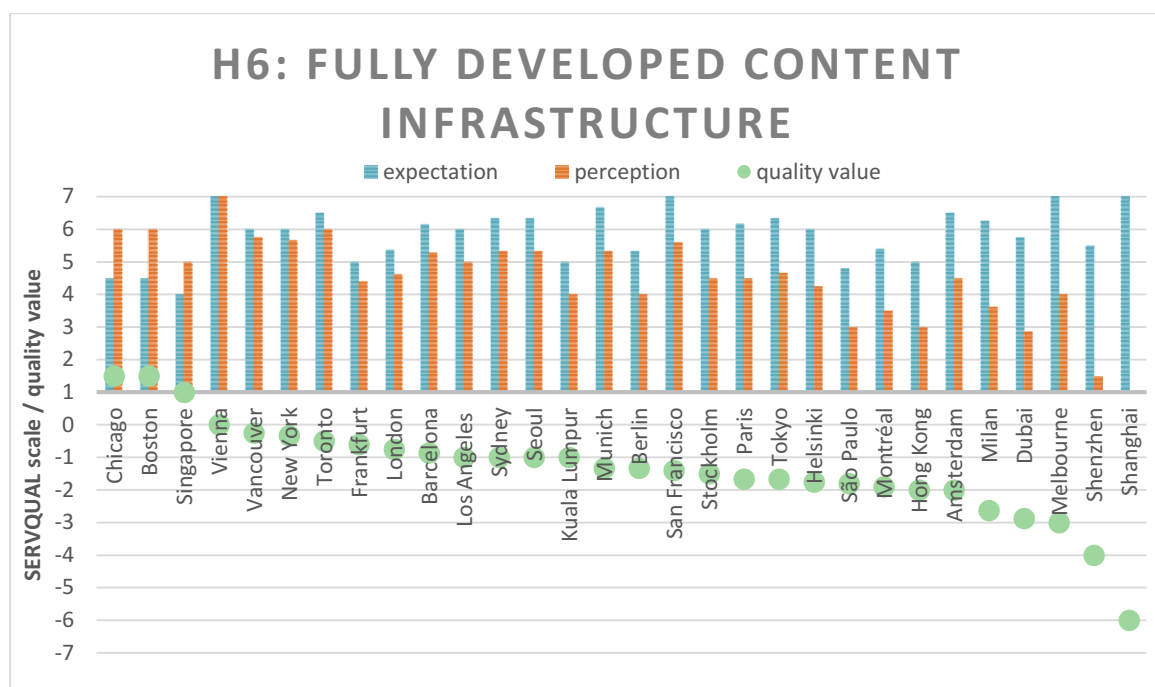
Figure 6-25: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the sixth hypothesis: "H6 A fully developed content infrastructure, e.g. supported by digital libraries, is a characteristic feature of an informational world city."

During the interviews, many experts have stated that it is not important to have a digital content support from any institution located in the city (19 experts). It is important to have access no matter where it comes from. The common argument was that through the ICT infrastructure access is given to the whole information in the World Wide Web. Interestingly, the SERVQUAL evaluation does reveal that there is a lack of having such institutions according to the average perception of the interviewed experts (Figure 6-25). Since for the most cities, a negative quality

value can be observed (in average -1.34). Accordingly, 17 experts stated that there is a need of improvement and that their public library is not the ideally content provider yet. Besides the content and digital access, the ability of the population to use this content was discussed. According to the location aspect, ten experts emphasized the need of open data, open source and open access to city and regional sources. To digitize regional data would be a support that could be encouraged by the public library (three experts). Finally, the high cost of licensed material will hinder many projects (four experts) but a network of libraries would probably be the only option to offer the access to the public (one expert). Summing up, the interviewees have on the one hand discussed the access to full content through any provider and on the other hand through the public library. In the following, I will discuss the arguments by the interviewed experts and present briefly the digital library service of the 31 cities investigated in the work at hand. The role of the public library as physical space will be discussed afterward in the next subchapter.

Access to full content database

A digital library can be understood as content collections on behalf of any community or as an institution or service provided by librarians (Borgman, 1999; Levy, 2000). They are more than metadatabases. They provide full content of diverse media in a machine readable and processable format (Mainka, Hartmann, et al., 2013). To offer such a service for the public, like in the case of Reykjavik that offers access to all scientific publications published in specialized journals on Elsevier's Science Direct for the whole population of Iceland (van de Stadt & Thorsteinsdóttir, 2007), implicates high costs for the public institution. Considering, *"libraries are very important content providers. Due to copyright and other licenses no other institution will be able to offer such content"* (BE 1, own translation).

In Singapore, for example, the library is sharing the costs within the national network of libraries (Chellapandi, Wun Han, & Chiew Boon, 2010; R. S. Sharma, Lim, & Boon, 2009). There is no branch that has to apply for databases on its own. Of course, Singapore is a special example since the city is a nation state and benefit from this governmental constitution. On the city level, we can find as well networks of libraries that cooperate and share resources, e.g. in Amsterdam and Paris (AM 7, PA 2). In contrast, public libraries in London have to struggle with those costs. Mostly on their own because they are not organized within a network of the whole city. They are just connected within their borough (LO 4). In Munich, the importance to share resources is already acknowledged. Hence, the library is connected to diverse networks within the nation and in Europe (MU1). One interviewee from Berlin (BE 7) has emphasized that in Germany university

and regional libraries are accessible for the whole population and not only for members of the university. Thus, full content to a diversity of databases has not necessarily be supported by the public library to offer access for the public. A similar openness is as well given for example in Canada. In other cities this access is limited. For instance, in Dubai, the university libraries provide an enhanced access to information and databases with full text (DU 1) but these are not accessible to the public (DU 2, DU 3).

It becomes questionable if it is important who is supporting the full content. One expert from Toronto (TOR 1) argues as follows: *"I think you can be a fully kind of informational city by having content infrastructure but it could be private. Is that the best? No. And I am all for open data and all kind of the other things. But… you can qualify if you have the content infrastructure and have that kind of information and it might be in private hands. So, the openness of it is, I think, of help but I don't think the openness is absolutely required."* The completely opposite is happening in France. Hence, Paris does a lot of projects to offer eBooks and online content. According to one expert from Paris (PA 2), the French people love to rebel against the rest of the world. For instance, fighting against Google and make own similar projects. In the end, probably Google will win this battle of content providers. Nevertheless, they try to offer own digital libraries with full content. Actually, the public library in Paris provides more online services than full content services (PA 3). In Montréal, as well a French-speaking region, a similar development can be recognized. *"There are many plans but there are too many barriers especially on the licensing of materials that make it difficult to offer full content"* (MO 5, own translation). In Montréal, there is a project going on to publish eBooks by authors from Quebec written in French language but these authors are afraid of their copyrights which make it difficult for the project to grow (MO 6). This project originates from the whole Quebec region and they like to push own authors and their own language and do not want to offer too many foreign materials (MO 4, MO 5).

In addition, censorship of information is a problem in some regions. For instance, in China. One expert from Shenzhen (SHE 2) has described the digital content market as follows: *"It can be very frustrating to do research because a lot of sites are blocked or limited. It is not just about the absolute censorship; it is also about knowledge competitors. A lot of sites are slowed down so that it comes not worth using them… There was a fight between China and Google. China had a selfish interest in holding off Google because they wanted to help the home grounding companies. If you want to get global information that can be very hard. You cannot access 'New York Times', 'Bloomberg'... You can see that articles exist but you cannot read the full text. [At the] illegal market you can get books that don't actually exist. It is easy for print shops to exist. You send everything to be printed to print shops because it is very cheap. They then have the drawings,*

competition rendering etc. They collect this treasure of information, sell it on DVD or as a book on the black market."

Hence, offering online full content services is always tied to high costs and licensing questions. For instance, *"[w]hen you have access to those databases it is amazing what you can do. I have access to a database [at the office]. When you gave my name in it, you will get a fifty-page report of everything that I have done… They would never give that out for free"* (LA 1). In addition, the usefulness of access to full content databases for the public needs to be considered. For instance, Los Angeles' public library is offering selected services for their users which they think they meet their needs. *"We offer many databases. We don't have to say offering Bloomberg real time but we do offer internet access and I think that within the libraries we offer instructions. We offer instructions on using different information sources… We have some specialized subscription databases that offer a… real selection of full-text databases. They can work better for the general public"* (LA 2). Hence, digital libraries are not used by the whole population (BA 3). Archives of Ph.D.'s or other content is no mainstream content and therefore only interesting for some individuals. *"Only experts know the existence of them because they have no use for general public"* (BA 3).

"The thing what you need is good broadband access. It doesn't matter where the digital library is located. For instance, the digital public library of America dp.la, Boston is the hub of the development of the dp.la. A digital library is not in any place" (BO 3). Hence, the ICT infrastructure is acknowledged to be more important since it offers access to all the global knowledge and not only to the local one. The local one is important for cultural things (MO 1). The location of the library can be of interest when it comes to own digitized documents. For instance, the public library in San Francisco is making available historical geographical data of the San Francisco region. But the access to this data is open for all people with an internet connection (SF 1). Another example comes from Canada. There hockey is a very important leisure activity. This is a regional phenomenon and to open a database on best ice rings is expected to be beneficial for the community. *"There is kind of APIs that you can plug yourself on the city data… There are ice rings in the city there you can go and play hockey during the winter. And the quality of the ice is compared by the city… There is a guy that created a website to basically show on a google map the quality of the ice in all of the parks of the city. So I mean this is a kind of need application of that"* (MO 2). The libraries in Barcelona, for instance, offer access to open data like cartographies but access to music or books is not fully developed (BA 3). The problem of a slow movement in digitization and open data in some locations could be due to the skills and experience of the decision makers. One expert from Amsterdam (AM 6) argues that *"people who are responsible for*

this are not really digital-minded." Free flow of information and national policies that constitute this are important to advance the development (SG 4). One pioneer in offering open data and full content on city related content is Vienna. The urban planning department offers a metadata and full-text retrievable database with all content and data published by the city (wien.at, VI 1). According to one librarian from Montréal (MO 6), libraries should act as a mediator between data and the society. *"I am a librarian and I think librarians or archivists work in their library or in their active center, but not work with people. They need to be more engaged in the society to bring together explicit knowledge with tested knowledge. They need to be a more intermediary resource for the society, especially to use data. Open data need to be mediated, curate or mediated by some people, maybe by [information scientists], but also by librarians and archivists, because ordinary people don't know to use data"* (MO 6). Libraries should help to bridge the gap between non-information literate and information literate people in the knowledge society (MO 6). The topics open data and free flow of information will be discussed separately in chapter H10 Free flow of information.

Hence, just to offer databases and online content does not reveal that the whole population is able to use the data or even has access to it. According to the interviewed experts, public libraries should offer instructions on how to use digital content, give assistance in information retrieval, and at least offer digital equipment and Wi-Fi connectivity at their branches. The availability of technological devices and internet connection is related to the physical library which will be discussed further in the next chapter. However, a full developed content infrastructure is not the holy grail of the 21st century as demonstrated by the example of Seoul. In Seoul (SE 1) one expert mentioned that South Korea plans to digitize all school materials and books till 2015. Accordingly, all educational content would be available online with additional multimedia hyperlinks and features for self-regulated learning (Kim & Jung, 2010). This was the idea behind this governmental plan but due to recent findings this plan has been downgraded towards using online and paper materials in parallel. Having access to materials anywhere and anytime does not automatically enhance the quality of learning. According to an article in The Washington Post *"[a]bout one in 12 students between ages 5 and 9… is addicted to the Internet, meaning they become anxious or depressed if they go without access"* (Harlan, 2012). Thus, the digital transformation can also cause negative health issues in addition to the exclusion of parts of the population. *"I think digital libraries are subservience to people knowing how to access information and read. Just because is it a digital library it doesn't mean that you know how to use a library. So the first question is: Who is training people to use libraries? How do you access digital information?*

Why do you believe that everything is on Wikipedia? … There are lots of libraries in LA. We have a huge construction of libraries and I think lots of people use them" (LA 3).

Digital library investigation of 31 informational cities

In a prior project on public libraries in informational cities, conducted by my colleagues and me (Mainka, Hartmann, et al., 2013), the corpora of the 31 cities has been investigated according to its digital and physical services. In this investigation, online services of public libraries have been identified and the availability of these services was proved. The underlying indicators are listed in Table 6-6.

According to the digital services of a public library full content service is just one aspect. However, to identify the availability of full content information through the public library service the investigated areas of e-documents (e-journals, e-books, digital images, audio books, music, e-magazines, videos, newspapers, bibliographic databases, other e-resources) and own digitized documents are of interest. Thosematerial can be made accessible through the web. Hence, to make these documents searchable a Web-Online Public Access Catalogue (OPAC) is needed. Furthermore, the availability of an OPAC in English extends the access of the materials to users with limited language skills (given that the user is able to read and write in English).

Referring to the results of this study 30 out of the 31 cities offer an available digital library (retrieved in December 2012). In Dubai, only a website including an English translation with some information about the library has been online. Nevertheless, the identified 30 digital libraries support all a Web-OPAC in their respective national language and 22 of them are available in English as well (Figure 6-26). The website of Vienna's public library is translated additionally into Sign Language for users that are not able to read (VI 3). The access to e-documents varies between the types of documents. The most common type is e-books, followed by e-journals and bibliographic databases. Videos are available only in 14 libraries and digital images in 13 libraries.

In addition to the availability of e-resources, the ability to use them is an important aspect as mentioned by several experts. Therefore, the types of instructions (FAQ, text documents, seminars, and video guides) for using the digital library services have been scrutinized. According to the results, those instructions and guides are not a common standard for all libraries (Figure 6-26). FAQs are the least common instruction guides (provided by four libraries). The most found instructions are available as text documents (ten libraries) and only seven libraries offer two different types of instructions. Finally, this does not reveal that the quality of those instructions is

good or bad. This just demonstrates that user guides on how to use the digital library are not the standard yet.

Referring to the statements of the interviewed experts, there is no common development of digital libraries in the 21st century. One expert from São Paulo (SP 3) estimates that the digital library in his city is developed like in the 19th century. For him, the digital library landscape in Brazil is like a desert. But as in other cities, the full content access is mostly offered for researcher and students in technical or university libraries. According to the interviewed experts, only a certain group of the population has a good access to knowledge and information in São Paulo. As well in Milan, all experts mentioned that the digital library service is not sufficient. It is more traditional and does not offer much online access to full content. Nevertheless, in Milan the university libraries are offering a superior access for researcher and students.

However, according to the findings in many cities a digital transformation can be identified. Though, this transformation could be enhanced and accelerated as, for instance, mentioned by experts in Stockholm (ST 2, ST 4). In New York, the public library is just starting to open the access to more digitized content. *"The NY public library system has an amazing e-book infrastructure but it is like in a pilot phase"* (NY 2). To access relevant research content in London, you need to go to the library since the digital access is very limited (LO 5) but there is a move to enhance digital content (LO 6). A problem acknowledged by one interviewee in Barcelona is that there is a lack of standardization. *"[The public libraries] offer many digital repositories and archives but no common standard or project is developed"* (BA 1). Just in one case, a member of the public library told me during the interview that the library has a good funding. This was the case for the Vancouver public library and they do offer a lot of digital content. *"I'd say we're pretty good in compared, for example to libraries in Britain… We're very well-funded, so we're able to supply"* (VA 3).

According to the weighted index of our library survey, this advantage of a good funding can be verified by the reached high scores (Figure 6-27). According to the support of the digital library only, the public libraries of New York, Toronto, and San Francisco are the ones with the widest range of online accessible services. At the bottom of this ranking, the public libraries of Tokyo, São Paulo, and Dubai can be found. The bad result for Tokyo can be due to the fact that the libraries and the society love to treasure their printed materials regardless of the population's habit to read novels on their smartphones (TO 3). Additionally, most Japanese prefer to send a fax instead of an email (TO 5). This reveals their resolute stickiness to printed material. However, printed materials are part of the physical space which will be discussed in the following H7 Library as physical space.

Table 6-6: Indicators of the digital library. Source: Mainka, Hartmann, et al. (2013)*.*

Group	Indicator
Web-OPAC	Web- Online public access catalog (OPAC)
	Web-OPAC in English
e-documents	e-journals
	e-books
	digital images
	audio books
	music
	e-magazines
	videos
	newspapers
	bibliographic databases
	other e-resources
databases with access to full papers	databases with access to full papers
guides	video guide
	podcast guide
	seminars
	text documents
	FAQ
	other guides
international access	website in English
digital reference services	e-mail
	chat / instant messaging
	SMS
	web form
	Skype
social media	blogs
	Facebook
	Twitter
	Flickr
	YouTube
	other social media
apps	apps
own digitization's	own digitized documents / collections

DIGITAL LIBRARY SERVICE
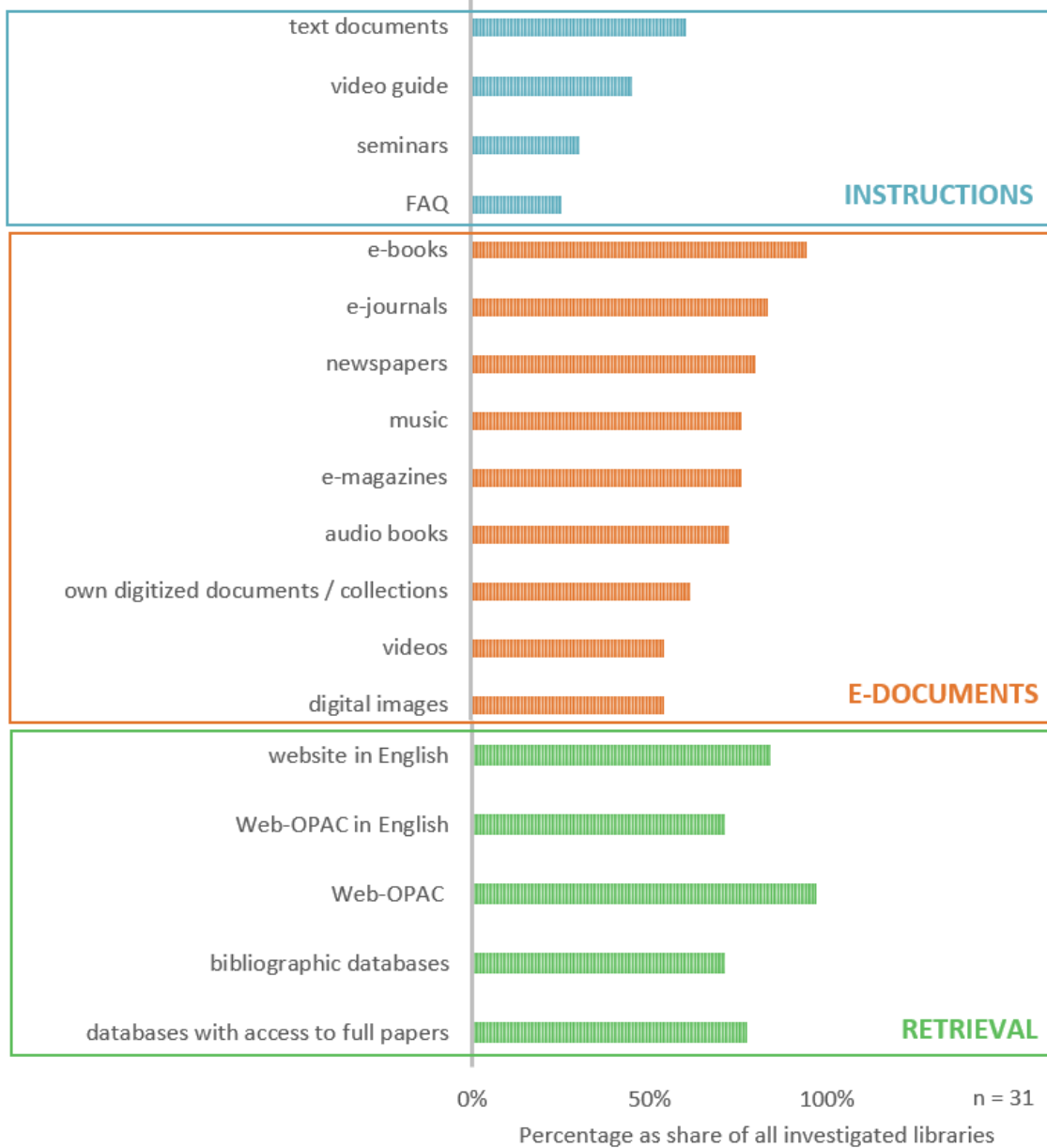
Figure 6-26: Digital library service provided by Informational world city's public libraries. Data source: Mainka, Hartmann, et al. (2013).
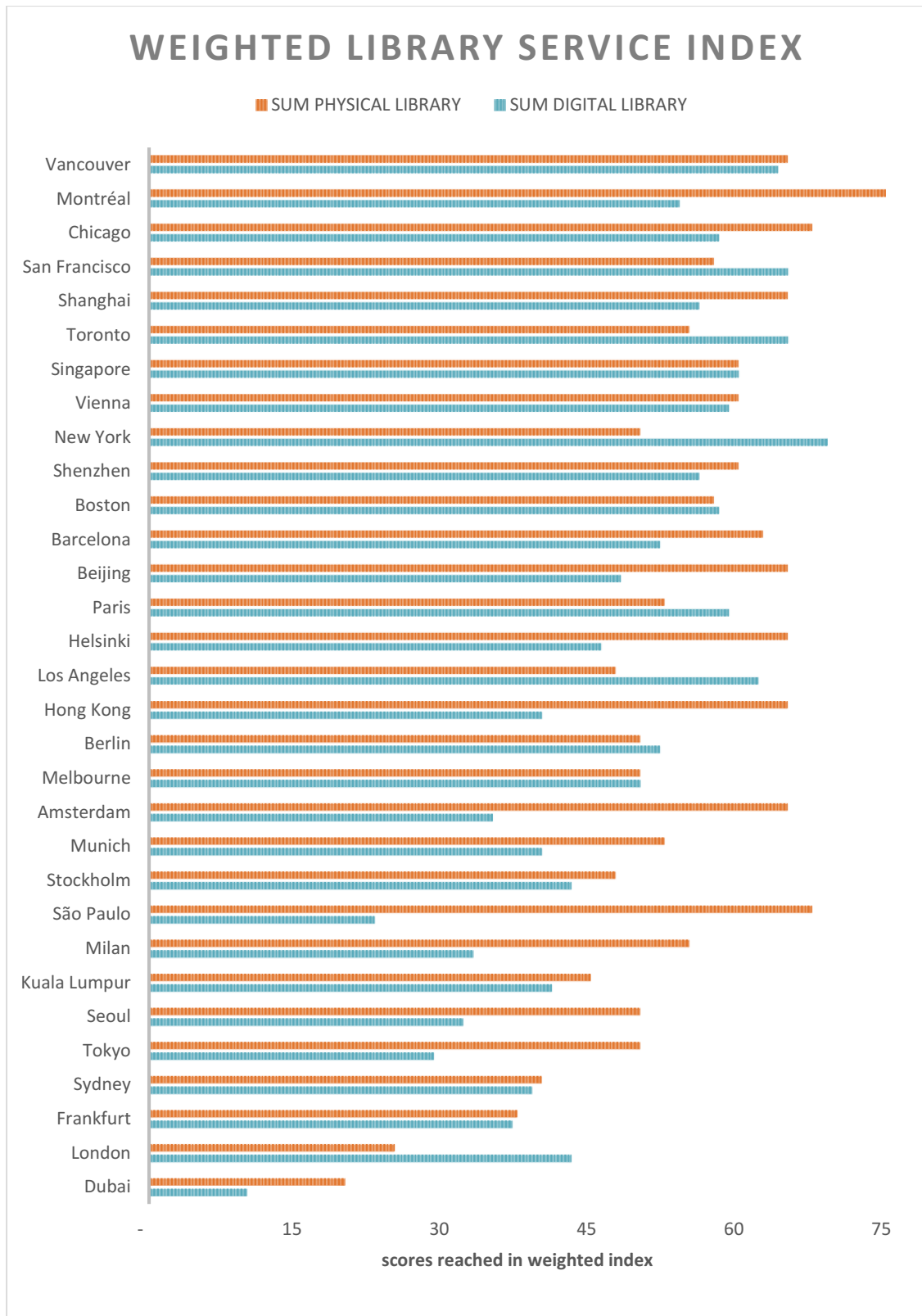
Figure 6-27: Ranking of informational world city's public library service represented in descending ordered according to total scores reached of digital and physical library service. Data source: Mainka, Hartmann, et al. (2013).

Conclusion: Fully developed content infrastructure

Referring to Dehua and Beijun (2012), knowledge in an informational world city is understood as service that is ubiquitous available through digital networks and devices. These networks can be represented as digital libraries providing content collections on behalf of any community or as an institution or service provided by librarians (Borgman, 1999; Levy, 2000). Summarizing the investigated cities there is no common development of digital libraries in the 21st century. Furthermore, the opinions of the experts are divergent if such a fully developed content services with access to advanced databases, full text, and specialized content is needed. Some have argued that it would be sufficient to have a private provider of such service or just to offer some full-text service for the public. Instead, the French-speaking communities in Paris and Montréal advocate local efforts to offer digital libraries with the intention to preserve their culture and language. According to the index of library services, the digital libraries provided by the public libraries of New York, Toronto, and San Francisco are the most advanced according to the diversity of supported services. To offer e-books and e-journals could become a standard service in recent years. Hence, more than 70% of investigated digital libraries do offer them today (see Figure 6-26). A feature of local digital libraries supported by the public library is dedicated to its role as a repository of open data, for instance, open the access to digitized local content.

Furthermore, access to databases and content does not reveal that the population is able to use this service. Thus, many interviewed experts stressed the need for information literacy and the library's role as intermediator of information literacy skills. According to the support of the investigated public libraries, there is a lack of guides and instructions. Seminars and FAQs are the least common instruction services amongst all. Hence, a better access to information will enhance the library as a place not only for books in shelves but for the community (BE 6). During the interviews, many experts emphasized the importance of the physical library as a place for the community. *"The role of libraries is important for people to meet, to get access to computer and web connection …, cultural activities in some libraries. It's more than just loan books. The city [government of Helsinki] tried to close a library but the Finns protested"* (HE 4). In Munich as well the public library is acknowledged as a cultural institution and that meet the needs of the whole society and not only that from young people who are using technology (MU 1). *"Actually, one of the interesting things that are happening in our library [in Vancouver] is a big move to… becoming a hub for the kind of the maker environment with 3D printers and where people can experience things. I think that's really the next…"* (VA 4).

H7 Library as physical space

Space within the library is changing from being a big archive of printed material towards more space for the community. Library buildings support the community with open space for learning, working, and collaboration. In addition, the presence of a public library enhances the economic value of a city and may serve as local revitalizer of city space. Eventually, public libraries are dedicated as soft location factor within the economy but for the society they serve as basic infrastructure (Florida, 2003; Landry, 2008; Stock, 2011). As already discussed, space of face-to-face interaction is growing in importance in an increasingly digitized world. Not only private places like cafés or bars should serve this need in an informational world city. Open public space should be offered by the city. Hence information and books are available through digital libraries, the physical library inherits a new role. If the physical space of a library has changed its role according to the needs of the knowledge society of the 21st century will be investigated in relation to the following hypothesis:

> *H7   Libraries are important in an informational world city as a physical place for face-to-face communication and interaction.*
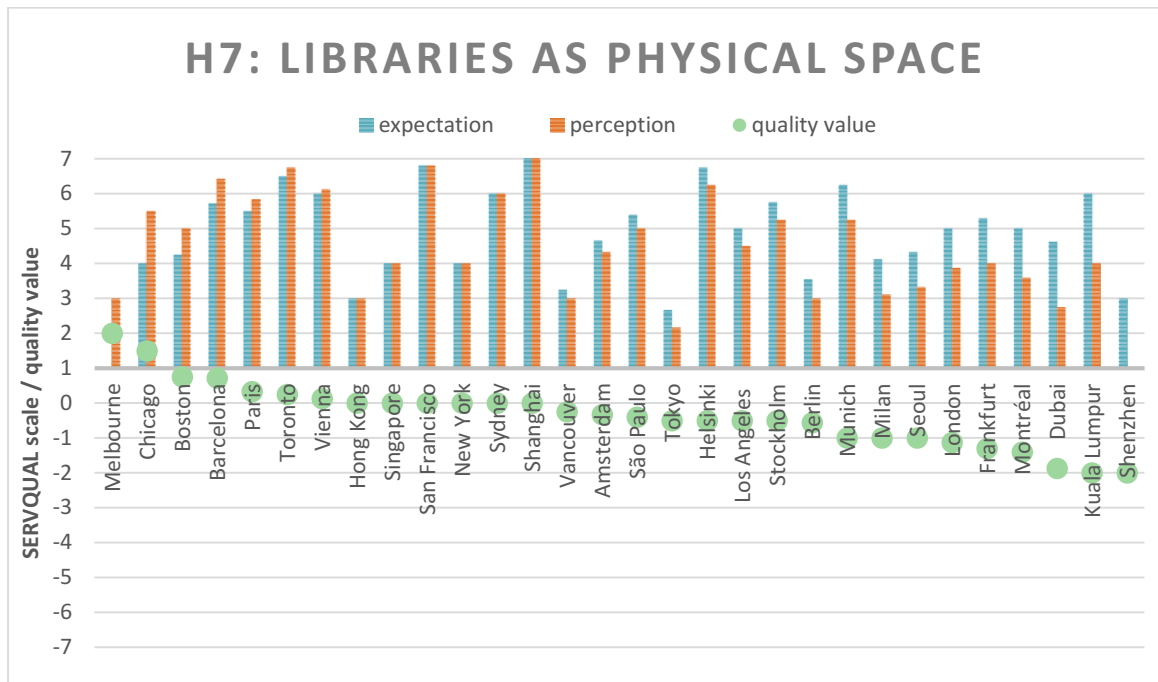
Figure 6-28: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the seventh hypothesis: "H7 Libraries are important in an informational world city as a physical place for face-to-face communication and interaction."

Public libraries are understood as a public space and as a cultural institution. During the interviews not all interviewed experts have been familiar with the idea of a public library as meeting space. In total, 24 experts mentioned that you have to be quiet in the library. You just go there if you like to lend a book (two experts). The SERVQUAL evaluation reveals that in average

per city many experts do not have a high expectation of public libraries serving as physical space for face-to-face meeting (Figure 6-28). For instance, for Melbourne, Hong Kong, Tokyo, and Shenzhen the expectation is scored with three and lower in average. In 23 cities the perception of the real use of the public library as collaborative space is lower than or as high as expected. For 17 cities the quality value is negative which dedicates that the library could improve their space according to become a place for face-to-face meeting. Furthermore, the experts stated during the interviews that in some cities the library as place is just important for a certain group of the population. For instance, just for children and students (four experts) which is dictated by the opening hours that overlap with the most common office hours (LA 1). For them, the library is important as a space for working and learning (five experts). *"In China, the bookstores are more important than the libraries. People are using book shops like a library. They sit there and read the books and spend the whole day there"* (SHE 1). In Shenzhen, for instance, the opening hours of the library are as well overlapping with the common office hours which makes bookstores automatically more attractive for the public. Libraries serve as well as a place for social inclusion (four experts). For instance, people that do not have the access to technology and internet but as well people who do not know how to use ICT need the library to access information (four experts). Thus, libraries could be understood as a bridge between the digital and physical world. At least, three experts argued that the physical library has lost its role as an information provider, hence all collections and data should be online (six experts). One expert also stated that *"Libraries will change to an office for librarians who work for digitalization processes"* (MI 1).

Though, on the other side 44 experts mentioned explicitly that it is important for a physical library to serve as space for face-to-face communication. It has always played a role as an event place (14 experts) like book readings, readers club, events for children, and much more. In addition, a library should offer space for collaboration (eight experts) like some are doing with maker spaces which offer 3D printers and other hands-on stuff. Hence, libraries have become a community place (four experts) but there is still space for improvement (six experts). As a public institution, they have to struggle with funding. Eventually, a definition of the role of a physical library in the 21st century is needed (four experts). Nevertheless, 22 experts argued that there are other places than the public libraries to offer space for face-to-face interaction. Therefore, in the following, I am going to discuss the arguments and examples of a physical library's role given by the interviewed experts. In addition, the results of an investigation of spaces within the physical library of the 31 cities will be discussed accordingly.

The physical library's role in the 21ˢᵗ century

The state of the art of the public library and its role as physical place reveals major differences compared on a global scale. In informational world cities, we can find libraries that are used traditionally as learning and working space but as well as innovation and creative center that foster collaboration. As a public institution, public libraries follow an educational task (MU 4). Thus, they try to include the whole population. The traditional library offers a huge collection and quiet working spaces which are most used by people who are reading, do research, or learn something. In Beijing, for example, which is a very crowded city with high costs of living, the space within the National Library of China is frequently visited by the population. Even the space of the public library is very crowded, the users are working quietly (Figure 6-29, right picture). Other libraries offer traditional working space and shelves with self-lending materials as well as space for meeting and collaboration. Figure 6-29 shows on the left the Stockholm Stadsbibliotek which is offering a mixed space for lending materials, working, using PC's, asking a librarian and a stage for events like talks or music performances.
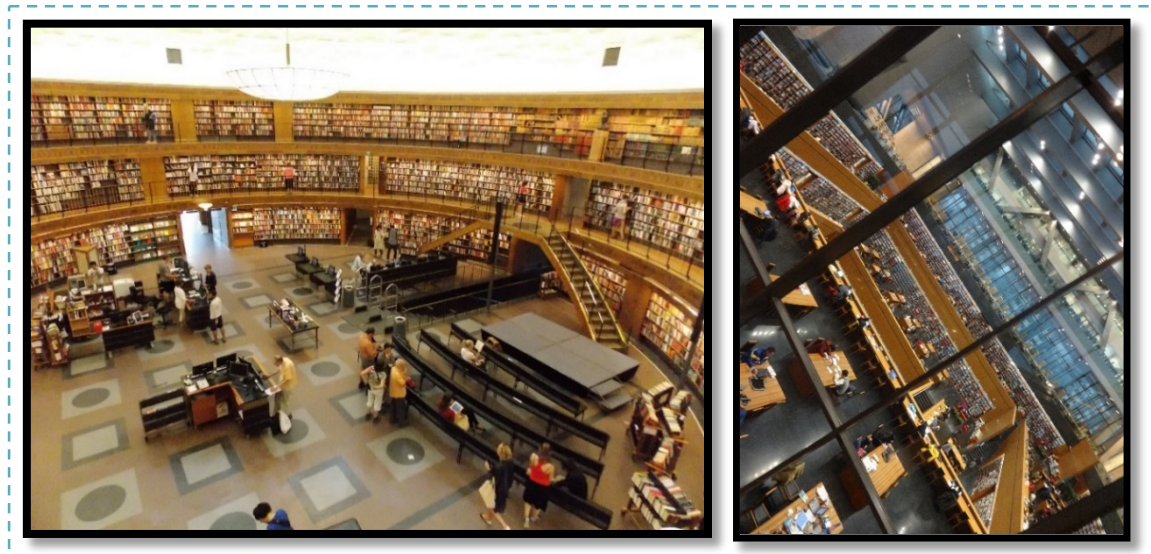
Figure 6-29: Physical space of public libraries. Left: Stockholm Stadsbibliotek. Right: National Library of China in Beijing. Photos by: Agnes Mainka.

"As much as I am a huge fan of libraries and books. I think the standard model of the library was never about a workspace. Librarians tell you to be quiet and stuff like this. Not made for brainstorming, not made for collaboration. It's a place made to come to research and relax. Books are still critical for libraries. Libraries have a job to modernize and adapt to a culture that wants to be more collaborative and that… But I haven't seen libraries really do that a lot. They try to fit the digital stuff into the old framework of quiet research and kind of things like that" (BO 2). Hence, the traditional library serves the needs of the whole population and includes people who otherwise would not have the access to information. *"The physical space of the Boston public*

library is a great library and it's always played a role as the place where the lower social classes and recent immigrants could educate themselves and could come and leave the ghettos and begin to see a different world. The cultural experience of sitting with lots of other people and reading books is something that kids couldn't have sitting at home in front of their screen. That's still important" (BO 3). Additionally, people who cannot afford an own internet access, use the free Wi-Fi at the library or the technology offered by them (LO 4). The public libraries serve as an information provider and this can be done by physical collections or through the access to PCs and Wi-Fi at all branches. For instance, in New York, it is *"a huge effort in the city to take those areas where people don't have access to digital content and give them access to"* (NY 2). In LA, *"Wi-Fi is available even the library is closed e.g. Sundays"* (LA 3). After the opening hours people sit outside of the library building and connect to the Wi-Fi which is still available (LA 3).

Self-education and life-long learning are two aspects of a library that make them as important for the knowledge society (Stock, 2011). One expert from São Paulo (SP 4) has stated that education is the key for libraries to become more attractive. *"I think we lack good basic education, fundamental for kids. This is something that's lacking here, so that's why… only certain degree… go to the libraries, … theaters, … [and] movies. These are expensive things here in Brazil and books also are very expensive... And people usually don't have the habit to read... They have a habit of watching TV… but that's it... No, it's something that has to be put more effort"* (SP 4). In São Paulo and in entire Brazil the government is going to establish a library next to each school and they should support as many books as the school teaches children (SP 1). This is just a plan and the future will show if this comes true. For children and the ordinary population, such institutions are important (SP 1). Books and reading are important for education. In general, the population in Brazil does not have the habit to go to the library to meet someone (SP 2). They prefer to go to the shopping mall.

The problem that arises today in many cities is that a lot of people can work quietly from any place they like to. They do not have to go to the library building. This may cause that many buildings are not visited frequently by the citizens. In cities where the living space is very expensive, the library can offer space for students to study and work (PA 5). Though, the most libraries in Paris, for instance, are empty places. It seems as nobody would be aware of them except for one, the Bibliothèque Sainte-Geneviève, which is more a kind of a meeting place. This one is attracting a lot of people (PA 5). To fill the physical library with life the space is going to be used in other manners. One expert from Boston (BO 3) reported that he is giving his classes at the library. *"We used the library as place for classroom because nobody was using the library for studying or meetings."*

In contrast, in other cities, the number of people using the physical library is very high. *"I don't know how many people have registered in a library. It is like a club. In short, it is the biggest club in the city after the football Barcelona. Almost every one of us goes there. Libraries are always full in Barcelona. Libraries also play a big role for integration. People that came from foreign countries. One of the first points of contact are the libraries. They make relations. Maybe they find internet points. It is also easy to follow programs like language [education]... Is maybe one of the vehicles to make that model of neighborhoods... I think that everyone knows where the public library is... I think we have a good experience"* (BA 6). In North America, the public libraries as well support immigrants with language skills or help citizens to write job applications as stated by several experts. Thus, their role as a sole information provider is enlarged with further public services. Additional services are, for instance, lectures and seminars for illiterate and non-information literate persons. In addition, *"libraries are one of the bridges between the digital and physical city"* (BA 1). Information and content not only in the case of scientific information need to be discussed and shared with other people (BA 1). Hence, public and other libraries are important places for knowledge exchange. In Frankfurt and in Munich the libraries have programs that inform the citizens, for instance, about social and political developments (MU 4, FR 2). Furthermore, libraries can serve as a hub for information and news. *"The library in Beverly Hills is a gathering place. Hurricane Katrina in New Orleans, they found out that the libraries were the places where people went to get the information. Mean when you really get all the support systems the library was the center place to go"* (LA 1).

As in many other cities, in Berlin, the government plans to cut the budget for the physical library spaces. In San Francisco (SF 1) one expert reported that the people "freak out" whenever any branch is going to be closed. *"They get very upset. They really want their little local spot to meet people and talk about things. And they don't just freak out. They give money. And we have one library for every two miles"* (SF 1). The library is for the public and therefore the San Francisco library is working closely with their customers. *"We are currently in the process... We revisit our open hours depends on what the public wants from us. We would change our hours in respond to that and we are expanding our hours in many locations and responds to public feedback. They want us open more"* (SF 1).

It is important to define the role of the physical library and, in addition, to communicate this role to the society (BE 6). Today, in Berlin the public libraries are used as meeting space only by the elderly population who read their newspaper and meet other persons of their age (BE 9). In Vienna, most of the public library branches are very small. In the past, they have been established within almost every social living court (VI 2). Nevertheless, the central library is bigger

and the chief librarian, Markus Feigl, has started to redefine the role of this library into a community place not only for the elderly. His vision was to reduce the number of printed material hosted in shelves in the library to offer more space for the people to meet and to exchange knowledge (VI 2). This is a change from the traditional library towards a modern interpretation of a library's physical role. But this needs to be communicated carefully. He stated that the media was reporting on his vision that he wants to throw out the books and even compared his development plans with the book burning during the Second World War. Hence, *"books are as well a cultural good and you cannot implement your vision of a community space library that offers more space for people than for books immediately. This hurts a lot of people that feel very much attached to books and they will protest against this development"* (VI 2, own translation).

In other cities, the library space is already redesigned for different kind of activities and users. In Helsinki, for instance, there is a library in the neighborhood Espoo, which offers many games for young people and which is a noisy community place but as well still offers space for quiet learning. Due to its opening hours till 10pm the library is not only available for students and children (HE 1). The university libraries, for instance in Berlin, are used by students foremost to get in touch with other students and to flirt (BE 3, BE 7). To make the library space more attractive for the public in the Eastern part of London they have been renamed to "IDEA STORE." Hence, *"libraries are not a natural place to go, not the first place to meet" (LO 3).* In Barcelona public libraries are *"spaces to do performance and other activities in parallel and … offering cultural activities" (BA 6)*. One expert from Chicago (CH 2) stated that library space *"is not just face-to-face communication. I think its face-to-face collaboration. They offer the most important public space in the city, more important than parks, more important than the public way outside."*

At least libraries have started to implement "hands on" seminars and projects for their users. *"[In Chicago] we run classes there, we do arts programming there, we actually have startups that are getting free office space in our libraries and then they have to give back to the library. Run seminars and things like that. That's a great setup actually. Free rent plus these really talented individuals have to give something to the community"* (CH 2). The maker space is where those seminars are given at the Chicago public library (Figure 6-30). The Toronto public library as well has some business development and incubation taking place in the libraries (TOR 2). They also offer a printing machine to allow the public to create own books (Figure 6-30). But the question is, is this the role of a library? In Boston, for instance, these kinds of activities are more related to locations near the universities in Cambridge. *"We have some amazing libraries but… you might see that more in coffee shops. You might see this in Cambridge Innovative Center and its right next to MIT. And the whole building is full of startups, adventure capital firms, little research divisions*

of companies, and it must have a hundred conference rooms. The walls are painted with whiteboard paint. There are kitchens, and food, and coffee and you can just go there and work and collaborate and get a room whenever you need one. It's producing that kind of environment. It's really fast internet connection. The whole environment is set up for that kind of digital economy and collaboration and working together. And just like the innovation district at this side of Boston is building those types of modern spaces that the class of engineers, researchers, creatives want. This kind of buildings is what they want instead of libraries" (BO 2).

Figure 6-30: Maker spaces. Top both and right: Maker space at the Chicago Public library. Photo by: Carsten Brinker. Bottom left both: Toronto public library "Espresso Book Machine." Photo by: Agnes Mainka.

There are much more examples of the physical use of public libraries instead of being a quiet reading and learning space. Hence, this development is not only recognized in public libraries it happens as well in university libraries like at the Mc Gill medicine library as stated by one interviewee from Montréal (MO3). Though, there is now more space for the students than for the books. Accordingly, one expert reported how their physical public library in Vancouver (VA 5) is used recently: *"We do have folks that come here and engage in connecting learning opportunities. They are here for the space. They are here for the quiet. They use their laptop. We do have a project on the goal. We will be creating an "inspiration lab" or digital "media lab." That will also be flexible to allow for different types of entrepreneurial activity within the creative sector. For example, if there is a local resident with an idea and want to pitch it to someone remotely then we will have the room. We do have meeting rooms that people can use for different types of activity. I think increasingly people are seeing the library as not just a space. More people are recognizing the potential of the library as public space for beyond study and beyond kind of recreational uses. There is more potential for different types of things like entrepreneurial."*

Physical library service

As the discussion above reflects, there are many different ways how the physical space of a library could be used. According to a prior project by my colleagues and me (Mainka, Hartmann, et al., 2013), we have investigated the offered spaces and services at physical public libraries of 31 informational world cities. The indicator catalog of the physical library that has been investigated is presented in Table 6-7. In the following I will concentrate on the available spaces in the diverse libraries (learning, meeting, working, and children's space). As discussed by several experts, physical libraries play a crucial role as mediator between the digital and physical world. Therefore, the aspects of offered Wi-Fi and seminars on information literacy will be presented in addition.

Table 6-7: Indicators of the physical library. Source: Mainka, Hartmann, et al. (2013)*.*

Group	Indicator
spaces	learning spaces
	meeting spaces
	working spaces
	children's spaces
use of technology	RFID
	interlibrary loans (borrow anywhere and return anywhere)
	Wi-Fi
architectural landmark	architectural landmark
the attraction of spaces	drinks / food
	the attraction of spaces
information literacy	seminars on information literacy

In Figure 6-31 the different kinds of spaces that are offered in the public libraries of the 31 investigated cities are represented. Consider, only the central public library or the biggest library near the city center has been used as a reference of this investigation. According to the findings, the most common available spaces are for children. Except for the Shanghai Library, which is a public library joined with the Institute of Scientific and Technical Information Shanghai that offers additionally special industry information research, all public libraries offer children's spaces. Less common are working spaces that offer the opportunity to collaborate with others.

SPACES IN PHYSICAL LIBRARIES
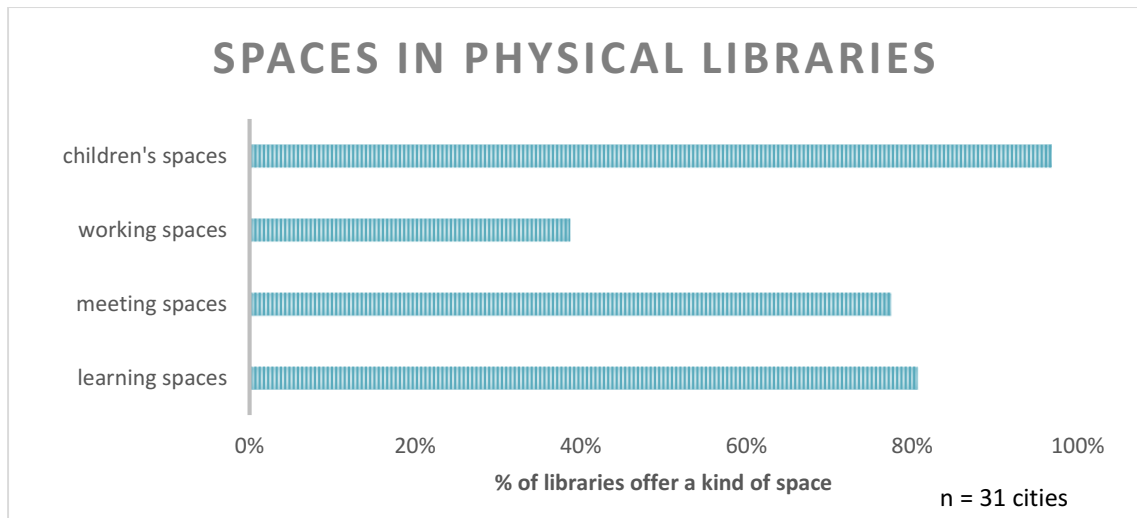
Figure 6-31: Spaces in physical libraries of 31 informational world cities. Data source: Mainka, Hartmann, et al. (2013).

Additionally, there do exist several more spaces in libraries than investigated here. For instance, the public library of Amsterdam is offering, in addition, a theater, a video screening room, music space, small single learning spaces, conference rooms, and furthermore a live radio broadcasting space (see Figure 6-32 for some examples). Spaces that are open for people who want to create something are called "maker space" or "innovation lab." As in the prior discussed examples of Chicago and Toronto most common are 3D printers but as well a book printing machine, media digitization systems, and other hands on stuff like digital designing are examples how people can become an active creator in a library. At the San Francisco public library, for instance, they are going to build a youth space that will include a sound studio (SF 1). Out of the 31 public libraries 40% are already offering some kind of maker spaces (Born, 2015).
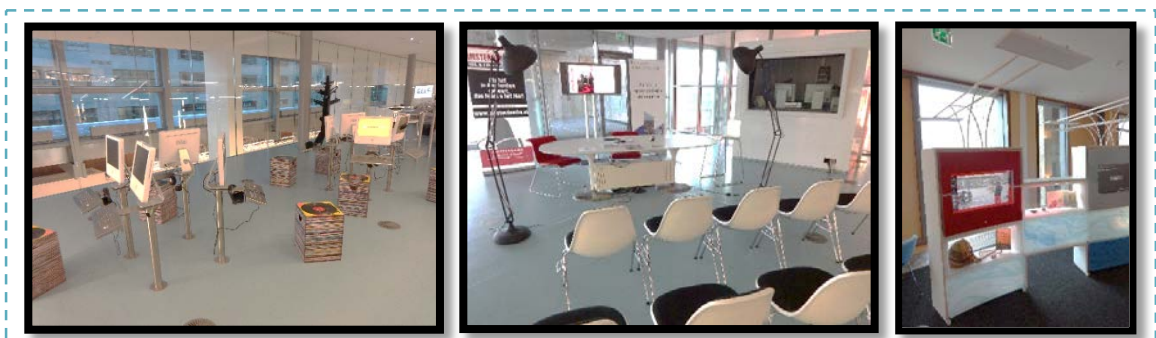
Figure 6-32: Spaces in the Amsterdam public library. Photos by: Agnes Mainka.

In addition, libraries play a crucial role as mediator between the digital and the physical world. Therefore, to offer Wi-Fi at the public libraries buildings enhance the connectivity to information for the whole society. Additionally, information literacy courses for people who are not familiar with technology and information retrieval are needed. Hence, according to the results of the study, 90% of the investigated public libraries offer a Wi-Fi connection. Some are free and

others are for registered users only. Just in very few cases, the user had to pay for the Wi-Fi connection. Seminars on information literacy are not available in each city. In total, 71% of the libraries do offer information literacy seminars. For instance, one librarian from the Toronto public library (TOR 4) reported that not everybody is using information literacy courses. They just ask people hanging in the library and they do help each other.

Libraries do not only act as a social inclusion space. The buildings and the space is designed in many cases to attract the citizens. In former studies, it already has been discussed that libraries are important "place makers" (Skot-Hansen et al., 2013). Thus, an attractive library could enrich a neighborhood. The public library of Vienna is one example that try to do that. As the chief librarian (VI 2) reported, the new building is next to red-light clubs which attract the attention of the police very often. Nevertheless, the library is frequently used by the public. The building is directly connected to the public transportation. One negative aspect of the architecture is the entrance which is not on the bottom level and therefore makes it not accessible for people in wheelchairs if the elevator is broken. Nevertheless, in the most cases (91%) central public libraries in informational world cities are attractive spaces that could be acknowledged as "place maker" (Mainka, Hartmann, et al., 2013). Some examples are presented in Figure 6-33.

Figure 6-33: Public libraries as "place maker." Top left to right: Amsterdam Openbare, Vancouver Public Library, Stockholm Stadsbibliotek. Bottom left to right: São Paulo Public Library, Paris Public Library, New York Public Library. Photos by: Carsten Brinker (São Paulo, New York), Agnes Mainka (others).

According to the weighted index of public libraries in informational world cities, the libraries in Montréal, Chicago, and São Paulo are ranked at the top looking at the physical library service only (Figure 6-27). Hence, the most libraries perform very well in this ranking. They offer a variety of services within the physical and the digital space. The only exception is Dubai. In 2012 the library in the old town was kind of an immigrant's newspaper room rather than used by the whole public

(Figure 6-34). And the digital library was not available online except for a short description of the library in English. According to the information on the governmental website of Dubai the website (www.dubaiculture.gov.ae) has been updated but no additional features, e.g. access to the digital library, are available (retrieved December, the 2nd 2016). The library seems to offer most activities and programs for children and in addition, a traditional library service with books in shelves and quiet reading areas. Hence,

Figure 6-34: Dubai physical public library. Photo by: Agnes Mainka.

Dubai as other cities in the Gulf have made a vast transformation in the last years and with it, in Dubai, many foreign investors and cultural influences arrived in the city (Kosior et al., 2015). Thus, it will be interesting to follow Dubai's transformation according to its increasing number of immigrants and investors from foreign countries.

Conclusion: Physical libraries are spaces for face-to-face communication

Summing up, libraries have made a transition in the recent years to meet the needs of the knowledge society in the 21st century. Hence, an increasing access to online resources is offered by the digital library whereas space for the public is growing in importance at the physical library. There is a trend of reusing the traditional library space in diverse manners. Of course, still space for quiet working should be offered but as well other needs should be met. Thus, the library is a space for the public to get access to information and to technology. Examples are the Wi-Fi connections and information literacy seminars in public libraries that offer the access to information for those who cannot afford it otherwise. Public libraries are mediators between the physical and digital world. Not only in seminars people can learn how to use information online, people in the library as well help each other as stated by one librarian from the Toronto public library (TOR 4).

That public libraries could serve as public space for face-to-face interaction is not a common interpretation by all interviewed experts. Hence, a lot of coworking spaces and incubators have opened their doors in recent years at which this use of space is more likely to happen (BO 2). However, coworking spaces are no public spaces. Entrepreneurship and startups are very common in cities of the knowledge society and public libraries can build a bridge between this community and the public like in the case of the Chicago public library. Here the entrepreneurs get free office

space to do a startup but they have to give back something to the community for instance by giving seminars on how to design objects for 3D printing (CH 2). As public institutions, libraries inherit an education task and should offer the amenities for life-long learning. Therefore, seminars that are run by smart individuals out of the community enable new opportunities. The library space is used in a new manner, individuals who like to share their knowledge get a platform to do that, and finally, the library can give something back to those individuals. For instance, in the case of the public library of Chicago, a win-win-win situation evolved—for the library which gets filled with life, the public which get access to fancy seminars, and for individuals which get free space for doing a startup.

Reusing the public library as open public space for interaction and collaboration needs to be implemented with caution and should not be established in a top-down development. There is a need to communicate the vision carefully and not to create the impression that the library is going to be closed or will not be able to serve the information needs. Depending on the community the needs can differ and therefore a library should not only open the space they should foremost open the dialog between them and the library and identify what the citizens want. This has currently happened, for instance, during the development phase of the new public library in Helsinki which will open its doors in 2018. This building is going to be a "place maker" with its special architectural design it will fill the new build neighborhood (next to the central station) with life. Hence, in most cases, the public library's architecture is a place maker in an informational world city (Mainka, Hartmann, et al., 2013).

Summing up, in most of the investigated hypotheses (H1-H7) San Francisco has been highly ranked. The city is of course one very interesting phenomenon evolved around ICT innovation. The San Francisco Bay Area is home to the elite university of Stanford. It has a high density of ICT related corporations and a thriving entrepreneurship landscape. Furthermore, through the public private partnership of San Francisco and Google the city is accessing free public Wi-Fi. As well the public library is very developed as represented through the 4th rank in the comparison of the 31 informational world cities. Special attention has been given in nearly all discussed hypotheses to the increasing importance of entrepreneurs and tech startups. However, in the following chapters it will be identified hence the political will and cityness will have a further impact on informational world cities.

6.2 Political will

The development of a city can be influenced by diverse factors. In this chapter, the political willingness of a city to become an informational world city will be investigated. In addition, the growing digitization of governmental services will be discussed. In particular, if the investigated cities are characterized by e-government, e-participation, and e-democracy. With this digitization process increased attention is being paid to the availability of open data and a free flow of information. The political will and its transformation based on an enhanced ICT infrastructure will be investigated according to the following hypotheses for the 31 cities:

> *H8*   *Political willingness is important to establish an informational world city especially according to knowledge economy activities.*

> *H9*   *An informational world city is characterized by e‑governance (inclusive e‑government, e‑participation, e‑democracy).*

> *H10*   *A free flow of all kinds of information (inclusive mass media information) is an important characteristic of an informational world city.*

H8 Political willingness

The political willingness of a city or region is most visible through agendas or master plans that define the goals of the future development. If these goals will be reached can only be investigated in retrospect. According to Yigitcanlar (2010), cities that have the willingness to become a knowledge, smart, or informational city focus, for instance, on a financial support and strong investments, on agencies to promote knowledge-based urban development, on an international, multicultural character of the city, metropolitan Web portals, value creation for citizens, creation of urban innovative engines, assurance of knowledge society rights, low-cost access to advanced communication networks, research excellence, and robust public library networks. As there are diverse examples of successful cities, e.g. New York, which is grown historically and mostly driven by its economic development, or Singapore, which has been led by a strong national vision, it is questionable which role the government plays in recent knowledge-based urban developments. Thus, the following hypothesis will be discussed accordingly:

> *H8 Political willingness is important to establish an informational world city especially according to knowledge economy activities.*
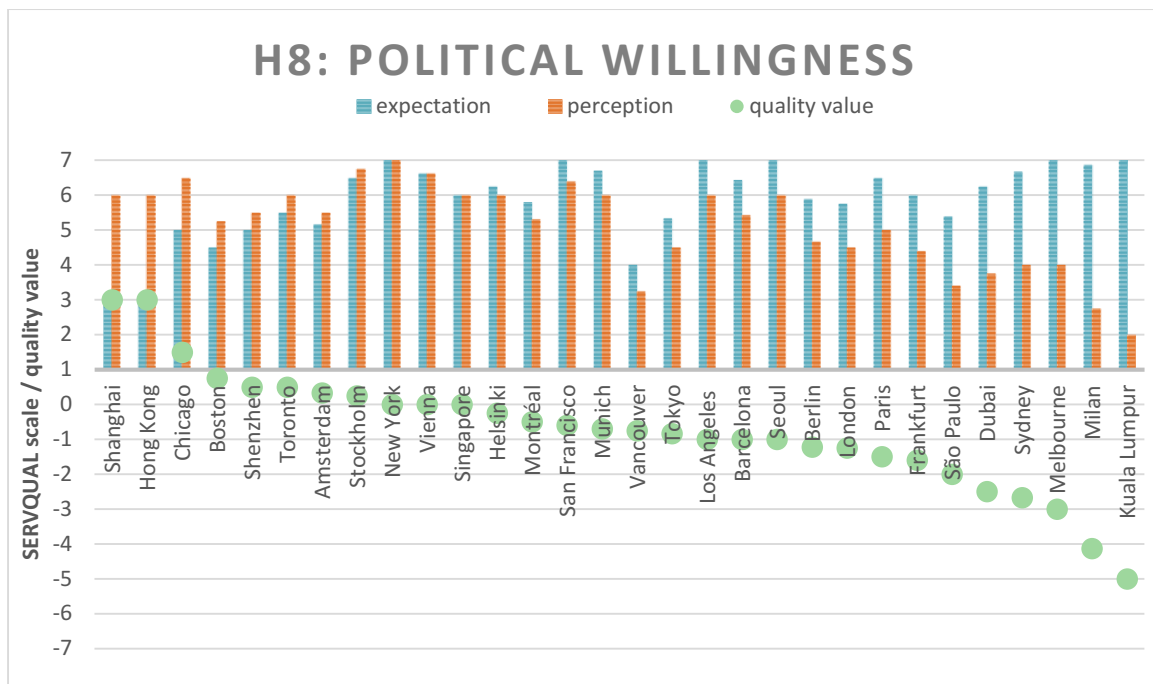
Figure 6-35: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the eighth hypothesis: "H8 Political willingness is important to establish an informational world city especially according to knowledge economy activities."

According to the interviewed experts, 46 have explicitly mentioned that the political willingness is very important to establish an informational world city. Eight experts stated that this development is only possible with a strong political willingness. *"If you do it without political willingness you will lose. You want to have support"* (CH 2). For another six experts, the political willingness is at least of help. Following the SERVQUAL evaluation (Figure 6-35), the experts from Shanghai, Hong Kong, Chicago, Boston, Shenzhen, Toronto, Amsterdam, and Stockholm have a higher perception of the political willingness than they would expect the importance in general. This assumes that in these cities in which the expectation is high the governmental influence to become an informational world city is acknowledged as positive. In Shanghai and Hong Kong the expectation is scaled below three in average which implies that the government had not been much involved in the development towards an informational world city. In New York, Vienna, and Singapore the perception of the political willingness is high. It is scored 6 and above. In these cities, the quality value is zero. Thus, the experts do approve that a strong political will can establish a successful informational city.

The perception of the importance of political willingness depends on the confidence in the political system (eight experts). Thus, *"if you are measuring the words of the politicians than of course [it is important], but when you measure the action than not"* (BA 3). *"[P]olitics can either help or hurt. But it is not necessary. A lot, in terms of being an informational city, goes back to the industry and what industry is doing. The government can really help that process or could really*

hurt that process" (TO 1). Accordingly, six experts mentioned that the political willingness is not important at all and that the development towards an informational world city is caused by the economy (eight experts). *"The willingness alone will not bring innovation. There are always people out of the society that brings the innovation. E.g. in the San Francisco Bay Area, Google and Apple have not been planned by the government"* (FR 4). Hence, the development of the knowledge society is a natural evolution (BA 8). However, many things happen without political interventions. For example, the Web 2.0 is not an invention of the municipality. It comes from the economic market and has grown into an own system at which people meet to participate (VI 1). To empower the economic market, the government may introduce tax incentives for companies of the knowledge economy to enhance the city's attractiveness to them (three experts). In total, the average quality value according to the importance of political willingness for 18 cities is negative. This implies that in most cities the political willingness could be stronger. For Vancouver and Tokyo, the expectation and perception are very low compared to the other cities. This implies that the interviewed experts do not agree that the political willingness would be important as currently, it is not in their city.

Summing up the interviews, money and funding are the keys for political power and impact (14 experts). Foremost, the government is responsible for the implementation of the needed infrastructures and spending on public welfare (three experts). Hence education is fundamental to become an informational world city, an adequate funding of education and universities must be ensured (ten experts). Additionally, it is of advantage if the city is open to highly educated people, open to smart city initiatives, and as well open to citizen's participation. At least open government initiatives like open public data increase the openness and transparency (five experts). In the following I will discuss the arguments given by the interviewed experts in more detail by discussing the political impact, funding possibilities, infrastructure issues, and finally the evolution of bottom-up and top-down developments.

Political impact

According to identify the political willingness of a city it is not easy to define whose willingness is of importance. Since the political willingness of a city can be another than the willingness of the whole region. For instance, *"[t]he Chicago region is heavy fragmented. So we have 300 units of different local governments in the Chicago metropolitan area. But the connection or the willingness to plan together, work together regionally, to create a vision, the prudential regulation signal is poor"* (CH 1). In contrast, one expert from Helsinki (HE 3) stated that the

political willingness is not only on the city level. The whole region is on the way to establish itself as an informational world city/region. To be determined by the region or nation can be of advantage but as well a disadvantage like one expert from Paris (PA 6) emphasized that the city government has no power. In Paris, the development of the knowledge landscape is governed by the ministry of the whole region and not by the city's mayor. Further, *"the advantage of London is that it is the central city of UK and government is centralized here. Nevertheless, the development and grow of London is not able to be controlled by politics. They can give incentives into the right direction"* (LO 1).

However, a problem could be that the political will is concentrated on one topic, as in the example of Vancouver. *"The political will is mainly focused on 'the greenest city,' and all that sort of thing. We did have a digital strategy committee… but it hasn't really had much impact and I think… they're too focused on [the greenest city] to give proper attention to the knowledge economy, digital creative city, informational city stuff. They have put some effort into it but not nearly as much as they could have"* (VA 4).

In New York, the city has made a vast step forward due to its mayor Bloomberg. He has introduced an information sharing system called 311 and open data (NY 2). Cities in the US are depending much on the mayor and his work. As well Boston has had a powerful development that is dedicated to the mayor's willingness. *"We have an incredibly understanding mayor, who pushes hard on this front. He really wants this innovation. The innovation district is really his effort… He is not digitally literate himself. He just understands how important it is and really pushes and supports this… He is a really good leader and you got to have that. It doesn't happen without that"* (BO 1). *"We have buildings for the digital innovation economy. They start having grants and things like that to give companies some incentives to be there. And that took a strong political will to make that happen. This rural transform in that area added jobs and technology etc. I think that stuff can happen anyway if the infrastructure is there like at Boston University. But the political stuff can encourage it that it grows"* (BO 2). This importance is as well acknowledged in other cities. For instance, in Munich, an economic board has been established that is working on the development of the labor market and economic development to push the knowledge economy (MU 4). In Seoul, the economic board was renamed to "ministry of knowledge" to represent the importance of knowledge within the economy (SE 1).

Funding

The political willingness is represented by its impact on the city's development and therefore funding and investment play a crucial role. Depending on the governmental structure funding comes from different units and is not decided by the city itself (ME 2). *"In Montréal, for instance, we have a special situation. The region of Quebec would like to become an own nation and due to this, the government of Quebec is investing a lot into the culture and other things that should enhance the development towards a knowledge society"* (MO 3, own translation). In general, how to spend public funding is important. In Los Angeles, for instance, a voting about the funding of the public library has resulted that 67% of the population are "pro" libraries. Thus, the government had to keep investing in the library system due to the citizen's democratic decision.

Decisions on governmental level are commonly hierarchical. In Canada, for instance, there is the federal, the provincial, and the city level. *"The problem is that the capacity of getting money is all at the federal level… So where I am going on that it's basically that political willingness yes, but it has to come from more than one level. The city wants to become a knowledge city it needs to be either very rich or to get the help of the federal government or the provincial government. We have got Ubisoft which is the French game creator company. They are benefitting from quite a lot of subsidies from the government… they don't have to pay taxes and some stuff. So we do see that there is a political willingness to create a city like that by having companies in the field of information in general"* (MO 2). Incentives seems to be a common procedure to attract companies of the knowledge or information economy. In San Francisco, for instance, Twitter is located in the city. According to one expert (SF 2), they have to pay fewer taxes to stay in the city and in return they have to hire local people. One expert from Shenzhen is arguing that *"the political willingness is about finance. Every single district is fighting against each other to attract companies to come to their district"* (SHE 1). Hence, China has introduced "Special Economic Zones" (SEZ) that should attract national and foreign companies. Therefore, laws and regulations like "Private Property Rights Protection," tax incentives, and a land use policy have been introduced (Wang, 2013). Amongst other cities in China, Shanghai and Hong Kong have set up those SEZs as well. The UAE have adopted a similar procedure and opened "Free Economic Zones" to attract foreign investments, e.g. at Dubai Airport Free Zone, Dubai Media City, Dubai Internet City, etc. (UAE Embassy in Ottawa, 2016).

Infrastructure

A city that is only driven by market regulations is not social (Robinson, 2016). Thus, cost of living, housing, and rents for offices are a problem which may or may not be the result of the government (BO 3). For instance, to intercept the high costs of living in Helsinki much funding is needed for students to access education. Nevertheless, *"the Finnish people are very proud of their very good educated children"* (HE 1). One interviewee from Vancouver (VA 1) emphasized that the governmental development is acknowledged as very slow. *"For instance, they have made a good job 20 or 15 years ago to implement the needed ICT infrastructure. But 5 years ago they talked about to open public Wi-Fi spots but in the end they did not. It was too expensive for the city. Thus, the big telecommunication provider implements the Wi-Fi hotspots and you are just able to use it if you have a contract from this provider"* (VA 1). Hence, the infrastructure is given but solely accessible for those who are able to pay for it. *"So the question is rather more basic and that is how do you even have enough money to take care of the infrastructures and services that are in place. Fire, roads, schools, police, water etc. So not alone information technology in addition to that… So people who can pay for the service will get it. But it's not a public service because we don't have any money for that kind of things anymore… [For instance,] LA is a working class city… So I just came back from Palo Alto, Silicon Valley, and the contrast in wealth is huge. There is a really rich white influent area. LA is not. And a lot of services are provided by private companies"* (LA 3). Hence, the key to wealth might be education as stated by several experts. For instance, *"Hong Kong was a manufacturing city before and now it is international and teaching in English"* (HK 3). The universities where smart people are educated are important (MO 1). E.g. Silicon Valley is not evolved due to political willingness rather due to the Berkeley and Stanford University. In Boston, the universities and knowledge people help to establish the knowledge and ICT industry, as well (BO 2). Thus, universities, science parks, and research institutes are important to become a knowledge society and to attract them reflects the cities willingness (MU 1, MU 3).

That education is important has been acknowledged but the problem of an adequate funding is still in question, in particular in São Paulo. *"Education is acknowledged as the major problem in São Paulo and in whole Brazil. In recent years the educational sector has made big efforts. Thus, we have enhanced the alphabetization rate, the access to universities and so on. Education will be the most important topic in future as well. The future will show if their efforts will help to manage this problem"* (SP 2, own translation). *"What is missing is to identify how this university knowledge can be transformed into economic goods and development"* (SP 5). Nevertheless, according to another expert the politicians in São Paulo do not have the long-term view to resolving the big problems (SP 4).

As already discussed in other matters of political willingness, the municipality or the city's mayor does not always have the power to impact the development. In Vancouver, for instance, the universities are under the control of the federal government and not under that of the city (VA 1). What can be supported by the political willingness is, for instance, the attraction of further research institutions to the city (FR 3). E.g. in Frankfurt a research hub is going to be established as the world's biggest research and development center of logistic and mobility. However, there is a difference in the finance model of scientific activities. In Germany, compared to Switzerland or the US, a tremendous amount is financed by the government and just to a less extent by private organizations and companies (MU 1). To keep the position of Munich as a hub for scientific activity in future a more diverse model in financing should be pursued (MU 1). In particular, London has the advantage that there is the very high concentration of finance and banks (LO 2) but according to another expert from London (LO 6), there is still a need for more funding, e.g. of projects on knowledge exchange.

Top-down or bottom-up?

In some cases, a development has happened without any political incentives. For instance, in Berlin, many things have happened because the politicians have not done anything against the development like for example, the startup scene in Berlin was a bottom-up evolution (BA 1). Yet, the startups are acknowledged as job creators that need to be supported. According to one expert from Berlin (BA 1), the problem in Germany is that those entrepreneurs are working with adventure capital. Thus, they make no profit and do not have to pay taxes. Finally, at the time of becoming profitable these startups are sold to foreign countries, e.g. the US or are transformed into a public limited company. In consequence, they cannot give anything back to the society. However, by ignoring some circumstances the government can help to flourish a development. Like in Shenzhen, there is a high amount of faking and hacking industry with which the government does not want to be associated with (SHE 2). Nevertheless, this industry is a fast and easy producing service for entrepreneurs that like to experiment and build prototypes. And this is what has made Shenzhen to a "Silicon Valley of Hardware" and attracts many entrepreneurs (WIRED, 2016).

In contrast, there are also initiatives by governments to push entrepreneurship and additionally citizen's engagement (top-down). *"It is interesting because the mayor's officers do strange initiatives... They having these 'the entrepreneur residents project'. They having this teams of two or three entrepreneurs who work to solve city problems that are mainly data and*

infrastructure related and that kind of initiative. They hoping that by sponsoring that through the mayor's office that they are going to be seen…. They are going to city departments like us [the public library]… and say: What are your big problems? Where are the places where you have troubles meeting the demand of your clients? And then will trying a respond for it like making apps for you or doing data analysis" (SF 2). Further, in Barcelona this kind of engagement is encouraged. *"We have a lot of activities which are done by the local government to engage citizens. A lot of things. Special programs for entrepreneurs like incubators for those people. We have the compact city model. Which means to mix industry and citizens at one cluster"* (BA 1).

Furthermore, *"[W]e need civil engagement to make the political willingness arrive"* (MO 6). To have citizen participation is an important aspect in enhancing the city's development. Thus, one expert from Barcelona (BA 8) stated that many projects are driven by democratic processes. *"This city has… to make a lot of steps to arrive at decisions with the civil society in urbanism, in mobility and in all the projects"* (BA 8). In Barcelona, a protocol has been introduced that specifies that each of the ten districts has to involve citizen's participation in development projects for the city and then find a common decision for the whole city. *"It's not an easy way to find a solution. I think we can improve the process but it is a good way"* (BA 8).

Nevertheless, in the 21st century, it is important to have a digital strategy for the city government and for all institutions including the public library (VA 1). All the plans need to be made visible to the society. Hence, for instance, in Vancouver, those documents are available online to the public (VA 3). Local benefits, public engagement, and the protection of civil and social rights should be the goals within this political willingness. But *"[t]he vast majority of investments in it are being made simply in the interests of profitable returns. Our political leaders are not shaping the markets in which those investments are made, or influencing public sector procurement practises, in order to create broader social, economic and environmental outcomes"* (Robinson, 2016, para. 35). According to Robinson (2016), the municipality is not in question to identify own ideas or to be creative. The creativity is already in the society and developed in many small startups. Political leaders need to invest in those ideas and transform them into "top-down" developments to reach a real impact on the city. This can be done by the government through bridging the institutional levels of the economy, university, and community.

Conclusion: Political will

The discussion on the political willingness has reflected that there is no "right" answer. In some cases, the interviewed experts have not seen the necessity of political interventions. For instance, in London, the interviewed experts are not convinced that politics will have much impact

on the knowledge economy (LO 1). However, in many more cases, the experts agree that a political willingness is important or at least is helpful. Furthermore, the question arises whose political willingness is of interest when it comes to the cities development towards becoming an informational world city. Thus, there are different regulations and authorities that are responsible e.g. for the educational system and the attraction of universities. From the economic perspective, different approaches have been made to attract companies, e.g. by the introduction of "Special Economic Zones" or "Free Economic Zones" in China and the UAE, or by tax incentives for companies like in Montréal and San Francisco.

The most common argument mentioned by the interviewed experts is that the political willingness in an informational world city should at least ensure an enhanced educational system. In addition, the attraction of universities and science parks is acknowledged as the basis for a further development. Hence, the best example, that has made a vast development within the knowledge economy, is Silicon Valley which has its roots at the Stanford University. The support of enhanced infrastructures, as for example citywide public Wi-Fi, is acknowledged as a consumer good that may be offered by private companies. Finally, the cities development has not only been driven by top-down initiatives of the government. Citizens' engagement and entrepreneurs may come up with creative ideas to solve urban problems. Accordingly, the government is in question to push these developments and enhance it through an adoption into "top-down" programs. One example was given by San Francisco and its "entrepreneur residents project" by bringing together startups and city institutions to identify and resolve problems through data analysis or bringing up new mobile app services.

There exist no index or measurement tool that can be used to identify and compare the political willingness on a global scale. Hence, in this subchapter real world examples have been discussed that can give a short insight on this complex problem. Thus, it is hard to identify whose political willingness is determining the development of a city and in addition to which extend a mayor or municipality is able to impact it. Attempts to include the political willingness as measure within a framework of knowledge cities development have been introduced, for instance, by Ergazakis, Ergazakis, Metaxiotis, and Charalabidis (Ergazakis, Ergazakis, Metaxiotis, & Charalabidis, 2009) in their article "Rethinking the development of successful knowledge cities: an advanced framework" or by the "Most Admired Knowledge City Award" (MAKCI) which is based on the knowledge-based urban development framework by Yigitcanlar, O'Connor, and Westerman (2008). Hence, both approaches are no manageable research methods on a global scale since not every city is providing a master plan on how to become a knowledge, informational, or smart city. Nevertheless, both approaches are emphasizing best practice examples of knowledge cities and

how political willingness impacts the development of those cities. For instance, Melbourne has been investigated as best practice example and is the winner of the MAKCI Award in 2010, 2013, and 2016. *"However there is a good evidence from the Melbourne experience that education and R&D institutions, three tier government and communities are altogether supporting the emergence of Melbourne as a [knowledge city] KC. Global recognition of Melbourne as an emerging KC and processes that have been established in Melbourne provide some useful insights for policy makers of other cities in designing, developing or moving towards a KC"* (Yigitcanlar et al., 2008).

H9 E-governance

Political willingness in an informational world city is as well represented according to its implementation of e-government services, e.g. "metropolitan Web portals" (Yigitcanlar, 2010). Due to an advanced ICT infrastructure, digitized services may help to solve urban problems. Further, they may be used in diverse ways for a citizen to government, business to government, and as well for the government to government interaction and transaction. With the 24/7 access to information through the web a demand for such a service offered by the government on public information has emerged (United Nations, 2016). The idea of e-government is not new but the implementation of adequate services is still in progress. Additionally, the online availability has opened further possibilities like e-participation and the integration of diverse stakeholders in decision-making processes to enhance e-democracy. Combining online services, enhanced possibilities of participation, and the integration of diverse stakeholders in the decision-making process is labeled as e-governance (Harrison, Burke, Cook, Cresswell, & Hrdinová, 2011). Hence, the maturity of this development may differ due to diverse reasons. To identify the state of the art and reasons that hinder the development of e-governance, the experts have been asked if they verify the following hypothesis:

H9 An informational world city is characterized by e‑governance (including e‑government, e‑participation, e‑democracy).
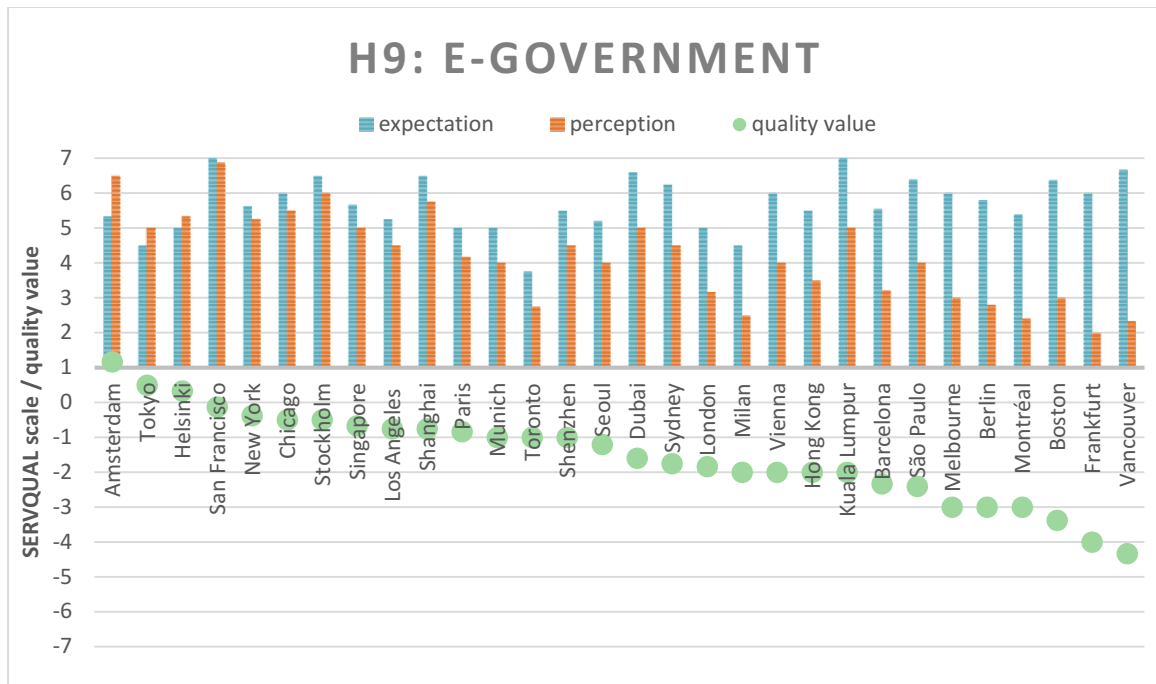
Figure 6-36: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the ninth hypothesis: "H9 An informational world city is characterized by e-governance (including e-government, e-participation, e-democracy)."

Looking at the SERVQUAL evaluation a negative quality value can be observed for the most cities (Figure 6-36). This indicates that for the experts in these cities the perception of the own development is under the expected maturity in an informational world city. Hence, experts from 25 cities have stated explicitly that they have e-government and respectively in eight cities that they have additionally e-participation. It is common to offer online information about the city and the government but a platform that asks for citizen's engagement is hard to find. In contrast, according to nine experts, there is no e-participation either e-democracy in their respective city. Hence, e-services should not replace the traditional system of voting. The enhanced ICT infrastructure should be used on top of face-to-face discussion and personal participation (SP 5, MU 3). Further, ten experts do not see the necessity of e-governance as a characteristic feature of an informational world city. "*You can have an informational city without e-government. It's another kind of. You don't need citizen participation when you look at some Asian cities*" (BA 1). According to another expert, without e-governance: "*[y]ou have characteristics of an informational city but e-governance is part of the outcome of the complete package*" (TOR 1).

To debate the characteristic features of e-governance and the maturity of this development in the 31 informational world cities I will refer to a former investigation of governmental websites by my colleagues and me (Fietkiewicz, Mainka, & Stock, 2016; Mainka, Fietkiewicz, Kosior, Pyka, & Stock, 2013). Accordingly, there are five pillars of e-governance: (1) information dissemination, (2) communication, (3) transaction, (4) interoperability (horizontal integration), and (5)

participation. Based on the fifth pillar, participation, the integration of enhanced democracy is able to be established through a decision-making process that includes all stakeholders (Harrison et al., 2011; Palvia & Sharma, 2007). Following one expert from Munich (MU 1), e-services are a special need of people of the creative class. The creative class used to be independent and autonomous. Thus, those people would like to have a voice in decision-making processes and they want to have all that kind of e-services to save time. Hence, to share the power in collaborating projects is acknowledged as e-governance or open government (Harrison et al., 2011). Accordingly, I will discuss in the following, first, the maturity of e-government and second, the implementation of e-governance on the city level.

Furthermore, there is an increasing demand on opening governmental data to the society as stated by several experts as part of e-government. The availability of open data on the city level is part of the governmental transparency and will be discussed in the subchapter H10 Free flow of information.
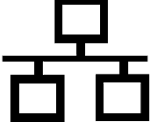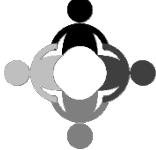
Maturity of e-government

As already described in the measuring methods of the political will, e-government and e-governance are not to be used synonymously. E-government describes the services that are available through ICT (Palvia & Sharma, 2007), e.g. websites, social media, mobile applications, etc. And e-governance is referred to the collaboration aspect of managing the city. With the use of ICT, participation and decision-making process can result in an open government (Harrison et al., 2011). That there are diverse degrees of maturity is visible, for instance, through the "United Nation E-Government Survey" which is based on national data (United Nations, 2016). They have investigated 193 nations around the globe. Accordingly, nearly half of the nations are acknowledged as having a very high (15%) or high e-government development (34%). Thirty five percent have an average and 16% a low e-government development. Most of the informational world cities investigated in the work at hand are located in one of the very high developed nations. Exceptions are Shanghai, Beijing, and Shenzhen in China, São Paulo in Brazil, and Kuala Lumpur in Malaysia which at least belong to the high developed nations.

Next to the ICT infrastructure (based on the "Telecommunication Infrastructure Index") and human capital (based on the "Human Capital Index"), the "E-Government Development Index" includes the scope and quality of online services (United Nations, 2016). Accordingly, to investigate the maturity of e-government on the municipal level for the 31 informational world cities, the available online city platforms have been investigated by my colleagues and me

(Fietkiewicz et al., 2016; Mainka, Fietkiewicz, et al., 2013). We prepared a survey on the five pillars of e-government (Table 6-8).

Table 6-8: Five pillars of e-government based on the five-stage model in accordance to Hiller and Bélanger (2001).

5	PILLARS OF E-GOVERNMENT	
	Information	Make information online available; Inform citizens through mobile applications for instance about current news.
	Communication	Open the conversation between the government and citizens (or businesses) through ICT; Using social media channels to reach the citizens where they are.
	Transaction	To pay taxes or apply for licenses online. Citizens are able to make a verified transaction with personal e-IDs.
	Interoperability	To share information across organizational/administrative boundaries.
	Participation	Involve citizens and other stakeholders in decision-making processes.

This five-pillar model is based on the five-stage theory of Hiller and Bélanger (Hiller & Bélanger, 2001). As the online available e-services are not introduced step by step the terminology used has to be switched from stages to individual pillars. For instance, a municipality does not have to install online transaction services before they start to enable public participation. Both can happen individually. According to one interviewee (BE 1), the implementation of e-government services is dependent on the people working for the administration and their willingness to use and introduce new services. In the following, the investigated pillars will be discussed according to the results identified for each city (Figure 6-37).
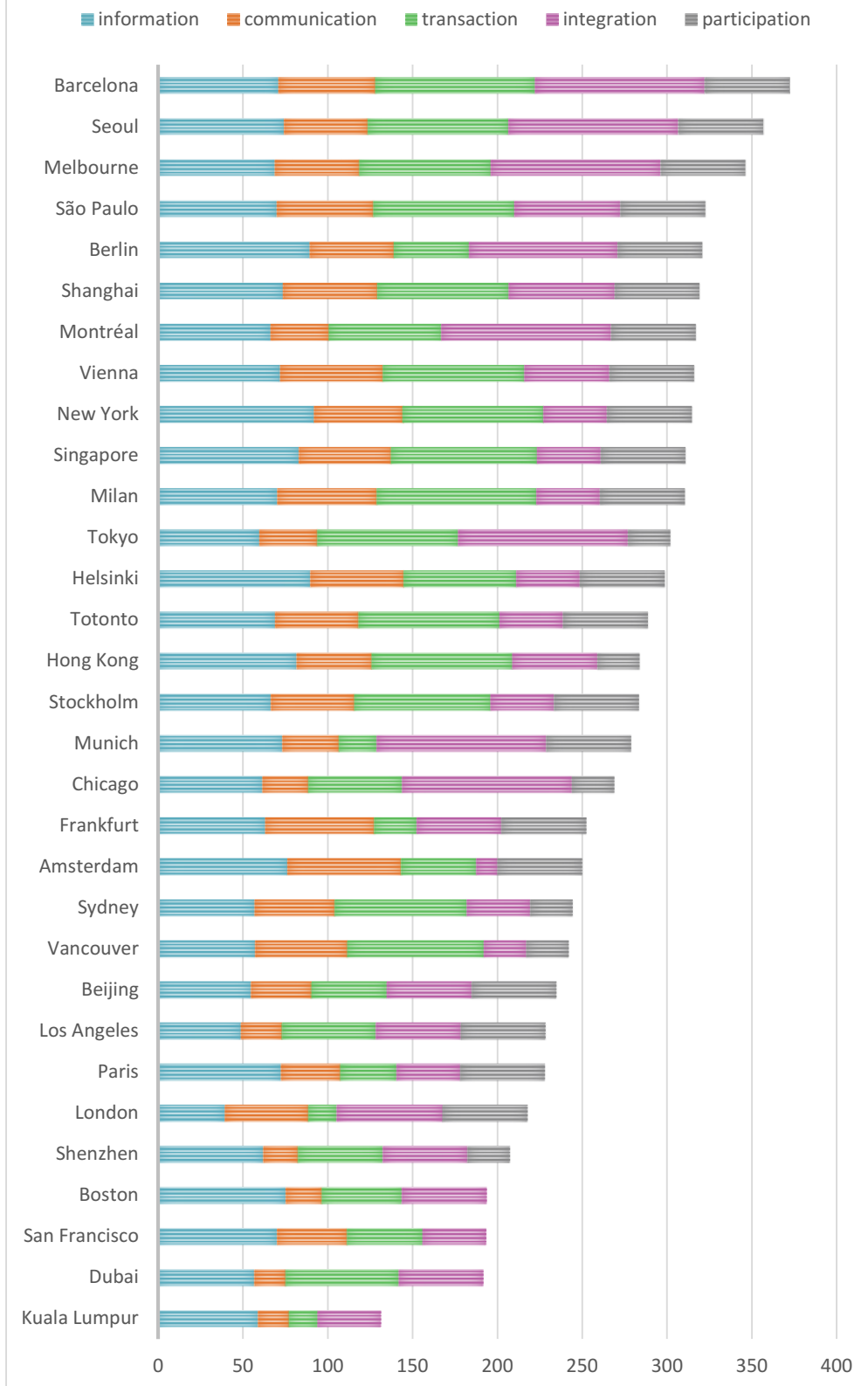
Figure 6-37: The maturity of municipal e‑government for the 31 informational world cities. Data source: Mainka, Fietkiewicz, et al. (2013).

Pillar 1: Information

To make governmental or city information online available through municipal websites is the first pillar of e-governance. According to our survey the municipal websites of New York, Helsinki, Berlin, Singapore, and Hong Kong offer the most of the requested information online. Thus, one can get for instance information about actual press releases, information on health care or about politics. In addition, the availability of that information can be investigated by the usability of the websites. To provide access to the citizens accessibility standards are needed. According to the usability of the municipal websites Vienna, Seoul, Shanghai, Stockholm, and Munich are the top rated municipalities (Mainka, Fietkiewicz, et al., 2013).

During the interviews some experts started to explain what kind of online information they think is of importance. For instance, information like FAQs (SY 1) or the availability of future governmental plans (ST 1) have been stated as important. A further argument to offer online information is, that the governmental services could be easily translated in the most spoken languages instead to train the staff to speak all of them (BE 1). This is as well, part of the survey on the first pillar that asks for the translation of the municipal websites into the three most spoken local languages and English. Hence, Hong Kong is offering much information online but this is not to be equated with e-governance. According to one expert (HK 1), the government in Hong Kong is not digital: *"Everything is print on paper. In China, in general, pdf documents and e-mail correspondence does not count as an official record. You print out the e-mail and stamp it so that it counts."* Thus, it is not clear for the public if the available information could be count as liable. In contrast, other cities use social media channels to spread current information to the public. For instance, Twitter is used as an information channel for news in Tokyo, like warnings for earthquakes or smog (TOK 4).

Even a city is offering a lot of diverse information, this does not mean that the city is transparent (CH 1). To offer information online and to offer open data are two different things. Hence, a municipality can offer some data they like to see in the spotlight. Open data, instead, is based on the public right to information law, for instance, data on public spending. Cities that are located in nations or regions that have established access to information laws are per se acknowledged as more transparent (Corrêa, Corrêa, & da Silva, 2014). According to Relly and Sabharwal (2009), nations that first introduced laws on transparency are the Scandinavian nations; Sweden in 1766, Finland in 1951, and Denmark in 1964, and the United States in 1966. These nations are the forerunner on the way to open government. However, a right to information law is not to be equated with open government per se (World Justice Project, 2015).

Today, many cities, regions, and nations have introduced open data portals that offer free access to a variety of open urban government data (Mainka, Hartmann, Meschede, & Stock, 2015b). These data are about local information in a machine readable format and thus are reusable for instance, in data visualizations or mobile applications. In combination with real-time data, those information become valuable gadgets in the citizen's everyday life (Mainka, Hartmann, Meschede, et al., 2015a). *"We have Apps like the parking App which informs me if I need a new park ticket or the bus app which informs me whether the bus is working…"* (SF 1). Finally, mobile applications make governmental and city related information ubiquitous available.

Pillar 2: Communication

The second pillar is referred to two-way communication. As investigated for the 31 informational world cities in many cases it is possible to make an appointment with a respective authority online, to correspond through email, and comments and feedback are welcomed. The most mature municipalities according to their two-way communication are Amsterdam, Frankfurt, Vienna, Milan, Barcelona and São Paulo (Mainka, Fietkiewicz, et al., 2013). According to one interviewee from Helsinki (HE 1), e-services are used to communicate with city administration: *"People working in city departments are easily available through email or through their social media channels."*

In particular communication within the understanding of e-government includes social media as an additional possibility to a phone call, email or other contact methods. Today, it is a common practice for governmental agencies to use Facebook, Twitter, or YouTube as a communication channel (Mergel, 2013). According to a further investigation on the social media use of the 31 informational world city's municipalities, we have identified that in average general government accounts are run on 5.9 different channels (Mainka, Hartmann, Stock, & Peters, 2015). General government accounts are referred to social media profiles that are representing the official municipality or official city website. In addition, further social media accounts are created for diverse agencies, institutions, or political persons. As presented in Figure 6-38, Barcelona is the city with highest number of diverse social media channels followed by Melbourne, Sydney, Munich, and Boston. For instance, Boston is represented on diverse channels especially due to accounts that are created for governmental agencies, institutions, and political persons and not only by general government accounts.
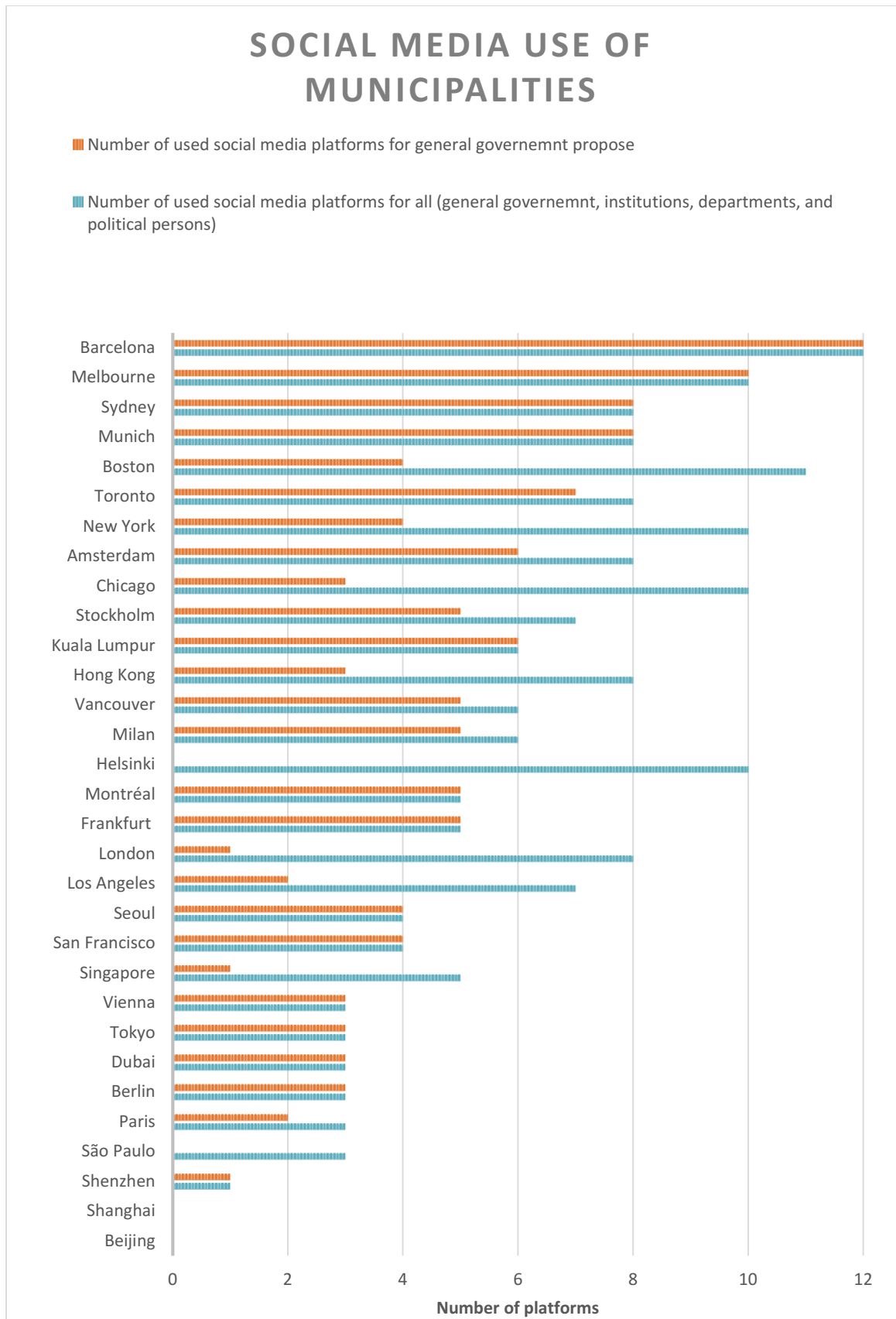
Figure 6-38: Social media platforms used for governmental purposes in informational world cities. Data source: Mainka, Hartmann, Stock, et al., (2015).

The most common platform is Twitter. In total, 24 out of the investigated cities are using this platform. The Chinese counterpart, called Weibo, is used by two cities, Hong Kong and Shenzhen. The second most used is YouTube followed by Facebook. Accordingly, the most published content by governmental accounts can be counted on Twitter which is due to its simple and short posting possibilities. Berlin, for instance, is posting about 500 tweets per month. The government of Seoul is tweeting nearly as often as Berlin and additionally use blogs as regular publishing method (40 posts per month). Furthermore, it is very common to use photo broadcasting platforms like Flickr and Instagram. Barcelona, for instance, has posted round about 70 pictures on Flickr and 30 on Instagram per month. The common idea to use social media platforms is to reach citizens where they are. In accordance with the investigated platforms, the most followers have been reached at Facebook and Twitter/Weibo. Hong Kong and Shenzhen have reached follower numbers of about 600,000 and 300,000 respectively. Nevertheless, this is only 8.3% of the population in Hong Kong and 2.8% in Shenzhen.

Social media channels are only one of several communications possibilities with the city or city department. For instance, in Boston, a citizen's relationship management (CRM) system called 311 has been introduced. This is a service where people can call, walk in personally, or communicate through a mobile app. This is a direct communication channel for the citizens. *"There is a pothole, there is a streetlight out, my trash didn't get picked up, the sidewalks were broken, those kinds of infrastructure issues [are managed through 311]"* (BO 2). *"Like ten years ago the people don't think like 'Oh, let's send a report while a streetlight is broken to the streetlight department' and think they will fix it. [Today,] you make a photo, mark the location and it goes right to public works. And when public works fix it you will get a notification back. Ten years ago that was not possible. For people to have that kind of interaction with government… becomes very important… I just go online to do this. I think it's really important to keep the government in a conversation on innovation"* (BO 2). Citizen's relationship management systems are adopted by companies that are using those systems to enhance their customer relationships. Hence, understanding citizens as customers' is one aspect of the changing philosophy towards an open government that is giving the society a voice in city development.

Pillar 3: Transaction

This pillar refers to all financial and non-financial transactional e-government services. For instance, to fill out a form online and wire it directly to the appropriate administration without printing or to pay taxes online. According to the maturity evaluation of the 31 cities (Mainka, Fietkiewicz, et al., 2013), Milan and Barcelona are the most mature cities referring to transactional

e-services whereas Kuala Lumpur and London are the last. *"E -services are something that the population today is expecting. That you can communicate online or order postal voting ballots through an online form helps a lot" (BE 1, own translation).*

Many municipalities have introduced online identities to offer transactional services. According to the interviewed experts, the population in Sweden as well as in South Korea can manage nearly each transaction online while using their personal online ID (ST 4, SE 2). In Singapore, the population is able to use e-government services with their "Singapore Personal Access" (SingPass) which is offering service to about 60 agencies (SG 5). Online IDs have already been introduced in diverse countries to offer verified e-government services. Due to its digital identity card Denmark and the UK are highly ranked within the UN e-government development ranking in 2016 (United Nations, 2016).

On city level, further services and online transaction possibilities have emerged by smartphone applications. A city that is offering many of those mobile services is Dubai. The governmental mobile application can for instance forward penalty notice for speeding (DU 3). Furthermore, the application is based on many sensible personal data. Hence, husbands get an information alert in real time if their wife is going to leave the country (DU 2).

Mobile applications can be combined with other city services like paying for a parking ticket or bus ticket. Hence, using ICT for sensible personal data or payment the service need to be secure and trustworthy (Srivastava, Chandra, & Theng, 2010). According to an investigation of mobile applications that are based on open urban government data, only 17 apps out of 471 offer mobile payment (Mainka, Hartmann, Meschede, et al., 2015a). Many, of the investigated apps, are covering topics like public transportation or traffic but most are mainly designed to transfer information in combination with geographical maps and GPS. In the US, for instance, to use mobile payment applications is a growing market but it is slowly accepted and most adapted by younger generations (Board Of Governors of the Federal Reserve System, 2016).

Pillar 4: Interoperability

The fourth pillar refers to information sharing across governmental and non-governmental organizations. It is stressed that organizations need to define a common standard to work within a network (Gottschalk, 2009). While the technical process of data sharing seems to be a manageable issue the integration of standards within the knowledge transfer on the semantic level is acknowledged as difficult (Cullen, 2010). Further, the level of integration between governmental agencies is introduced most in the back and is not presented on governmental

websites. Hence, only municipalities that are publishing their governmental goals including the use of ICT could be investigated. One example is Singapore that is publishing and informing their citizens how they introduce ICT solutions on a municipal level by their city development plans. Thus, one important aspect was to emphasize that the governmental agencies are no silos. Instead, the action plan has stressed the interagency collaboration (Ke & Wei, 2004).

According to the investigated municipal websites, the interoperability has been investigated from the users perspective (Fietkiewicz et al., 2016). Websites that offer special entry pages for diverse user groups or include standardized forms could be count under the term "boundary objects." These documents make it possible to share asynchronous knowledge among diverse user groups, e.g. through an introduction on how to use a document. However, municipal websites share information to all citizens and can enhance the accessibility of this information through boundary documents. From the investigated municipal websites only Tokyo's governmental websites offer a "how to use" guide and 26 websites offer separate entry pages for different stakeholders, e.g. business, citizens and tourists. Nevertheless, this is only a method how the government can make information better accessible for different user groups but does not tell us anything about the information sharing between the agencies within a municipality. According to one interviewee from Barcelona (BA 2), it is a big problem that governments do not work together. Instead, they often have to fight against each other, for instance, to apply for a higher budget.

One good example of interoperability is the citizen's relationship management system 311 in the US. This system has been introduced, for instance, in Boston and New York to manage government to citizen's interaction (Hartmann, Mainka, & Stock, 2017). It is kind of an one-stop shop where citizens can access all governmental (non-emergency) services they need. It is available through a mobile application, the internet, phone and personally. Thus, 311 is able to be accessible by every user group. Additionally, through 311 a diversity of services is available through one platform. Hence, all governmental services need to be connected to the network of 311.

Today, many online portals can be found that offer open governmental data which contains non-personal public information. Those exist on a regional level, e.g. the European Union (data.europa.eu), national level, e.g. Germany (govdata.de), as well as on a municipal level, e.g. Munich (opengov-muenchen.de). The amount and quality of the data vary between these portals. In an investigation of the open data movement in Amsterdam, Barcelona, and Paris, for instance, the cities have offered from 130 (Paris) up to 424 (Amsterdam) datasets (Mainka, Hartmann,

Meschede, et al., 2015b). The data has been available in different formats, e.g. non-machine readable as images and PDF documents and machine readable as CSV, XML, or JSON. Generally, the data at those portals is gathered from diverse sources, mostly governmental agencies, interoperability is needed to make them accessible within a common standard. In the cases of Paris (opendata.paris.fr) and Barcelona (opendata.bcn.cat) both platforms are hosting the data and therefore need to be able to integrate the diverse sources. Amsterdam (amsterdamopendata.nl), instead, is a meta-platform that is linking to all city-related data sources and thus has no integration at one place. Finally, for users or app developers, it is easier to use one platform instead of metadata like in Amsterdam, hence the access is offered at one place with one common standard.

Pillar 5: Participation

The last pillar refers to e-participation and focuses on an enhanced democracy by including further stakeholders in decision-making processes. Online participation can be realized for example through online surveys, political discussion forums or online voting (Fietkiewicz et al., 2016). However, the involvement of non-governmental persons in discussions on future city plans is introduced most in case studies and has not become a standardized practice (Susha & Grönlund, 2012). Accordingly, with e-participation new challenges have to be faced (Sæbø, Rose, & Molka-Danielsen, 2010): On the one hand, to identify the right stakeholders and furthermore to address them during the development and decision process and on the other hand, to open the political administrations towards a participatory cooperation.

With reference to our study on the maturity of e-government (Mainka, Fietkiewicz, et al., 2013), e-participation has been investigated according to the possibilities of citizens to become involved in online surveys, available forums for questions and discussion, online participation in community meetings and finally, according to online voting possibilities. The most municipalities offer online questionnaires to involve citizens (23 cities) and second most common are discussion forums at which citizens can communicate and ask questions (21 cities).

Accordingly, in Frankfurt a website has been introduced, called "Frankfurt gestalten" (frankfurt-gestalten.de), which is inviting all citizens to discuss city planning and problems to create a better quality of living (FR 5). But to which extent these attempts impact the decision-making process is not clear for the interviewed experts. According to the website's own description, the focus is to make political information more transparent for citizens. Therefore, people can identify information about political decisions with reference to their location, for instance, the neighborhood they are living or the city center where they are working. To

communicate at this platform only citizens are addressed. If politicians and administrations are aware of the discussions at this website is not clear.

Another expert has emphasized the use of a software which allows citizens to comment directly on a map (HE 4). The methodology used called SoftGIS is rest upon geographical information which was developed at the Aalto University in Helsinki (Kyttä, Broberg, Tzoulas, & Snabb, 2013). It is based on a citizen's survey that includes the location of the respondent participant to identify environmental issues for the urban planning process. In other cities, e.g. Stockholm or Boston, the city uses social media platforms to involve citizen's participation (BO 1, ST 4). *"You can do almost anything here digitally. There are tons of opportunities for online participation. From social media to surveys to forum systems. The city is pretty connected. It's a small city. It's a lot easier here than in a city like New York City. But the mayor is absolutely admitting about hearing the voice of everybody. Of all the constituents… [T]here is always room for improvement but we do it very well"* (BO 1).

One expert from Helsinki (HE 2) is criticizing such platforms. According to him, a discussion platform has been established but not many citizens have used it and in many cases, the comments have been at a very low level. A further argument from Hong Kong is, that the people would not have the time to participate in decision-making processes (HK 2). An equal statement has been given by an interviewee from London (LO 1). He considers that the people do not care about politics they just care about their personal issues. Today, a fast possibility to participate are online petitions. The people create e-petitions for everything but if they are helpful is another question (BA 2). In addition, it is questionable if those have the same weighting like paper petitions with signatures. However, if the citizens are the only user of those platforms and their voices never get heard by decision makers e-participation and e-democracy are not fulfilled. *"I mean they still do projects without informing really. They inform the people once the project is designed and ready to go… There has been a project where they say they've done more… [T]hat is the project of 'Les Halles'… So they've said that they are going to do a large so-called participation process which has been, in my point of view, a caricature of a participation process"* (PA 2). In Paris, there is no e-participation or e-democracy (PA 6) and there is not enough transparency as for instance on budget spending (PA 6). *"We are in the middle age of participation in Paris… [But] I'm not sure there is even an awareness of the problem"* (PA 2).

Nevertheless, it is becoming more common to involve citizens in the decision-making process (Janssen & Helbig, 2016). In São Paulo, for instance, one interviewee has stated that the city is actively promoting participation processes in city development plans, e.g. with posters in

the metro stations which invite the citizens to get involved. E-services could add incentives to reach more people but not to replace personal communication (SP 5). To make everything just online makes the people anonymous. This would be dangerous to have e-democracy and e-voting. It is important to take the time to vote personally (LO 7).

Implementation of e-governance

E-government services have enabled further possibilities to share information, to communicate, to make transactions, to cooperate and finally for citizens and businesses to participate in political processes. The utilization of these possibilities to enhance planning, innovation, and funding e.g. on the municipal level is called "e-governance" (Palvia & Sharma, 2007). And to acknowledge citizens and businesses in a city as important innovators in the decision-making process is labeled as "open government" (Harrison et al., 2011). Hence, this is referred to the term "open innovation" which originates from economics and is used to define the free flow of knowledge and innovation between different stakeholders (Chesbrough, 2003). On city level those innovation flows can occur if the government accepts innovative ideas from outside their agencies, e.g. from citizens and businesses. Together they may enable, for instance, new services based on open data or establish better conditions to start a business.

"It only helps in so far as your creative class looks at the government and says: 'They value the things we value…' But often times that creative class just looks if the government is not doing that. 'Who cares? We do our own thing!' And they do… Chicago was like that for a long time. Before mayor Manuel came in, we were not an e-government and yet we have a still thriving information economy" (CH 2). Therefore, to establish e-governance or open governance the community need to be active and engaged. According to some experts, this is only possible if the community trusts in the government and acknowledge the political willingness of their municipality. In Milan, for instance, one interviewee has stated that there is a lack of political willingness to implement e-governance (MI 7). Thus, the citizens do not see the possibility to participate. A further interviewee from Tokyo mentioned that the politicians in Japan would have no good standing (TOK 3). Therefore, young people are not interested in politics and election turnouts are very low. In Barcelona, an equal problem exists as one expert has stated: *"The problem is that we don't have much experience in e-participation and e-government or democracy. The councilor has asked the people: 'Which project would you prefer to be realized?' The people's option was 'none' because they don't want this councilor and representatives at all"* (BA 3). In

general, there is a skepticism that e-services will lead to more democracy. Hence, *"how many really have e-democracy in the world? This is very low"* (BA 1).

Furthermore, the political willingness is as well about to integrate all people working for the administration. They should also get the feeling that the digitization process is able to help them in their everyday work and does not only constitute more difficult work process. Currently, in Barcelona, there are a few forerunners that implement some good ideas but there is no common standard how to implement e-government services (BE 1). Thus, the availability of e-services depends on the administration's willingness to implement them. For instance, in Frankfurt the immigration administration has no e-services whereas the city office supports many online applications (FR2, FR 3). Finally, in particular, in Germany, e-government seems to be a national development that is only adapted if it is implemented by law (BE 7).

However, e-governance goes one step further and asks for a share of power between all stakeholders in the city (government, citizens, organizations, business, etc.). In Boston, for instance, *"[t]he political system is partly conservative and doesn't welcome a kind of distribution of power and loss of central power"* (BO 3). In Tokyo, e-governance is not possible because there is no horizontal integration (TOK 2). The agencies do not work together and that makes it difficult to invite further parties to cooperate. And São Paulo is a city that seems to be very far away from this development as one expert stated: *"I don't think I will see it in my lifetime here… It will require a lot of changes in the mindset of the politicians, of the population... This would be a dream"* (SP 4). This change in the mindset can be observed, for instance, at some projects of developing public services like to build or rebuild public libraries (Mainka et al., 2016). Thus, the public library of Helsinki has actively engaged the citizens in the design development of the new public library. They call it "open and participatory planning." Hence, if the users of the library have been involved in the development they have a feeling of ownership and stronger affiliation to the library.

Accordingly, to identify open government initiatives first indices have been introduced that are investigating the degree of participatory and democratic governance on a national level. One example is the "Sustainable Government Indicator" introduced by the Bertelsmann Stiftung (Bertelsmann Stiftung, 2016). It is based on the three pillars "Policy Performance," "Democracy," and "Governance" evaluated through 67 indicators. The indicators of the policy performance are investigating the national conditions in a broader sense according to economic, social, and environmental policies. Aspects that are more related to open government are evaluated according to the quality of democracy and of governance. For instance, the right of voting, popular decision making, and corruption prevention are investigated as part of the quality of democracy.

Part of the quality of governance is the citizen's participatory competence according to citizen's knowledge on policies, people voicing their opinion to a public official as well as the voter turnout. A further global investigation that is including e-participation indices is published by the "United Nations E-Government Survey." *"The Survey evaluates e-participation, i.e., use of online services to engage citizens and non-citizens including through provision of online information (e-information), interaction with stakeholders (e-consultation) and engagement in decision-making processes (e-decision making)"* (United Nations, 2016, p. 145). Both indices are based on a combined methodology considering quantitative and qualitative data. Top-ranked nations according to the "Sustainable Government Indicator" are Sweden, Finland, and Denmark and according to the "UN E-Government Index" the United Kingdom, Australia, and the Republic of Korea. However, on city level, no comparable index has been published. According to municipal openness, the transparency and availability of open data have been in the foci by several researchers, e.g. in the "Open Cities Index 2016" (Canada's Open Data Exchange, n.d.). Nevertheless, the implementation of e-democracy should always go hand in hand with an advanced data security level (SP 3).

Conclusion on e-governance

All in all, the investigated pillars of e-government (information dissemination, communication, transaction, interoperability, and participation) have shown that there are diverse approaches on how ICT is used to make governmental services accessible in a digital era. Actually, ICT opens the way for more transparency and add possibilities of participation that have not been imaginable ten years ago. Hence, making complaints or retrieving information is possible through the web and mobile apps on a 24/7 basis. To communicate with their citizens, the government has adapted to use social media channels as Twitter, Facebook or YouTube. To offer online transaction in many municipalities e-identities have been introduced to verify the correspondence. However, sharing information across governmental and non-governmental parties need common standards. One good example of governmental interoperability is the 311 citizen's relationship management system introduced in municipalities in the US. This is a one-stop shop where citizens and businesses can reach governmental information and services at one place. Finally, e-participation has been discussed controversially by the interviewed experts. On the one hand, it is acknowledged as very fruitful like in the adoption of citizen's information in a combination of location based data. Thus, for example, in Helsinki, this data was able to be used for urban planning based on citizen's feedback. On the other hand, online platforms are not always

having the expected impact and attract people to comment on a low level or even do not reach many citizens.

However, e-services are just the tool with which the government tries to reach citizens or to transfer information. According to implement e-governance or open government, the active engagement of all city stakeholders is required (government, citizens, businesses, organizations, etc.). As stated by many interviewed experts, the municipal government has still its difficulties to become open and to share the power. Thus, a real e-democracy is not established right now in any of the investigated cities. To compare the degree of e-governance some indices exist on a national level but not on the city level. However, the data evaluation is highly complex and is based on qualitative as well on quantitative data. On city level, comparisons on transparency and open data can be found which will be investigated in the following subchapter as an aspect of the free flow of information.

H10 Free flow of information

Following Yigitcanlar (2010) the "assurance of knowledge society rights" is a basic element of an informational city. One of these rights is the freedom of information. Without freedom of information it is possible to be an informational city but not a knowledge society (Lor & Britz, 2007). Affordable access to knowledge, the exchange of knowledge, critical thinking, and exchange of ideas are the basic requirements of a knowledge society. Further, the freedom of information is essential for an transparent, open, and democratic government that help to prevent corruption (La Rue, 2011). Thus, independent information flows through the mass media as well as online and offline public data enable the open exchange of information and knowledge. In the work at hand, the definition of the informational world city inherits the emergence of the knowledge society, the dimensions and the existence of a free flow of information will be investigated according to the following hypothesis:

H10 A free flow of all kinds of information (incl. mass media information) is an important characteristic of an informational world city.

As represented in Figure 6-39, the interviewed experts have a rather high expectation of the free flow of information in an informational world city. According to the result of the SERVQUAL evaluation, the average of all expectations is 6.4. A lower expectation can be observed by the experts from Vienna, Chicago, Los Angeles, Hong Kong, and Berlin. This lower rate is caused by the definition of "all information." Hence, for nine experts the protection of private information is essential which could not be given if "all information" would be free. There need to be a balance

between privacy and transparency (LO 8). In the following free flow of information is referred to public data and mass media.
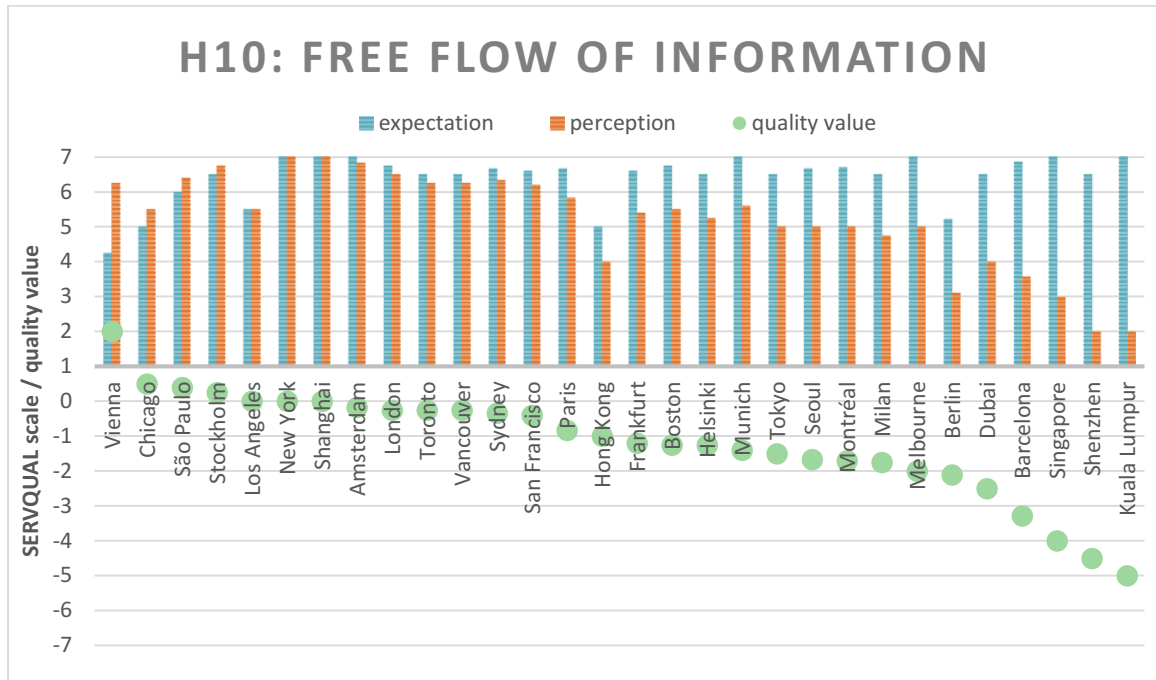
Figure 6-39: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the tenth hypothesis: "H10 A free flow of all kinds of information (incl. mass media information) is an important characteristic of an informational world city."

The access of information requires information literacy. For example, due to the censorship in China there is an information barrier but, according to one interviewed expert (HK 2), it is possible to get information at the black market. Thus, a free flow is not given. A further precondition to a free flow is the access through the internet (four experts). Hence, the library or free public Wi-Fi are possibilities to enable it (LO 6, LA 2). With reference to the SERVQUAL evaluation, a positive quality value is rated for the cities Vienna, Chicago, São Paulo, and Stockholm. São Paulo, for instance, has been described by the most experts as a city with a free flow of information but the information broadcasting is very selective, e.g. what is shown in the top news (SP 5). However, mass media inherits a critical role of free flow of information. A diversity of TV stations, newspapers, and magazines is expected to inform the society about current news and politics on national and global level (17 experts). Nevertheless, a problem of mass media is observed according to self-controlled media that is due to oligopolistic markets or cartels (six experts) and with reference to governmental censorship (three experts). Further, a trend is observed that mass media, like newspapers, are going to be read favorably online (Chandra & Kaiser, 2015), in particular by the younger generations (VA 1). This medium opens new ways of communication and discussions in an online environment. In consequence, free flow of information could result in an information overload (LO 4, TOK 3). Additionally, a negative aspect

is the growing number of hate speech that can be found online (HE 3). In Sweden, for example, there is a law against hate speech but as well a law on the freedom of expression (ST 1). Finally, a free flow of information is protected by the freedom of expression (four experts) as well as by the freedom of access to information (ST 1).

Within the context of public information municipalities are going to open their public datasets at online platforms to create transparency. However, open data has become an important aspect within the context of free flow of information (six experts). Nevertheless, politicians need to hide some information (BA 8) but they should open those that increase transparency (three experts). Accordingly, there is a need of political willingness to open public data (BO 2). In some cases, this development is prevented due to the administration's fear of losing the control or of publishing wrong data (BE 6). Four experts argue that access to public data should be free. Hence, it can create engagement and innovation. In sum, according to the interviewed experts the topics mass media and open data play a critical role within the free flow of information which will be further investigated in the following.

Mass media

Related to the question of free flow of information many interviewed experts have started to count how many broadcasting corporations, newspapers, or publishers are located in their city. *"We have public television stations, … commercial television, … publishing, tremendous free street publication all over the place. When you are out of the streets there are glossy magazines, neighborhood newspapers [etc.]"* (BO 4). The diversity of mass media, e.g. newspapers and TV stations, plays an important role in informing the society (BO 3). In Montréal, for instance, three newspapers are published. Two are in a conglomeration and one is independent. It is important to have independent publishers (MO 2). One expert from Toronto (TOR 2) expects that in his city the free media speech is higher than in any other places in the world. In São Paulo, as well a free media speech is given but it seems to be a selective media correspondence (SP 5). The overall impression is that news are mostly about crime and traffic jams. In Shanghai, for instance, current news about politics are not broadcasted (SHA 1). However, the global press is accessible in China but then to a great extend in English and most Chinese people do not speak English (SHA 1).

The free flow of information within the mass media is evaluated by Reporters without Borders according to the "World Press Freedom Index" on national level. This evaluation is based on an expert survey and the underlying framework and covers the topics: pluralism, media independence, media environment and self-censorship, legislative environment, transparency,

infrastructure, and abuses (see 3.2 Political will). Table 6-9 presents the World Press Freedom Index 2016 for the respective nations of the cities investigated in the work at hand.

According to the overall investigation of the world press freedom a decline of the index is acknowledged for the years 2013 to 2016 (Reporters without Borders, 2016). The mass media is under pressure by "oligarchs" that are buying media outlets all over the world. Next to the governmental pressure, those are increasing the force on the media according to publications about e.g. religious ideologies. A further problematic issue is the access suspension of the internet by the government as well as the destruction of printed publications that governments dissatisfy. Thus, enhanced "self-censorship" is acknowledged which is further amplified through the legislation in many nations that punish journalists according to infractions like "insulting the President," "blasphemy," or "supporting terrorism."

Table 6-9: Overview of rank, score, and category of nations ranked in the "World Press Freedom Index 2016" (Reporters without Borders, 2016) with reference to the 31 cities in the work at hand.

World Press Freedom Index 2016

Categories	Country	City	Rank	Overall Score 2016
Good	Finland	Helsinki	1	8.59
	Netherlands	Amsterdam	2	8.76
	Sweden	Stockholm	8	12.33
	Austria	Vienna	11	13.18
	Germany	Munich, Frankfurt, Berlin	16	14.8
Fairly good	Canada	Toronto, Montréal, Vancouver	18	15.26
	Australia	Sydney, Melbourne	25	17.84
	Spain	Barcelona	34	19.92
	United Kingdom	London	38	21.70
	United States	New York, Boston, Chicago, San Francisco, Los Angeles	41	22.49
	France	Paris	45	23.83
Problematic	Hong Kong	Hong Kong	69	28.50
	South Korea	Seoul	70	28.58
	Japan	Tokyo	72	28.67
	Italy	Milan	77	28.93
	Brazil	São Paulo	104	32.62
Bad	UAE	Dubai	119	36.73
	Malaysia	Kuala Lumpur	146	46.57
	Singapore	Singapore	154	52.96
Very bad	China	Shanghai, Beijing, Shenzhen	176	80.96

The results show that only twelve of the 21 nations are categorized as having a good or fairly good press freedom in 2016 (Table 6-9

Table 6-9). However, in a city like London which is located in a country that has a fairly good freedom of press the interviewed experts are aware of the "oligarchs." Thus, one expert (LO 2) stated that London is a hub of mass media information, which is publishing information globally, but in the end mass media information is mostly dictated by a few big corporations. Further interviewed experts that are living in countries with problematic or bad press freedom are as well aware of the situation. In Milan, for instance, there is a self-censorship in the media because there are things that cannot be said (MI 2). As well in Japan the press seems to be free but it is acknowledged that they are cooperating in one cartel (TOK 1). Thus, the mass media "oligarchs" will decide which information will be broadcasted (TOK 6). Further, in a nation like Malaysia the news seem to be used to teach the population how to behave by focusing on their fears (KL 1). For example, to determine waste in the streets the press is publishing that malaria could break out if the garbage is not collected appropriately (KL 1). The same problem is acknowledged for Hong Kong, but according to one interviewee (HK 3) *"Hong Kong is pretty free… Singapore is an example of an Informational City that is not free."*

Today, a lot of news and information can be found online. Thus, blogs and social media sites are used to retrieve current news. But they are not always trustworthy. This lead to the problem of "fake news" that are able to circulate around a big user group due to the social network dissemination. To avoid those "fake news" social media platforms like Facebook are stressed to implement algorithms that will detect them (Beuth, 2016). However, the users are as well forced to enhance their information and media literacy to identify those fakes by themselves. Thus, a further worry is that "trustworthy" printed material will lose in significance in future (BO 4). Regardless of the medium (printed or online) independent and trustworthy sources are important. Those could be, for example, independent online blogs that are informing and representing current news. In Singapore, which has a bad press freedom index score, blogs recently are going to supersede printed newspapers (SG 10). But as well in regions with a fairly good press freedom index like Canada many people tend to retrieve information online. *"Young people do not read newspapers. They don't trust them, they don't rely on them, they think it is just a kind of garbage getting thrown at them"* (TOR 2). Hence, social media and blogs are becoming the information source for them.

Thus, to investigate the free flow of information through the internet the Freedom House (2016) is evaluating a survey on national level based on three main indicators: Obstacles to Access, Limits on Content, and Violations of User Rights (see chapter 3.2 Political will). In total the freedom

of the internet scores is comparing 65 countries all over the world. However, not all nations of the respective informational world cities investigated in the work at hand are represented. Figure 6-40 shows the freedom of the net and freedom of press for 14 countries in ascending order of average freedom scores. The higher a score reached by a country the less freedom exists. Thus, countries with a high degree of freedom in both indices are Canada, Germany, and Australia. And those with a low degree are Singapore, UAE, and China. In the freedom of press as well as the freedom of the internet is declining. Hence, 67% of internet users live in countries where a censorship on the criticism of government, military, or ruling family exist (Freedom House, 2016). In 2016 authorities from 38 countries have arrested people due to posts at social media platforms. Furthermore, secure messaging apps like What's App or Telegram are going to be blocked by governments. However, just eight out of the 14 compared countries have a high freedom of the net which implies that in cities like Kuala Lumpur, Singapore, Shanghai, or Dubai a free flow of information does not exist.
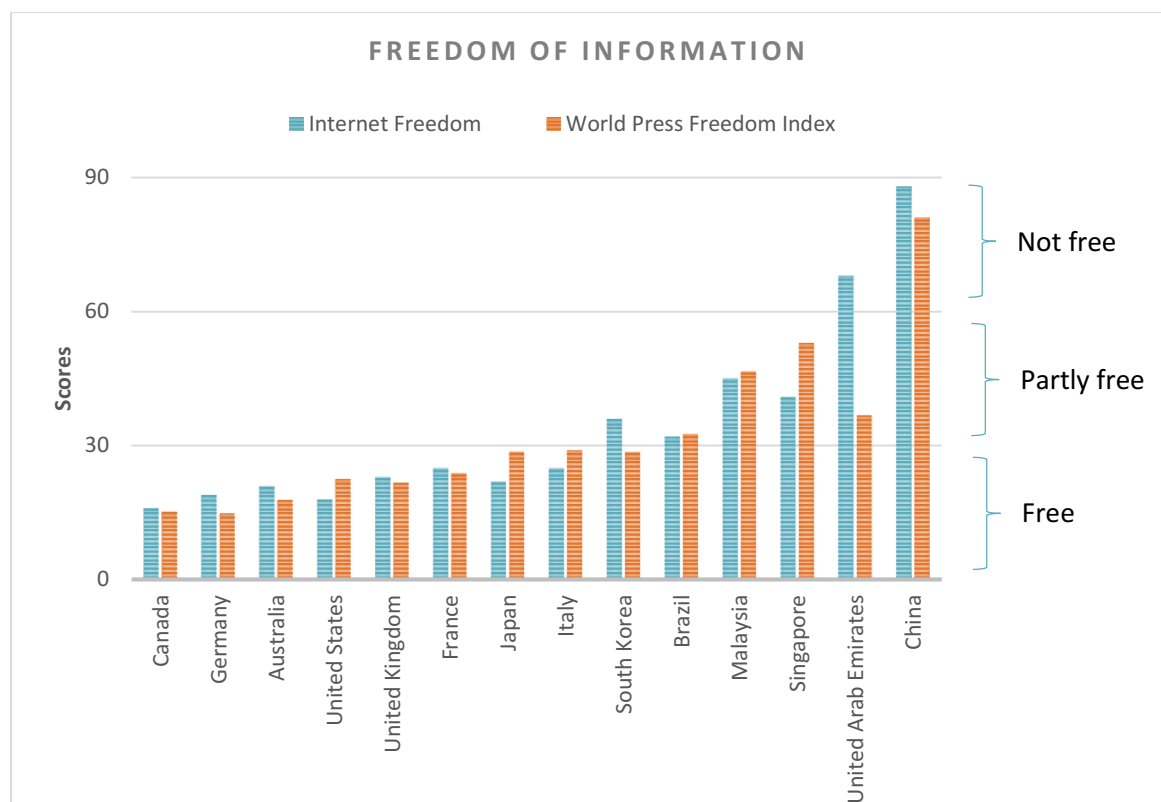
Figure 6-40: Freedom of information according to the internet freedom compared to the world press freedom index. Nations represent cities investigated in the work at hand and listed in ascending order according to average scores of both indices. The higher the scores the less the freedom. Data source: Freedom House (2016), Reporters without Borders (2016).

Transparency and open data

In addition to mass media an increasing demand for open data is acknowledgeable as stated by several experts. Benefits are for example improved decisions based on big data (Castelnovo, 2015). *"The idea to be data driven is to understand that you can actually use data to help make better decisions and make things better for citizens. And Toronto does some of that. They never do as much as anyone would like but they are at least doing some of it"* (TO 1). In New York, data driven decision-making has started with mayor Bloomberg (NY 1). And in Boston the *"City Hall has got a whole bunch of folks together and we created this really unique apps... One of them is called street bomb and it uses the accelerometer in your phone which you have put in your car and you drive around the city. Every time you go over a bomb it takes your GPS, shoots it up to the sky and it goes to the Boston public works department and they collect and aggregate all this data to figure out where all the problems are and resolve them... That's saves money, is creative, and let citizen participate. All the things you want in a city... It's a very interesting city. We have an office in the mayor's department called the office of new urban mechanics... [This] office have done this really creative cutting edge things"* (BO 1).

Open data may as well help to make information available like data on air quality. Thus, for instance, the US Consulate in Shanghai has implemented a pollution sensor at their building and offer a real time measurement which is accessible online (U.S. Consulate General in Shanghai, n.d.). Due to this open information which was globally available the city government of Shanghai was under pressure to enhance the air quality (SH 1). In contrast, there is many data that need to be protected. An informational or smart city is something different than a big data city (VI 1). However, opening data to the public may result in a push in creativity and innovation (MU 1). Startups and the economy may use this data to create something out of it.

According to the "Open Data Barometer" published by the World Wide Web Foundation and Open Data for development network, robust data is necessary to drive democracy and development as well as to reach the sustainable development goals: *"end poverty, fight inequality and tackle climate change by 2030"* (Web Foundation, 2015). Just in a very few cases data on public spending, health, education, maps, or census data is available online and free. With the "Open Data Barometer" the development on national level is calculated for 92 countries. The underlying indicators investigate the readiness, according to open data initiatives and policies, implementation, with reference to the governmental practical realization of their commitments, and impact, based on the practical benefits that come with open data.

A further indicator of open data is the right to information law. The World Justice Project is investigating the development of open government on national level on its basis. However, *"countries with relatively weak laws may nonetheless be very open, due to positive implementation efforts, while even relatively strong laws cannot ensure openness if they are not implemented properly"* (World Justice Project, n.d.). Comparing the results on national level based on the related cities investigated in the work at hand, a direct impact of the right to information on the open data barometer cannot be proved (Figure 6-41). However, on the one hand, the United Kingdom as well as the United States reach relatively high scores in both ratings. But on the other hand, China and the UAE reach both high scores according to their rights on information but very low scores when it comes to the implementation and real impact calculated by the Open Data Barometer score. Nevertheless, according to one expert from Amsterdam (AM 2), *"the city of Amsterdam thinks that they are creating systems to become even more knowledge city than they already are, but Amsterdam is a core example of a city that already was a knowledge city before they started the policy."* Accordingly, the Netherlands have reached fairly good scores in both ratings.
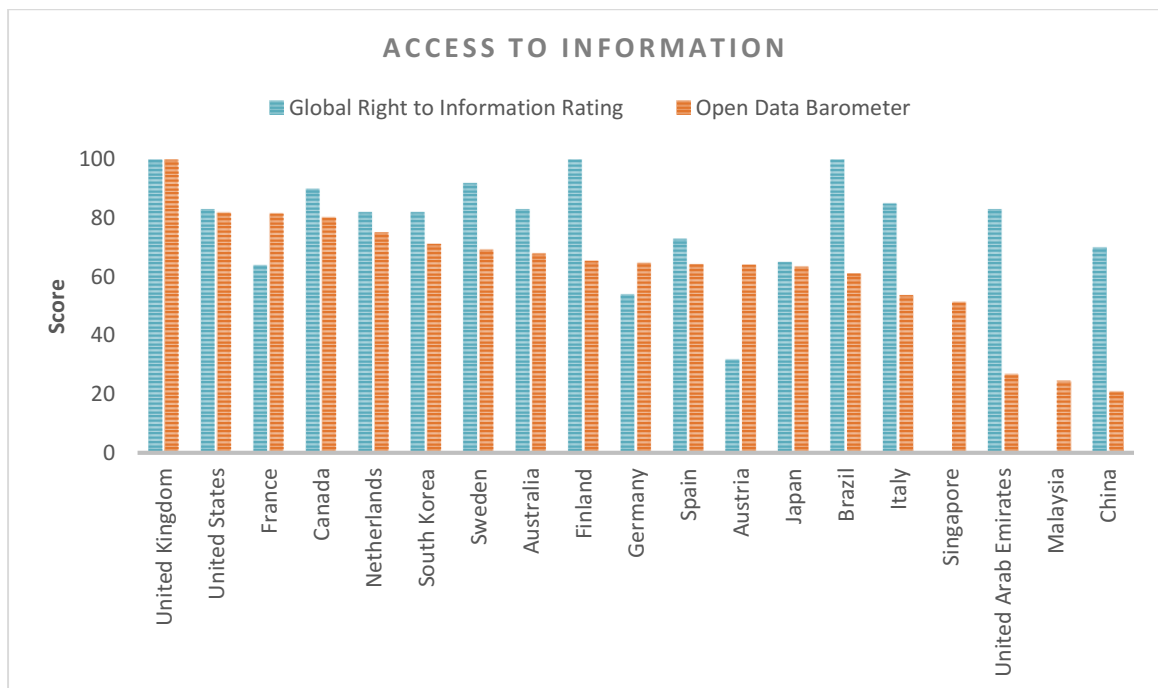
Figure 6-41: Access to information on national level according to the "Global Right to Information Rating" for the year 2016 and the "Open Data Barometer" for the year 2015. Nations listed in descending order according to the scores reached in the Open Data Barometer. The higher the score the more open data/better right to information is available. Data source: "Global right to information rating. Country data," (n.d.), "Open Data Barometer 2015," (n.d.).

Referring to the interviewed experts the open data development in informational world cities is on different levels. For instance, one expert from Toronto (TOR 1) has stated that open data and access to information is pretty well in North America. Open data and crowd sourcing are things that happen in Toronto (TOR 1). This is as well mentioned by another expert from Los

Angeles (LA 2), since in LA many records and statistics are online. Even the police department is making their statistics public available and all representatives in the city have an online available email address to easily contact them. However, in other cities, open data is something that the experts wish to have. Thus, one expert from Melbourne (ME 1) stated: *"Free access to state information is highly wanted. City council is currently setting up a new digital strategy."* According to open data and e-government, Munich is in its infancy and could profit from a stronger support (MU 1). As well Milan is not far developed, hence *"it's difficult to find information concerning traffic mobility, [or] public transportation"* (MI 6). Barcelona is a further example of low open data access (BA 3).

Finally, one expert argues*: "I think we always want more information than we have"* (BA 6). Open data has further restrictions as for instance in Frankfurt you have to pay for them (FR 3). Furthermore, in Frankfurt it is frustrating to find information online (FR 5). Thus, there is a need of information literacy with reference to open data: *"The information is pretty open but you need to know how to find the information"* (LA 3). For instance, if you like to have access to information than you need to have the language skills (SP 1). People in China and Russia do not speak English and therefore a lot of information for them is not accessible. The same problem is acknowledged in Seoul (SE 1).

Eventually, free access to information enables equal possibilities for everybody in the society. *"You look at somebody like Bill Gates. His father was a wealthy man. Steve Jobs didn't had anything. And both of them built gigantic empires… Bill Gates parents paid for his access to computer that let him do the programming. It is not to diminish even one of them. But it was easier for Bill Gates than it was for Steve"* (LA 1). A provider of this access could be the public library: *"We at LA Public Library, we do our best to support that. Again with our Wi-Fi access and free… hardware computers that people also can sign up for two hours per day. That's all free access"* (LA 2).

To make open data available enormous costs for the city need to be calculated (MU 1). In addition, there are fears to open the data by the administrations. Eventually this fears will hide the open data development. Therefore, transparency and openness are needed as described by one expert from Boston (BO 2): *"When you put out the information than take the responsibility. And then take responsibility for correcting it … like look: here it is. The good the bad and all is here together. Now help us fix it. Help us make it better. Engage with people. I think moving the restrictions on data and information helps with it. Whether it's research from universities and peer reviewed journals. Whether it is open source code and technology stuff. Whether it is government*

institutions opening up data to the media, press, researchers, advocacy groups, so they can make better decisions and better inform people. I think on every level more information is critical to … till the whole process. …information wants to be free" (BO 2).

Free flow of information opens new possibilities of democracy (FR 1). For instance, how the city government is communicating could be more transparent (BA 1). According to one interviewee from Berlin (BE 6) many information is hide because people in administration are afraid of too many questions, e.g. about contracts. Hence, persons in manager positions, if in administration or business, make decisions for the society or for the company and have commonly the attitude to think that the mass do not have to know everything (BE 6, own translation). As well in Chicago, one interviewee mentioned (CH 1): *"there is knowledge in the government which is not completely transparent, decisions are made through our … officers, political parties [behind closed doors]."*

In a society with open data it is important to have space for privacy. It is important that politicians are able to discuss things behind the doors and become clear about their political strategies etc. before they have to make them public. Too much openness can be used against you. This has happened, for instance, between members of the pirate party. *"They had an open SMS conversation channel and everybody was able to see that they fight against each other within this party. This was not very professional and has hurt the image of the party"* (BE 7, own translation).

In Montréal, for instance, there has been established an open contract platform which has made visible all contracts between the public and private sector. This helped to overcome corruption issues (MO 3). However, Montréal has a "free access information law" (MO 6) but as well a problem with corruption. Recently they have lost two mayors due to corruption (MO 4). However, in Vancouver, another Canadian city, one expert has mentioned that *"corruption wouldn't really work here, because people just work their way around it"* (VA 1).

Conclusion: Free flow of information

Summing up, the free flow of information can be investigated by the freedom of information referred to journalists and the mass media publication on the one hand and to open data on the other hand. Both have underlying policies that protect the human rights of expression and of information. According to the "World Press Freedom Index 2016" not all cities are located in a nation with a good or fairly good rating. The worst situation is detected in China followed by

Singapore, Malaysia, and the UAE. Thus, respectively six informational world cities have no freedom of press. Comparing these results with the freedom of the internet the same conclusion can be made. Problems are governmental laws against unlikely publications which result in self-censorship by journalists. In addition, the growing conglomeration of media outlets results in "oligarchies" that are dictating the news. Furthermore, laws against postings on social media channels and the blocking of secure chat applications, like What's App, decline the freedom of expression in many countries. At all, an increase of violation of the human rights of expression has been identified by the freedom of press as well as by the freedom of the net investigations.

A rather newer indicator of free flow of information is the accessibility of open data. Hence, the law on the right to information has been already established in the 18th and 19th century in the Scandinavian countries. However, a strong law on the right to information is not to be equated with a good implementation of open data. This is shown for example by the nations China and the UAE. Both have strong right to information laws but both have as well weak open data developments. However, a strong law can as well positively impact this development as, for instance, in the UK and the US. Both nations have strong laws and are rated high according to the Open Data Barometer which investigates the readiness, implementation, and impact of open data. Finally, open data can be an accelerator of innovation and creativity but it needs to be implemented on the right data. Hence, the World Wide Web Foundation is asking for data on public spending, health, education, maps, or census data. However, private data should be protected.

With reference to the investigated hypotheses on the political will (H8-H10) the increasing importance of online information has been dominant in each of them. Thus, transparency and online accessible political plans are important aspects of the political willingness. However, e-governance can be used to bridge the institutional levels of the economy, university, and community to foster innovation processes. Nevertheless, openness is not easy to handle at all levels. According to the interviewed experts, some discussions and decisions need to be made behind closed doors. Despite the shrinking freedom of information, information overload, and fake news are becoming a growing problem particularly on social media platforms. Hence, information literacy and education is needed. In addition, language skills in English open the doors to global information. It further intermediates an open and welcoming culture which will be further investigated as cityness factor of world cities in the next chapter.

6.3 World City

In the work at hand, the investigated cities are world cities. Not according to their size and number of population but with reference to their importance within the global network of cities. To become a successful player within the global market the financial sector is of crucial importance. Hence, the theory of flows of capital, power, and information is the basis of the informational city construction as described by Manuel Castells (1996). Thus, world cities are the hubs within this global network. Accordingly, the world city network can be explained through the "central flow theory" where the economy, merely the firms located in a city, are building networks through branches in other cities (Taylor, Hoyler, & Verbruggen, 2010). But cityness is as well referred to the local process that happens within the space (Sassen, 2001). For Castells, this is the "glocality" of cities. They interact locally within the physical space and their surrounding area and digitally with the global network. Based on the already discussed definitions in chapter 3.3 World city I will investigate in the following both hypothesizes:

> H11   *An informational world city has to be a financial hub with a lot of banks and insurance companies.*
>
> H12   *An informational city is supposed to be a global city ("world city").*

H11 Financial hub

To be located in a hegemony state has been of advantage for a city to emerge to a global hub (Jacobs, 1969). Hence, those states have always been leading in production, commerce, and finance (Taylor, Hoyler, & Smith, 2012). Furthermore, the financial sector is acknowledged as part of the advanced producer service firm network that is building the global network of cities in the 21st century (Sassen, 2001). The investigation of financial markets has been done by several researchers and institutions like the GAWC (Taylor, Derudder, Hoyler, & Witlox, 2012) or by the Z/Yen Group with their "Global Financial Centres Index" (GFCI) (Yeandle & Z/Yen Group Limited, 2016). In the subsequent, I will investigate the following hypothesis with reference to the expert interviews and already existing indices:

> H11   *An informational world city has to be a financial hub with a lot of banks and insurance companies.*

According to the interviewed experts, many of the investigated cities are financial hubs. However, they are not global hubs but at least within the nation or region. Thus, for instance, Milan is a financial hub within Italy (MI 4), Vienna is a hub for Middle and East Europe (VI 1), and

London is a global financial hub (LO 2). In total, 44 experts have stated that it is not a precondition of an informational world city to be a financial hub. Whereas, 40 of these experts live in a city that they would describe as such a hub at least within a specific region. This is further reflected in the SERVQUAL evaluation in Figure 6-42. In average the quality value is positive (+1.15). However, the mean expectation is +4.41. The highest quality values are observed for Kuala Lumpur and Hong Kong. Hence, one expert from Hong Kong explains his scoring as follows: *"Hong Kong is big in financial things, but weak in other, e.g. culture. Hong Kong is too much about money [and it] is not a balanced city"* (HK 3). Accordingly, it is important for a city to find the balance between finance and other economic sectors (TOR 1).
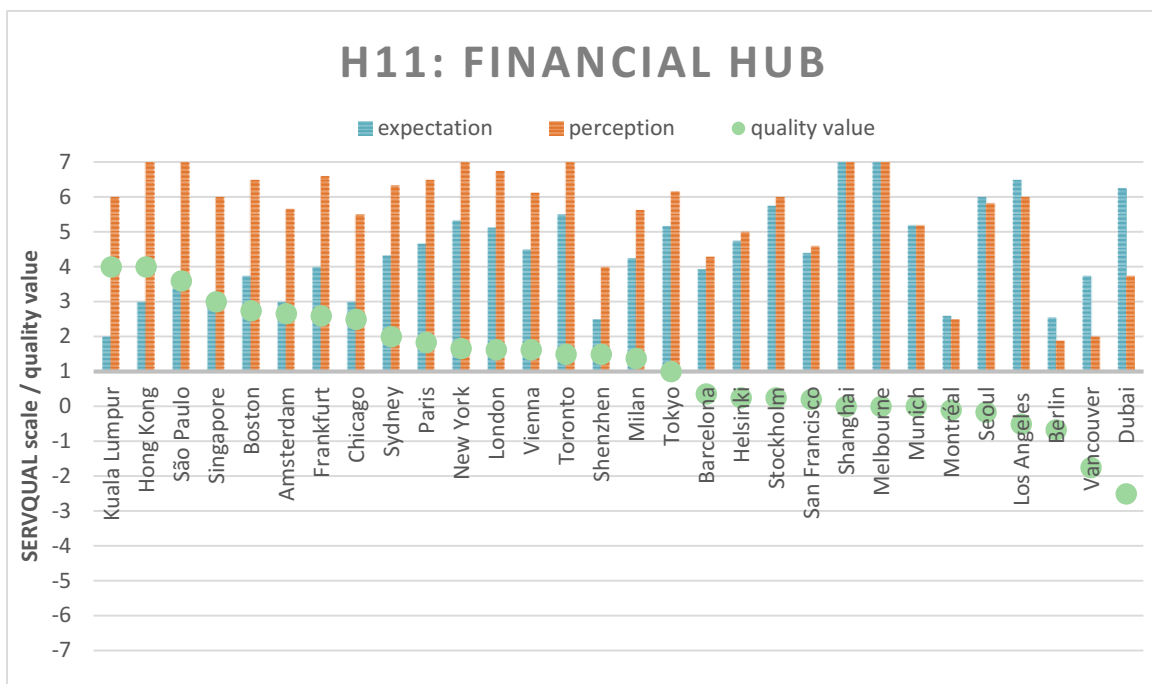
Figure 6-42: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the eleventh hypothesis: "H11 An informational world city has to be a financial hub with a lot of banks and insurance companies."

A further argument to rate the cities' financial sector rather high, in contrast to the expected value of an informational world city, is the historic development. In history, banks have always played an important role (AM 4) but in future, this will be less related to the city's development (VI 3). Another expert describes this hypothesis as a *"Chicken-Egg-Question. It creates each other. Banks create infrastructure or come there where infrastructure is. Helsinki has this infrastructure and therefore attracts banks and other companies"* (HE 4). In addition, on the one hand, the interviewed experts mentioned that the financial sector is important as job market (e.g. LO 2). But on the other hand, there are experts that do not agree, hence in their respective cities the financial sector has lost many jobs (e.g. AM 6). However, "*they do business in the entire country. I am not sure the physical location of head offices is as important*" (TOR 2). Further, as the global player,

they are part of the producer service firm network which will be investigated accordingly in chapter H12 Cityness. However, as location factor they play a tremendous role according to funding (LO 1). Finally, the financial sector is increasingly information-driven which enhances technology development and the infrastructure at places where they are located (CH 1). But in consequence, jobs may be lost due to the increasing digitization. Hence, the local financial sector could be a catalyst for venture capital and startups, e.g. in the financial technology sector (FinTech).

Summarizing the discussed arguments, I will investigate in the following the correlation of financial hubs and cities of the knowledge society. First, according to the financial sector as important part of a city's economic success and second, with reference of the future role of financial hubs related to venture capital and FinTech companies.

Financial sector as indicator of the knowledge society

That London and New York are financial hubs is not a new evolution. Since decades they have played a crucial role within the financial sector (LO 5). *"If the informational city is a world city than probably the city has a financial market or can as well be a financial hub. But if the informational city is a small or medium size city than the financial sector is not that important"* (PA 5, own translation). As described above, many experts do not see a relation between the financial sector and the informational city. Of course, money can be a huge advantage but the city should be able to invest and not the private banks (BE 7). Hence, an informational city could be an university town without any financial headquarters (AM 2). However, four experts emphasized that knowledge institutions and research are of higher importance than financial institutions.

Thus, comparing the financial market ranking and the performance of the best university for each city, the experts' arguments are correct. Figure 6-43 presents the performance of informational world cities in the "Global Financial Center Index" (GFCI) and in the "Center for World University Rankings" (CWUR). For five cities the data has not been available. In sum, there is a slight positive correlation of both scores but at all the numbers are too small to make a significant statement. However, the cities that are the biggest financial hubs are London, New York, and Singapore. Within the top ten of the best performing universities only Boston, San Francisco, and New York are overlapping both indices. Thus, New York is a city that is a financial hub as well as a university city. In contrast, Boston has already been multiplied mentioned as being home to the elite universities Harvard and MIT but not as being a financial hub. Nevertheless, according to one expert (BO 2): *"Boston has a strong financial stuff here. There are several hedge*

fund type banks. There is a strong history of finance here, but I think the balance in other data intensive things such as research, health care, medicine, biopharmaceutical, types of staff [is of importance]. There is all those kind of things that are at least as critical to pushing that kind informational city economy."

According to the world city researchers, Beaverstock, Smith, and Taylor (1999), global financial centers are only categorized as prime, major, and minor global banking service centers. Those who are within the prime category are Frankfurt, Hong Kong, London, Milan, New York, Paris, San Francisco, Singapore, Tokyo, and Zurich. Nevertheless, not all cities that are prime financial centers as well have a university that is ranked within the top of the world as for instance in Frankfurt and Milan. The investigation of Beaverstock et al. (1999) is based on the theory of spaces of flows. Hence, cities or, more explicitly, headquarters in the cities are related to flows of power (Stock, 2011). Thus a headquarter is determining their branches in other cities (Beaverstock et al., 1999). However, there are many financial headquarters within each of the global banking services centers. Finally, no city can determine the other city which makes them all to financial hubs of the first category. Accordingly, one could argue that universities within the top ten or top twenty within a global ranking could verify a city as university hub. Hence, there are as well university branches like the Rochester Institute of Technology which is headquartered in New York and is operating a branch in Dubai. However, the relation of city networks and flows of power will be further discussed in chapter H12 Cityness.
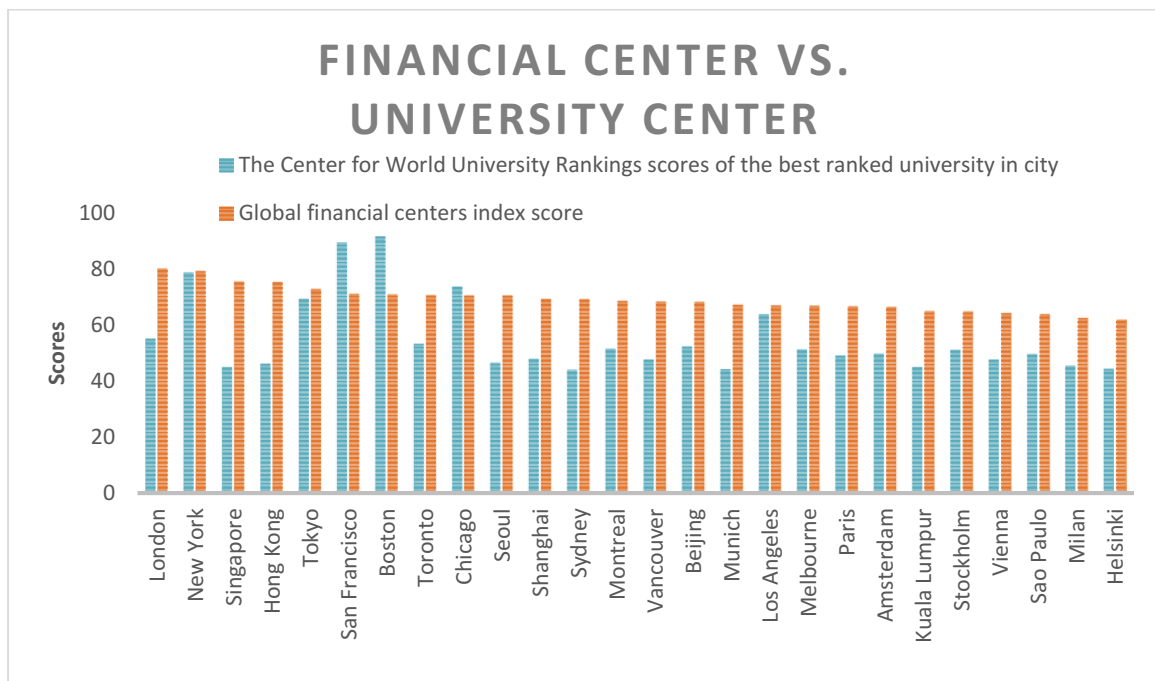
Figure 6-43: Cities performance within the Global Financial Center Index (GFCI) and the best performing university in each city according to the scores of the Center for World University Rankings. Cities presented in descending order of their GFCI score. GFCI scores are adjusted (n/10). Source: O'Neill (2016), Yeandle & Z/Yen Group Limited (2016).

Economic success

"From a historic view banks are important. Banks attract companies to settle down here" (AM 4). But *"banks and insurances are not creative and thus do not impact innovation"* (FR 4, own translation). *"The economy of a future‑focused city shouldn't be over-leveraged in any one industry... There are leading industries in given cities and it's actually a liability in cities if you are over-leveraged in one specific industry. So New York, for example, is highly leveraged by finance. Los Angeles is highly leveraged in the cinema movies. What is unique about Chicago, it is one of the major cities in the US in which no one sector accounts more than 30% of our economy. So we are the big economic driver for this region in the United States and one of the things that makes it a much more stable economy is that we have multiple sectors that make up the pie"* (CH 3). Montréal is an example that has found its new role after the financial institutions had left the city. Due to conflicts between Quebec and the rest of Canada, many investors and companies have moved to Toronto (MO 4). But in the following, the costs of living have increased in Toronto and Montréal became attractive for creative people. Today, Montréal is no longer a financial hub but a cultural hub (MO 4). In addition, *"Singapore is a phenomenal example of an informational city based on logistics. Because they really run that port and they are really smart about it. A financial hub it is as well. But I think of the balance of requirements"* (TOR 1).

Thus, it is of importance to be competitive in diverse economic sectors. Following Stock (2011), the turnover of the stock exchange market can quantify the city's economic significance. Hence, the turnover is as well an indicator of the flows of capital. Simplified, a turnover of a stock market is the measure of how often shares have changed hands (The Economist, 2001). It does not concentrate on the headquarters of banks and insurance companies it rather quantifies the regional economy. Thus, taking a look at the cities that have been identified as primary global banking service centers in the fiscal year 1999 (Beaverstock et al., 1999) some of them are as well the cities with the highest turnover according to the local stock exchange in 2015 (Table 6-10). Exceptions are Shanghai, Amsterdam, Shenzhen, and Toronto.

Hence, the overall economic activity is measured as well by the Gross Domestic Product (GDP) of a region. *"The GDP is the monetary value of all goods and services produced in a nation during a given time period"* (Brezina, 2011, p. 4). The Global Metro Monitor Map is investigating metropolitan regions according to their GDP, GDP per capita and employment ratio (Parilla, Leal, Berube, & Ran, 2015). The change ratio of the GDP for the fiscal years 2013 and 2014 as well as the GDP per capita in US$ are represented in Figure 6-44 for the investigated informational world cities in the work at hand. Accordingly, the cities with the highest GDP per capita in 2014 are

Boston, San Francisco, and New York. Only New York is as well listed on the global top ten stock exchanges (Table 6-10). Whereas the highest growth rates of the GDP per capita have been reached by East Asian cities: Shanghai, Shenzhen, Dubai, and Kuala Lumpur.

Table 6-10: The ten biggest stock exchanges according to the highest market capitalization value of shares in 2015. Data source: "Biggest Stock Exchanges in the World" (2016).

Rank	Stock exchange, country	Headquarter city	Market capitalization value of shares in 2015 (USD)
1	New York Stock Exchange, United States	New York*	$19.223 Trillion
2	NASDAQ, United States	New York*	$6.831 Trillion
3	London Stock Exchange Group, United Kingdom, and Italy	London*	$6.187 Trillion
4	Japan Exchange Group, Japan	Tokyo*	$4.485 Trillion
5	Shanghai Stock Exchange, China	Shanghai	$3.986 Trillion
6	Hong Kong Stock Exchange, Hong Kong (SAR China)	Hong Kong*	$3.325 Trillion
7	Euronext, United Kingdom, Belgium, Portugal, France, and the Netherlands	Amsterdam	$3.321 Trillion
8	Shenzhen Stock Exchange, China	Shenzhen	$2.285 Trillion
9	TMX Group, Canada	Toronto	$1.939 Trillion
10	Deutsche Börse AG, Germany	Frankfurt*	$1.762 Trillion
*Cities are primary banking service cities according to Beaverstock, Smith, and Taylor (1999)			

Looking at the overall development in East Asian metros, the growth rates between the years 2000 to 2007 have dropped compared to the rates 2009 to 2014 (Parilla et al., 2015). However, comparing the GDP per capita with the turnover of the global top ten stock exchanges a positive Pearson correlation can be observed (+0.60). This result is not surprising since all of the cities are successful global hubs. Concluding, the GDP or stock exchange turnover is not able to represent the diversity of industries within an economy but it can refer to the success of the whole economy. And to be at the top according to the GDP per capita it is not necessary to be a prime global banking service center or neither within the global top ten stock exchanges as represented by Boston. However, to have a strong financial sector can be at least of help to have a successful economy.
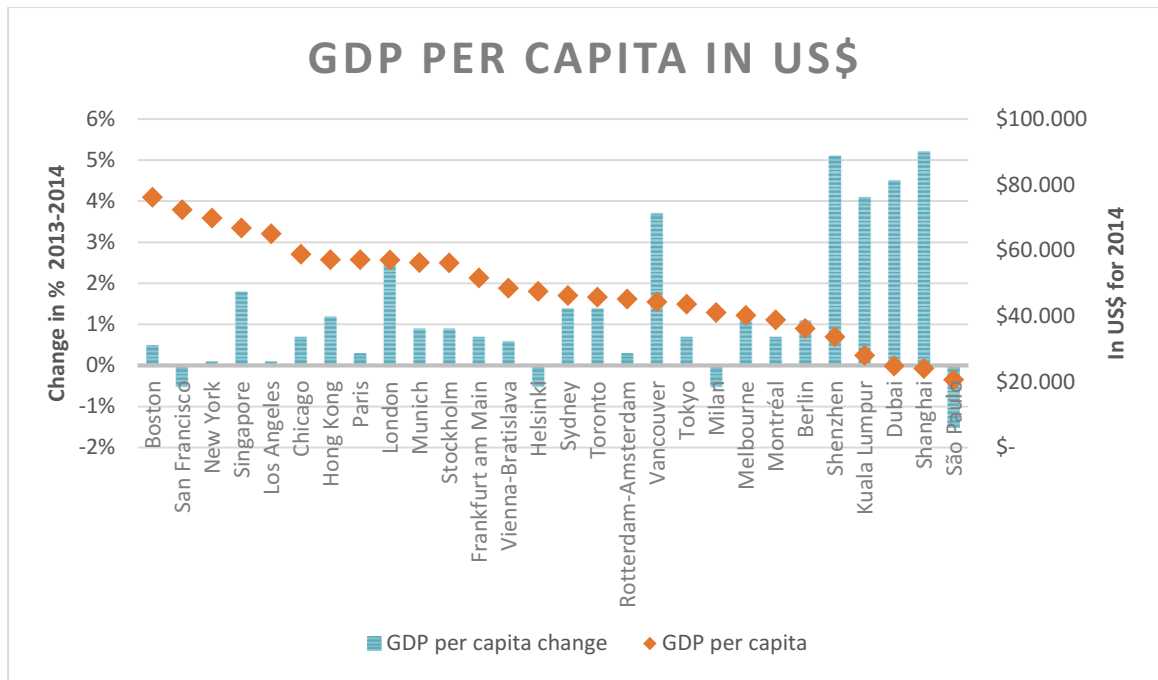
GDP PER CAPITA IN US$

Figure 6-44: Combined change in employment and GDP per capita per metropolitan region for the time period 2013-2014. Metros are listed in descending order according to their GDP per capita in US$ for the fiscal year 2014. Data source: Parilla, Leal, Berube, and Ran (2015).

Future role of finance

In comparison to the creative city, physical space for face-to-face meeting, hence a dense city, as well can bring together entrepreneurs and those who like to fund startups. Thus, a dense area where both will meet is of advantage and then the physical location of a bank becomes of interest (BE 1). Today, venture capital is becoming increasingly important instead of conservative banks and insurances (BE 1). According to one expert (LO 1), *"London is the best place for funding."* Whereas, in Berlin there are first venture capitalists that are settling down in the city (BE 1). Hence, to push the startup scene you need financing, business angels, and those who support entrepreneurs to start their business (MU 1). Following one expert from Munich (MU 1), the advantage of the city is that it is rich, with a lot of small finance institutions and rich private investors that have the ability to invest venture capital. However, Munich cannot become the financial hub as Frankfurt is but it has a strong financial sector. According to another expert from Vienna (VI 3), the importance of the global financial hub was of interest in history but will no longer be in future. Thus, it is crucial for a city to offer venture capital. Otherwise, entrepreneurs and startups will have to leave like one expert from Montréal (MO 3) has stated that the entrepreneurs have to go to the US to apply for funding.

According to the global financing trends of venture capital backed companies, the total quarterly investment has grown about 241% within four years looking at the third quarter in 2011

in comparison to the third quarter in 2015 (KPMG, 2016). The peak of investment has been in this third quarter in 2015 which was about US$ 39.6 billion. Following the report of EY (2016), the total raised amount through venture capital deals was about US$ 72.3 billion for the fiscal year 2015. On a quarterly calculation, a global decline can be observed of about -39% for the time period between the third quarter in 2015 and 2016 (KPMG, 2016). Following the report of KPMG, the highest number of venture capital deals are made for the tech sector. In 2015 and 2016 about 77% to 79% of the deals have been signed within the tech sector only and round about 11% have been signed in the health and further 11% cumulated in other sectors per quarter. However, venture capital has become an increasing market in the last years. On the one hand it has become part of the financial sector and on the other hand, the subject of funding are startups and young businesses within the tech sector.

Florida and King (2016) have investigated the venture capital investments on a metropolitan level based on data from Thomson Reuters for 2012. Accordingly, Table 6-11 represents the metropolitan regions in descending order of their venture capital investments in million US$ (only for the informational world cities investigated in the work at hand). San Francisco is at the top of this list followed by three further US-American cities: Boston, New York, and Los Angeles. At the fifth position, London is following. However, San Francisco's share of global venture capital investment is about 15.9%. Looking at the whole San Francisco Bay Area, adding San Jose, the total share is 25.8%. For San Francisco, this makes up 1.95% of its total economic output. On a national level, the venture capital investments make 0.17% of the total US GDP as calculated by the OECD (OECD iLibrary, 2013). In comparison, the total information industry makes 4.9% and the financial industry 17.8% of the total GDP in the US in 2016 (US Department of Commerce & Bureau of Economic Analysis, 2016). Hence, due to the size of some of the investigated metros, a high amount of venture capital is accumulated there. Thus, for instance, London is the city with the highest venture capital in European cities but calculated on a per capita basis the metropolitan region Copenhagen-Malmö has the highest investment rates (Florida & King, 2016). Comparing the most economically powerful cities with the leading venture capital investment cities some overlaps can be identified (Florida & King, 2016). Many cities like New York, London, Paris, San Francisco, or Boston can be found in the list of the top 20 global cities as well as in the list of the top 20 venture capital cities. Nevertheless, a city like Tokyo which is a leading global city makes up only the 54th rank within the venture capital cities. According to one interviewee (TOK 2), this is not surprising, because in Tokyo, very few private investments are made.

Following one expert from New York (NY 2) "*financial industries, particularly stock markets, and marketplaces… very heavily drive advances in technology in terms of the speed and*

performance. There is a lot of research like whether developing the fastest network router to go faster on the stock exchange." Hence, *"finance is a major type of hub and very information dependent"* (CH 1). A further expert stated: *"I think you attract a certain kind of talent having banks… and to some degree, banks and trading options attract network connectivity because you really want fast transactions… even San Francisco is not a really banking hub and yet it is an informational city"* (CH 2). However, the finance sector and tech startups merge into the FinTech industry.

Table 6-11: Overview of metros according to their venture capital investment in million US$. Only metros listed that are investigated in the work at hand as informational world cities and are mentioned within the top 20 venture capital cities within their geographical region. Data source: Florida and King (2016).

Metro Name	Venture Capital Investment (millions US$)
San Francisco	6,471
Boston	3,144
New York	2,106
Los Angeles	1,450
London	842
Beijing	758
Chicago	688
Toronto	628
Shanghai	510
Paris	449
Montreal	267
Amsterdam-Rotterdam	205
Berlin	178
Seoul-Incheon	156
Stockholm	148
Munich	120
Shenzhen	117
Helsinki	99
Tokyo	94
Frankfurt	78
Singapore	57

According to several experts the physical role of banks will decline, hence they are only relevant mainly for the older population and those who do not feel comfortable to use technology (MI 1, TOK 1, ST 1). Following EY (2015b), the user group of FinTech may rise as they identified that 53.2% of persons interviewed in their survey have not even known that FinTech services do exist. Looking at the ranking of the top global providers of financial technology by IDC Financial Insights (2016) the majority of the listed companies have their headquarter in the US (51 FinTech companies, see Table 6-12). India is represented with eight and France with seven companies

within the top 100. On the city level, the highest number of FinTech company's headquarters is in New York, followed by London and Paris. However, all three cities have been identified as global banking service centers 17 years ago (Beaverstock et al., 1999) and except for Paris are as well listed in the top ten of cities with the highest stock exchanges turnover ("Biggest Stock Exchanges in the World," 2016).

Table 6-12: Top three cities and countries according to their number of headquarters of FinTech companies based on the 100 most successful global providers of financial technology. Data source: IDC Financial Insights (2016).

Headquarter city	Number of companies in the IDC FinTech 100
New York	6
London	4
Paris	4
Headquarter country	**Number of companies in the IDC FinTech 100**
USA	51
India	8
France	7

Conclusion: Financial hub

Summing up, there is no evidence that it is of importance of being a financial hub to become an informational world city. According to the interviewed experts, it could be of advantage but it is not necessary. Hence, 44 experts do not agree with this hypothesis whereas 40 of them live at least in a regional financial hub. Comparing the rankings of financial hubs with that of university hubs a slight positive correlation can be observed. However, the rankings are not able to be equated. Hence not only the financial sector is of importance, an informational world city should be competitive in diverse industries especially if one sector will not survive in future. The economic success can be evaluated for instance by the flow of capital. Stock (2011) has suggested the turnover of the stock exchanges as an indicator. According to the results, there are overlaps of cities that are acknowledged as financial hubs in 1999 by Beaverstock et al. and those with the highest turnover in 2015. Hence, Shanghai, Amsterdam, Shenzhen, and Toronto are the cities that have not played that role fifteen years ago whereas New York, London, Tokyo, Hong Kong, and Frankfurt are at the top on both scales. A further indicator of the economic success is the GDP. Comparing the informational world cities, it is not necessary to be within the top cities according to the turnover of stock exchanges or within the prime global financial service hubs as represented by Boston. However, Boston is the city with the highest GDP per capita and is one of the top global university hubs.

With reference to the future development of the financial market venture capital and financial technology (FinTech) firms grow in importance. US American metropolises have the highest amounts of venture capital investments. At the top of the list are San Francisco, Boston, and New York. Venture capital is heavily invested in technology industries. However, the financial sector itself is highly information-driven. Those FinTech firms emerge around the globe. Hence, the most successful ones have their headquarter in the US as represented by the "Top 100 IDC FinTech" ranking. On the city level, the most companies of the top 100 are headquartered in New York, London, and Paris. Hence, these three cities are as well hubs within the world city network which will be further discussed in the following chapter.

H12 Cityness

Cityness can be understood in two ways. First, as the urbanity and local process that constitutes the inner-city and second, as the flows between cities as an inter-city relation. According to the second definition, cities interact with each other which set up the world city hierarchy (Friedmann, 1986). Following Castells (2001), informational cities are "glocal" cities. Hence, they act as the physical concentration of the society and economy (locally) and through the spaces of flows (capital, power, and information) they are hubs within a global network. The flows of capital have already been discussed in the previous chapter (H11 Financial hub) and the flows of information and knowledge have been referred to the ICT and cognitive infrastructure (see chapter 6.1 Infrastructures). Finally, the flow of power is referred to world cities that are *"large, urbanized regions that are defined by dense patterns of interactions rather than by political-administrative boundaries"* (Friedmann, 1986). Those interactions are primarily referred to the economic market. Producer service firms, as well as multinational corporations, link between cities on hierarchical and horizontal levels (Friedmann, 1986). This constitutes economic hierarchies with reference to headquarters in cities interacting with branches in other cities (see chapter 3.3 World city for a detailed explanation). Accordingly, I will investigate the flows of power of informational cities based on the expert interviews and on secondary research data with the following hypothesis:

H12   An informational city is supposed to be a global city ("world city").

All of the cities investigated in the work at hand have been identified as world cities at least in the research of John Friedmann, Peter J. Taylor or Saskia Sassen. However, not all interviewed experts do agree that they are living in a world city. 17 experts have stated that they maybe live in a regional or in a kind of world city but the only real world cities are New York, London, and Tokyo. Hence, all of the interviewed experts from London and from New York do agree that their

respective city is a world city. One exception is Tokyo. Two experts have not agreed due to the lack of openness (TOK 3, TOK 4). This is as well reflected by the negative quality value of -2 for Tokyo in the SERVQUAL evaluation (Figure 6-45). Comparing the results of all cities, eleven have a negative quality value, five a neutral and 14 have a positive value. Thus, there is no overall representation if an informational city is supposed to be a world city or not. In total, 22 experts mentioned explicitly that it is not important and 17 that it is important for an informational city to be a world city. Hence, in London, the interviewed experts in average see it as very beneficial to be a world city as indicated by an expectation value of six. That they see London as the leading world city is represented through the scaled experience with seven. For the experts in New York, it is a must to be a world city as they marked their perceptions and expectations both as seven in average. Hence, in Tokyo, the experts as well have rated their expectation very high but not their experience, which refers to a lack in cityness.
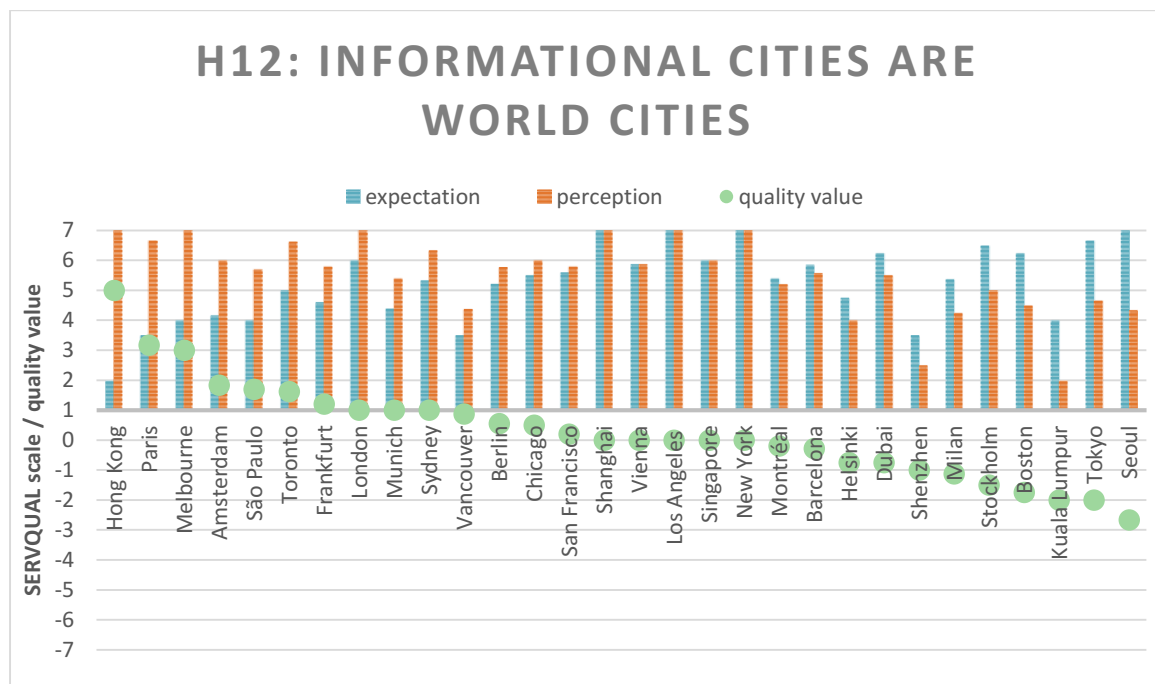
Figure 6-45: Quantitative interview results according to SERVQUAL (quality value = perception – expectation) for the twelfth hypothesis: "H12 An informational city is supposed to be a global city ('world city')."

During the interviews, the question arose if the city is a world city when it is a global city? Hence, for many of the interviewed experts, it is no question that they live in a global city (37 experts agreed). As through import and export, a city is entering the global market (BA 6, PA 6). Through the internet, information can be retrieved globally (seven experts). Even through an own or nearby airport, the city is able to be reached within a certain time (BE 1). But to be globally connected, whether digitally or physically, does not result in being a world city. Thus, nine experts mentioned that they are not living in a world city. Respectively the experts are from Barcelona, Berlin, Frankfurt, Milan (three experts), Stockholm, and Tokyo (two experts).

However, several options have been discussed what constitutes a world city. *"World city, does this mean like we are world class or that we interact with the world and across the world?"* (TOR 2). Accordingly, seven experts mentioned that it is important that the economic market is globally oriented through global trade and an international workforce. If the city is not a world city than it probably has not that multilayered structure. For example, Oxford is a knowledge city and is less economically oriented and Tallinn, for example, is an IT hub but lacks in other aspects (LO 2). Cities that are acknowledged as a regional hub may convey a cosmopolitan lifestyle as well. Hence, for example, São Paulo, is the most important city in South America (SP 5) and Stockholm is the hub of Scandinavia (ST 4). However, an informational city does not necessary have to be a world city if the city is able to invest in the right infrastructures of knowledge and information. Examples of informational cities that are no world cities are Oulu in Finland or Aalborg in Denmark (PA 2) as well as Vanarasi, a knowledge hub in India (TOR 1). For two experts (BO 2, MO 2), to be a hub for research and development is more important than to fulfill the conditions of being a world city.

An informational city can be a top tech city with universities and a high graduate population but without direct flights (MO 2). But this could not be a world city due to the lack of the physical connectivity. For nine experts it is of crucial importance to be very well connected with the world. A global airport (nine experts), conferences (two experts), and trade fairs (MI 4) enhance the physical infrastructure. Furthermore, to be open and welcoming has been emphasized as very important. Thus the mix of people (four experts), ethnical and cultural diversity (eight experts), and openness to immigrants (five experts) represents this attitude. In addition, it is of advantage if the population is able to speak English (seven experts). *"The language helps in London to be open and attract people"* (LO 6). *"Over the half of Toronto's population have been born outside Canada and about half of our population are minorities. I think it's probably the most diverse city in the world sometimes… Our diversity is our strength. That is the slogan that Toronto has"* (TOR 2). This culture, diversity, and openness is an important aspect in attracting people. Hence, cities that are lacking in culture have the problem to be not acknowledged as a world city. For instance, Shenzhen is no cultural hub and has as well to struggle to be accepted as a hub within the global economy (SHE 1). Many cities that are built from scratch have to overcome those problems. Thus, for instance, Songdo, a new planned city near Seoul has to identify its own urbanity (Ilhan, Möhlmann, & Stock, 2015). Accordingly, Saskia Sassen has stated in an interview that those cities are deurbanized places (Meister, 2012). It is possible to build a global economic hub but the culture is anchored with the people and has to arise from human interaction.

Summing up, that an informational city is a world city may be a consequence and not the starting point of a development (MI 1). Hence, during the interviews diverse aspects have been mentioned that constitute a world city or global city. Accordingly, in the following, I will further investigate the importance, first, of the economy, second, of the physical connectivity and finally, the importance of an open and welcoming culture.

Hubs of power, knowledge, and innovation

Diverse measuring methods have been established how to identify flows between cities (see chapter 3 Measuring cities of the knowledge society). Hence, economic measures are related to the flows of power between cities in a global network. Accordingly, diverse rankings, indices, and benchmarks have been published that represent a city's position in comparison to others. Following Clark, Moonen, and Couturier (2015b), till 2015 in total 29 publications are based on city investigations with reference to business, finance, and investment and further 16 to the economic growth and performance have been published. In the majority of world city comparisons, six cities have been represented on the top: New York, London, Paris, Singapore, Hong Kong, and Tokyo. They are referred to as established world cities (Clark, Moonen, & Couturier, 2015a).

Hence, other cities are able to be or become global hubs according to specific activities. For example, *"Boston doesn't have the same business corporations like London or New York. What you find in Boston is a lot of companies open up their research and development offices here. [It] … is not about having the CEO … here. It's about having the real knowledge arms of these corporations located here. … Microsoft has its base in Seattle, Google in San Francisco… but because of the richness of Boston's information they choose to put engineering [and] research … here"* (BO 2). Frankfurt, for example, is a small city referring to its size. Only due to its financial market it is a global hub (FR 2). A further niche is served by Shenzhen. This city is a production hub for the world. It is able to attract talents within China but not on a global scale (SHE 1). Taylor, Derudder, Faulconbridge, Hoyler, and Ni (2014) emphasize that specific strategic places can constitute global hubs relating to "one" economic sector. Hence, a global city can find its specific activity within the world economy.

However, global or world city comparisons are referred to a cities role within the global economic market and thus to its economic success at all. Hence, to be a capital intensive city is of advantage. Further the ability to finance the necessary infrastructure (SG 13). And if you are an informational world city than the information flows are of crucial importance (MO 3). As by

definition, an informational city is home to the knowledge society (Stock, 2011). Thus, flows of information and knowledge are dominating. To identify the control and command centers of the contemporary economy the amount of headquarters in a city is used as an indicator (Taylor & Csomós, 2012). And to measure the knowledge production of a city the amount of STN publications could be counted (Stock, 2011). Finally, the knowledge that results in innovation is counted by the amount of patents (Stock, 2011).

According to an expert from Tokyo (TOK 3), Japanese firms have branches around the world. Thus, there is a power flow from the headquarters to all branches in other cities. But Tokyo as city is not international oriented. The city acts preferably within the closed national market. This results in fewer investments, for instance, in R&D. However, this has preserved Japan from the global financial crisis in 2008/2009. Following Taylor and Csomós (2012), Tokyo has developed most of its powerful corporations before the 1990s. This is as well true for some corporations in the US. There are newcomers like Silicon Valley or Shanghai that will reorder the hubs of power in the global economic market. As presented in Figure 6-46, the typical global cities (Tokyo, New York, London, and Paris) are at the top counting the amount of headquarters in the city, listed in the Fortune 2000 (Taylor & Csomós, 2012).
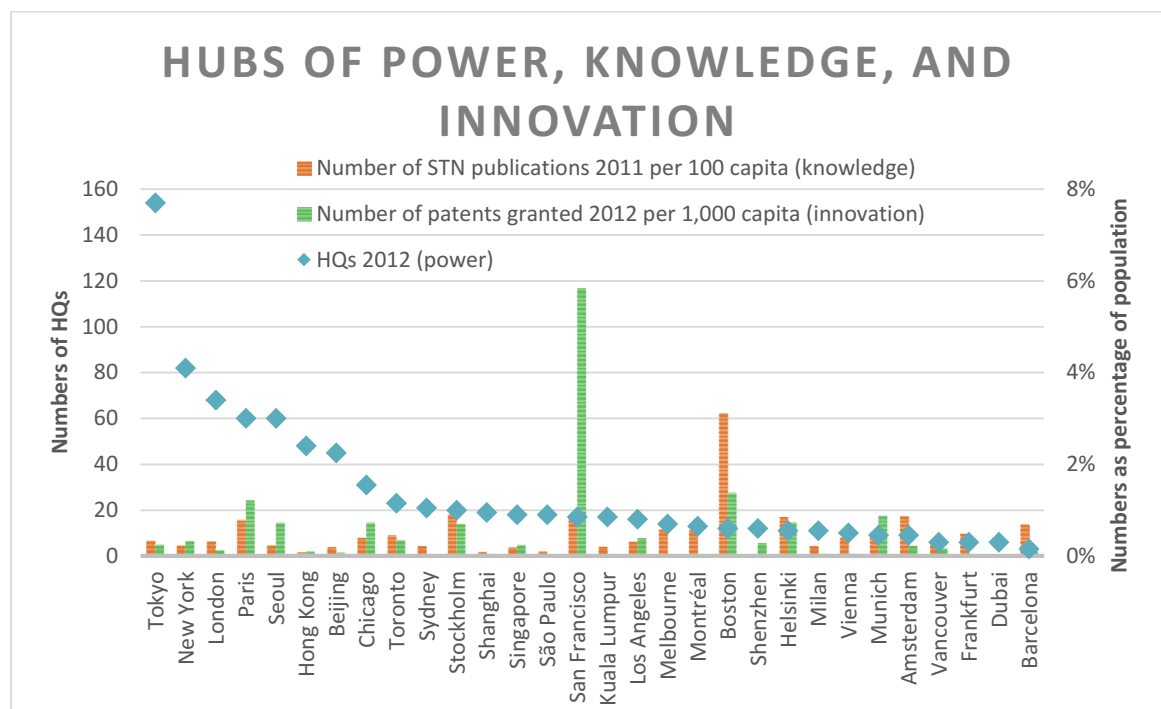
Figure 6-46: Hubs of power, knowledge, and information according to the number of headquarters, STN publications, and patents in a city. Data source: Web of Science (retrieved in 2014), Derwent World Patent Index (retrieved in 2013), Taylor & Csomós (2012).

Hence, in comparison to the knowledge and innovation output represented by the number of publications and patents slight diverse orders can be identified. According to the total amount

of publications Beijing, Tokyo, London, and Seoul are at the top and on a per capita basis Boston is topping the list followed by Stockholm, San Francisco, and Amsterdam. Comparing the cities innovation output the highest number of granted patents is counted for Seoul, followed by San Francisco, Shenzhen, and Paris and on a per capita basis the highest numbers are counted for San Francisco, Boston, Paris, and Munich. Concluding, to be a world or global city based on the economic market is not a guarantee to be as competitive according to the other flows. Hence, cities like San Francisco, Shenzhen, Munich, Stockholm, and Beijing have already established or are growing in importance as a hub within the global information and knowledge flows that are of high importance according to the definition of informational world cities. Nevertheless, the presented figures just reflect a snapshot of the year 2011/2012. Hence, in future research, it would be interesting to investigate the development for a longer time period.

Physical connectivity

To be a global or a world city the city needs to be connected with the rest of the world (nine experts). That all of the 31 cities investigated in the work at hand have an enhanced ICT infrastructure and some of them are as well hubs of the ICT economic market has already been discussed in chapter 6.1.1 ICT infrastructure. Next to the digital connectedness the physical infrastructure is of importance that connects a world city not only with its hinterland but as well with the rest of the world. Hence, the global digital world needs to be connected to the physical local world (SG 5). Accordingly, in world city research the physical connectivity is associated with the number of flights and the number of direct destinations (Budd, 2012). Being a hub of international flights is referred to be an "aerocity." Budd (2012) has counted the connectivity of the top five busiest international airports for the year 2008/2009 and ranked them by the number of international passengers (Table 6-13). Comparing the investigated airports, the number of international passengers is not correlated with the number of direct destinations served or of airlines serving the airport. However, it could be of advantage to be a direct neighbor of a world city and to profit from all existing infrastructures (BE 1). Examples are Silicon Valley, which is located within the area of San Francisco, or Cambridge that is directly affiliated at Boston. Other modes of transport can increase the connectivity further. Thus, for instance, in Singapore, especially the port has pushed the development towards a global city (SG 4). Following an expert from São Paulo (SP 4), the airport of São Paulo is well connected but it lacks in the local infrastructure. Hence the connection from the airport to downtown is rather poor. According to the world city researcher Taylor (2012), the main user of the physical infrastructure are

multinational corporations. To build this infrastructure, however, is planned on a political level. Thus, political decisions are able to influence the global connectivity but in the end, a city's government can only invest if the economy provides the necessary capital. Thus, for example, Dubai is growing in importance. Hence, in 2015 Dubai is the city with the most international passengers (77 million) and London is ranked second (66 million international passengers). Further, Dubai is willing to become the world's leading container port in 2030 ("Growing up. The Gulf state's expansion is more sustainable than its previous boom," 2015). Today Dubai is named "gateway city" and it has the ability to reach an equal status as Singapore in future (Clark et al., 2015a).

Table 6-13: Connectivity of the top five busiest international airports for the year 2008/2009, *2007. Data source: Budd (2012).

Number of international passengers (in million)	Airport	Direct destinations served	Number of countries served	Number of airlines
62	London - Heathrow	180	90	90
55	Paris - Charles de Gaulle	294	106	66
48	Amsterdam – Schiphol*	267	87	98
47	Frankfurt	304	106	119
46	Hong Kong	180	46	85

World city culture

A world city is not only all the offices and housing in a city. It is further constituted by a process of *"complexity, incompleteness, and making"* (Sassen, 2013, p. 209). Thus, as a world city, it is important to be an open city, open for globalization, open for culture and people with diverse backgrounds (BE 1). For example, xenophobic people and right-wing extremists may hurt the city's image (MU 1). This is the case at the research institute Max Planck in Dresden, Germany. The institute has problems to attract talented people to the city due to past xenophobic incidents. In consequence, this will harm the economy hence talent cannot be attracted from around the world. In contrast, Boston is a city that is attracting these talents to educate them at Harvard or at MIT. The problem is, as one expert (BO 3) stated, that the people come here, graduate, and in many cases leave the city afterwards. Seoul, for instance, is a globally known city, but it is lacking in openness (SE 2). According to one interviewed expert (SE 2), the population is rather closed. They cannot speak English and have to overcome many barriers. Tokyo, as well, is lacking in

internationality, openness, and language skills as stated by one expert (TOK 1). Japanese people tend to remain for themselves. However, openness to a diversity in culture and immigrants is not always recognized as positive. *"Milan doesn't have the willingness to become a global city because people do not want to lose their soul"* (MI 8). To feel lost due to the fast growing population and immigrants has been mentioned as well as a problem in Dubai. Especially the older generation has to struggle with the diversity of culture and people they have not grown up with (DU 2).

Nevertheless, to become a global hub the city has to attract the creative class. An investigation of New York's labor market has identified that the cultural sector is the most dominant in the city which helps attracting further talents (Currid, 2006). However, there are not the highest salaries paid in comparison to other cities. *"New York's great attraction may be that it is an integrated production and distribution system that provides access to high volumes of knowledge, ideas, information, skill sets, and greater possibilities for individual success within one's field"* (Currid, 2006, p. 343). Thus, the attraction of talent is an important factor of a world city.

To identify whether a city is open to talented immigrants can be observed by the share of foreign-born population. Figure 6-47 is representing these shares for the informational world cities investigated in the work at hand. Due to missing data, São Paulo had to be excluded. In comparison, Dubai is the city with the highest share of foreign-born population (83%). This is not surprising, hence Dubai had a growing boom ("Growing up. The Gulf state's expansion is more sustainable than its previous boom," 2015). In the 2000's it was mainly based on the oil reserves. In addition, economic free zones have attracted many foreign corporations to open a subsidy in Dubai. In some of these economic zones, businesses were allowed to open a branch without any local partner. Thus, the labor market was open to non-local firms as well as to non-local talents. According to an interviewed expert (DU 3), local men prefer to work for the state hence the jobs are very good paid and the living costs are very high. Finally, Dubai has a major proportion of immigrants that work at the construction sides to build the high rise buildings as well as talents that are responsible for the economic market growth (Kosior et al., 2015). The second and third highest share of foreign-born population have Toronto and Vancouver. The interviewed experts from both cities have mentioned that their city is very open for immigrants and that this is of importance for the local labor market (TO 2, VA 3). Instead, Montréal, the third Canadian city in this investigation, is less open due to the language barriers (MO 3) and a lesser representation of international organizations (MO 6). However, the established world cities London and New York have both a share of 37% of foreign-born population. Whereby Tokyo is the big exception with

only 3%. Further low rates are as well identified for other Asian cities like Beijing and Shanghai. Both with less than one percent.
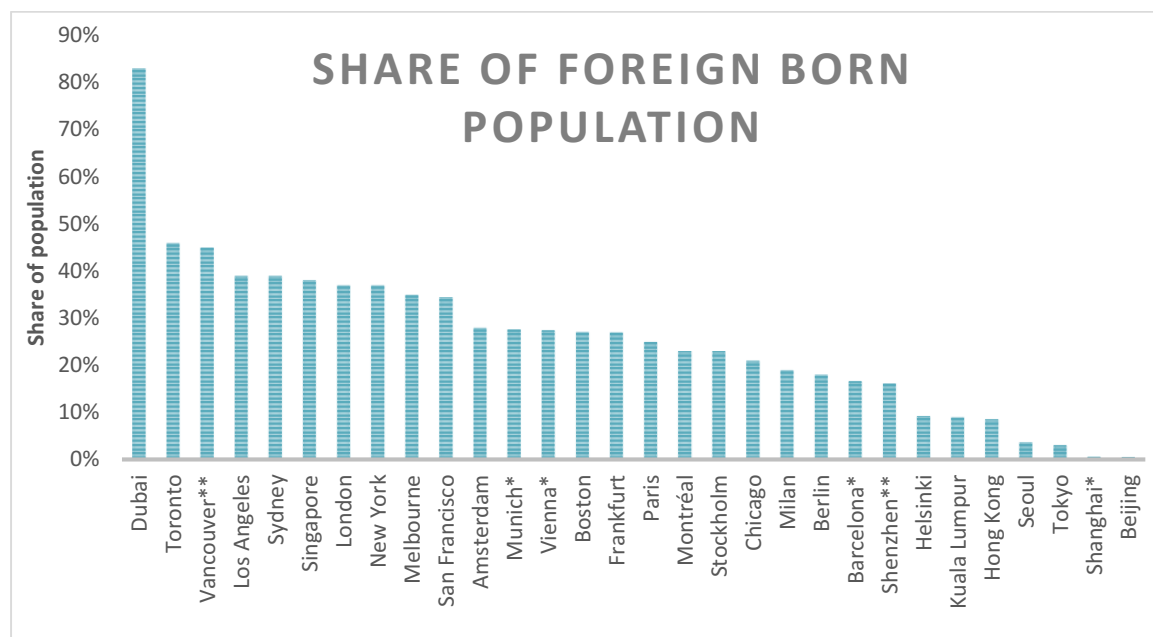
*Figure 6-47: Share of foreign born population of informational world cities (Year of statistics **2011, 2015, *2016). Data based on diverse resources see Appendix VII Share of foreign born population.*

The "Global Talent Competitiveness index" (GTCi) is investigating the countries and businesses ability to attract a talented workforce. This index is produced jointly by INSEAD, Adecco, and Singapore's Human Capital Leadership Institute and was already published for the years 2013, 2014, and 2015/16. The index is concentrated on the openness of nations towards a global workforce. However, according to the "World Migration Report 2015," migrants tend to concentrate in global cities and not to be spread in the nation (IOM, 2015). Thus, for example, Australia has a share of 28% of foreign-born population and the majority is concentrated in the world cities, Sydney and Melbourne. Therefore, it is obviously that Singapore as a city-state has reached the top of the talent competitiveness ranking in 2015 (see Figure 6-48).

Nevertheless, the GTCi aim is to be neutral, global respected and to contribute to the global debate on talent attraction and economic success. As cities are agiler in attracting talents not enough advice is given how governments can contribute to this development on a national level (INSEAD, Adecco, & HCLI, 2015). The calculation is based on two sub-indices. First the competitiveness sub-index, which measures, for instance, the climate of the regulatory market and business environment, and further what a country is doing to attract talent, to grow the talent e.g. by education, and to retain it e.g. through lifestyle and sustainability. The second sub-index is based on the talent competitiveness output, which measures the actual situation at the labor market as an indicator of the success of current regulation and talent attraction.
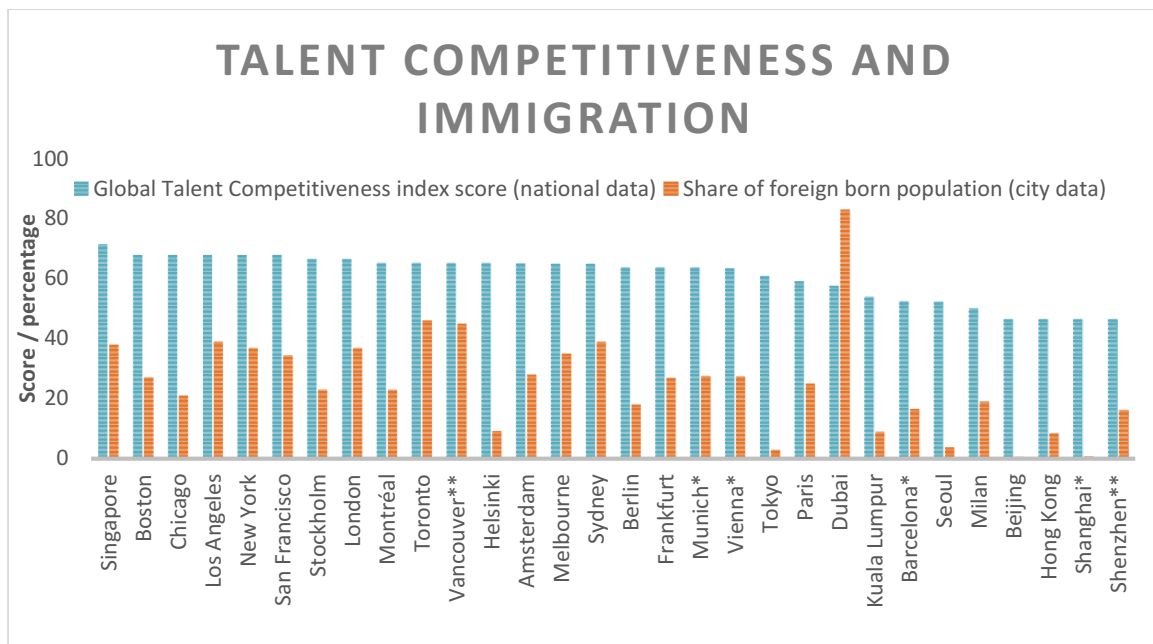
Figure 6-48: Global Talent Competitiveness index 2015 on national data in comparison to the share of foreign born population based on city data. Data source INSEAD, Adecco, and HCLI, (2015) and Appendix VII Share of foreign born population.

Hence, comparing the talent competitiveness on a national level and the share of foreign-born population on city level a slight positive Pearson correlation of +0.5 can be identified. Hence, comparing the US-American cities, which have slightly lower scores than Singapore on a national level, the share of the foreign population is varying between 27 and 39% on the city level. Nevertheless, these are very high scores compared to the cities located in Asia. These cities have a share of between 0.5% and 16.2% and in consequence China is the worst nation in this list according to attract foreign talents.

Finally, the findings of all countries investigated in the global talent competitiveness ranking show a correlation of a nation's income with its ability to attract talent (INSEAD et al., 2015). Further, in a world of talent circulation, cities become "talent hubs." Hence cities can best contribute to attracting talent by offering *"(1) high-quality infrastructure, (2) competitive market conditions and business environment (including clusters), (3) an existing critical mass of talents, with excellent networking and cooperation possibilities, and (4) superior living conditions (including factors as diverse as climatic conditions, cultural environment, safety and easy access to key services such as health or education)"* (INSEAD et al., 2015, p. 37).

Conclusion on cityness

Concluding, the investigation has not proven that it is important for an informational city to be a world city. Hence, inter-city relations constitute the global city. Cities are physically and

digitally connected with the rest of the world. Especially, cities located in nations of a high human development. Those cities are able to become hubs within the global economy. However, world cities are measured primarily according to their status as a hub of multinational corporations or producer service firms. To be home to the headquarters of these firms is referred to as being the place of command and control. Those are dominating subsidies in other cities. This can be referred to as the flows of power that built the inter-city connectivity. Comparing the flows of power with that of knowledge and information no direct relation is observed. Hence, the cities that are recognized as knowledge hub like Boston, or innovation hub, like San Francisco, are not the leading cities of power flows. Therefore, an economical definition of the term world city in the 21st century will refer to Tokyo, New York, and London as primary cities within a hierarchy. Thus, economic success can enable the necessary infrastructure but it is no guarantee to be a leading world city of knowledge or innovation.

A further indicator of a world city is to be physically connected with the rest of the world. This can be measured by the number of international passengers, direct destinations, and airlines per airport. Further, the number of cargo handled at a container port is used as measuring method. However, the development of certain infrastructures is based on political decisions. Therefore, business and government have to work properly together to reach a successful development. A city that is profiting from its enhanced physical infrastructure is Dubai. The city has the busiest airport and is able to become the largest container port in the world in future.

Finally, the inner-city process is acknowledged as an important aspect of being a world city. Urbanity constitutes real cities and this is based on human interaction and not on planned dense areas of offices and housing. In world cities, the global labor force is welcomed which can be represented by the number of foreign-born population. This number reflects openness to cultural diversity but is not to be equated with the ability to attract a talented workforce. Therefore, multinational corporations and producer service firms are needed as adequate labor market. Hence, business and cities can mutually benefit from each other. The city is offering the superior infrastructure and metropolitan lifestyle and the firms are creating the capital. However, a slight positive correlation can be identified comparing the share of foreign-born population and the ability to attract foreign talent. Nevertheless, a city like Tokyo is home to the highest number of multinational corporations but is not attracting international talents. Other Asian cities have as well a very low international population. According to the experts, the language barriers could be a problem in attracting talents. Thus, cities in the US or Singapore, with its bilingual population, are scored very high in the GTCi in contrast to China or Malaysia. Hence, comparing the Canadian

cities, the Anglophone cities Toronto and Vancouver have a much higher percentage of the foreign-born population than the French Montréal.

Summarizing the both hypothesis (H11 and H12) investigated within the aspect of being a world city no clear result can be revealed. A city like New York is an established world city since decades. It has a high GDP, has the highest capital flow at the stock exchanges and as well is home to six of the 100 most successful FinTech companies. But New York is not the city with the highest knowledge or innovation output. Nevertheless, it is able to attract talents and multinational corporations. Both are world city indicators. However, this does not disclose smaller cities to be able to be successful, e.g. Boston. The economic market will be more specialized. As identified by Taylor et al. (2014) that constitutes global hubs relating to "one" economic sector. Eventually, it will be enough to be a regional hub assumed that information, innovation and talent may flow globally.

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7 Conclusion

The work at hand was a first attempt to investigate the influence of political willingness, infrastructures, and the status as a world city on the state and development of prototypical cities of the knowledge society. The underlying theories on cities of the 21st century have been developed in the last decades but a global comparison of real cities is missing. Thus, for example, the emergence of the creative class is demonstrated first of all in the US and cannot be revealed for cities in other countries (Murugadas, Vieten, Nikolic, Fietkiewicz, & Stock, 2015). Other case studies as for instance the correlation of the "Human Development Index" and the "ICT Development Index" have shown that ICT is globally growing in importance (Stock, 2011). Nevertheless, this data is based on national level and not on the city level. At least it demonstrates that a higher human development positively affects the maturity of the ICT infrastructure and vices versa. But what does this mean for our cities in a global economy? As there are different definitions of prototypical cities of the knowledge society and indices on city level are missing on a global scale the approach to the work at hand has been to identify the "new field" of real world examples of informational world cities. Hence, the attempt was not to refer only to the increase of ICT as in many case study projects of smart cities. The work at hand deals with the recent development of cities according to governmental, human, and economic interaction.

In this chapter, I will summarize the main findings of each hypothesis and reveal if the hypotheses developed on the literature review could be proved or if they have to be rearranged based on the expert interviews. Finally, the identified characteristics will be summarized in a typical informational world city.

7.1 Infrastructures

The main infrastructures of an informational world city are digital and cognitive. The digital is referred to investigations on the information and communication technology (ICT). Its use and access are highly correlated with the human development as investigated on a national level (Stock, 2011). Hence in the work at hand, all of the investigated cities are located in a high or very high human development environment, it can be assumed that the underlying ICT infrastructure is enhanced. Furthermore, as a global hub, an informational world city is adding value to the economic market of the ICT sector. In accordance with the cognitive infrastructure, researchers are referring to the knowledge and creative city (Ergazakis, Metaxiotis, & Psarras, 2004; Florida,

2002; Landry, 2008). As described in the literature review, it is difficult to separate both city types hence they have many overlapping indicators. Thus, the infrastructure has been investigated according to knowledge and creative institutions. In total, seven hypotheses have been investigated as part of the digital, knowledge, or creative city. However, the hypotheses have not been proofed as valid for each of the 31 cities but have emphasized some best practices.

Looking at the first hypothesis "H1: Informational world cities are hubs for companies with information market activities, e.g. telecommunication companies" it can be agreed that information market activities play an important role in the majority of the investigated cities. However, the market is changing from being a hub of telecommunication and hardware production, as Helsinki has been in the past due to the former success of Nokia, towards increasing numbers of technology driven corporations and software products. Technology hubs are for example San Francisco Bay Area, Taipei Region, and Seoul Region. Telecommunication hubs are Tokyo, Beijing, and Dallas. Furthermore, cultural and other institutions located in ICT hubs may profit from synergy effects. In addition, universities are needed to educate the knowledge workforce. Interestingly, most experts associate the ICT market with entrepreneurship and tech startups. However, the job-growth impact has only been revealed for North American cities and not globally (Murugadas et al., 2015). Cities that are ranked at the top of being entrepreneurship-friendly are Silicon Valley, New York, London, Los Angeles, and Helsinki. Those can be interpreted as the entrepreneur ICT hubs. Finally, due to the increasing possibilities, how information and technology are used it is presumable that an informational world city is an ICT related hub at least with reference to tech-startups.

Hence, the second hypothesis "H2: The ICT infrastructure in an informational world city is more important than automotive traffic infrastructure" has been extremely provoking since the physical space in a city is still of high importance. Nevertheless, on the city level, an independent measuring of the ICT maturity is missing. Indicators that are only useful to be calculated in dense areas are the access, quality, and use of Wi-Fi. However, the shrinking importance of cars in the city is a natural result of density and not directly emphasized by enhanced ICT. Thus, the people are going to use other modes of mobility than a car and ICT is making them more comfortable, e.g. through mobile payment. Finally, fewer cars result in a more sustainable city. Because of that, the hypothesis has to be reformulated as follows: The maturity of ICT and sustainability are highly correlated in an informational world city.

The third hypothesis "H3: Science parks or university clusters that cooperate with knowledge intensive companies are important in an informational world city" is acknowledged as

being the heart of the knowledge society. Hence, the best practice examples of ICT hubs as well as most innovative cities are home to "elite universities." Science parks and clusters are in need of collaboration with top quality universities. Best practice examples are Cambridge in the Boston Area and Silicon Valley in the San Francisco Bay Area. Both are agglomerations of universities and knowledge intensive companies which demonstrates the success of physical concentration. Furthermore, both cities have a flourishing startup scene and are highly innovative. Concluding, cities with highly ranked universities are more likely to be a knowledge and/or innovation hub.

With regard to the fourth hypothesis "H4: An informational world city needs to be a creative city" a mixed understanding of the traditional and modern definition has been discussed. Hence, the term creativity has been widened from culture and arts towards technology and innovation. Creative institutions (museums, galleries, etc.) are not meaningful indicators to identify a creative city, whereas the innovation output is measurable by the amounts of patents. In total numbers, Seoul is the leading city and on a per capita basis, San Francisco and Boston have the highest share in 2012. Furthermore, the creative economy impacts the digital economy e.g. by online sales of cultural goods. A creative city further allows a free flow of people. This is measured by the city's tolerance. Most tolerant in the US are San Francisco and Los Angeles (among the 5 US cities investigated in the work at hand). Finally, creativity needs space: "Creative milieus" for artists and "milieus of innovation" for the technology talents and entrepreneurs. Thus, being a creative city is at least of advantage. However, San Francisco again is one of the leading best practice examples. Finally, out of the creative city aspects, the most important characteristic is space for and flow of the creative class.

The role of physical space has been investigated according to the following hypothesis: "H5: Physical space for face-to-face interaction is important for an informational world city." Two main aspects protruded. First, the city should have an architecture that encourages face-to-face meeting e.g. by a "coffee house culture" as it is known in Vienna or Paris. Second, coworking spaces are growing in importance in an increasingly digitized world. Hence, entrepreneurs and startups profit as other businesses and corporations from tacit knowledge exchange and an open innovation process. However, most cities offer commercial places like cafés, bars or restaurants, and less free community space is known. To positively impact creativity, it is important to mix up people and to work interdisciplinary. Libraries offer this space as well as the necessary infrastructure through Wi-Fi hotspots. On a per capita basis Amsterdam, San Francisco, and Boston are offering the most coworking space—hence spaces for people to meet face-to-face.

A special role inherits the public library in an informational world city. Hence it is assumed that "H6: A fully developed content infrastructure, e.g. supported by digital libraries, is a characteristic feature of an informational world city." Access to specialized databases needs to be adjusted to what is of importance to the general public. Relevant are, for example, instructions on how to use digital content, give assistance in information retrieval, and at least to offer digital equipment and Wi-Fi connectivity at all branches. As a digital content provider, the library could help the municipality to open data and to digitize them. Based on an investigation of the offered digital services the cities New York, San Francisco, and Toronto are best practice examples. Finally, a fully developed content infrastructure is not of importance. The hypothesis needs to be reformulated into the knowledge society is in need of advanced information literacy as well as local information provider (e.g. open data portals).

Finally, the libraries' importance as physical space has been investigated: "H7: Libraries are important in an informational world city as a physical place for face-to-face communication and interaction." That physical space for face-to-face communication is a need in an informational world city has already been revealed by the fifth hypothesis. Hence, it is not a common standard in informational cities that libraries are those places. However, library space has to be adjusted to the community's demands. In Beijing, the working spaces and in Shenzhen the bookstores are crowded. Instead in Stockholm space for a variety of activities is given. Interestingly, maker spaces add a new dimension to the existing spaces in libraries. Best practice examples of physical library spaces can be found in Montreal, Singapore, and Shenzhen. However, interesting maker spaces are introduced in Chicago and Toronto. Now, citizens can create something. Further, they can be invited to the public library to be part of the libraries' program as well as participate in the decision-making of the future development. Indeed, the public library is important as face-to-face space for the community. However, the community should be able to interact and participate in the future of this space.

7.2 Political will

The political will of an informational world city is referred to the governmental plans and push forward the knowledge-based urban development. Further, in relation to the development of the ICT infrastructure, e-services can be made available on the municipal level. Hence, through e-participation and e-democracy, the city can reach the level of e-governance or furthermore become an open government if it is able to step forward in open innovation processes. Finally,

transparency is identified as key to a trustworthy government. However, on a global scale, the free flow of information is shrinking.

Concerning the eighth hypothesis "H8: Political willingness is important to establish an informational world city especially according to knowledge economy activities" it cannot be proved that it is a necessary requirement. What government can do is to push forward the informational city development through funding and incentives. Particularly, incentives to attract the information and knowledge economy are of advantage, e.g. Twitter in San Francisco, Ubisoft in Montréal, or the whole special economic zones in Dubai and in several Chinese cities. In conclusion, political action in an informational world city can help or hurt. In Berlin, for example, the startup evolution was a bottom-up development. This is comparable to the creative milieus that have emerged in free spaces. Hence, today milieus of innovation follow this trend. For instance, Shenzhen has grown up to a Silicon Valley of Hardware. This was just possible because the government has not interfered. Cities that are acknowledged as having a strong political will towards a knowledge-based urban development are Barcelona, Boston, Melbourne, Montréal, Seoul, Shenzhen, Singapore, Tokyo, Vancouver and Vienna out of the 31 cities investigated in the work at hand.

A further characteristic of the political will is the integration of e-governance as investigated by the ninth hypothesis: "H9: An informational world city is characterized by e-governance (including e-government, e-participation, e-democracy)." Accordingly, the majority of the cities do not perform as the interviewed experts would like to see. There are still many fears that need to be faced before e-governance will be established on the municipal level, like high costs and the reliability of their data. However, on a national level, many governments have introduced online identifications that can be used to verify government to citizen or to business transactions, e.g. the SingPass in Singapore. This is a major step forward on the level of e-services but far away from becoming an open government. Hence, participatory approaches in decision-making processes need an engaged population as well as an open-minded administration. Finally, e-governance could become a characteristic feature of an informational world city but is not yet fully available.

Regarding the political will and e-services, the hypothesis on freedom of information has been evaluated: "H10: A free flow of all kinds of information (inclusive mass media information) is an important characteristic of an informational world city." Thus, freedom of information can be investigated on the one hand, by the political will referring to the law of freedom of information and of expression, on the other hand, by political actions represented through the implementation of open data portals. However, a freedom of information law does not prevent corruption, like in

the example of Montréal. Further, the access to mass media is not to be equated with free flow of information, since self-censorship is growing and independent publishers are becoming rare. However, they are really important within a knowledge society, for instance, to foster critical thinking. In conclusion, the investigated cities that are located in China, Singapore, Malaysia, or the UAE have no freedom of information. Thus, informational cities in "Western" countries tend to have a higher degree of freedom of information than others but there is a global decline in the free flow of information that should alarm the knowledge society.

7.3 World city

Research on world cities as well as on informational cities deals with the flows of information, capital, and power. Hence, all three aspects have been investigated. Capital and power are related to financial hubs and financial flows as measured by multinational financial institutions, stock exchange, and the GDP (Taylor, 2004). Furthermore, the cityness as an aspect of urbanity and inter-city flows has been investigated based on the case study of the 31 informational world cities.

Looking at the eleventh hypothesis: "H11: An informational world city has to be a financial hub with a lot of banks and insurance companies" the interviewed experts did not agree. Hence, the overall economic success is more important than the financial sector (measured by the stock exchange and GDP). Thus, many cities like New York, London, Paris, San Francisco, or Boston can be found in the list of the top 20 global cities as well as in the list of the top 20 venture capital cities. Finance and insurance are not creative and therefore do not add value to the informational world city, whereas the FinTech sector may close the gap between the world city and informational city. Global hubs of both city types are New York, London, and Paris. Interestingly, Boston is no global hub of finance and is not under the top stock exchanges but it is the city with the highest GDP per capita and is one of the top global university hubs. Thus to be successful, it is not important to be a global financial hub, at least in the case of Boston.

Concerning the last investigated hypothesis: "H12: An informational city is supposed to be a global city ('world city')," it is not revealed if small or medium size cities are not able to be informational cities. Hence for some experts, it is more important to be a hub for research and development. However, those cities are not having the same infrastructure which attracts especially multinational corporations. Since those attract eventually the talents. But as revealed by Boston, it is not important. Hence, the city is the hub for R&D of the multinational corporations

instead of the headquarters. Therefore, these institutions, as well as the elite universities, attract talents to graduate and to work there. Finally, in a world of talent circulation, cities become "talent hubs" independent of their size but depending on their openness. Thus, the hypothesis referring to world city research have to be adjusted to questioning the openness of informational cities towards talents and innovation. However, this is just true for cities in "Western" countries. Surprisingly, cities in Asia are growing according to their GDP per year but not according to their openness for talents or information. Hence, based on the measurement of power, knowledge, and innovation flows they are able to compete or even lead the top cities like in the case of Seoul according to the total number of patents granted per year.

7.4 The typical informational world city

Merging the described ideas above we are able to draw the prototypical informational world city as follows:

An informational world city is by definition ubiquitous connected as well as enables a sustainable lifestyle. You will easily find an ICT related job. This will not be an IT hardware manufacturing job. It may be related to culture, health, finance or any other discipline that can enhance its efficiency and possibilities through ICT. Furthermore, you can start your own tech-related business. As it is supported by the government, you will enjoy many benefits and incentives. Otherwise, the multinational corporations in the special economic zones additionally are interested in creative talents.

Whenever you need, you will find highly educated people even for a coffee break in any of the countless restaurants or at your favorite coworking space. To share your knowledge with others you join the library community for a hack event or demonstrate your 3D design skills in an open seminar. The library promotes information literacy skills and keeps you up to date with social end environmental topics. Every now and then you can find space that is redesigned for different kind of activities, like art, performing or coding workshops.

With reference to the world city status, it becomes less important to be a hub of the financial sector. To make investments and to be able to apply for venture capital will replace traditional finance institutions. However, both are located where they are able to access an enhanced ICT infrastructure and additionally may profit from the synergies with entrepreneurs of the FinTech sector.

However, you are connected everywhere and anytime. The taxes and bus tickets are paid via mobile application and the news that you read is pre-filtered pro-government information. Access is not restricted but limited. In addition, language barriers make it difficult to retrieve the worldwide knowledge. Talent inflow is only noticed in preferably English speaking regions. For reliable full content data, you need to access the university library which is often limited to students and faculty. Therefore, you will engage in political decision processes to protest against this violation of the freedom of information but nobody replies your Tweet. The government is too busy due to the digitization processes in each administration. Finally, to be one of the most successful cities e.g. in finance, innovation, or education is just reserved for a few. The majority will remain as regional hubs and not become the command and control destinations.

These findings are based on the investigated case studies. To get more evidence about the city development in the 21st century interdisciplinary approaches as in the work at hand and further empirical and statistical data are needed. Finally, the identified characteristics based on the literature review and modified according to the expert interviews will contribute to the further understanding of cities development, growth, and success in the 21st century. Hence, now we are able to benchmark informational cities on a global scale according to its political willingness, infrastructures, and cityness. In future research at the Department of Information Science at the Heinrich-Heine-University Düsseldorf will continue to investigate the 31 informational world cities with reference to the indicators of the labor market, corporate structure, and weak location factors. Considering the increase of the Internet of Things, open innovation, and sharing industry it will be interesting to see how the cities will develop in the following years.

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Appendix I: List of all interview partner

Amsterdam; Netherlands:

AM 1, personal communication, January 24, 2014

AM 2, personal communication, January 21, 2014

AM 3, personal communication, January 21, 2014

AM 4, personal communication, January 21, 2014

AM 5, personal communication, January 22, 2014

AM 6, personal communication, January 23, 2014

AM 7, personal communication, January 21, 2014

Barcelona, Spain:

BA 1, personal communication, December 4, 2013

BA 2, personal communication, December 4, 2013

BA 3, personal communication, December 4, 2013

BA 4, personal communication, December 4, 2013

BA 5, personal communication, December 4, 2013

BA 6, personal communication, December 5, 2013

BA 7, personal communication, December 5, 2013

BA 8, personal communication, December 5, 2013

BA 9, personal communication, December 5, 2013

Berlin, Germany:

BE 1, personal communication, November 20, 2013

BE 2, personal communication, November 20, 2013

BE 3, personal communication, November 20, 2013

BE 4, personal communication, November 20, 2013

BE 5, personal communication, November 20, 2013

BE 6, personal communication, November 20, 2013

BE 7, personal communication, November 19, 2013

BE 8, personal communication, November 20, 2013

BE 9, personal communication, November 20, 2013

Boston, USA:

BO 1, personal communication, August 29, 2013

BO 2, personal communication, August 30, 2013

BO 3, personal communication, August 30, 2013

BO 4, personal communication, August 30, 2013

Chicago, USA:

CH 1, personal communication, September 4, 2013

CH 2, personal communication, September 5, 2013

CH 3, personal communication, September 4, 2013

Dubai, UAE:

DU 1, personal communication, February 20, 2013

DU 2, personal communication, February 20, 2013

DU 3, personal communication, February 20, 2013

DU 4, personal communication, February 25, 2013

Frankfurt, Germany:

FR 1, personal communication, May 12, 2014 (phone call)

FR 2, personal communication, November 13, 2013

FR 3, personal communication, November 12, 2013

FR 4, personal communication, November 12, 2013

FR 5, personal communication, November 12, 2013

Helsinki, Finland:

HE 1, personal communication, August 6, 2013

HE 2, personal communication, August 6, 2013

HE 3, personal communication, August 6, 2013

HE 4, personal communication, August 5, 2013

Honk Kong, China:

HK 1, personal communication, July 15, 2011

HK 2, personal communication, July 15, 2011

HK 3, personal communication, February 13, 2014

HK 4, personal communication, February 14, 2014

Kuala Lumpur, Malaysia:

KL 1, personal communication, February 19, 2014

London, UK:

LO 1, personal communication, June 27, 2013

LO 2, personal communication, June 27, 2013

LO 3, personal communication, June 27, 2013

LO 4, personal communication, June 27, 2013

LO 5, personal communication, June 27, 2013

LO 6, personal communication, June 27, 2013

LO 7, personal communication, June 27, 2013

LO 8, personal communication, June 27, 2013

Los Angeles, USA:

LA 1, personal communication, September 9, 2013

LA 2, personal communication, September 9, 2013

LA 3, personal communication, September 12, 2013

Melbourne, Australia:

ME 1, personal communication, February 28, 2012

ME 2, personal communication, March 1, 2012

ME 2, personal communication, March 1, 2012

Milan, Italy:

MI 1, personal communication, November 6, 2013

MI 2, personal communication, November 6, 2013

MI 3, personal communication, November 6, 2013

MI 4, personal communication, November 6, 2013

MI 5, personal communication, November 7, 2013

MI 6, personal communication, November 7, 2013

MI 7, personal communication, November 6, 2013

MI 8, personal communication, November 6, 2013

Montréal, Canada:

MO 1, personal communication, March 17, 2014

MO 2, personal communication, March 14, 2014

MO 3, personal communication, March 14, 2014

MO 4, personal communication, March 15, 2014

MO 5, personal communication, March 14, 2014

MO 6, personal communication, June 3, 2014 (phone call)

Munich, Germany:

MU 1, personal communication, April 29, 2014

MU 2, personal communication, April 28, 2014

MU 3, personal communication, April 28, 2014

MU 4, personal communication, April 28, 2014

MU 5, personal communication, April 28, 2014

MU 6, personal communication, April 30, 2014

New York, USA:

NY 1, personal communication, August 27, 2013

NY 2, personal communication, August 21, 2013 (phone call)

NY 3, personal communication, August 21, 2013 (phone call)

NY 4, personal communication, August 21, 2013 (phone call)

NY 5, personal communication, August 28, 2013

Paris, France:

PA 1, personal communication, December 06, 2013

PA 2, personal communication, December 10, 2013

PA 3, personal communication, December 11, 2013

PA 4, personal communication, December 11, 2013

PA 5, personal communication, December 12, 2013

PA 6, personal communication, December 12, 2013

San Francisco; USA:

SF 1, personal communication, September 17, 2013

SF 2, personal communication, September 17, 2013

SF 3, personal communication, September 17, 2013

SF 4, personal communication, September 17, 2013

SF 5, personal communication, September 17, 2013

SF 6, personal communication, September 16, 2013

São Paulo, Brasil:

SP 1, personal communication, February 24, 2014

SP 2, personal communication, February 24, 2014

SP 3, personal communication, February 25, 2014

SP 4, personal communication, February 26, 2014

SP 5, personal communication, April 16, 2014 (phone call)

Seoul, South Korea:

SE 1, personal communication, July 23, 2012

SE 2, personal communication, July 23, 2012

SE 3, personal communication, July 23, 2012

Shanghai, China:

SH 1, personal communication, July 13, 2012

Shenzhen, China:

SHE 1, personal communication, February 12, 2014

SHE 2, personal communication, February 12, 2014

Singapore, Singapore:

SG 1, personal communication, February 12, 2014

SG 2, personal communication, June 24, 2010

SG 3, personal communication, June 29, 2010

SG 4, personal communication, June 29, 2010

SG 5, personal communication, June 28, 2010

SG 6, personal communication, June 24, 2010

SG 7, personal communication, June 24, 2010

SG 8, personal communication, June 24, 2010

SG 9, personal communication, June 25, 2010

SG 10, personal communication, June 25, 2010

SG 11, personal communication, June 29, 2010

SG 12, personal communication, June 30, 2010

SG 13, personal communication, June 30, 2010

SG 14, personal communication, June 28, 2010

Stockholm, Sweden:

ST 1, personal communication, August 9, 2013

ST 1, personal communication, August 8, 2013

ST 1, personal communication, August 8, 2013

ST 1, personal communication, August 8, 2013

Sydney, Australia:

SY 1, personal communication, July 7, 2011

SY 2, personal communication, July 9, 2011

SY 3, personal communication, July 8, 2011

Tokyo, Japan:

TO 1, personal communication, July 26, 2012

TO 2, personal communication, April 27, 2013

TO 3, personal communication, April 28, 2013

TO 4, personal communication, April 28, 2013

TO 5, personal communication, April 27, 2013

TO 6, personal communication, July 26, 2012

TO 7, personal communication, April 28, 2013

Toronto, Canada:

TOR 1, personal communication, March 11, 2014

TOR 2, personal communication, March 11, 2014

TOR 3, personal communication, March 11, 2014

TOR 4, personal communication, March 10, 2014

Vancouver, Canada:

VA 1, personal communication, March 19, 2014

VA 2, personal communication, March 19, 2014

VA 3, personal communication, March 20, 2014

VA 4, personal communication, April 9, 2014 (phone call)

VA 5, personal communication, April 28, 2014 (phone call)

VA 6, personal communication, March 20, 2014

Vienna, Austria:

VI 1, personal communication, January 29, 2014

VI 2, personal communication, January 29, 2014

VI 3, personal communication, January 30, 2014

VI 4, personal communication, January 30, 2014

VI 5, personal communication, January 31, 2014

VI 6, personal communication, January 31, 2014

VI 7, personal communication, January 31, 2014

VI 8, personal communication, January 31, 2014

Appendix II: Literature Review

City Name	World / Global City Author	Year	Knowledge City Author	Year	Creative City Author	Year	Digital City Author	Year	Smart City Author	Year
Amsterdam	Taylor, P. J.	2000	Musterd, S.	2004	Hitters, E., &	2002	Ishida, T.	2000	Hollands, R. G.	2008
	Hall, P.	2005	van den Berg, L.	2005	Hospers, G.-J.	2003b	van den Besselaar, P.	2001	Abdoullaev, A.	2011
			Musterd, S., & Deurloo,	2006	Musterd, S.	2004	Riemens, P., & Lovink,	2002	Komninos, N.	2011
			Matthiessen, C.W.,	2006	Uitermark, J.	2004	Coudelis, H.	2004	Walravens, N.	2015
			van Winden, W., van	2007	Landry, C.	2008	Schuler, D.	2005		
			Gilderbloom, J. I.,	2009	Heywood, P.	2008	Horne, M., Thompson,	2007		
			Musterd, S., & Gritsai,	2009	Evans, G.	2009	Shin, D., Nah, Y., Lee, I.-	2008		
			Pethe, H., Hafner, S., &	2010	Bontje, M., &	2009				
			Pareja-Eastaway, M.,	2010	Romein, A., &	2012				
			Pareja-Eastaway, M.,	2013						
			Streit, A., & Lange, B.	2013						
Barcelona	Taylor, P. J.	2000	Ergazakis, K.,	2004	Foord, J.	2008	Gdaniec, C.	2000	Bakıcı, T., Almirall, E.,	2013
	Hall, P.	2005	Musterd, S.	2004	Landry, C.	2008	Schuler, D.	2005		
			Walliser, A.	2004	Costa, P., &	2009	Evans, G.	2009		
			Dvir, R., & Pasher, E.	2004	Bontje, M., &	2009				
			Edvinsson, L.	2006	Cohendet, P.,	2011				
			Ergazakis, E., Ergazakis,	2009	Marti-Costa, M.,	2011				
			Musterd, S., & Gritsai,	2009	Landry, C.	2012				
			Yigitcanlar, T.	2009	Hospers, G.-J.	2003a				
			Pethe, H., Hafner, S., &	2010	Hospers, G.-J.	2003b				
			Pawlowsky, P.	2011						
			Metaxiotis, K., &	2012						
			Wesselmann, S.,	2012						
			Pareja-Eastaway, M.,	2013						
Beijing	Taylor, P. J.	2000	Ergazakis, K., 2004	2004	Keane, M.	2009	Keane, M.	2009	Zhu, Z.	2011
	Hall, P.	2005	Matthiessen, C. W.,	2006	Kong, L., &	2009	Song, J., Zhang, J., &	2009		
	Bassens, D.	2012	Zhao, P.	2010			Anthopoulos, L., &	2010		
Berlin	Taylor, P. J.	2000	Franz, P.	2009	Hospers, G.-J.	2003b	Horne, M., Thompson,	2007	Walravens, N.	2015
	Eckardt, F	2005	Streit, A., & Lange, B.	2013	Hall, P.	2004				
	Hall, P.	2005			Ebert, R., &	2007				
					Foord, J.	2008				
					Lange, B.,	2008				
					Landry, C.	2008				
					Evans, G.	2009				
					Brake, K.	2012				
					Streit, A., &	2013				
Boston	Taylor, P. J.	2000	Kotkin, J., & DeVol, R.	2001	Hospers, G.-J.	2003b	Kotkin, J., & DeVol, R.	2001	Glaeser, E.L. and Berry,	2006
	Hall, P.	2005	Edvinsson, L.	2006	Wu, W.	2005	Horne, M., Thompson,	2007		
			Matthiessen, C. W.,	2006	Evans, G.	2009				
			Ergazakis, E., Ergazakis,	2009						
			Reffat, R. M.	2010						
			Yigitcanlar, T.	2012						
			Carrillo, F. J.	2014						
Chicago	Friedmann, J.	1986	Kotkin, J., & DeVol, R.	2001	Lloyd, R.	2002	Deren, L., Qing, Z., &	2000	Walravens, N.	2015
	Taylor, P. J.	2000	Reffat, R. M.	2010	Landry, C.	2008	Kotkin, J., & DeVol, R.	2001		
	Hall, P.	2005								
Dubai	Bassens, D., Derudder,	2010	Edvinsson, L.	2006	Durmaz, B.,	2008	Horne, M., Thompson,	2007	Al-Hader, M., & Rodzi,	2009
	Taylor, P. J.	2000	Alraouf, A. A.	2008			Shin, D., Nah, Y., Lee, I.-	2008		
	Bassens, D.	2012	Pawlowsky, P.	2011						
			Carrillo, F. J.,	2014						
Frankfurt	Friedmann, J.	1986	Szogs, G. M.	2011	Landry, C.	2008	Horne, M., Thompson,	2007		
	Taylor, P. J.	2000								
	Hall, P.	2005								
Helsinki	Taylor, P. J.	2000	van den Berg, L.	2005	Landry, C.	2008	Ishida, T.	2000	Landry, C.	2008
			van Winden, W., van	2007	Bontje, M., &	2009	Coudelis, H.	2004		
			Yigitcanlar, T.	2009			Roper, S., & Grimes, S.	2005		
			Inkinen, T., &	2010			Horne, M., Thompson,	2007		
			Pethe, H., Hafner, S., &	2010			Yigitcanlar, T.	2009		
			Stachowiak, K.,	2013						
			Carrillo, F. J.	2014						
Hong Kong	Friedmann, J.	1986	Edvinsson, L.	2006	Foord, J.	2008	Blythe, S. E.	2005	Nam, T., & Pardo, T. A.	2011
	Taylor, P. J.	2000	Pawlowsky, P.	2011	Heywood, P.	2008	Horne, M., Thompson,	2007	Komninos, N.	2011
	Hall, P.	2005			Kong, L., &	2009	Shin, D., Nah, Y., Lee, I.-	2008		
	Bassens, D.	2012								
Kuala Lumpur	Taylor, P. J.	2000	Edvinsson, L.	2006	Yusuf, S., &	2005	Yigitcanlar, T., &	2010		
	Hall, P.	2005	Yigitcanlar, T., &	2010						
			Carrillo, F. J.,	2014						
London	Friedmann, J.	1986	Musterd, S.	2004	Hospers, G.-J.	2003b	Aurigi, A.	2000	Angelidou, M.	2015
	Taylor, P. J.	2000	Matthiessen, C. W.,	2006	Foord, J.	2008	Horne, M., Thompson,	2007	Ben Letaifa, S.	2015
	Sassen, S.	2001			Evans, G.	2009			Walravens, N.	2015
	Hall, P.	2005			Maitland, R.	2010				
Los Angeles	Friedmann, J.	1986	Kotkin, J., & DeVol, R.	2001	Hospers, G.-J.	2003b	Ishida, T.	2000		
	Taylor, P. J.	2000	Winkel Schwarz, A., &	2006	Foord, J.	2008	Kotkin, J., & DeVol, R.	2001		
	Hall, P.	2005					E. M., & Podevyn, M.	2000		
Melbourne	Taylor, P. J.	2000	Ergazakis, K.,	2004	Landry, C., &	1995	Deren, L., Qing, Z., &	2000	Nam, T., & Pardo, T. A.	2011
	Hall, P.	2005	Dvir, R., & Pasher, E.	2004	Baum, S.,	2008				
			Edvinsson, L.	2006	Yigitcanlar, T.	2009				
			Yigitcanlar, T.,	2008						
			Yigitcanlar, T., &	2010						
			Yigitcanlar, T.	2012						
			Metaxiotis, K., &	2012						
			Carrillo, F. J.,	2014						

City Name	World / Global City Author	Year	Knowledge City Author	Year	Creative City Author	Year	Digital City Author	Year	Smart City Author	Year
Milan	Friedmann, J.	1986	Musterd, S.	2004	Landry, C., &	1995	Hospers, G.-J.	2003b		
	Taylor, P. J.	2000	Musterd, S., & Gritsai,	2009	Hospers, G.-J.	2003b	Benini, M., De Cindio,	2005		
	Hall, P.	2005	Pareja-Eastaway, M.,	2010	Foord, J.	2008	Schuler, D.	2005		
					Evans, G.	2009	De Cindio, F.	2009		
							Evans, G.	2009		
Montreal	Hall, P.	2005	Ergazakis, E., Ergazakis,	2009	Ley, D.	2003	Hampton, K. N., &	2008	Hollands, R. G.	2008
			Yigitcanlar, T.	2009	Gertler, M. S.	2004			Leydesdorff, L., &	2011
			Metaxiotis, K., &	2012	Cohendet, P.,	2010				
					Cohendet, P.,	2011				
Munich	Taylor, P. J.	2000	van den Berg, L.	2005	Landry, C.	2008	Horne, M., Thompson,	2007		
	Hall, P.	2005	van Winden, W., van	2007	Bontje, M., &	2009				
			Ergazakis, E., Ergazakis,	2009						
			Musterd, S., & Gritsai,	2009						
			Yigitcanlar, T.	2009						
			Pethe, H., Hafner, S., &	2010						
			Metaxiotis, K., &	2012						
New York	Friedmann, J.	1986	Kotkin, J., & DeVol, R.	2001	Hospers, G.-J.	20003b	Kotkin, J., & DeVol, R.	2001	Angelidou, M.	2015
	Taylor, P. J.	2000	Bugliarello, G.	2004	Currid, E.	2006	Horne, M., Thompson,	2007		
	Sassen, S.	2001	Edvinsson, L.	2006	Foord, J.	2008	Hampton, K. N., &	2008		
	Hall, P.	2005	Matthiessen, C. W.,	2006	Heywood, P.	2008				
					Evans, G.	2009				
					Zukin, S., &	2011				
Paris	Friedmann, J.	1986	Matthiessen, C. W.,	2006	Hospers, G.-J.	20003b	Hospers, G.-J.	2003b		
	Hall, P.	2005			Evans, G.	2009	Horne, M., Thompson,	2007		
	Taylor, P. J.	2000			Vivant, E.	2010				
San Francisco	Friedmann, J.	1986	Kotkin, J., & DeVol, R.	2001	Heywood, P.	2008	Kotkin, J., & DeVol, R.	2001	Glaeser, E.L. and Berry,	2006
	Taylor, P. J.	2000	Matthiessen, C. W.,	2006	Evans, G.	2009	Horne, M., Thompson,	2007	Hollands, R. G.	2008
	Hall, P.	2005	Reffat, R. M.	2010					Nam, T., & Pardo, T. A.	2011
									Lee, J. H., Hancock, M.	2014
Sao Paulo	Friedmann, J.	1986	Ergazakis, Metaxiotis,	2004	Costa, P., &	2009				
	Taylor, P. J.	2000	Rocco, R.	2012						
	Hall, P.	2005								
Shenzhen	Cartier, C.	2002	Wang, D., Wu, Z., Li, Y.,	2012			Wang, C. C.	2012	Wang, D., Wu, Z., Li, Y.,	2012
			Carrillo, F. J.,	2014					de Jong, M., Yu, C.,	2013
									Kang, Y., Lei, Z., Ca, C.,	2014
Seoul	Friedmann, J.	1986	Reffat, R. M.	2010	Yusuf, S., &	2005	Lee, S.-H., Yigitcanlar,	2008	Nam, T., & Pardo, T. A.	2011
	Taylor, P. J.	2000			Lee, Y.-S., &	2012	Shin, D., Nah, Y., Lee, I.-	2008	Lee, J. H., Hancock, M.	2014
	Hall, P.	2005					Evans, G.	2009		
							Choi, J. H., &	2009		
Shanghai	Taylor, P. J.	2000	Sigurdson, J.	2005	Yusuf, S., &	2005	Ding, P., Lin, D., &	2005	Sigurdson, J.	2005
	Hall, P.	2005	Reffat, R. M.	2010	Kong, L., &	2009	Song, J., Zhang, J., &	2009	Nam, T., & Pardo, T. A.	2011
	Bassens, D.	2012			Wei, L. W., &	2009	Lagerkvist, A.	2010	Zhu, Z.	2011
					Chen, Y.	2012				
Singapore	Friedmann, J.	1986	Heng, T. M., & Low, L.	1993	Landry, C., &	1995	Ishida, T.	2005	Al-Hader, M., & Rodzi,	2009
	Taylor, P. J.	2000	Edvinsson, L.	2006	Yusuf, S., &	2005	Horne, M., Thompson,	2007	Nam, T., & Pardo, T. A.	2011
	Hall, P.	2005	Hornidge, A-K.	2007	Wong, C. Y. L.,	2006	Baum, S., Yigitcanlar,	2008	Zhu, Z.	2011
			Wong, C.	2008	Evans, G.	2009	Shin, D., Nah, Y., Lee, I.-	2008		
			Ergazakis, E., Ergazakis,	2009	Kong, L., &	2009				
			Yigitcanlar, T.	2009						
			Reffat, R. M.	2010						
			Edvinsson, L.	2011						
			Carrillo, F. J.,	2014						
Stockholm	Taylor, P. J.	2000	Edvinsson, L.	2006	Landry, C., &	1995			Abdoullaev, A.	2011
	Hall, P.	2005	Ergazakis, E., Ergazakis,	2009	Hospers, G.-J.	2003b			Nam, T., & Pardo, T. A.	2011
			Yigitcanlar, T.	2009					Shahrokni, H.,	2015
			Metaxiotis, K., &	2012						
Sydney	Friedmann, J.	1986	Yigitcanlar, T., &	2010	Baum, S.,	2008	Horne, M., Thompson,	2007	Abdoullaev, A.	2011
	Taylor, P. J.	2000	Hu, R.	2012						
	Hall, P.	2005								
Tokyo	Friedmann, J.	1986	Matthiessen, C. W.,	2006			Horne, M., Thompson,	2007		
	Taylor, P. J.	2000								
	Sassen, S.	2001								
	Hall, P.	2005								
Toronto	Friedmann, J.	1986	Evans, G.	2009	Ley, D.	2003	Horne, M., Thompson,	2007	Nam, T., & Pardo, T. A.	2011
	Taylor, P. J.	2000			Gertler, M. S.	2004	Hampton, K. N., &	2008		
	Hall, P.	2005			Heywood, P.	2008				
					Catungal, J. P.,	2009				
					Evans, G.	2009				
					Henry, R.	2010				
Vancouver	Hall, P.	2005	Yigitcanlar, T.	2012	Ley, D.	2003	Horne, M., Thompson,	2007	Hollands, R. G.	2008
					Gertler, M. S.	2004			Nam, T., & Pardo, T. A.	2011
					Heywood, P.	2008				
Vienna	Friedmann, J.	1986	Trippl, M.	2012	Hospers, G.-J.	2003b	Ishida, T.	2005	Hofstetter, K., & Vogl,	2011
					Hall, P.	2004	Horne, M., Thompson,	2007		

Appendix III: Bike sharing

City	URL	Comments
Amsterdam	no	Bike renting: http://www.iamsterdam.com/en/visiting/plan-your-trip/getting-around/rental/bike-hire
Barcelona	https://www.bicing.cat/	
Beijing	yes - but no official website found	http://www.cbsnews.com/news/china-beijing-bike-share-more-lanes-aim-to-reduce-congestion-pollution/
Berlin	http://www.nextbike.de/de/berlin/	
Boston	https://www.thehubway.com/	
Chicago	http://www.divvybikes.com/	
Dubai	http://www.bykystations.com/en/dubai/	Available around tourist destinations (Pal Jumeirah and Burj Khalifa)
Frankfurt	http://www.nextbike.de/de/frankfurt	
Helsinki	https://www.hsl.fi/en/citybikes	
Hong Kong	no	Just as touristic attraction and freetime activity within a park http://www.westkowloon.hk/en/smartbike
Kuala Lumpur	no	First Bikelines are introduced https://www.theguardian.com/cities/2015/sep/18/how-crowd-sourced-map-kuala-lumpurs-ideas-cycling
London	https://tfl.gov.uk/modes/cycling/santander-cycles	
Los Angeles	https://bikeshare.metro.net	
Melbourne	http://www.melbournebikeshare.com.au	
Milan	https://www.bikemi.com	
Montreal	https://montreal.bixi.com/	Project: renting bikes with OPUS card which is the usual public transportation card which can be preloaded and used as payment
Munich	http://www.nextbike.de/en/muenchen/	
New York	https://www.citibikenyc.com/	
Paris	http://en.velib.paris.fr/	
San Francisco	http://www.bayareabikeshare.com/	
Sao Paulo	http://www.mobilicidade.com.br/bikesampa.asp	
Shenzhen	http://www.qfggzxc.com/index.php	
Seoul	https://www.bikeseoul.com:447/main.do?lang=en	
Shanghai	http://www.chinarmb.com/	
Singapore	no	Prototype http://www.zaibike.com/
Stockholm	http://www.citybikes.se/home	
Sydney	no	
Tokyo	http://docomo-cycle.jp/minato/en/	
Toronto	https://toronto.bixi.com	
Vancouver	https://www.mobibikes.ca/	
Vienna	https://www.citybikewien.at/de/	

Appendix IV: Best ranked university in city

City	Institution	Academic Ranking of World Universities (Shanghai Ranking Consultancy)	QS World University Rankings	Center for World University Rankings (CWUR)
Boston	Massachusetts Institute of Technology	3	1	3
San Francisco	Stanford University	2	3	2
London	University College London	18	7	27
Chicago	University of Chicago	9	10	8
Singapore	National University of Singapore	101	12	65
New York	Columbia University	8	22	6
Paris	ENS - Paris	72	23	37
Montreal	McGill University	64	24	42
Beijing	Tsinghua University	101	25	78
Los Angeles	University of California, Los Angeles	12	27	15
Hong Kong	Hong Kong University of Science and Technology	201	28	319
Toronto	University of Toronto	25	34	32
Seoul	Seoul National University	101	36	24
Tokyo	University of Tokyo	21	39	13
Melbourne	University of Melbourne	44	42	93
Sydney	University of Sydney	101	45	88
Vancouver	University of British Columbia	40	50	62
Shanghai	Fudan University	151	51	195
Amsterdam	University of Amsterdam	101	55	114
Munich	Technical University of Munich	51	60	101
Stockholm	Royal Institute of Technology	201	92	126
Helsinki	University of Helsinki	67	96	111
Berlin	Free University of Berlin	301	119	147
Sao Paulo	University of Sao Paulo	101	143	132
Kuala Lumpur	University of Malaya	301	146	498
Vienna	University of Vienna	151	153	223
Barcelona	University of Barcelona	151	166	116
Milan	Polytechnic University of Milan	201	187	397
Source:				
Academic Ranking of World Universities. (n.d.). University and college rankings list. Retrieved from http://www.shanghairanking.com/resources.html				
Quacquarelli Symonds. (n.d.). Top universities. Retrieved from http://www.topuniversities.com/				
O'Neill, M. (2016). World university rankings. Retrieved from https://www.kaggle.com/mylesoneill/world-university-rankings				

Appendix V: Patents granted 2000-2012

Publication Year Basic	2000	2001	2002	2003	2004	2005	2006
Dubai	n.v.	5	7	7	12	18	22
Frankfurt	8	24	33	43	19	53	52
Kuala Lumpur	2	12	18	15	25	37	33
Melbourne	37	50	51	55	56	57	80
Sydney	68	72	115	92	93	115	107
Sao Paulo	24	54	76	95	106	123	140
Vienna	58	127	177	215	249	178	223
Montreal	384	351	185	164	168	171	165
Barcelona	42	115	187	236	244	281	339
Vancouver	110	214	360	433	410	455	535
Amsterdam	106	207	327	351	471	731	820
Milan	221	398	475	555	573	646	687
Hong Kong	26	101	246	383	468	574	704
Helsinki	312	444	518	627	570	670	658
Berlin	270	479	678	713	636	731	831
Shanghai	27	54	106	206	348	481	652
Stockholm	519	726	825	660	553	658	701
Toronto	215	385	602	747	759	849	1051
Beijing	56	114	216	280	401	626	838
Boston	414	590	925	932	964	1165	1113
Singapore	161	298	704	987	964	1394	1531
Los Angeles	278	532	975	1152	1218	1373	1487
London	1321	1484	1573	1562	1480	1516	1460
Shenzhen	13	28	80	205	367	549	1307
Chicago	432	572	1082	1642	1770	1991	2111
Paris	891	1087	1681	2065	2103	2124	2269
New York	826	1317	2201	2346	2426	2808	3036
Munich	1257	2034	2834	3152	3076	3375	3507
San Francisco	446	808	1584	2093	1806	2566	2834
Tokyo	1545	2009	2417	2525	3025	3485	3021
Seoul	827	1784	2892	3439	4894	6751	8622

Publication Year Basic	2007	2008	2009	2010	2011	2012	Total 2000-2012
Dubai	32	39	33	29	44	24	272
Frankfurt	47	54	36	38	50	19	476
Kuala Lumpur	47	69	65	91	86	39	539
Melbourne	80	78	59	44	46	9	702
Sydney	101	111	117	105	111	64	1271
Sao Paulo	160	151	180	148	139	70	1466
Vienna	220	212	196	207	164	100	2326
Montreal	215	200	167	171	148	30	2519
Barcelona	346	330	385	340	273	169	3287
Vancouver	524	605	558	500	489	374	5567
Amsterdam	677	605	563	494	344	233	5929
Milan	639	582	527	520	445	227	6495
Hong Kong	707	830	736	691	738	668	6872
Helsinki	670	729	648	605	563	437	7451
Berlin	845	878	938	862	762	365	8988
Shanghai	977	1057	1196	1458	1437	1031	9030
Stockholm	765	975	1086	1093	1113	607	10281
Toronto	1083	1127	1044	950	1067	924	10803
Beijing	991	1397	1732	1903	1994	1535	12083
Boston	1149	1242	1121	1092	1051	853	12611
Singapore	1503	1527	1593	1625	1530	1318	15135
Los Angeles	1434	1557	1493	1488	1444	1475	15906
London	1623	1665	1535	1537	1444	1048	19248
Shenzhen	1966	2303	2901	4099	3887	2958	20663
Chicago	2208	2280	2203	2060	2012	1989	22352
Paris	2365	2453	2491	2609	2638	2706	27482
New York	3006	3197	2886	2797	2591	2699	32136
Munich	3364	3199	3155	2490	2086	1225	34754
San Francisco	3244	3775	3996	3932	4175	4702	35961
Tokyo	3112	3445	4183	3687	4656	2323	39433
Seoul	9647	9405	8568	8555	8645	7163	81192

Appendix VI: Coworking spaces

City Name	Number of spaces	Source
Amsterdam	60	http://www.launchdesk.nl/en/desk-amsterdam?flexdesk=no&days=1&price=25-450&persons=1
Barcelona	31	http://barcelonanavigator.com/barcelona-co-working-spaces/
Beijing	7	http://www.labsterx.com/blog/beijing-coworking-spaces/
Berlin	93	http://www.berlin.de/projektzukunft/standortinformationen/coworking-spaces-in-berlin/
Boston	34	https://bostonstartupsguide.com/guide/boston-coworking-spaces-roundup/
Chicago	152	https://www.desktimeapp.com/
Dubai	10	https://www.wamda.com/2013/07/10-popular-coworking-spaces-in-the-arab-world https://www.quora.com/What-are-the-best-co-working-spaces-in-Dubai own search on google
Frankfurt	15	https://www.designoffices.de/standorte/frankfurt-westend/coworking-spaces/ http://www.the-office-frankfurt.de/ https://www.coworking.de own search on google https://www.yelp.de/search?find_loc=Frankfurt+am+Main,+Hessen&start=10&cflt=sharedofficespaces
Helsinki	15	http://www.helsinkibusinesshub.fi/article/find-your-coworking-space-in-helsinki/
Hong Kong	24	http://www.9amconsulting.com/coworking-spaces-hong-kong.html
Kuala Lumpur	19	http://www.startupblink.com/blog/kuala-lumpur-startup-ecosystem/ http://www.lifestyleasia.com/450062/thrive-10-co-working-spaces-around-kuala-lumpur-to-know/ http://www.nextupasia.com/9-awesome-coworking-space-around-kuala-lumpur-malaysia/ http://zafigo.com/stories/zafigo-stories/your-essential-guide-to-12-co-working-spaces-in-kuala-lumpur/
London	167	http://www.coworkinglondon.com/co-working-spaces/
Los Angeles	65	https://www.desktimeapp.com
Melbourne	38	http://www.creativespaces.net.au/find-a-space#!/?sort=newest&page=1&usage=567&municipal_ids%5B%5D=342
Milan	11	https://www.sharedesk.net/search/list/Milan-Italy http://www.coworking-news.de/european-coworking-directory/#italy
Montreal	21	https://www.quora.com/Where-are-the-coworking-spaces-in-Montreal

Munich	13	http://www.coworking-news.de/coworking-verzeichnis/#muc
		http://www.t3hero.com/blog/die-besten-co-working-spaces-in-hamburg-muenchen-und-berlin.html
		https://www.sharedesk.net/search/list/Munich,+Germany
New York	50	https://blog.getkisi.com/top-coworking-spaces-in-nyc/
Paris	19	http://www.eu-startups.com/2016/01/overview-of-the-best-coworking-spaces-in-paris/
		http://frenchtechhub.com/blog/2015/10/the-10-best-coworking-sites-in-the-paris-region/
San Francisco	48	http://wiki.coworking.org/w/page/16583935/SanFranciscoCoworking
Sao Paulo	109	https://coworkingbrasil.org/espacos/?city=S%C3%A3o+Paulo
Shenzhen	14	http://startuplivingchina.com/top10-best-coworking-spaces-in-china/
		https://www.globalfromasia.com/shenzhen-startup-overview/
		own google search
Seoul	6	https://www.coworker.com/south-korea/seoul
Shanghai	11	http://startuplivingchina.com/top10-best-coworking-spaces-in-china/
		https://www.coworker.com/search/shanghai
Singapore	19	http://thehoneycombers.com/singapore/co-working-spaces-in-singapore-shared-offices-for-freelancers-budding-entrepreneurs-and-start-up-companies/#WkQqozlZ4VhL75O8.97
Stockholm	17	http://www.swedishwire.com/business/19627-top-co-working-spaces-in-stockholm-
		http://www.yourlivingcity.com/stockholm/community/networking-community/co-working-spaces/
		https://www.routesnorth.com/stockholm/six-of-the-best-co-working-spaces-in-stockholm/
		own search on google
		http://lukeryan.me/the-best-co-working-spaces-in-stockholm/
Sydney	38	https://www.coworker.com/search/sydney/australia
		http://wiki.coworking.org/w/page/16583720/CoworkingSydney
Tokyo	25	https://tokyocheapo.com/business/drop-in-coworking-spaces-tokyo/
Toronto	43	http://startupheretoronto.com/support-category/coworking-spaces/
Vancouver	15	http://wiki.coworking.org/w/page/16583740/CoworkingVancouver
		own search on google
		http://www.bcliving.ca/5-best-coworking-spaces-in-metro-vancouver
		https://www.yelp.com/search?cflt=sharedofficespaces&find_loc=Vancouver%2C+WA
Vienna	26	https://goodnight.at/magazin/freizeit/216-co-working-spaces-wienown search on googlehttp://wiki.coworking.org/w/page/16583742/CoworkingVienna