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The Informational World City London

Duwaraka Murugadas, Stefanie Vieten, Janina Nikolic and Agnes Mainka
Department of Information Science, Heinrich-Heine-University, Düsseldorf, Germany

Abstract

Purpose – The Department of Information Science of the Heinrich-Heine-University in Düsseldorf is currently conducting a research project on Informational World Cities – the prototypical cities of the knowledge society, which have been growing in the twenty-first century. In total, 31 potential Informational World Cities were identified and a set of criteria was developed to evaluate the degree of informativeness of a city through coherent criteria. The purpose of this paper is to investigate London.
Design/methodology/approach – The investigation was based on the Grounded Theory, ethnographic field research, interviews, bibliometrics, patentometrics, official statistics and the analysis of web content. During the stay in London, eight semi-standardised interviews according to SERVQUAL were conducted.
Findings – The characteristics of an Informational World City are well-marked in most cases, especially London's knowledge infrastructure. Furthermore London places value on smart innovations and tries to adapt public transport to the growing population. This includes, next to an enhancement of the train capacities, information and communication technology, since the digital infrastructure keeps gaining importance. The ethnic/cultural diversity as well as the international connectivity and the creative infrastructure are also distinguishing marks of London. Nevertheless, especially the digital and smart infrastructure require enhancement. London's government is ambitioned, though, to make progress and pursues plans which are of benefit to the city's informativeness.
Social implications – This paper gives insight into the characteristics of the prototypical city of the upcoming knowledge society.
Originality/value – This paper follows an interdisciplinary approach and combines information science, urban studies and sociology to analyse cities of the knowledge society. Furthermore it is the first time that London is considered an Informational World City in an empirical study.

Keywords Case studies, Knowledge workers, Information science, Information society
Paper type Case study

Introduction

The term "Informational City" was first used by Castells (1989). He was one of the first who thought about the connection of cities, society and information and communication technology (ICT) in a global context and about the emerging possibilities of innovation based on this connections. Today we can see such cities in front of our eyes (Stock, 2011a). But how can we define their maturity or describe their development? Stock has defined an indicator catalogue[1] based on the definition of Informational World Cities which will be used here. The indicators are analysed with interdisciplinary methods. The development of cities and the society are not genuine topics of information science. The tremendous importance of information, knowledge and ICT in this research field should not be limited to urbanists, economists, regional planners, government agencies or sociologists but include methods and research by

The authors' special thanks goes to the interview partners for offering a deeper insight into life and development in London regarding the various aspects of informativeness.

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information scientists. In the following, this paper presents an exploratory study of London as an Informational World City and highlights which characteristics of an Informational World City it possesses.

What is an Informational City?

Informational Cities are the prototypical cities of a knowledge society and the new centres of power, which have a "glocal" orientation since they can act out both locally and globally (Stock, 2011a, b). This arising of a knowledge society and the hence emerging informational cities (Yigitcanlar, 2010) can be explicated by the fifth Kondratieff-Cycle (Kondratieff, 1926). Nefiodow's (1991) version of the theory of long waves predicates that since the beginning of capitalism there were four economic cycles (long waves) to be observed: the cycle of the steam engine, followed by the cycle of the railway, the cycle of chemistry and electricity and the fourth one being the cycle based on petro chemistry and automobile manufacture. The fifth cycle is in the process of emerging and is borne by the resource information, which will eventually lead to a knowledge society, which is characterized by a massive use of ICT. The ICT infrastructure as well as the cognitive infrastructure are significant because they are the base for a knowledge and creative city. While the ICT infrastructure can be described by hard data, the cognitive infrastructure contains cognitive abilities as knowledge and creativity. Hence, knowledge plays a key role in the society (Linde and Stock, 2011). Since knowledge changes continuously, knowledge-based tasks and knowledge industries keep gaining importance, which causes a higher significance of education and the process of learning (Heidenreich, 2002) – lifelong learning becomes essential (Stock, 2011a). Thus, by means of libraries, which provide explicit knowledge via digital networks, and the educational system, highly skilled knowledge workers can be trained (Khveshchanka *et al.*, 2011).

In this respect Castells (1989) defines Informational Cities as an outcome of the knowledge society. In such cities there are two kinds of spaces that coexist: the "space of places" and the "space of flows", meaning the flows of information, capital and power. He concludes:

> […] we can see […] the historical emergence of the space of flows, superseding the meaning of the spaces of place. […] The new industrial space and the new service economy organize their operations around the dynamics of their information-generating units, while connecting their different functions to disparate spaces […]. […] New information technologies are not in themselves the source of the organizational logic that is transforming the social meaning of space: they are, however, the fundamental instrument […] (Castells, 1989, p. 348).

Informational Cities are important nodes of the space of flows (Castells, 2000) and if they are important glocal cities, they often are world cities (Stock, 2011a). According to Friedmann (1995, p. 23), "world cities are large, urbanized regions that are defined by dense patterns of interactions rather than by political-administrative boundaries". Furthermore global cities serve as locations for the headquarters of global companies. These companies require information and expert knowledge. And since there are a lot of different companies with various talents and expertise within one global city, the city itself becomes an information centre (Sassen, 2001).

In cities in which the support of the physical and digital infrastructure is not dominated by the economic sector the government has to face the necessary investments (Johnson *et al.*, 2005, p. 217). According to this, the political willingness is an essential aspect for becoming an Informational World City. Thus, a high use and a

high penetration of ICT may result in a higher support of e-government and e-commerce, e.g. a better interaction between enterprises, citizens and authorities through ICT connections (Fischer-Brauer, 2010, p. 18). All in all, the aspects ICT, provision of explicit knowledge and the facilitation of sharing implicit knowledge are undoubtedly topics of information science.

Indicators of an Informational City

To investigate whether a city is an Informational City, different indicators based on Stock's (2011a) indicator catalogue introduced in his work "Informational Cities: Analysis and Construction of Cities in the Knowledge Society" are to be taken into consideration. One of these indicators is the urban infrastructure, which holds the digital infrastructure, the knowledge infrastructure, the creative infrastructure and the green infrastructure. The analysis of the digital infrastructure deals with the development of ICT in the city, for example, how many WiFi hotspots are to be found in the city or how fast the broadband connection is, since the telecommunication network is the "predominant infrastructure of informational cities" (Mainka *et al.*, 2011). The knowledge infrastructure describes the structure of the educational system and its institutions which is the basis of knowledge intensive output like the number of publications coming from the city. The investigation of the creative infrastructure focuses, i.e. on creative institutions in the city, e.g. opera houses, theatres, etc., as a basis of the frequency of their incoming visitors. And by analysing the ecological friendliness encouraged in the city, the green infrastructure can be defined. The next indicator is the cityness, i.e. the indicators of a global city. These include factors like the population, the international connectivity or the flow of people coming into or leaving the city. Also the openness and tolerance within the city are an issue of cityness. The labour market is another indicator because in Informational Cities a special form of job polarization is likely to exist (Mainka *et al.*, 2011). Furthermore a knowledge society demands knowledge intensive jobs, which is why the number of people working in this sector is an indicator of how the development into an Informational City has progressed already. Referring to Sassen's (2001) statement that global companies settle in global cities, the diversity of companies within the investigated city serves as a further indicator. Another indicator is the political willingness of the government to establish an Informational City and in this respect it is investigated whether there are political programmes "to build [the] necessary infrastructures" (Mainka *et al.*, 2011) which characterize an informational city. The last indicator is made up of the soft location factors like leisure time facilities, a tremendous architecture or shopping malls. These are important since they attract people to come into the city, both as tourists and for business (Hall, 1997b).

Why London?

The main reason for choosing London as a city for our investigation is that London seemed to be the perfect candidate for an Informational World City. Mainka *et al.* (2012) describe how the Informational Cities were defined: a city can be defined as an "Informational City" if it is manifested in the literature as "world city" or "global city" and if at least one of the criterions "digital city", "knowledge city", "smart city" or "creative city" is applicable to it. They identified 31 cities as potential Informational World Cities, one of which is London. According to A.T. Kearney's and the Chicago Council on Global Affairs' Global Cities Index (ATKearney, 2012), which "measures global

engagement of cities across five dimensions: business activity, human capital, information exchange, cultural experience, and political engagement", London belongs to the leading cities next to New York, Paris and Tokyo. The purpose of this work is to examine if London is an Informational World City and, if so, to elaborate which features of an Informational World City London possesses according to the nominated indicators based on Stock (2011a). In most cases quantitative data will be adequate to determine to what extent dimensions are developed in London, e.g. the penetration rate of mobile internet users, but in other cases a qualitative presentation of the city's practices and visions are crucial. The aim is to work out which characteristics of an Informational World City are especially well-marked in London and which characteristics are less marked so that a conclusion can be drawn about which attributes make London an Informational World City. Since this is one of the first studies which combines the theoretical ideas of measuring Informational Cities with Stock's (2011a) indicator catalogue and real city data, a comparison to other cities could just be given in a few examples.

Methods

The investigation of the Informational World City London was approached in stages. The basic theoretical framework was already given by Stock's (2011a, b) elaborations on informational urbanism and the therefrom deduced case study about Singapore by Mainka (2011) and Khveshchanka *et al.* (2011).

Grounded Theory

The common theory which underlies the way of proceeding during the investigation of Informational World Cities is the Grounded Theory. It is a theory by Glaser and Strauss first mentioned in 1967 (Mey and Mruck, 2011) which deals with the discovery of a theory on the basis of systematically won data (Glaser and Strauss, 2005) and which has been established in various practitioner fields (Tan, 2010). The development of methods to generate theories gains in importance for the reason that in times of social changes and globalization, quantitative techniques are not sufficient anymore since, by definition, they only gather what exists of verifiable theoretical foreknowledge and the therefrom derived hypotheses (Mey and Mruck, 2011). According to the Grounded Theory, a theory which arose out of data has to fulfil four characteristics to be implementable: it has to fit in the area field it is supposed to be utilized in, it has to be understandable for lay people active in this field, it has to be common and not too specific so it can apply to more than one situation, and it has to enable its operator to have a partial control over structures and processes of the ordinary situations, even and especially if they change in the course of time (Glaser and Strauss, 2005). This work aims at developing a theory about whether London is an Informational World City or not, namely via the Grounded Theory.

Field research

Including this form of research into this project was organized in three different steps: first, desktop research was conducted to gather information such as demographic development or labour market statistics about London. A stay of six days in London enabled eight semi-standardised interviews with professionals who had been selected and contacted beforehand as well as the chance to get own impressions of the earlier won information. Following this, the interviews were analysed and a well-balanced picture of London including both experiences and facts could be created.

Interviews

To receive more insights into how London is perceived as an Informational World City, interviews were conducted locally as a part of the field studies. In this work, semi-standardised interviews were utilized which means the questionnaire contained both quantitative characteristics – closed questions – and qualitative characteristics – the interviews still allow space for questions and remarks which can provide further information. The qualitative information still have priority, though, since they can lead to further findings and possible new research questions, which had not been considered before. This way, a quantification of the data is enabled and at the same time qualitative aspects can be foregrounded. The interview can hence be seen as a guideline-based interview, where the questionnaire only serves as an orientation for the interview (Weischer, 2007). The quantitative social research usually is characterized by a high number of cases (Weischer, 2007); for this investigation, though, only eight people were surveyed so that no common conclusions can be drawn, but instead tendencies can be derived which provide first impressions to profoundly investigate processes and areas based on these. The choice of interviewees aimed for experts who cover an important research aspect of the investigation such as experts from universities, libraries or embassies. The used questionnaire was based on the SERVQUAL method by Parasuraman *et al.* (1988). It is a standardised method for the assessment of the service quality. These questions are again divided into expectations and the respective perceptions which were to be assessed on a scale from 1 to 7, where 1 means irrelevant/not applicable and 7 means totally relevant/applicable (Parasuraman *et al.*, 1988). The evaluation of the interview breaks down to two ways of proceeding: one for the quantitative data and one for the qualitative data. The quantitative data won through the SERVQUAL method can be analysed statistically. At first, the assessments of the interviewees regarding their expectations and their perceptions have to be encoded into data and transferred to a data storage device. Parasuraman *et al.* (1988) suggest the calculation of the difference (Q) between perception value (P) and expectation value (E), where $Q = P - E$. Furthermore the arithmetic average for the expectations and perceptions each can be computed. The qualitative data on the other hand can be evaluated by an interpretative data analysis, where qualitative information obtained through interviews was matched with and used to complement official statistics and data retrieved from online content analyses. Subsequent to that, these data can be investigated profoundly and analysed by means of the methods of the Grounded Theory.

Official statistics

Giving profound statements about the investigated indicators requires, inter alia, the usage of statistics, mainly official statistics which are based on the respondents' obligation to give truthful and unmitigated information (Lippe, 1996). To guarantee the possibility of an international comparison between the investigated Informational World Cities, time series from 2000 to 2013 are created if the statistics provide the necessary data so that the development of the indicators is comprehensible. It is important, though, that different periodicity, levels of aggregation and indicator specific features are considered within the time series (Linde and Stock, 2011). Furthermore a trend line which can give a prediction about the further development (Baumert and Liu, 2009) is determined by calculating moving averages. Statistics which handle prices are moreover adapted to the standardised currency PPP dollars so that the comparability between different countries and their different currencies is

still given. The respective values for the calculation of the British pounds into PPP dollars were retrieved from the Organisation for Economic Co-Operation and Development (OECD).

Furthermore, a unified system for the representation is needed to ensure the comparability of international statistics. The Statistical Office of the European Communities named Eurostat processes and publishes statistical data at European level (Eurostat, 2013a). It uses the industrial classification NACE (Eurostat, 2013b) which is based on the international classification ISIC, which, in the context of this work, is used to analyse the economic diversity within the city.

Informetrics

The city's knowledge intensive output was measured by the produced publications and patents. To determine the number of patent applications and of granted patents, a search was performed in the database Derwent World Patent Index (DWPI) which was provided by the host STN International. This database's search function enables a patent search whilst taking into account the country (search command /PAA.CNY) and the city (search command /PAA.CTY), where the following patent offices' data collections are utilized:

- German applications, granted patents and utility models (DE-A1, DE-B1/B2/B3/B4, DE-C1/C2 and DE-U1) starting 1968;
- European applications and granted patents (EP-A1/A2, EP-B1/B2) starting 1978;
- US applications and granted patents (US-A, US-A1, US-B1/B2) starting 1975;
- PCT applications (WO-A1/A2) starting 1978; and
- Japanese applications, granted patents and utility models (JP-A, JP-B/JP-B1/JP-B2, JP-U, JP-W, JP-X, JP-Y, JP-Z) starting 1978.

To include potential errors by the indexed patent like misspellings of the city name into the search, the appropriate denotation from the index directory was utilized. The search with the country restriction /PAA.CNY was required for the avoidance of homonyms, so that the displayed patents would only be those of the London in Great Britain but not from the London in Canada.

The number of publications was researched by means of the interdisciplinary database Web of Science by Thomson Reuters, where the following data collections are browsed:

- Conference Proceedings Citation Index starting 1990;
- Science Citation Index Expanded starting 1900;
- Social Sciences Citation Index starting 1900;
- Arts & Humanities Citation Index starting 1975; and
- Book Citation Index starting 2005.

The advanced search function allowed an investigation for the city (CI = city name) and the publication years (PY = year). The results were then refined by the country for the exclusion of publications from London other than the one in Great Britain.

This research method has its limitations, though. Both, Web of Science and the patent database, do not contain all publications or patents, respectively worldwide.

Online content analysis

Web sites can provide useful information on any number of occasions, too, which can be taken into consideration by applying the classic method of the content analysis on the online content (Volpers, 2013; Welker *et al.*, 2010). Even though web content can depict only a snapshot in time due to its dynamics, Welker *et al.* (2010) think that scientists should not exclude it from their research. Since not all data are provided in official statistics, the online content analysis is also part of this work's methodology as it offers a variety of information, e.g. on soft location factors or political programmes. The online content analysis also includes the finding of the library evaluation according to Mainka *et al.* (2012) and the evaluation of e-governments by Mainka *et al.* (2014).

Results

In this section a short summary of each indicator will be given and London will be analysed in each case. The indicators are presented in Figure 1.

Global city

In the 1980s the research about world cities was stimulated by the work of John Friedmann (1995). A world city forms a whole contiguous economic region, which is the reason why this work covers Greater London and not only the City of London. A global city is not only defined by its population. An important point is the position of the city in the world economy; the leading cities are its control centres.

Demography. The key figures give a first insight into London's demography and its development. First of all it is important to define London's area. The administrative area Greater London comprises the City of London, and the 32 boroughs, 13 of which

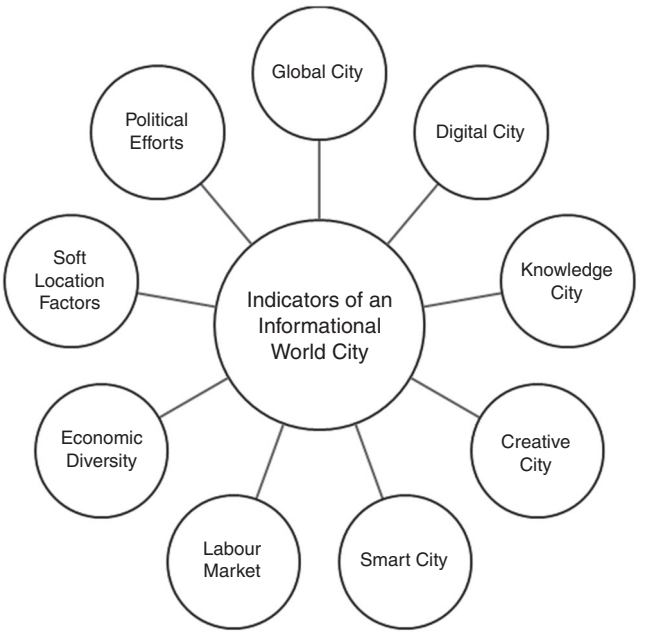


Figure 1.
Indicators of an Informational World City

are in Inner London and 19 are in Outer London. The regional authority is the Greater London Authority (GLA) (One World – Nations Online Project, 2013; ONS). As the capital of England and the UK, London is also its most populous metropolitan area (UK Cities, 2013). In 2000, the number of inhabitants amounted to 7.2 million, while by 2012 it had already increased to 8.3 million connoting an increment of about one million people. The development was positive for all years, which means that London has grown continuously.

London's population rises constantly, but the main reason for this growth is not migration, but the increase of inhabitants in recent years due to natural change. While the young generation first began to grow in 2006, the number of 15-64-year-old people increased continuously by 600,000 people altogether from 2000 to 2010. Meanwhile, the number of people of the old generation (65 years or older) has decreased from 2000 to 2007 (London Datastore, 2001; OECD.Stat, 2013), possibly because pensioners tend to leave London and rusticate because of the high living costs in the city, altogether leading to a young age structure in London.

In addition the number of different ethnicities living in the city is interesting as well. While the share of white British people decreased from 2001 to 2011 and amounts to around 60 per cent, all other groups have grown (GLA; Neighbourhood Statistics, 2011). London is a very ethnically diverse city and this development continues.

Space of place and space of flow

In knowledge societies as well as in informational cities two spaces coexist: the geographic or physical space ("space of place") and the space of flows (flows of power, capital and information) originating from digital connections. The flow of capital can be described by the stock exchange turnover, which in the case of London is the turnover of the London Stock Exchange, the most international of all stock exchanges worldwide. Until 2009, the revenue has grown steadily – the highest increase took place between 2007 and 2009, but 2010 and 2011 the turnover was lower. Then again the turnovers of 2012 could live up to the earlier success, and the turnover in 2013 is 318 per cent higher than in 2000 (London Stock Exchange, 2013).

The power can be described by the highest-grossing companies with headquarters in London. According to Sassen (2001), companies which act worldwide have their headquarters in a global city. As a result, more firms will settle in global cities like software companies and agencies which provide services for the major corporations. So how powerful is London's economy? An annual ranking, called Fortune Global 500, of the top 500 companies worldwide will give us a first overview since the ranking based on the annual turnover of all leading companies.

The development of the total sales from 2006 to 2012 of the global 500 firms with headquarters in London is not continuously increasing or decreasing, it is rather an up and down progress. The highest turnovers were recorded in 2008 with an amount of around $1.2 trillion, but one year later already, in 2009, the turnovers had decreased to $994 billion. In the following years, though, the companies were able to pick up and stay above $1 trillion (CNNMoney, 2013).

All those companies depend on information – both digital information and the knowledge of professionals – which makes the city an informational centre. Especially in such an informational centre, different kinds of information flow are in existence. First, the connectivity between companies is important for a global information flows. The Globalization and World Cities (GaWC) network's research focuses on the world

cities' external relations, one part of which is the global network connectivity (GaWC, 2013). In 2000, London was "the most connected city" with a total connectivity of around 63,000, while in 2008 London had lost its first rank to New York but is still close behind (GaWC, 2009).

Additionally, London is one of the world's top global cities according to the Global Cities Index (GCI). The GCI, first released in 2008, measures global engagement of cities bi-yearly. From 2008 until 2012, London was on rank 2 behind New York (ATKearney, 2012).

A very crucial indicator for an Informational World City is the freedom of information because it is the fundament of information flows as well as creativity. In general there should be no censorship (personal communication, Michael Moszynski, interview, 27 June 2013) and all public information should be open, but personal information need to be protected (personal communication, Antonis Bikakis, interview, 26 June 2013).

To ensure the freedom of information the Freedom of Information Act 2000 was released – an act of the Parliament of the UK that granting the public the "right of access" to information held by public authorities (Legislation, 2013).

When it comes to internet censorship in the UK, the OpenNet Initiative (ONI) monitors the internet filtering. It distinguishes between four categories: political, social, security and tools filtering. In all these categories the UK has the result "No evidence of filtering" (OpenNet Initiative, 2010).

Short distances

An Informational World City is characterized by short distances, so there are often clusters of creative, finance or research areas which is advantageous for the communication and knowledge exchange of several communities. An important factor is the distance between London and its airports because they are the foundation of global interactions. London has five major airports: London Heathrow, London Stansted, London Gatwick, London Luton and London City (Visit London, 2013). All in all the travel distance between London's airports and the city centre is between around 10 and 60 km with a travelling time between 20 and 75 minutes.

Flow of people

Another important element in the world city network is the flow of people because it emphasizes the role of London as an international hub or node that mediates local networks with global networks, and thus enabling an uncomplicated inflow and outflow of people. Airports are the basis for tourism and international economy. London Heathrow, for example, has direct flights to nearly all informational cities (mentioned by Mainka *et al.*, 2013a).

Digital city

"For the city as a whole the important thing is the ICT infrastructure. If we don't have that, it can't be an Informational City" (personal communication, David Bawden, interview, 25 June 2013). As part of the urban infrastructures, the digital infrastructure forms the central nervous system of a city (Van Dijk, 2006, p. 3) which consists of ICT as well as telecommunication networks (Melzi, 2009). On the basis of ICT, it has become possible to store knowledge and make it accessible to everyone. Through the transfer of data via landline, mobile phones and especially the World Wide Web, the emerging digital networks provide information and knowledge in real time, thus enabling a new form of interaction (Castells, 2000, p. 15; Melzi, 2009, p. 7). On the one hand this network

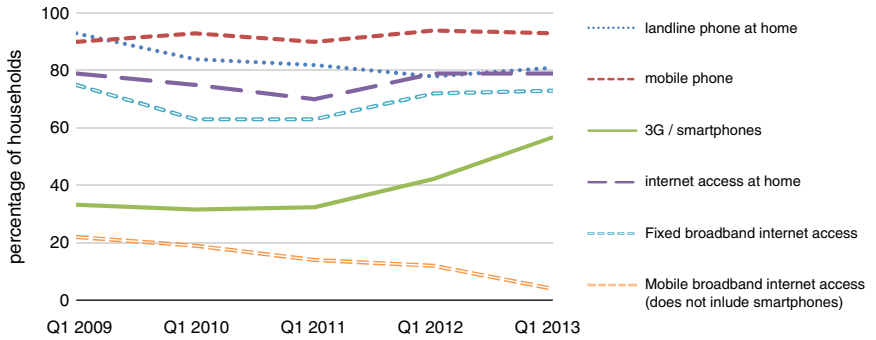
is built of physical cables and radio networks which connect households, institutions, companies and authorities of a city and on the other hand it is built of ICT devices like televisions, computers, laptops or mobile phones which have access to the network (Mainka, 2011). But not the network itself constitutes a digital city – the usage of the digital infrastructure is crucial as well (Khveshchanka *et al.*, 2011).

ICT infrastructure

More than 23,000 ICT and software companies are located in London. Because of its strengths in finance and business services, its creative potential and its role as a global media centre, London has a preeminent position supported by digital technologies (Theseira, 2012).

For the purpose of supporting the digital infrastructure and a free flow of information, the London Datastore was initiated by the GLA. It provides previously unavailable public data for everyone to use free of charge. Furthermore, the GLA is working on a greater WiFi connectivity including WiFi on the London Underground which can be accessed at no extra costs for customers of the primary providers Virgin media, Everything Everywhere, T-mobile, Orange, Vodafone and O2. Overall, there were more than 3,220 WiFi hotspots provided by TheCloud to be found in London in 2013 (Ofcom).

As can be seen in Figure 2, 79 per cent of households have access to the internet at home via any device. Mostly households are made up of more than one person, so this value does not imply that there are only 79 internet connections per 100 inhabitants. Considering the data is based on a survey, this change does not need to carry great weight. Theseira (2012) assessed that internet access has had an impact on leisure time. People are doing their shopping online or at least compare products via internet before they purchase them in a retail outlet. Furthermore they spend their leisure time in social networks or watch TV online. Most of the internet users have fixed broadband access (around three-quarters). The number of these connections developed more or less simultaneously to the number of internet connections in general. By contrast, the number of people using mobile broadband connections (not including smartphones) decreased constantly from 22 to 4 per cent. A reason for this might be an increase of smartphone users who access the internet via mobile phones, so they do not use devices like internet sticks anymore. Being on the road, the internet gains in importance as well. This development has created a new industry based on generating and selling mobile



Notes: Data ascertainment through Ofcom; own calculation

Figure 2. Digital infrastructure development in London

applications like online mapping, locating of shops or cash points or using social media (Theseira, 2012). This development is reflected by the number of mobile phones with access to the internet (Figure 2). Constantly, more than 90/100 people in London own a mobile phone, whereas in 2009 only one-third (or 37 per cent of the people having a mobile phone) owned a smartphone, and by 2013 already 57/100 inhabitants (or 61 per cent of people having a mobile phone) had been in possession of one. Consequently, an accumulation of mobile internet use can be noticed. It should be positively mentioned that 99.7 per cent of all premises in London are covered with 3G by at least four operators (Ofcom). But according to Bawden (personal communication, interview, 25 June 2013), there are places in Outer London without broadband. Nevertheless, maybe as a result of this, the decrease of landline phones can be explained. People do not need them tantamount to before the boom of smartphones because they can interact with each other via mobile phone and internet independently from their location. But still, a high number of people use their landline connections to access the internet at home (Ofcom). So, despite the decrease of 12 per cent, around 80 of 100 households still have a landline phone at home.

In times where the internet has become part of many aspects in everyday life, the ICT quality is an important factor of the development of a city. When it comes to Greater London, the average sync speed has improved well from 2011 to 2012 from around 9 up to almost 15 Mbit/s. The percentage of addresses which are within the coverage area of superfast (over 24 Mbit/s) broadband networks has improved from 85 to around 86 per cent (Ofcom). Even if London has the fastest broadband connection speed in the UK, there are big speed discrepancies depending on the postcode (Steen, 2010).

Knowledge city

In a knowledge society knowledge is a crucial resource and institutions and people in this society hold the knowledge and technology (Bell, 1973). David and Foray (2002, p. 1) emphasize the relevance of knowledge: "Knowledge has been at the heart of economic growth and the gradual rise in levels of social well-being since time immemorial. The ability to invent and innovate, that is to create new knowledge and new ideas that are then embodied in products, processes, and organisations, has always served to fuel development". According to Stehr (1994, p. 6), knowledge societies develop slowly and do not appear all at once, but in "a gradual process during which the defining characteristic of society changes and a new one emerges". Ergazakis *et al.* (2004, p. 7) conclude that a knowledge city should maintain research in a way which "provides the platform for new knowledge-based goods and services". Carillo (2004) ascribes the development of cities to knowledge cities to the transition from the industrial production to the knowledge-based production and thus reasons the evolution of cities becoming increasingly knowledge-based themselves.

In London there are several indicators to be found which provide evidence that London has arisen in a knowledge society. To measure how far London has become a knowledge city, the following indicators were utilized: knowledge intensive institutions, usage of knowledge intensive institutions, affordability of and investment into knowledge intensive institutions, the knowledge intensive output and the information literacy.

Knowledge intensive institutions

Knowledge intensive institutions are institutions such as universities, colleges, science parks and libraries. If a city offers a large amount of such institutions, the city provides

sufficient opportunities and facilities to train knowledge workers. The fast development of information technologies has influenced the way of collecting, manipulating and transmitting knowledge which has also changed the role of universities. They can be seen as "knowledge servers" which provide knowledge services such as the creation, preservation, transmission and application of knowledge (Duderstadt, 1997, p. 79). It was found that in London there are 45 accredited higher education institutions, 25 of which are universities (studylondon, 2013).

The QS World Ranking 2012 has ranked the world's leading universities. According to this ranking, London has two higher education institutions within the top ten leading universities: University College London on rank 4 and Imperial College London on rank 6 (Quacquarelli Symonds, 2012). In addition to these institutions there could be found a high amount of private colleges and only one private university in London: Regent's university, formerly Regent's College, is the first private university in London and the second one in Great Britain (Adams, 2013).

Apart from the academic training of knowledge workers, research and development are another crucial part of the knowledge society. For this purpose higher education institutions and companies cooperate in the form of science parks. In the UK the UK Science Park Association (UKSPA) holds the definition of which facilities qualify for being a science park (Massey *et al.*, 2003) and has registered seven science parks in London. During the interviews it was said that London has plenty of universities doing a large amount of research, but it does not have many science parks, especially not in London's centre which can be explained by the fact that there is simply not enough free space in London (personal communication, Antonis Bikakis, 26 June 2013). In these science parks the emphasis lies on research and the attaining of "new" and applicable knowledge. When it comes to sharing the knowledge that has already been acquired, though, it is still the libraries which are the driving force in a knowledge society (Stock, 2011a, Mainka *et al.*, 2013a). In London there are 355 public libraries, which leads to a library density of around 0.004 libraries per 100 people (as measured by London's population figure in 2012) (ONS).

The Department for Culture, Media and Sport in London conducted a survey from April 2008 to April 2009 (GLA), in which it was investigated, how frequently public libraries are used by adults. The result was that 51.6 per cent had made use of a public library in the analysed time span. For a knowledge society it is preferable for a larger amount of people to visit libraries frequently. To make libraries more attractive for people and to adapt them to the consumerist age (Dehaene and Cauter, 2008), a new kind of libraries has been established in parts of London – the Idea Stores. They still primarily have the role of a library but additionally they offer a wide range of courses, which normally adult education centres would offer (Kaiser, 2008). There are four Idea Stores in the borough of Tower Hamlets in London: the Idea Store Bow was opened in 2002, the Idea Store Chrisp Street in 2004, the Idea Store Whitechapel in 2005 and the Idea Store Canary Wharf in 2006 (Idea, 2009).

In a recent study, Mainka *et al.* (2013a) compared the core services of public libraries in 31 Informational World Cities. The leading task was to analyse "which core library services are provided in typical cities of the knowledge society" (Mainka *et al.*, 2013a, p. 300). This research included an analysis of the digital library and the physical library. The London Library, in this study, performed rather poorly due to the lack of certain offers such as e-books, audio books, a video guide or various digital reference services, e.g. Skype – it is the city with the second worst result before Dubai. It was found, though, that London fared better in terms of digital libraries than in terms of

physical libraries; London's digital libraries even outperformed those of cities on far higher ranks such as Hong Kong on rank 17. The main reason for this result may be due to the fact that London does not offer one big library system which covers all branches and thus, they cannot profit from each other.

Usage of knowledge intensive institutions

Taking a closer look at the above mentioned knowledge intensive institutions is the next step of analysing the knowledge intensity of a city. One indicator numbered among this is the magnitude of knowledge intensive institutions which also gives evidence about whether a city has established a knowledge society. The magnitude could be described by the amount of students. In London it has in total risen by around 28 per cent in the past ten years (data provided by HESA), which signalizes that London has been growing as a knowledge city. A high number of students is no guarantee for eventually obtaining knowledge workers for the city yet. In this respect the number of students who graduate is more significant. The total number of graduates in London has increased heavily in the past twelve years by circa 49 per cent (data provided by HESA). It is to be considered, that an unusually high amount of graduates can be seen as artificially enhanced, which is why it does not have to represent quality.

Affordability of and investments into knowledge intensive institutions

Another indicator is the affordability of and investments into knowledge intensive institutions. This comprises the average annual costs for a degree course for both public and private colleges and universities, which amount of money is invested in universities and colleges by the government and by various companies plus how much the government, companies, universities and colleges pour into research and development each year.

Studying in London is not possible at little cost. The average costs for a course amount to £10,133 ($15,738.17) each academic year. Studying at a private university or college in London demands even higher expenses. At Regent's university, the annual fees for a regular three to four years undergraduate course range from £14,200 ($22,055) to £14,850 ($23,064) (Regent's University London, n.d.). In addition to the tuition fees paid by the students, universities receive grants for research projects and programmes by "[t]he Research Councils, charities, the European Union and government departments" (HEFCE, 2014). For example, there is the UK Research partnership investment fund which "was set up in 2012 to run for three years until 2015" (HEFCE, 2014) by the higher education funding council England (HEFCE), which has allocated funding for three London higher education institutions: Brunel University, Imperial College London's Imperial West Technology Campus and University College London.

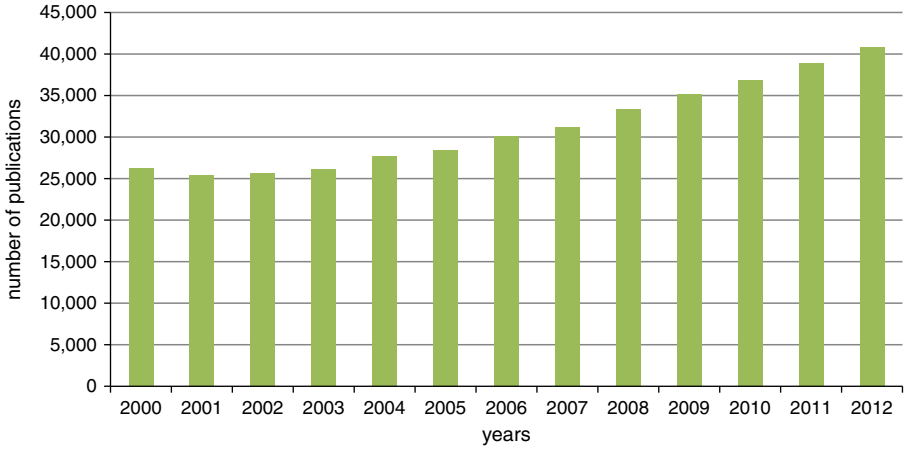
Knowledge intensive output

Also indicating a knowledge city is the city's knowledge intensive output. In this respect it was analysed how many publications the city has had per annum and how many patent applications have been registered yearly. The aim of doing this was to find out which sector is the apparently most active one in research and developing new ideas.

London's knowledge intensive output in terms of scientific publications can be seen in Figure 3 which shows the number of London's publications registered in Web of

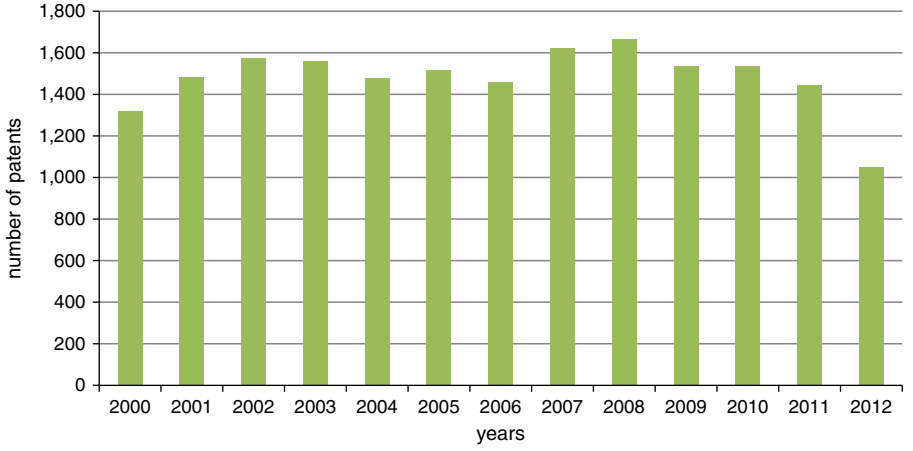
Science. After a slight decrease from 26,198 publications in 2000 to 25,407 in 2001, the number of publications coming from London constantly grew to a quantity of 40,845 publications in 2012, which is an increase of circa 56 per cent within 12 years.

Apart from the scientific output in the form of publications, London is also active concerning the patenting of new ideas. Figure 4 depicts the progression of patent applications in the years from 2000 until 2012. Already at first appearance it is conspicuous that the development is relatively fluctuating. Neither a clear increase nor a clear decrease is recognizable. The amount of applications usually circles around 1,500 each year. In comparison to the continuously rising number of publications, the patent applications remain fairly constant.



Note: Numbers extracted from Web of Science, effective 21 July 2013

Figure 3.
Publications from London per annum between 2000 and 2012



Note: Data provided by Derwent via STN

Figure 4.
Patent applications from London per annum between 2000 and 2012

Information literacy

The last indicator of the knowledge city is the literacy rate, meaning how many people can or cannot read or write. In a knowledge society, literacy carries a greater weight: "[…] literacy means more than knowing how to read, write or calculate. It involves understanding and being able to use the information required to function effectively in the knowledge-based societies that will dominate the twenty-first century" (International Adult Literacy Survey, 1997, p. 1).

In a survey called "The 2011 Skills for Life Survey" by the UK Government it was found that in London 17 per cent among the 16-65 year olds whose first language is English have literacy skills that lie at Entry Level 3, which corresponds to the literacy skills of a nine to 11 year old child, or even beneath. Together with the north east this is the lowest literacy level in England. If the inhabitants who do not have English as a first language are also taken into consideration, the percentage of 16-65 year olds whose literacy level is Entry Level 3 or below amounts to 28 per cent (Department for Business Innovation and Skills, 2012). Among pupils in London on the other hand the percentage of children below Entry Level 3 in 2010 only amounts to 7 per cent, which is slightly below the average (~7.6 per cent) in all of England (Shepherd, 2010). There is a remarkable research gap: data of the degree of the information literacy in the UK was not available.

Creative city

An informational city does not only focus on knowledge in respect of finance, economy and technology but on the growing significance of creative industries. Creativity in cities is not something new itself, but in times of globalization and international competition, the creative sector "has become the principal driving force in the growth and development of cities" (Florida, 2005, p. 1). Creative industries mean creative workers, people with special individual talents and skills. The creative industries often get together in clusters and interlink. The connections also enable face-to-face communication and exchange of ideas (Storper and Venables, 2004). Creativity and culture are essential parts of a city – they enable new jobs and improve the quality of life.

Apart from the financial sector, London is also known for its growing creative sector (Yardley *et al.*, 2013). Just the film industry alone has an annual turnover of around 13 billion pounds. It is the largest post production centre except from Hollywood (Freeman, 2007). The number of creative employments in London in comparison to the rest of Great Britain also clarifies the great weight of the creative sector in London. There are by far more people working in London's creative sector than in the whole rest of Great Britain.

London has a huge creative infrastructure, for example, 214 theatres, 173 museums as well as numerous film, publishing, TV and radio companies. All in all the creative industries amounts to nearly 68,000 companies (World Cities Culture Report, 2012; Hartley *et al.*, 2012).

The creative infrastructure itself is worthless as long as it is not used by the public, meaning the support for the creative sector and culture by citizens and visitors, which can be measured in the form of attendance. In 2012 there were about 25 million visits to the five most popular museums and galleries and about 14 million theatre admissions. While the number of attendances is one way of measuring the tourists' and citizens' support of the creative sector, the expenditure on arts and culture of private households is another method. As a percentage of the total expenditure per household the expenses amount to nearly 5 per cent (World Cities Culture Report, 2012).

In the past 25 years, the arts and cultural institutions have undergone a great development regarding an enhancement of their financial basis and have moreover adjusted public and private investment. With far higher levels of private funding and support, this has eventually led to an appreciable difference to the rest of the UK, which received nearly 70 per cent of all private funding in the years 2008/2009 by London's arts organizations (Cultural Metropolis, 2012).

When it comes to the distribution of annual cultural funding in London, the majority of support is provided by the Ministry of Finance and local authorities. The private funding by sponsors, trusts and foundations is also mentionable, whereas the European Union only makes a small contribution to arts and culture in London (GLA).

As a result, the private and public funding are collateral and enable London to be a creative and cultural centre. During the interviews, the notion emerged that it is not essential for an Informational City to be creative, still the majority of the interviewees assume creativity to be important since "creativity creates knowledge" (personal communication, Antonis Bikakis, interview, 26 June 2013).

Smart city

An important aspect of the complex urban infrastructure of an Informational World City is the presence of characteristics of a smart city (Shapiro, 2006; Hollands, 2008). Depending on the professional background, the term "smart city" is used in many different ways. In this paper, the smart city infrastructure, as part of the urban infrastructure and its usage, is analysed in terms of sustainable and smart mobility. In doing so, the local traffic, especially the local public transport, is the leading point. Due to the dense population structure in an Informational City (Beaverstock, 1996), the mobility of the continuously growing population needs to be ensured and an infrastructure focusing on sustainability has to be created (Zhao, 2010). A high number of cars on the streets emit noise and exhausts. In addition to that, a high penetration of cars in a city interferes with the traffic flow (Gakenheimer, 1999; Kenworthy, 1995; Khisty, 1993). To counteract this effect, a lot of cities expand the underground network or build elevated railways to improve the mobility in the city (Mainka, 2011, p. 101). In an Informational City, the local public transport should be developed in such a way that every area can be reached and that there are only small distances between places of work, leisure facilities, housing estates and shopping facilities (Hall, 1997a). This could result in cars no longer being needed in the city (Banister, 2008). To reduce congestion in Inner London, since 2003, a Congestion Charge has to be paid when entering the Congestion Charging Zone in Central London. Over the first year, the congestion within the zone could already be reduced by 30 per cent (Santos and Shaffer, 2004). Generally, the use of cars can be assessed by the number of licensed cars. In London, it has increased from 2,415,900 in 2000 to 2,535,500 licensed cars in 2012. Nevertheless, the effective use of cars diminished because of the continuously growing population (Department for Transport, 2012b; ONS; own calculation). This decrease of cars per capita might originate from an increase of car maintenance costs. Running a car was 72 per cent more expensive in 2012 than in 2000. To reduce CO_2 emissions, the Low Emission Zone was introduced in 2008 (Transport for London) and the Mayor of London advanced the uptake of electric vehicles (Johnson, n.d.).

Looking at public transportations, it can be observed that the use of rails (assessed by the number of passenger journeys) has increased enormously during the last years (Figure 5). The most fundamental public transportation in London, handling more than 3.5 million passenger journeys a day, is the London Underground, which is mostly

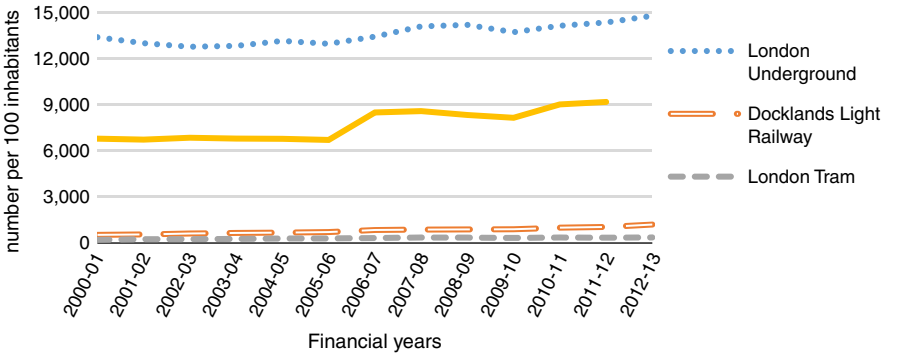


Figure 5.
Number of passenger journeys per 100 inhabitants in the local London traffic by type of rail

Notes: Data ascertainment through ONS; Office of Rail Regulation, Transport for London; Department for Transport; own calculation

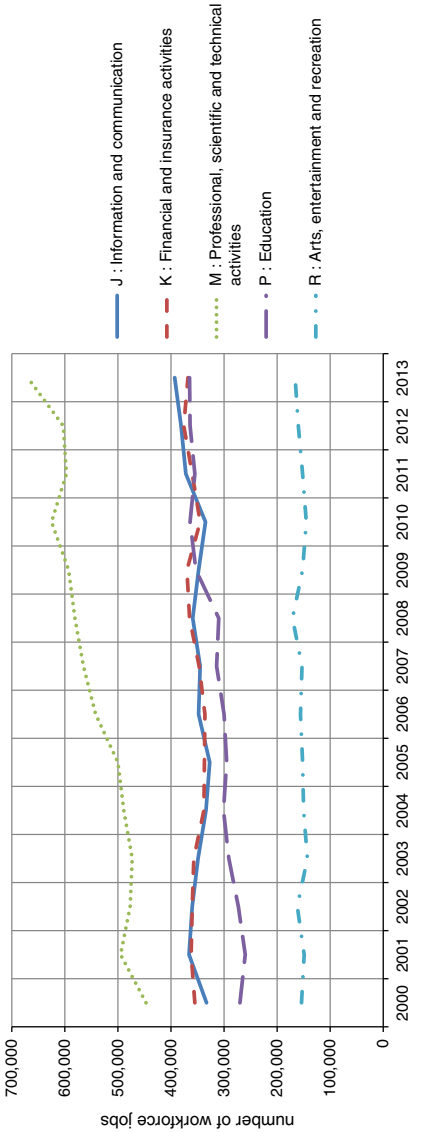
known as the tube. It is the first underground railway in the world, opened 150 years ago in 1863. To get smarter, the tube improvement plan ensures that the underground network will be upgraded in the next ten years and has already achieved some improvements. Nevertheless, the most used local public transport in London is the bus. Due to that, more environmentally friendly buses were planned to be utilized. So, since 2012, all new buses are hybrid (Transport for London).

Labour market

With the change of the knowledge infrastructure and the thereby induced transition of the society to a knowledge society, which, according to Hack (2006), is characterized by lifelong learning, a changing of the labour market comes along as well. The further development of the information technologies and the digital infrastructure also is an issue in the course of this, since as a result more eligible work forces are needed (Gurbaxani *et al.*, 1990; Weber and Kauffman, 2011). In London, the transition into a knowledge society can be observed on the basis of the development of the number of work forces in sundry industries defined by the Standard Industrial Classification (SIC) 2007 (Figure 6).

It is conspicuous at first appearance that sector M (professional, scientific and technical activities) has been a very strongly represented area since 2000. Still, this sector has grown from 447,000 work forces in 2000-670,000 in 2013, which endorses the statement that the changing into a knowledge society requires more eligible people (Gurbaxani *et al.*, 1990; Weber and Kauffman, 2011). So does sector P (education), although not as significantly as sector M, which has undergone an increase as well, since education is a core element of the knowledge society (Mainka, 2011).

While sector J (information and communication), with an average percentage of almost 8 per cent labour market share, has experienced a slight growth, which speaks for a development and expansion of the information industries in London, sector K (financial and insurance activities) has remained almost constant. This is probably due to the fact that London has been "the largest and most important financial centre in Europe throughout the century" (Michie, 2006, p. 51) so that the financial sector had been stable for years already. Sector R (arts, entertainment and recreation) with an average percentage of 3-4 per cent labour market share (Figure 7), has remained almost constant, too.



Note: Data provided by Nomisweb

Figure 6.
Work force jobs in London by industry (SIC 2007) between 2000 and 2013

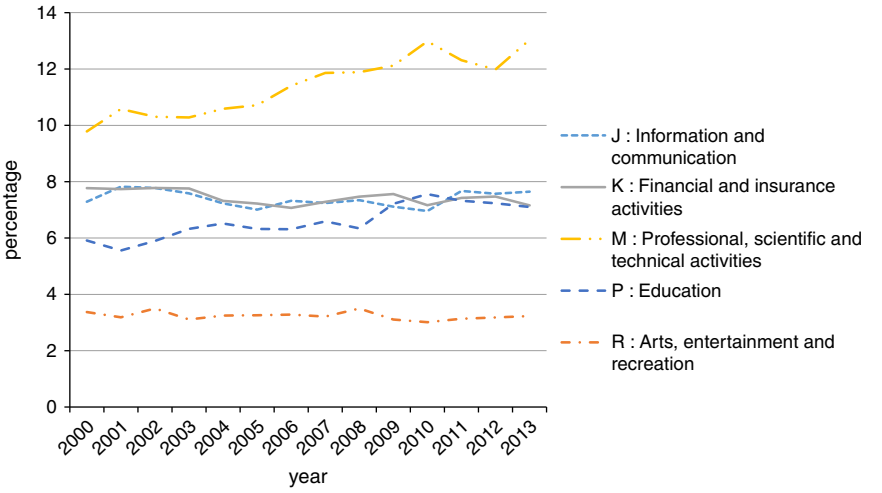


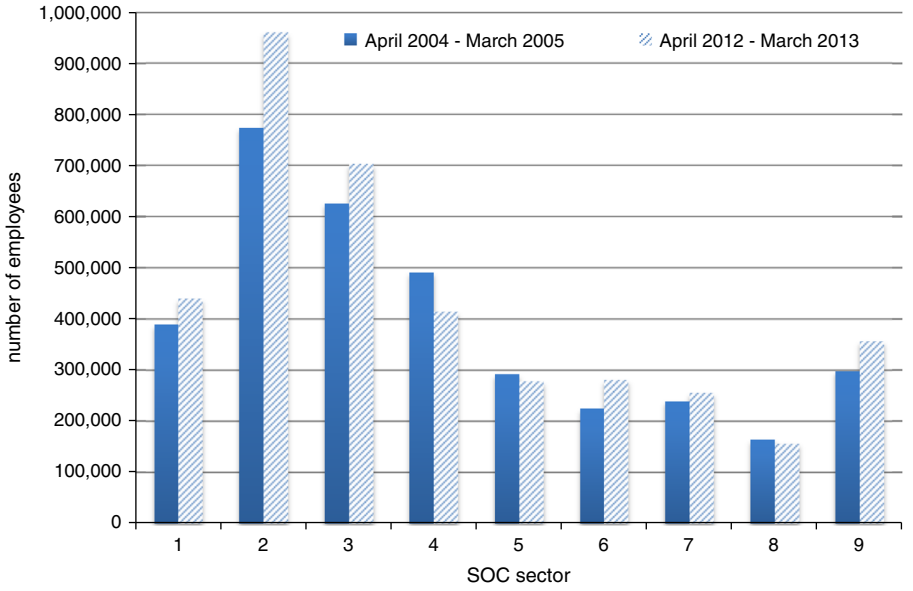
Figure 7.
Percentage of work forces in London by industry (SIC 2007) between 2000 and 2013 compared to the total amount of work forces

Note: Data provided by Nomisweb

Another effect on the labour market is the job polarization (Goos and Manning, 2007) through the "automatization of large economic sectors" (Linde and Stock, 2011, p. 88). Routine jobs like jobs of manual craft or book keeping can be taken over by technology, which makes human labour redundant. Non-routine jobs like professional and managerial jobs but also unskilled jobs such as construction or taxi driving on the other hand cannot be passed to technology, which is why these jobs still require human work forces. Thus, the relative demand for both well-paid and low-paid skilled jobs rise and at the same time the relative demand for the routine middle class jobs decrease (Goos and Manning, 2007). London has had a job distribution similar to the described job polarization for the last few years.

Figure 8 shows the distribution of employees by means of the standard occupational classification (SOC) in the years 2004/2005 and 2012/2013. SOC distinguishes between nine occupational categories, which at the same time are consistent with different qualifications and income groups (from 1 high to 9 low qualification or income). It can be seen that job polarization as described by Goos and Manning (2007) applies to London as a basic principle. The occupational groups 1, 2 and 3 with a higher income have undergone an increase from 2004 until 2013, especially group 2, which has been the most strongly represented one in both years. The same is true of group 9, the group with the lowest income. The middle class does not entirely decrease though. While the number of employees in the occupational categories 4, 5 and 8 falls, the number of employees in categories 6 and 7 slightly rise. In general it stands out that the distribution is skew, since there are more people working in the high qualification/income groups than in the lower qualification/income groups, which is in accord with Moritz Godel's statement during the interview (personal communication, 26 June 2013) that in London it is significant that there are a lot of people at the peak of the well-to-do.

The same result was found by Dornstädter *et al.* (2011), who conducted a study on job polarization in selected Informational Cities. It is concluded that in London the better qualified work forces are being promoted and have become irreplaceable in the job market (Dornstädter *et al.*, 2011).



Note: Data provided by Nomisweb

Figure 8. Employees in each SOC sector in London in 2004/2005 and 2012/2013

Economic diversity

Apart from aspects like the infrastructures of a city, the economic diversity is an informative indicator of Informational World Cities, meaning the structure or mix of companies in the city. Many worldwide settled companies have their headquarters in global cities (Sassen, 2001) which become information centres and production sites for companies in the information industry (Stock, 2011a). It has to be differentiated between four types of companies which have their headquarters in global cities: capital-intensive enterprises like banks or insurances (NACE classes K64, K65, K66), knowledge intensive enterprises which also include medical or energy industries (NACE section M, class P85.4), enterprises of the information economy like information services or software development companies (NACE classes J61, J62, J63, S95.1, R91) and creative companies which mostly assist the other types of companies or provide cultural facilities (NACE classes J58, J59, J60, R90), for example, advertising agencies or architectural firms (Mainka and Khveshchanka, 2011; Mainka *et al.*, 2011). All these companies depend on information (Stock, 2011a), so a well-developed ICT infrastructure as well as places for face-to-face information exchange can attract companies to settle down in a city.

Concerning London, it is hard to find data about the number of companies coming under these special classes. The Companies House, the official UK government register of UK companies, offers a monthly updated DVD directory which contains basic information on all companies registered in England, Scotland, Northern Ireland and Wales. It is a service of the Department for Business Innovation and Skills (BIS). Following a free trial version of this DVD ROM (last updated in May 2013) 773,430 companies are registered in the mentioned classes. Companies incorporated since May 2012 are not included. The number of companies of the information economy holds the majority with 68 per cent, followed by the creative companies with 26 per cent. In comparison to the other types, a number of 596 companies (1 per cent) in the

capital-intensive sector seems very small. But since London is one of the leading financial centres in the world (Yardley *et al.*, 2013) and the Global Financial Centres Index 2012 (Yeandle, 2013) actually ranked London as the leading one, the financial sector in London carries major importance.

In 2012, 16.6 per cent of all enterprises were part of the professional, scientific and technical activities sector. So this sector also carries great weight in London. In comparison to other UK regions, it has the highest proportion there (BIS, 2011). Most of the ICT companies are spread throughout London with large numbers in the City, Canary Wharf and West End (Theseira, 2012). Most of the high-tech companies are located in Europe's fastest growing tech cluster, called Tech City, where companies like Google, Amazon or Microsoft and more than 1,300 start-ups are settled down (Tech City UK). According to Bawden (personal communication, interview, 25 June 2013), the government supports small companies in this cluster to grow up.

Soft location factors

A further aspect of cities is its attraction for visitors like tourists or business people (Hall, 1997b, p. 317; Stock 2011a). Those can be impressed by institutions of culture, leisure activities and consumption, which form soft location factors (Stock, 2011b). They include museums, galleries, libraries, music halls, operas, theatres and the number of events per week (Hall, 1997b). But also casinos and transnational major sports events attract people (Stock, 2011b). Peterson and Kern (1996) define the typical customer of an Informational City and its leisure facilities as a "cultural omnivore". It means that such a customer can, e.g. be the supporter of a football team but also go to the library, to the opera or a rock concert regularly (Mainka and Khveshchanka, 2011; Peterson and Kern, 1996; Stock, 2011a, b). Moreover, architectural buildings, which represent the urban culture of event societies (Sewing, 2003, p. 6), are soft location factors, too. For example, Las Vegas has an architecture which is an event in itself. This is called "Architainment" (Klein, 2004, p. 403). So, well-developed soft location factors support a city's magnetic effect (Stock, 2011b) because they are aspects of attractiveness and quality of life (Droege, 1989, p. 39). This attracts people to live and work in a city or to pursue entrepreneurial activities (Mainka, 2011). London is an entertainment and an architainment city (personal communication, Antonis Bikakis, interview, 26 June 2013). There are a lot of shopping centres, an impressive skyline, galleries, theatres, casinos, trade fairs, lots of impressive buildings and also major events take place in London. In 2012, for example, London was host of the Olympic Games, which meant that all eyes were focused on London for a few weeks during the event but also during the preparatory period before the Olympics started.

Political efforts

It is important that the government is willing to participate in the changes which are necessary for becoming an Informational City. A lot of projects such as the establishment of a faster broadband connection cannot be realised without the government's consent.

E-Government

The political efforts, inter alia, include e-government or the participation of the government in social media. In a case study of 31 Informational Cities, Mainka *et al.* (2014, p. 1715) describe the impact of social media as follows: "Social media platforms are increasingly being used by governments to foster user interaction. Particularly in cities with enhanced ICT infrastructures (i.e. Informational World Cities) and high

internet penetration rates, social media platforms are valuable tools for reaching high numbers of citizens". For each city, its respective government web site was analysed in the above mentioned case study, which in the case of London was london.gov.uk. Hence, London does not provide any corporate social media account for the whole city. It was not possible to compare London's activity with other cities. Thus, London seems to operate in this case like it does concerning public libraries and prefers to have many single acting authorities over one big network.

The web sites of the Informational World Cities' governments have also been analysed in terms of e-government maturity in a related project (Mainka *et al.*, 2013b). When it comes to the maturity score divided in the four stages information, communication, transaction and participation, London has one of the lowest ranks (28 of 31). London even is the only of the investigated cities with less than 50 points (out of a maximum of 100 points) in the first stage which refers to the one-way communication in which information is transmitted from e-government to its users. All in all, London got 155.4 points while the first ranked New York reached a score of 277 points.

According to the usability of the 31 governmental web sites – measured by a usability test –, London is also at the bottom of the ranking with 620 points, while Vienna, Seoul and Shanghai are the top- ranked Informational World Cities.

Political programmes

For the build-up of an Informational City, it is also important that the city's government supports this process. This way, the needed leadership in "creating a cohesive framework for public and private investment in digital technology systems for communities" (Horan, 2001, p. 17) can be provided. In London, the government is a "two-tier system of local and regional government" (London Councils, 2013). Each of London's 32 boroughs and the City of London governs itself locally, but additionally the GLA coordinates the city borough across.

Digital infrastructure – "Programme Athena"

"Programme Athena" focuses on the improvement of London's ICT infrastructure. Its aim is "to create shared solutions for London public sector organisations" (Elvery *et al.*, 2010, p. 4), which include all London Local Authorities, by laying the foundations to create one single ICT platform for them (London Councils, 2013). Outcomes of the project are the following (Elvery *et al.*, 2010, p. 6):

- reduction in the number of systems and suppliers meaning reduced annual running costs and one-off costs;
- solutions that are accessible to all London boroughs providing flexibility for the state of readiness;
- boroughs enabled to share back office staff, so as to reduce costs, provide resilience and improve skills; and
- London sharing back office systems in the same way as other organizations across the country.

Digital infrastructure – station WiFi

By 2020 WiFi is to be introduced all across the tube, London's underground system (GLA). WiFi is already accessible at selected stations, but a cooperation with the

internet provider Virgin Media is supposed to make WiFi available at 120 tube stations altogether. Customers of Virgin Media broadband and Pay Monthly Mobile, EE, T-Mobile, Orange, Vodafone and O2 have free access to the provided WiFi (Transport for London). People who are not customers of any of these service providers can get access as well, though, since a daily (£2), weekly (£5) or monthly (£15) Virgin Media WiFi Pass can easily be purchased online (Virgin Media, 2013).

Digital infrastructure – super-connected cities

In 2011 the super-connected cities programme started when the government set aside £100 million with the purpose of creating up to ten 'super-connected' cities across the UK. These cities should benefit from faster and better broadband (broadband with 80-100 Mbit/s) and public WiFi access in large areas. London was one of them (Department for Culture, Media and Sport, 2013).

Besides the investments in the UK, London has its own super connected city plan . The Mayor plans to invest £50 million to support the next generation of leading digital entrepreneurs (GLA).

Knowledge infrastructure – GLA Education Programme

To foster education in London, the GLA has set up the GLA Education Programme which follows three themes: to promote excellent teaching in all schools in London, to make available a good school place for every child in London and to prepare the students for the living and working in a global city. The aims will be to improve literacy and numeracy as early as primary school and enhance the standards in maths, sciences and language in secondary schools (GLA). The GLA describes the programme's ambition in the following way: "The ambition is to make London state schools amongst the best in the world and ensure that young Londoners can compete successfully for jobs and university places against the talent our city attracts from around the globe" (GLA). With this in mind, the Mayor contemplates ensuring that young people get better opportunities and standards in education, with the GLA being aware that London is already developing to be the world leader in education (GLA).

Smart infrastructure – the Tube improvement plan

The Tube improvement plan provides an upgrade of the underground network in the next ten years and has already achieved some improvements in the last years. Its goals are to increase the Tube's capacity by 30 per cent with a combination of new signalling and longer trains. Furthermore, a new communication system is already established which operates on all underground lines. It enables more quickly information transmissions. To inform rail user about news and current states, ICT is used in forms of tools like weekly information mails, journey planner, live travel news, a Twitter travel alert and real-time line information. The London Overground has planned to introduce five-car trains by the end of 2015. This development shall increase its capacity by 25 per cent by investing 320 million pounds to construct longer platforms and to provide another 57 carriages (Transport for London).

Smart infrastructure – Crossrail

Another project, which is running until 2018, is the construction of a new, sustainable railway, called Crossrail. It is built to reduce congestion, offer better connections and optimize journey times and shall set world-class standards for major infrastructure projects. The Crossrail helps improve London's sustainability and ensure London's

competitiveness as a Smart City. When the railway is finished, it will cover a 118 km route with 21 km of new rail tunnel. The construction includes the upgrade of existing train stations and the building of eight new stations in Central London and the Docklands. It will be the first rail that connects London's main business centres Heathrow, Paddington, Canary Wharf, the City of London and the West End. It will increase the rail network capacity by 10 per cent and contribute to the reduction of car usage (Crossrail, n.d.).

Smart infrastructure – hybrid buses

In addition to the rail network, buses are very important for the development of sustainable transport objectives. They are the most viable form of urban public transportation (Bentley, 1998). Since the introduction in 2006, more environmentally friendly buses were to be introduced (Transport for London). Since 2012, all new buses are hybrid. That means that the buses have extra electric motor, additionally to the conventional engine. That leads to less noise, a higher degree of cleanness, greater fuel efficiency and less emissions of local pollutants than normal diesel buses. Furthermore, energy of braking is recycled and used for battery charge to drive the electric motor (GLA and Transport for London). In 2013, 368 hybrid buses out of 8,500 buses in total were in use in London (Transport for London).

Labour market

Until 2016, the Mayor of London intends to increase the number of apprentices to 250,000 (GLA). For that purpose, the government calls upon the city's companies to employ apprentices and shows itself ready to contribute to the training costs. The National Apprenticeship Service (NAS) can fund up to 100 per cent of these costs and beyond that might the company receive a grant of £1,500 (GLA), which assuredly is an incentive for some firms and companies.

Conclusion

This paper had the purpose to investigate London's characteristics of an Informational World City concerning nine aspects: the digital infrastructure, the knowledge infrastructure, the creative infrastructure, the smart infrastructure, the features of a global city, the labour market, the economic diversity, the soft location factors and the government's support to foster these aspects. As a result it can be claimed that London can absolutely be described as an Informational World City because it fulfils most of the dimensions of such a city. Some indicators have been described in numbers but only in a few cases a comparison with other cities was possible.

Although there already is a well-developed, solid ICT infrastructure, it has to be advanced in many cases. According to Stock (2011b), it has to be ensured that everybody has the possibility to use ICT offers like mobile applications or to interact with the government, enterprises or other inhabitants. Therefore Informational World Cities are expected to provide wireless access to the internet in the whole urban area. Following the example of Singapore, wireless broadband access could be supplied in the whole city. Even if there is a large amount of WiFi hotspots to be found in London, it is not always possible to access the internet fast and from everywhere. The government is desirous to advance this aspect of the ICT infrastructure. Hence, the GLA is working on greater WiFi connectivity including WiFi on the London Underground. This is a good attempt to develop London's digital infrastructure.

The knowledge infrastructure in London certainly matches that of an Informational City since it has a high amount of knowledge intensive institutions. There are many higher education institutions such as universities and colleges and, as the QS World Ranking 2012 showed, some of the world's leading universities (Quacquarelli Symonds, 2012). The development in the field of libraries is quite remarkable as well. The introduction of idea stores in the borough of Tower Hamlets, the council of which aimed at counteracting "the sharp decrease in library use" (Dehaene and Cauter, 2008, p. 239), has shown that the willingness to make libraries more popular again has already come to fruition.

The creative sector also plays a significant role in the city with a very busy film industry, a wide range of museums, theatres etc. as well as creative companies and festivals. Private as well as public funding in arts and culture focuses on London more than on any other part of the UK.

Furthermore London places value on smart innovations and tries to adapt the public transport to the growing population. This, next to an enhancement of the train capacities, includes information and communication technologies, since the digital infrastructure keeps gaining importance. It has been found that London intends to develop its digital and smart infrastructures to attract people visiting the city or even working and living there. Many companies, especially the creative ones and the ones of the information economy have settled down in business. Centres of finance and high-tech have been constructed pre-eminently on the waterfront of the Thames, built up of tall, modern buildings. The best examples for those centres are Tech City, Canary Wharf and the Eastern Cluster. Hence, an amazing skyline of modern and historical buildings arose. Apart from the impressive waterfront and skyline, many shopping possibilities and trade fairs attract people.

The ethnic and cultural diversity are also distinguishing marks of London. In accordance to London's position as a global city, its population has grown continuously to over eight million inhabitants. Furthermore it has a young age structure: in the time series from 2000 to 2012 the number of births is rising while the number older people decreases. The different ethnic groups in the capital are also growing, except of the white British people which amount to less than 60 per cent of the total population. The international connectivity and the creative infrastructure are noticeable as well.

London's labour market shows the typical features of an Informational World City. While the typical job polarization of average non-informational cities shows a curve which is extremely high on both ends and extremely low in the middle since the high income and the low income jobs increase while the middle class routine jobs decrease, the curve for London rather resembles a skew curve as the amount of people with a high income is extremely high and there are less people with a really low income.

The soft location factors in London also correlate with the expectation of an Informational World City. London has a large recreation offer including facilities such as casinos, poker rooms, cinemas, golf clubs, health clubs, leisure centres or swimming baths so that it caters for various tastes of both citizens and visitors. It is what makes the city an attractive place that attracts people to live and work in the city. Furthermore London is a place where major events take place such as the famous Wimbledon tennis tournament or the Olympic Games in 2012.

It can be concluded that the characteristics of an Informational World City are well-marked in most cases. Nevertheless, especially the digital smart infrastructure as well as a centrally organized e-government (including governmental use of social

media) are not the best on a global scale. London's government, the GLA, is ambitioned, though, to make progress and pursues plans which are of benefit to the city's informativeness.

All in all, this research has confirmed that London is perceived as an Informational World City with justification. London still is a financial city in the first place but nevertheless it possesses the necessary infrastructures which make a city an Informational World City.

Note

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Corresponding author

Duwaraka Murugadas can be contacted at: duwaraka.murugadas@uni-duesseldorf.de