1. Introduction

Just as there are typical cities of the industrial society (such as Manchester in the 19th and early 20th century) and the service society (e.g. New York’s Manhattan of the late 20th century), so there exist or will exist in future typical cities of the knowledge society. Following Manuel Castells (1989), we will call such cities “informational cities” (Yigitcanlar, 2010). When Castells published his book on such cities in 1989, he could not have known how existing informational cities would look like (since the internet had not happened yet at the time), but the theoretical foundation for dealing scientifically with informational cities had been laid. Such a city includes a cognitive infrastructure which is based on the infrastructure of information and communication technology (ICT) and consists of a knowledge infrastructure with regard to scientific knowledge and the institutions thereof (Carillo, 2006), as well as a creative infrastructure with regard to “copyright-based industries” or a “creative economy” (Florida, 2005). Referred to Castells “space of flows” builds the main infrastructures in informational cities. This concerns both the ICT infrastructure and the cognitive infrastructure. 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) and Shanghai 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 use Castells’ theory to analyze this development.

The aim of this article is to develop a theoretical framework that allows quantifying the degree of informativeness of a city. We work with a framework of six groups of indicators:

- Infrastructures (ICT infrastructure and cognitive infrastructure as groundwork for knowledge cities and creative cities),
- Position in the world city hierarchy,
- Structure of the labor market (including analysis of job polarization),
- Mix of companies,
- Political willingness to establish an informational city,
- Weak location factors (e.g., leisure facilities, shopping malls).

In this article, we give a brief overview how the indicators of informational cities could be measured, using mainly the example of Singapore.
An informational city is deeply ingrained in the information and knowledge society. On information markets (Linde and Stock, 2011), it can be observed that the development of standards follows principles of network economics (Shapiro and Varian, 1998). After a “combat zone”, in which several candidates for the future standard meet and do battle, one of the candidates reaches the critical mass of users and become the market leader, whereas his competitors lose market share and, in the best case, are still able to service niche markets. The successful candidate gains new customers purely on the strength of the market power he has acquired thus far, improves his offer, which attracts more customers, etc. In cybernetics, this principle is characterized as a “positive feedback loop”, it is said that “success breeds success”. The many iterations of the loop result in the establishment of one single standard (“the winner takes it all”) for one (technological, economic, regional) area; this does not have to be the best of all solutions—it is, rather, the solution that was able to convince the most customers. Does this principle of network economics also hold for the development of informational cities? If so, the result would be, from a global perspective, one single informational world city, or between one and a select few per world region. Those informational cities become new centers of power. It is possible that other cities and regions fall into economic irrelevance and become economic deadlands.

This article is a part of a research program on informational cities at the Department of Information Science at the Heinrich-Heine-University of Düsseldorf. The state of the art of our research consists of theoretical foundations of informational cities research (Stock, 2011a, 2011b, 2011c) and of first empirical results about job polarization in informational cities (Dornstädt et al., 2011), about informational world cities (Nowag et al., 2011) and about Singapore as a case study (Khveshchanka et al., 2011).

2. Infrastructures

ICT infrastructure

The predominant infrastructure of informational cities is its telecommunication network, which connects workplaces and private households with one another. The ICT infrastructure of a city is mainly based on telephony, broadband networks and the internet, forming the basis of the way these technologies are used in private households, in the economy as well as in governmental institutions. Telephony is described via landline, mobile network and VoIP (Voice over Internet Protocol). Broadband networking involves fast data nets such as the currently growing use of VDSL. The indicator bundle for the internet registers internet hosts, computer density (number and penetration of computers), internet connections (households and companies with internet access) as well as internet users. We can expect an informational city to provide (wireless) internet access at any place in the municipal area, either for residents only or for everyone. For Singapore we can use the Networked Readiness Index, which also uses indicators of the ICT infrastructure to measure the development degree of a nation. Singapore was always ranked in the top ten in the last ten years and in 2009 as second behind Sweden (Dornstädt et al., 2011).

Cognitive infrastructure

The cognitive infrastructure of an informational city cannot be described and measured via hard facts, like its ICT infrastructure, but rather concerns “soft” location factors—which are, however, of central importance for informational cities. Two types of cognitive activity are essential for the informational city:

- Scientific-technical-medical (STM) activities and the results thereof (“knowledge city”).
• Creative-artistic activities and the results thereof (“creative city”).

“A knowledge city is a city that aims at a knowledge-based development, by encouraging the continuous creation, sharing, evaluation, renewal and update of knowledge” (Ergazakis et al., 2004, p. 7). Examples of successful knowledge cities are Munich, Dublin, Barcelona, Stockholm, Montreal and Delft (Ergazakis et al., 2006). The significance of a knowledge hub can be measured both via the numbers of successful graduates and via the extent and effect of their STM publications. For the latter, some parameters like number of citations in the Science Citation Index or in the World Patents Index may be useful. Two indicators for this are known in scientometrics:

• Scientific-technical performance: number of publications (articles and patents granted),
• Scientific-technical impact: citations of these publications.

According to the data in Web of Science, Singapore’s publication output is characterized by a continuous growth over the last ten years. In this respect, the highest increase can be observed in 2008. For the year 2007, Haustein et al. (2011) found out, that in terms of visibility Singapore performed as the second-best Asia-Pacific country behind Australia with eight out of twelve field-specific citation rates above world average.

Informational cities do not restrict themselves to STM knowledge, but also attract creatives and creative industries. The latter distinguish themselves via the individual creativity of employees, their abilities and talents. Baum et al. (2009, p. 48) name six industries that form the core of the creative city: (1) film, television, entertainment, (2) authors, publishers, print media, (3) composers, music production, (4) architecture, visual arts, design, (5) advertising, marketing, (6) performing arts. Apart from the core professions of the creative class, there are points of contact with the typical professions of the knowledge city.

In Singapore, the development of the creative industries is guided by the “Creative Industries Development Strategy”. According to this concept, the city has to build up “a vibrant and sustainable creative cluster” in order to contribute to Singapore’s economy. Moreover, the GDP contribution of the creative cluster should increase from 3.2 percent in 2005 to 6 percent in 2012 (Yim, 2009, p. 3).

3. Position in the world city hierarchy

World city research arises with the fundamental work “The World City Hypothesis” by Friedmann (1986). It concerns the placement of a city in the world economy. “(W)orld Cities are large, urbanized regions that are defined by dense patterns of interactions rather than by political-administrative boundaries” (Friedmann, 1995, p. 23).

World cities form a hierarchical system according to their respective significance (measured, for instance, by the capital that a city is able to attract and bind to itself). Like Sassen (2001), Friedmann (1995) also regards New York, London and Tokyo as the leaders in this category for the last decade of the 20th century. On the second tier, we can see cities that may not dominate the entire world, but still have significance beyond national borders. Examples stated include Miami, Los Angeles, Frankfurt, Randstad and Singapore (Friedmann, 1995).

Following Sassen (2001), companies acting worldwide have their main headquarters in a global city. To register the information streams between cities, one can count all connections of companies from that city (no matter whether they have headquarters or only a branch) to its respective branches as well as to steady suppliers and customers as an
indicator for economic informational connectivity. A second indicator is the STM connectivity, which can be captured by counting co-authorships or co-citations on city level (Nowag et al., 2011). According to the Fortune 500 companies, we can find 55 branches and 2 headquarters of these firms in Singapore. In 2009, Singapore has quantitatively important co-authorships with 96 countries mainly with South East Asia and Australia (Nowag et al., 2011).

4. Labor market and job polarization
The current economic development has repercussions on income and jobs, which are characterized as income and job polarization, respectively (Goos and Manning, 2007). Income polarization means that the difference in income between the rich and the poor increases, whereas the area in between rich and poor loses in significance. Income polarization says nothing about any changes to specific professions. This is only accomplished by the conception of job polarization. For the workers, then, there remain the tasks that have not been automatized, and these are divided into manual (e.g. cleaning) and analytic (e.g. research and development) and interactive labor (e.g. management). The labor market in developed societies is split into well-paid (and well-trained) workers and (very) badly paid workers with limited qualifications – employees in the middle segment of education and income will, tendentially, disappear, due to the increasing automatization of their former activities.

Based on statistical information about manpower, personal income and occupational category, ten job groups are categorized with regard to the International Standard Classification of Occupations (ISCO-88). The lowest income can be observed in the first job group (Cleaners, Laborers and Related Workers). In contrast, the last job group (Managers and Administrators) has the highest salary. The changes of Singapore’s labor market from 1999 to 2009 show a strong increase in high skilled job groups and as proposed a decrease in the middle (Dornstädt et al., 2011). Jobs in the first category are mainly performed by foreign workers which are not allowed to stay in Singapore after finishing their projects. About 5 percent of Singapore’s labor force conducts jobs in the information and communications industries (Dornstädt et al., 2011).

5. Mix of companies
There are four types of companies in particular who have their headquarters here. First and foremost, capital-intensive service providers (as part of “advanced producer services” APS; (Sassen, 2001)) have their head offices in the global informational cities. The space of flow, in this case, is represented by the international stream of capital; participating branches are stock exchanges, banks and insurance companies. In informational cities, too, there is some industry, but those companies concentrate on knowledge-intensive high-tech industries, such as the medical, pharmacological, chemical and agrarian industry. The third type includes the information economy, to which belong industries such as computer manufacturing, software development, telecommunication, internet firms as well as information service companies. As a fourth pillar of companies, we will list creative enterprises, which either assist the aforementioned companies (e.g. advertising agencies) or provide cultural facilities (museums, theaters etc.). In 2009, the mix of companies in Singapore was dominated by wholesale and retail trade (27.5 percent of all companies by industry). The knowledge-intensive enterprises in particular sectors (infocomm, financial, insurance sector and firms
with professional, scientific and technical activities) came next. The prevailing number (47.2 percent) of all knowledge-intensive enterprises operated in scientific, professional and technical activities (Khvoshchanka et al., 2011).

6. Political willingness
In many growing informational cities, there have been or are political programs to build necessary infrastructures and to coordinate the way towards them. Communal programs for the creative city are downright inflationary (the role model being London Creative).

In Singapore exists a lot of political programs and government authorities, who develop master plans for different spaces of informational city needs. To enhance the ICT infrastructure the Infocomm Development Authority of Singapore (Khvoshchanka et al., 2011) created a master plan “Intelligent Nation 2015” (iN2015) to push the society to a knowledge society by increasing the high speed broadband connection and by offering a free wireless access for citizens. We also find an increase in e-governance activities, in where business and citizens are able to participate with the government.

7. Weak location factors
For Hall (1997), it is a mark of global cities to attract many foreign visitors. Here the following cultural institutions play a role: museums, galleries, libraries, opera houses, music halls, theaters and the number of “events” in any given week. Casinos, too, draw visitors. Furthermore, large sporting events with supraregional importance are significant. A typical customer of an informational city’s leisure facilities is the “cultural omnivore” (Peterson et al., 1996). In an informational city such as London, one can, at the same time, be a supporter of Arsenal F.C. and a regular visitor to the British Library, go to the opera or see a musical or a rock concert.

Singapore offers in 2010 22 libraries, 52 museums, 7 zoos, 2 casinos, 122 shopping-malls as well as 7,807 art and culture events (Khvoshchanka et al., 2011). Examples for large events are the Formula One Singapore Grand Prix or the Youth Olympic Games in 2010.

8. Conclusion
In this paper, we presented some of our identified indicators for measuring the degree of informativeness of a city by demonstrating examples of Singapore as a case study. The next steps of our research will broaden the perspective to other candidates of informational cities (e.g. London, Munich, Stockholm, New York City, San Francisco and the Bay Area, São Paulo, Shanghai, Seoul and Tokyo) and adjust the framework of indicators.
References