Towards a Sustainable *i*-City: Intelligent Transition Management of Digital Places

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ABSTRACT

Modern cities operate in a force field of great challenges. The introduction of digital technology may facilitate the necessary transition management of cities but calls also for a new and intelligent use of a wealth of information for coping with great many urban challenges. This paper provides an exploration of the various challenges and tasks of an intelligent city (*i*-city) faced with unforeseen challenges and an unprecedented supply of 'big data'. Professional data management based on solid cognitive expertise in this area seems to be a wise strategy of a modern *i*-city.

Purpose: This paper provides an exploration of the various challenges and tasks of an intelligent city (*i*-city) faced with unforeseen challenges and an unprecedented supply of 'big data'.

Methodology/Approach: The aim of this brief exploratory paper is to provide a sketch of the context and the force field of modern digital technology for urban areas. Our objective is to provide a positioning of Sweden – and in particular Stockholm – from the perspective of ICT use and digital technology use. Consequently, against the background of global and national ICT developments, the present paper will zoom in on Sweden and Stockholm as a reference case, so as to provide concrete and operational information in a benchmark exploration. At the end, some ingredients for a research and policy agenda will be offered.

Findings: The conclusion may be drawn that Sweden is an advanced Internet-rich country, in which the top of the hierarchy is dominated by Stockholm. Clearly, this city may be seen as a role model for others in the use of Internet activities. It is a typical example of a leading *i*-city.

Research Limitation/implication: The paper provides in a cascade form various relevant data on smart cities, from an international, national and local perspective, with the main focus on Stockholm.

Originality/Value of paper: Professional data management based on solid cognitive expertise in this area seems to be a wise strategy of a modern *i*-city.

Category: Research paper

Keywords: *i*-city; digital technology; transition management; intelligence; big data; strategic urban planning

1 INTRODUCTION

The far-reaching potential and pervasiveness of digital technologies and information systems have in recent years created unforeseen possibilities and challenges for creative urban policies, and have induced a radical transformation and drastic improvement of strategic urban planning, design and architecture in both developed countries and developing economies, with far-reaching implications prompting the need of new and unconventional urban policies. This force field is nowadays rapidly developing with a view to the enhancement of urban efficiency and competitiveness in order to ensure socio-economic progress and to maximize a sustainable urban quality of living and working, the so-called XXQ strategies (based on the '*XXQ*' principle; see Nijkamp, 2008) for (local) communities in a global playing field. Cities are nowadays in a state of flux; they are 'on the move', particularly as a result of digital technology use (see e.g., Ratti, et al., 2007; Townsend, 2013).

It is noteworthy that the use and implementation of new technological artefacts and communication inventions (e.g., social media, remote sensing, smartphones, androids, tablet computing, big data, cloud computing) effect also the daily life in cities (Latour, 1992; Waelbers, 2009; Verbeek, 2006). ICT offers the potential for enhancing external and internal bridging and bonding linkages between local and global communities, actors and spaces across a variety of networks (Ratti, et al., 2007) in combination of education, work, leisure, and social activities in the digital world. Our world is moving towards a multi-faceted and interconnected global system with interdependent digital communication, decisions, virtual actions and novel activities (Camagni, 1991; Batty, 2013; Nijkamp, 2016; Kourtit, 2016). The recent concept of the '*New Urban World*' heralds also the age of new urban ICT challenges.

The unprecedented wealth and use of new opportunities and the efficiency of radical digital technologies and information resources in our modern societies, that provide more and more raw materials for collecting 'big or bigger data' (see Kitchin, 2013; Kourtit, 2016), have as yet not been completely framed in an integrated metabolic urban system that is driven by a transition towards a sustainable development on a healthy winning edge and that is supported by an

effective action platform to the benefit of urban (sub)systems for various stakeholders, the so-called notion of *i*-cities (see also Kourtit and Nijkamp, 2015).

The *i*-city concept takes from granted that an intelligent city is able to use its manifold resources (both material and virtual) for a sustainable enrichment that goes beyond the standard use and the mission of a conventional smart city label in current urban policy, by identifying, monitoring and controlling a multiplicity of indicators and effects of '*grand challenges*' and by implementing technological initiatives and strategies to ensure and to offer a structurally improved quality of life in the city through intelligent solutions. Such intelligent solutions originate from the effective use of all cognitive (hardware, software, orgware, ecoware, know-how) resources in a city and are decisively driven by the unprecedented potential of modern ICT, in particular digital technology. In other words, an *i*-city operates on the basis of intelligent initiatives and solutions through the broad acceptance of digital technology in all constituents of the urban system

The above sketch of unprecedented future changes in the functioning and positioning of modern cities calls for a professional and informed transition management. The ingredients of this transition management are based on two pillars: (a) systematic mapping of the urban opportunities and impacts of modern technologies, with particular emphasis on digital technologies (or ICT, in general), leading to the need for a systematic urban technology impact assessment; (b) a comprehensive and integrated analysis of all varied data sources concerned in relation to the drastic role change of cities, leading to the need for urban 'big data' analysis and data mining. Clearly, digital technology and 'big data' go hand in hand.

The aim of this brief exploratory paper is to provide a sketch of the context and the force field of modern digital technology for urban areas. It is clear that the use and penetration of digital technology shows much variation across Europe. Our objective is to provide a positioning of Sweden – and in particular Stockholm – from the perspective of ICT use and digital technology use. Consequently, against the background of global and national ICT developments, the present paper will zoom in on Sweden and Stockholm as a reference case, so as to provide concrete and operational information in a benchmark exploration. At the end, some ingredients for a research and policy agenda will be offered.

2 THE BROADER ICT CONTEXT

The intelligent policy, strategy, transfer and management of digital information in a city are not developed in isolation from the rest of the country or the world. ICT is a pervasive technology that penetrates all regions of the world and all sectors of the industry, but of course, with varying degrees of acceptance and adoption. Normally, the acceptance and adoption of a new technology follow a

spatial-hierarchical pattern, from large urban glomerations to rural areas. This geographical pattern of the spread of innovations was already observed by Hägerstrand (1953) in his study on space-time dispersion of agricultural subsidies in Sweden. Clearly, in the context of information technology, the space-time acceptance and adoption rhythm is much faster, but yet there is much evidence that the fruits of new technologies are first reaped in larger urban agglomerations, which are in turn influenced by the technological development patterns in other regions or countries. In order to position the digital technology importance for a capital city like Stockholm in Sweden, it is therefore meaningful to provide a broader picture of digital technology evolution in Europe, through a series of informative pictures on recent developments.

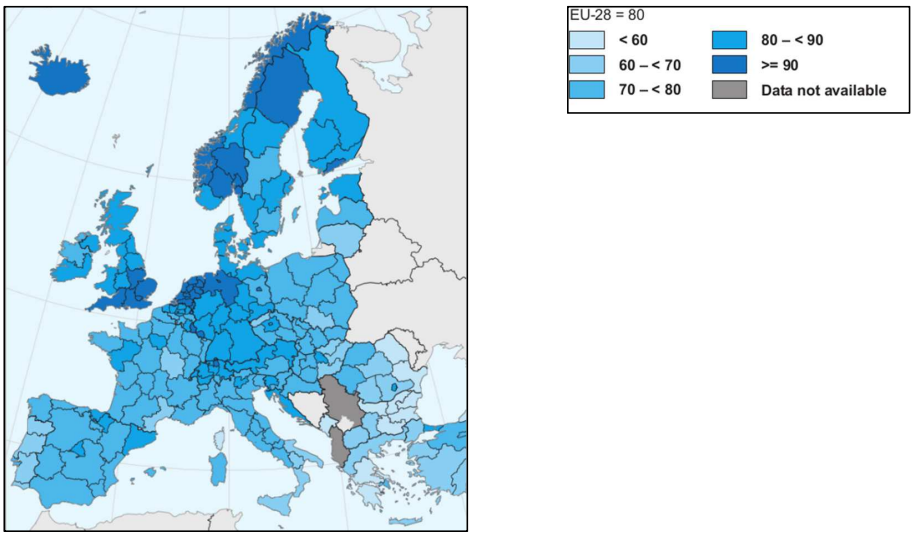

Figure 1 – Broadband connections in households, by NUTS level 2 region (Source: Eurostat, 2015)

We will first present here the broadband connections in households at a NUTS-2 level in Europe (see Fig. 1). This map leads to the following observations:

- Many Western European and Northern European countries have an above average availability of household broadband connectivity.
- The Central European and Mediterranean countries have a much lower achievement level for broadband connections.
- Large urban agglomerations (e.g., Greater London, Randstad Holland, Ile-de-France, Madrid, Stockholm, Helsinki) exhibit relatively high scores for household broadband connections.

It is thus clear that the Nordic countries – and their capital cities – have an above-average ICT potential.

The previous findings on the positive picture of Nordic countries are supported by an 'inverse' map of Europe, viz. people who never used Internet (see Fig. 2), as well as by a map showing the regular use of the Internet (see Fig. 3).

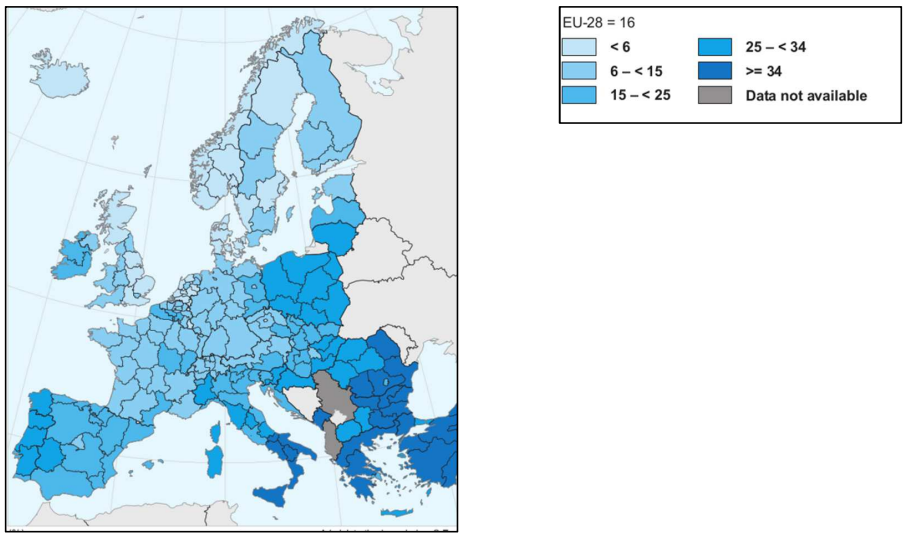

Figure 2 – People who never used the internet, by NUTS level 2 region, % of persons who never accessed the internet (Source: Eurostat, 2015)

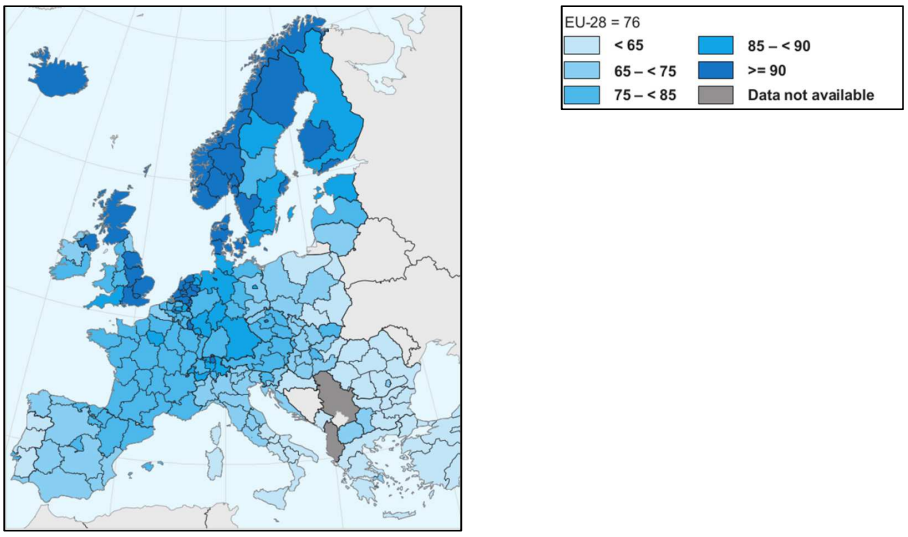

Figure 3 – Regular use of the internet, by NUTS level 2 region, % of persons who accessed the internet on average at least once every week (Source: Eurostat, 2015)

Consequently, there are significant discrepancies (spatial disparities), both between and within EU countries, in the adoption and use of the Internet (see

also Fig. 4). Apparently, Northern European countries belong to the high-performing ICT areas in Europe.

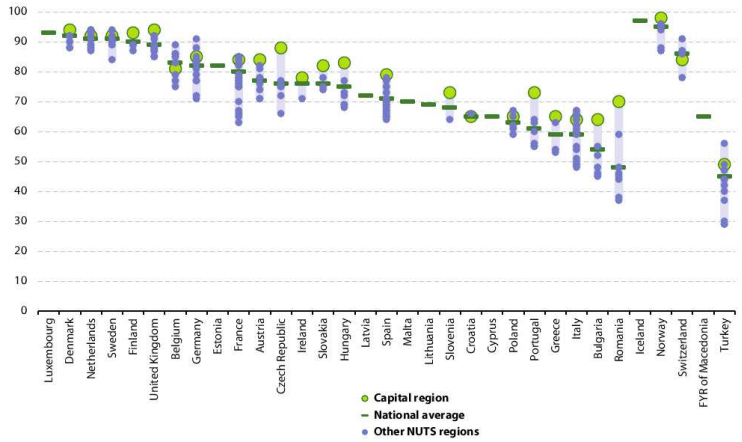

Figure 4 – Regional disparities in regular use of the internet, by NUTS level 2 region, % of persons who accessed the internet on average at least once every week (Source: Eurostat, 2015)

Finally, an almost similar pattern can be identified for the Internet use by public authorities in their communication with the public (see Fig. 5).

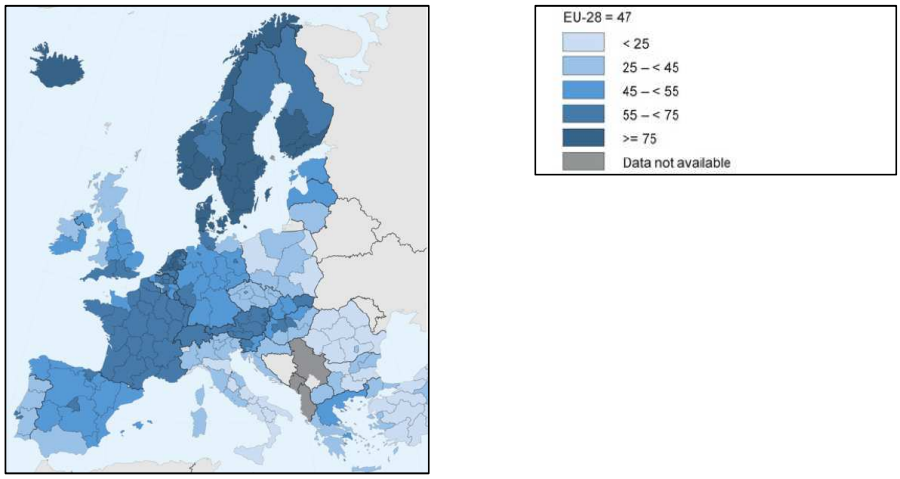

Figure 5 – Use of the internet for interaction with public authorities, by NUTS level 2 region, % of persons (Source: Eurostat, 2014)

It turns out that Stockholm is among the cities with the highest adoption rate of urban residents using the Internet for their interaction with public authorities. The previous observations are once more supported by Fig. 6, which shows that in all 5 relevant aspects of digital technology (connectivity, human capital, use of the

Internet, integration, digital public interaction) Sweden scores well above the European average. The generally strong position of the Nordic countries (Denmark, Finland and Sweden) is also visible from an analysis of the DESI-index (Digital Economy and Society Index) depicted in Fig. 7.

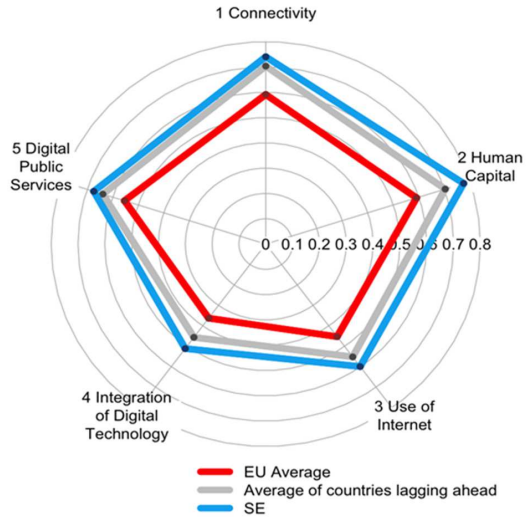

Figure 6 – Digital Economy and Society Index (DESI), Country Profile Sweden (Source: European Commission, Digital Agenda Dashboard, 2016)

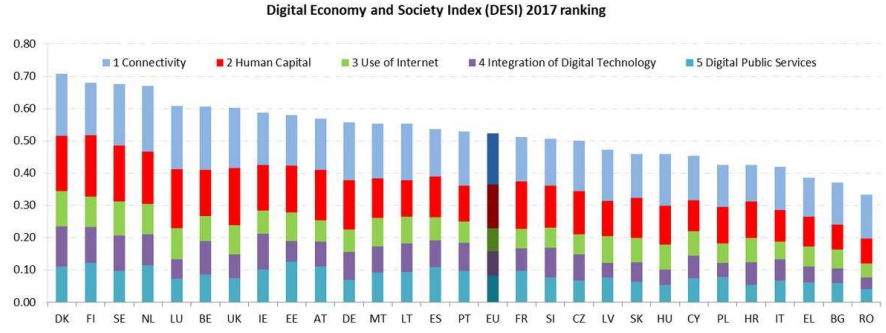

Figure 7 – Digital Economy and Society Index (DESI): A comparison of Denmark's, Finland's and Sweden's Digital Performance (Source: European Commission, Digital Agenda Dashboard, 2017)

The next question is now: how is digital technology performance distributed within the country of Sweden? If we focus now on the intra-country Swedish patterns of Internet access, it is noteworthy that this access is broadly distributed (with only an exception of the oldest age cohort) (see Fig. 8), while the Internet is used for various different purposes by citizens in their contact with public authorities (see Fig. 9).

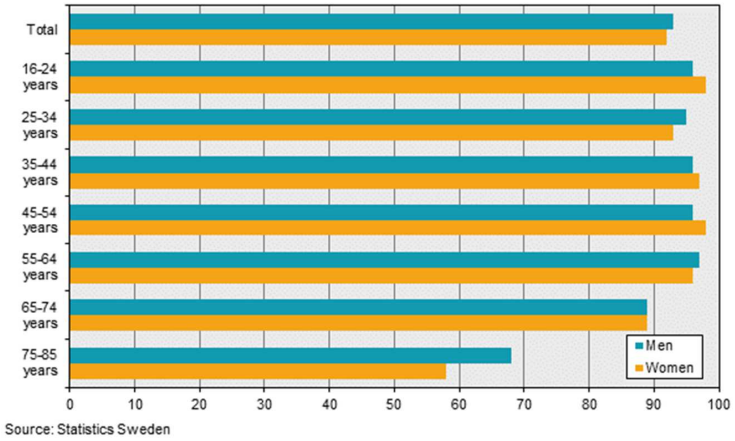

Figure 8 – Share of persons who have access to the Internet at home in Sweden, by age groups 16-85 years of age, shares in percent (Source: Statistics Sweden, 2016)

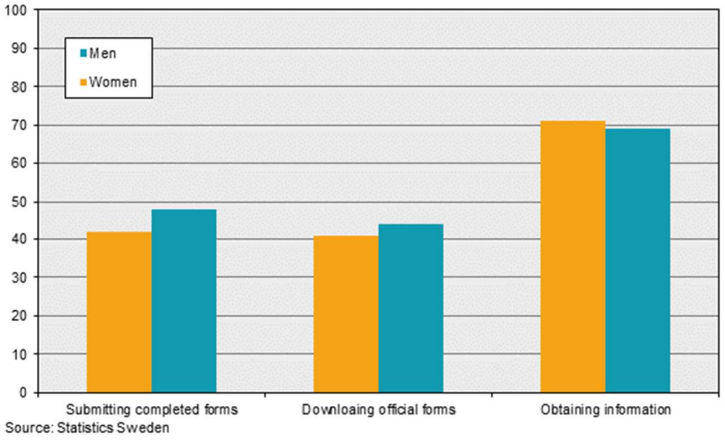

Figure 9 – Share of persons who used websites of public authorities by area of use (Source: Statistics Sweden, 2016)

At the national level of Sweden, Fig. 10 and Fig. 11 show again the strong position of Sweden: it has a broadly composed use of Internet activities in the country and may be seen as one of the European pioneers.

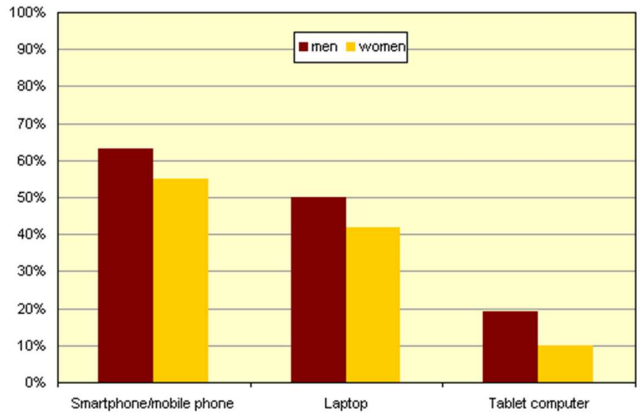

Figure 10 – ICT usage in households: different type of devices used for connection to the Internet away from home or work, first quarter 2012, percentage of persons aged 16-74 (Source: Statistics Sweden, 2012)

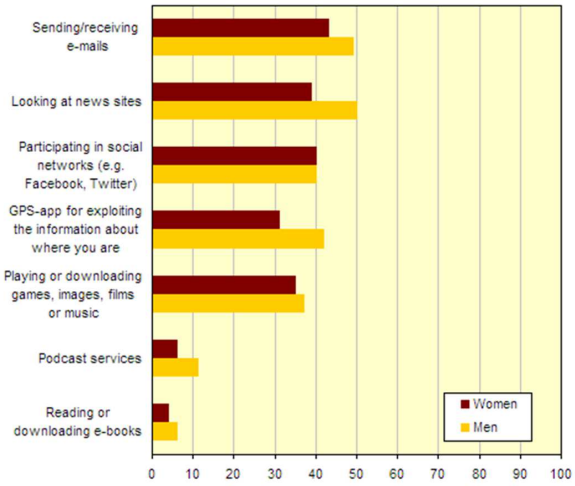

Figure 11 – ICT usage in households Internet activities carried out with a smartphone or other handheld device, outside the home or workplace during the first quarter 2012, percentage of persons aged 16-74 (Source: Statistics Sweden, 2012)

It is noteworthy that, if we zoom in on the spatial top of the urban hierarchy of Internet adoption in Sweden, viz. on Stockholm, we find again a confirmation of the high Internet penetration rate of households (see Fig. 12), but also of the business sector (see Fig. 13 and Fig. 14). It appears that in Europe Sweden is a high performer, while in Sweden Stockholm is a high performer.

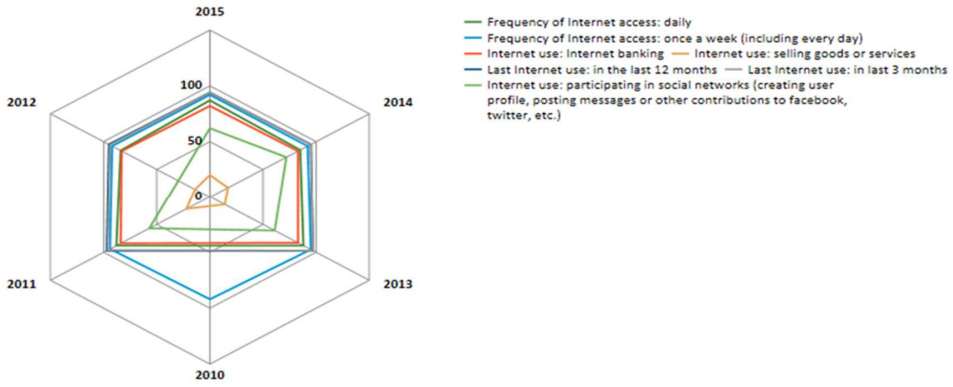

Figure 12 – Individuals who used the internet, frequency of use and activities in Stockholm (Source: Eurostat, 2010-2015)

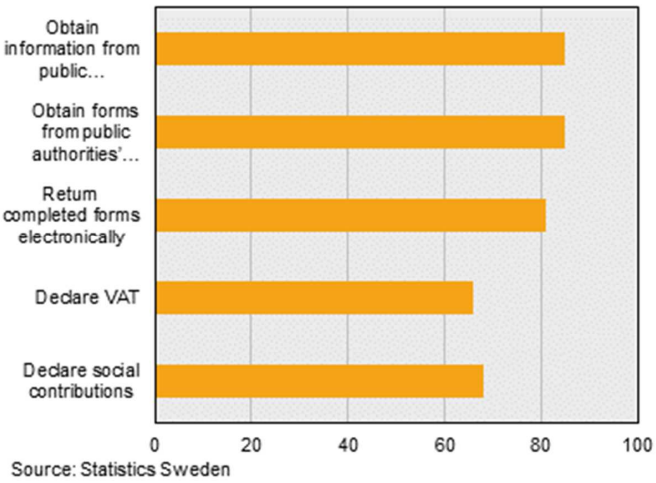

Figure 13 – Share of enterprises using the Internet for interaction with public authorities for different purposes (Source: Statistics Sweden,2015)

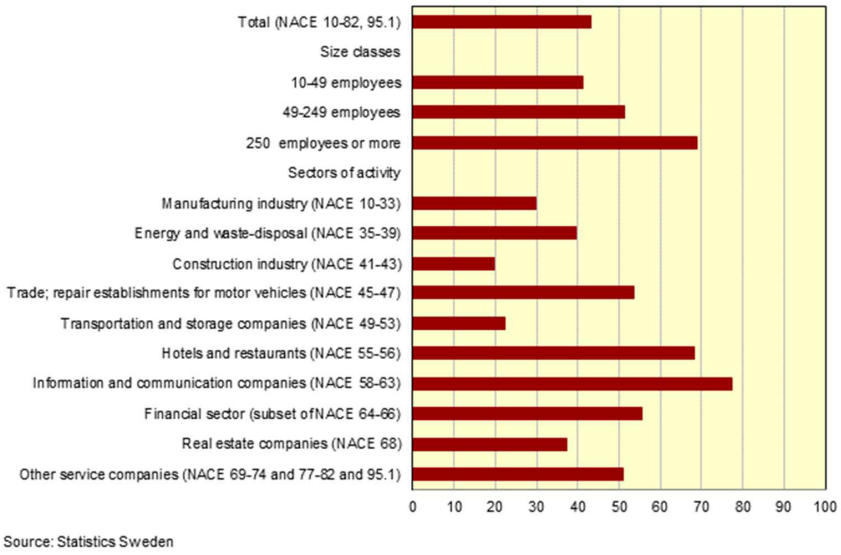

Figure 14 – Share of enterprises' that use social networks, by size class and sector of activity, 2013, 10 or more employees, percent (Source: Statistics Sweden, 2013)

The conclusion may be drawn that Sweden is an advanced Internet-rich country, in which the top of the hierarchy is dominated by Stockholm. Clearly, this city may be seen as a role model for others in the use of Internet activities. It is a typical example of a leading *i*-city. We will now offer some further considerations for a deeper reflection on the significance of digital technology for intelligent cities.

3 DIGITAL TECHNOLOGY AS URBAN INTELLIGENCE

The trend breach of digital technology calls for a *new urban analytics* (NUA) based on a combination of digital technology use and 'big data' analysis but does not make conventional information and data systems in cities obsolete or redundant. It adds an entirely new digital data dimension to such systems in order to incorporate also the fast changing and volatile space-time dynamics of the urban fabric. The merger of two tiers of information and data calls for adjusted techniques and research tools so as to extract evidence-based knowledge in support of strategic and pro-active urban planning. In the action arena of urban evolution – with slow and fast dynamics occurring at the same time – detailed geographically-oriented information and data are then needed, based on GIS technology dealing with geo-referenced and geo-coded data. This has led to the popularity of modern geo-science as a contemporaneous analytical framework for understanding the complexity of urban systems (Fischer and Scholten, 1994).

It should be noted that NUA is a constellation of an unprecedented and rich portfolio (or package) of hardware, software, infoware, ecoware and orgware so as to enhance the quality of urban life (see also the XXQ principle advocated by Nijkamp, 2008). NUA complies with the need for an integrated assessment, based on informed and scientifically valid information, in order to cope with the ever changing pattern of modern cities, either through unanticipated shocks or endogenous responses of a great many stakeholders. NUA seems to be a proper response to a wide variety of urban challenges through the use of modern digital information systems.

Finally, an effective implementation of the NUA calls for a professional urban information management, not as a hobbyist activity of a city official, but s a systematically organised cognitive task imposed on a knowledge division of a city council with the involvement of various stakeholders in the urban system that is fit for purpose. Clearly, such a structured and integrated information management calls also for 'big data' expertise, transparency, and alignment with the general city's vision and strategies, since one of the greatest handles in using a wide array of data sources is its quality and coherence control and steering. This is a *sine qua non* for any *i*-city, as otherwise 'big digital data' will lead to inconsistencies that may lead to an erosion of the necessary transition management of *i-cities* in the '*New Urban World*'.

4 SYNTHESIS: THE NEW URBAN ANALYTICS

It is noteworthy that in recent times cities have adopted new roles, viz. from a data user for urban planning to a data engine for research and management (Batty, 2003). Digital data production, analysis and application have become almost magical instruments to govern current complex city operations, e.g., in the field of mobility, public transport, safety and security, use of public amenities, access to public services, tourism, parking management, etc. 'Splintering urbanism' is a new phenomenon that reflects the geographical position and individual intersections of residents and visitors in a city (Graham and Marvin, 2001).

This calls – as mentioned above – for an entirely new model of examination and management of the daily-life patterns in cities, in the form of a *new urban analytics* (NUA). The sources of such data are manifold: camera's, sensors, GPS data, GSM data, parking data, etc. The identification, monitoring alignment, and management of the overwhelming complexity of daily urban patterns and interactions is one of the difficult tasks in an intelligent strategy for a city. The control of the manifold space-time signatures of citizens and visitors calls for intelligent solutions, on both the research and the policy side. The big challenge of such 'big data' systems is not so much the collection of all relevant data, but the systematic and integrated analysis of all such data from different space-time constellations in one coherent research and management framework. All such data act as real-time heartbeats of the city, and one of the greatest tasks in

modern and strategic urban planning is to monitor, analyse and forecast urban dynamics so as to create realistic conditions for smart and sustainable cities. This is the critical mission of *i*-cities.

From an empirical perspective, we have observed pluriform patterns in the adaptation and use of digital technology, across countries and regions. It turns out that countries and cities in Northern Europe have a high access to and use of ICT and digital technologies. Stockholm appears to be a typical high performer in the digital era.

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