Indicators for smart cities: What do we need from a planning point of view?

Rudolf Giffinger
TU Wien, Vienna, Austria – rudolf.giffinger@tuwien.ac.at

Abstract

In order to meet the challenges of urban development, the idea of 'Smart City' has been discussed for some years now. The term itself has become a buzz-word with different interpretations, often lacking a clear definition but mostly claiming technical and data driven solutions.
In this contribution I show what is meant by 'Smart City' from a planning point of view, and which dimensions are crucial for smart urban development. According to the different understandings an overview is elaborated from a methodological point of view, focusing objects, content and quality of information used and how this possibly provides for indicator development in urban planning. Their meaning in the urban development and policy context is elaborated. Finally, perspectives and pitfalls of different types of indicators are discussed supporting the respective understanding of the Smart city idea. Most of these experiences and conclusions are based on findings from the project PLEEC (Planning Energy Efficient Cities), funded by the EU FP-7, DG Energy; and Smart City experiences in the project SMART_KOM Kraków (2014), funded by EU Transnational Agreement, Priority Axis 8 Trans-Regional Co-operation.

Keywords: indicators, urban development, ICT, methodology

1. Introduction

In front of new and increasingly complex challenges in urban development the idea of 'Smart City' emerged some years ago. (Giffinger, et al., 2007; Caragliu, et al., 2009; Acatech, 2012) This enforced a strategic discussion regarding new concepts meeting such challenges. As the 'Smart City' idea was taken up by different institutions like the EC, scientists from different backgrounds, and medium sized and larger cities, in each regard very specific understandings of the concept 'Smart City' along the dimensions 'technology', 'citizens' and 'institutions/governance' had been developed (Nam, et al. 2011; or Diamantini, et al., 2014) Due to these diverse understandings specific fields and dimensions of smart city development are discussed intensively and different types of information are elaborated. Therefore, this contribution does not provide a long and comprehensive list of indicators, but gives an overview to specific methodological implications for their operationalization.
Due to these objectives the different understandings are elaborated. They are characterized in their predominant view on urban development and their respective understanding for improving 'urban quality of life'. In a methodological perspective answers are elaborated regarding the questions, 'What is the object bearing and providing information?', 'Which content do indicators express in which quality?', and 'How are different types of indicators operationalized and through which kind of measurement?'. Finally, an outlook discusses the importance of different types and combinations of indicators from a strategic planning point of view whereby ethical problems are considered in particular.

2. Smart City understanding in the context of urban development

Since some decades the discussion of urban development has become rather diversified regarding processes of globalisation, socio-demographic changes and new technologies changing the conditions of communication and mobility. However, in the very centre of this discussion on urban and regional development are the objectives of the increase of a city's competitiveness and its quality of life. The discussion increasingly emphasizes that future urban development will not only depend on market dynamics and related tangible factors like the production of goods but also on intangible factors. Obviously, urban development is not only dependent of traditional economic forces, but of other intangible factors as well. Environmental quality, human, social and relational capital or creativity and international connectedness have increasingly become decisive components of quality of life and urban

competitiveness. (Begg, 1999; Florida, 2002; Camagni, 2009; Giffinger et al., 2009) These intangible factors are regarded as crucial for urban development, as they have a decisive importance for productivity and economic growth, and freedom and well-being of the different groups of an increasingly urbanized society in a competitive environment. (Camagni, 2009)
Along with this discussion the 'Smart City' idea was introduced in relation to three major challenges on the global scale:

- the need for corresponding investments in ICT-infrastructure considering the urbanization and fast growth of cities; (Acatech, 2012),
- the need for energy efficient urban development considering problems of GHG-emissions and transformation towards local and renewable energy resources. (United Nations, 2014), and
- the need for strengthening the position of cities in the global urban network considering increasing competition and endangered quality of life. (Giffinger, 2008; Caragliu, et al., 2009)

The basic understanding of 'Smart City' originated from that of the 'information city', and evolved to an idea of an ICT-centered smart city which believes in a wired ICT-driven form of urban development in order to enable a better life in cities. A rather wide economic but also ICT-focused understanding of urban development is shown in the definition by Caragliu, et al. (2009, p.6)*: "… when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance."* Along with investments in technical infrastructure they are emphasizing human and social capital as driving forces of urban development supporting quality of life. In addition they claim a participatory setting as a precondition for sustainable economic growth, acknowledging a more process-oriented understanding of smart urban development.
With regard to technological progress, Batty et al. (2012) discuss which new facilities the development in the ICT-sector is providing. They stress that ICT enables new information through the integration of data bases on the one hand side and through sensors delivering real time information about actual developments and trends. They regard these facilities of producing and collecting information as a decisive new component impacting the possibilities in urban research and modelling of certain urban systems. In particular, new perspectives of modelling are described regarding mobility and transport behavior, land use transport, market transactions and supply chains. Obviously, they did not discuss the impact of ICT facilities in energy efficiency in the housing sector, which has become one of the major fields of strategic activities. (Dammann, 2013) And, they regard ICT as an important improvement of the information base, which supports more complex modelling and faster, in some cases real time decision support. Hence, ICT is delivering technical knowledge for decision support in planning and the governance of cities and city regions. However, the issue of 'decision support and participation' as well as the issue of 'urban governance' are mentioned but remain relatively undifferentiated.

3. Indicators in different Smart City understandings

Despite similar challenges and a clear positioning of ICT between research and decision support and governance, different understandings of 'Smart City' emerged. Based on a partly modified classification by Nam et al. (2011), who classified the smart city concepts along the terms 'technology', 'people' and 'institutions', I concentrate on selected concepts/understandings. Hence, in the next chapter the most important and different understandings of 'Smart City' are characterized. For each of them the main focus and crucial dimensions of the respective empirical approach are discussed. Consequently, from a methodological point of view, the following aspects are dealt with producing specific types of indicator in terms of

- the 'object bearing and providing information' to which indicator values are related,
- the 'content and quality of information through corresponding indicators' and
- the 'applied method of information production '.

The data driven understanding

Based on integrated databases, Batty et al. (2012) developed an economic-functionalistic approach which aims predominantly at a more efficient use of existing infrastructure capacities, thereby reduc-

ing the demand of energy sources and emissions. According to this objective, monitored or sensed data is used for modelling efforts which are a precondition for decision support.
In line with this understanding the City of Barcelona is recently implementing a corresponding Smart City concept based on a digitalized model of the city. (Sanz, 2014). In this concept three different levels of information are to be distinguished. On the first level the model describes the anatomy of the city which implies different data sets on physical structures and endowments (environment, infrastructure, buildings), and on society (public space, functions, people/residents/visitors). On the second level the conceptual model describes the urban characteristics in terms of ICT-networks, water and energy infrastructures, building materials, mobility and environment. A spatial model will be implemented to aggregate information on distinct spatial levels describing public and private services. On the third level information is produced through smart metering and monitoring in order to manage 12 different infrastructure systems more efficiently by corresponding programs delivering specific urban services.
From a methodological point of view one can resume:
The data driven understanding of Smart City predominantly processes and treats data for different objects on varying spatial levels. The more precise objectives in distinct smart city efforts are defined, the more it is expected that ICT should deliver more precise and faster (real time) information through respective sensor systems. Along with this development there is the tendency to use spatially disaggregated information. In particular, this means that individuals with their electronic devices have become the object bearing relevant information which could be used for indicator operationalisation.
This approach mainly delivers data about observable phenomena and trends for different objects in urban development. Hence, indicators are defined in order to describe structures and trends quantitatively, in a geo-referenced and economic perspective. Herewith, capacities and actual usages of infrastructures and bottle-necks can be identified from a technical management perspective. Also, 'problematic' or deviant behaviour from a social or political perspective (i.e., crowding) can be detected. ICT enables the processing of real time information which is transformed into knowledge about actual structures, processes and trends. The information gained by such sensor systems is reduced to easily observable characteristics like numbers/amounts, speed, congestion, and noise, all combined with geo-referenced information. But while this information may help to increase the efficiency or effectiveness of infrastructure systems, it cannot meet challenges in the social and participatory governance context.
Usually, information is produced through sensor or monitoring systems or from corresponding official statistical sources. Obviously, quality and content vary across cities and in particular across countries due to different traditions of national statistical efforts. Of course, the possibilities of aggregating data on different spatial levels or combining data describing different objects depend strongly on the elegance and power of the basic data model.

The technical innovation driven understanding

In this understanding the technical innovation is in the main focus. It regards the 'Smart City' as a corresponding urban fabric determined through the interplay of the multiple (not triple) helix for the emergence of technical innovations (Leydesdorff et al, 2011). Therefore, the main attention is directed at six dimensions which should positively influence the emergence of technical-economic innovations. These 6 factors are 'university', 'knowledge', 'industry', 'market', 'government' and 'learning'. Particular emphasis is put on (1) the interrelation between universities and government regarding learning processes; (2) the interplay between universities and industry regarding knowledge production; and (3) the interconnections between industry and the government regarding market dynamics. Hence, this approach aims at improving economic and urban performances in different fields of urban development but predominantly tries to strengthen economic competitiveness.
From a methodological point of view one can resume:
In the technical innovation driven understanding the city as object is described in its characteristics in certain domains based on indicators describing the six different elements of the multiple helix in a structural and procedural way. The indicator values for each city describe its profile enabling the benchmarking between cities.
The indicators describing the 6 factors are only defined as absolute or relative values expressing the intensity or the performance. So, obviously this approach on innovation is theory-based, while the

empirical description of driving factors is by far not as easy considering the question how one has to define 'innovation' and how governance may impact it. Therefore, the operationalization of the 6 factors by mostly performance-oriented indicators seems problematic. Governance-related indicators describing the quality of knowledge production, learning processes and market conditions (regulations, directives) regarding innovation are not considered by this approach.
Finally, data production has to be unified across countries and cities. But the implementation of a monitoring system, however, should be easy and would provide information about relevant trends for further strategic decision making.

The governance driven understanding

In this understanding Smart Cities are driven by initiatives of smart communities, aiming at the implementation of (mostly technical) innovations. 'Institutional factors' are a core component of a smart city here, because they are fundamental for the design and implementation of corresponding initiatives under certain governance conditions. (Nam et al., 2011) Correspondingly, 'governance' is understood as the complex interplay between public regulations and directives, policies and citizens' initiatives aiming at the improvement of urban liveability through the use of ICT. Smart governance is enabling those initiatives that are driven by integrated, collaborative and inclusive communities and composed of different neighbourhoods and actors with specific interests but the common objective of creating public and economic value through technology. (Dameri et al., 2014, or Dameri, 2014)
Facing the changing challenges of urban development smart governance should be adaptive. This means that *"…it is a form of governance that takes into account the fluidity of the relationships - a fluidity due to the increased flow of information. The relationships are neither rigid, nor top-down. Rather, they are flexible and obedient to the logic of the network. A network that is rebuilt is continually redefined, in relation to the problems to be faced and the solutions to be found."* (Diamantini et al., 2014, p.4).
In general, the governance-driven understanding of the 'Smart City' means that it can be built from top-down or bottom-up. In fact, 'smart governance' is approached in completely different ways and needs completely different types of indicators. Some use performance data describing characteristics of governance on the level of cities or neighborhoods. For instance, the European Smart City model of TU Wien (2007, 2013 and 2014 see Giffinger et al., 2007) uses indicators describing human and social capital and participatory issues; or the Kominos model (2008), very similar to the multiple helix model, describes human capital but also institutions of knowledge production and innovation. Besides, in the European Smart City model of TU Wien specific social issues related to governance like corruption or quality of public services are described as the cognitive representation of citizens through representative surveys in EU member countries and cities. The e5-appoach (2015) aims at the support of energy aware and climate friendly municipalities and cities. This program supports municipalities in their energy efficiency objectives, controls and modifies relevant activities and implements projects. Hence, the e5-program first aims at capacity building for local authorities related to energy efficiency. In this program an internal set of indicators is developed which allows assessing and certifying the municipality on its way to an energy aware and climate friendly municipality. Different fields of urban/municipal development are in their focus: urban planning, strategic planning, energy planning, technical infrastructure systems, transport and mobility, lighting, communication, internal organization of working groups or co-operations.
From a methodological point of view one can resume:
In the governance-driven understanding, objects of description largely vary. In the e5-approach it is the description of a wide field of activities realized by municipalities, and in TU Wien's European Smart City Model it is citizens describing and assessing their social experiences.
Indicators which had been used up to now are rather simple facing the dimensions which should be covered. Besides the different forms of collaboration and documents in particular the process orientation of such collaborative social activities (and their interplay with regulations) should be considered and described by relevant indicators. But then other factors like relational capital with capabilities and capacities, truth, cooperative ability become relevant.

Hence, smart governance indicators should go beyond the description of endowments and performances and should be related to specific objects with different approaches of measuring. Indicators should in particular focus on corresponding initiatives, their actors and describe factors of the social capital like collaborative capability, co-operative competences or trust on the social level. However, information describing such factors is not easy to gain and will need completely new instruments for measuring.

The evidence based and socially driven understanding

The TU Wien model of European Smart Cities elaborated a comprehensive understanding that is more integrative and place-based. In a hierarchical approach, the authors develop a city profile including characteristics on different levels. 6 key fields are defined by a respective group of domains (in total 28) and each domain is empirically described by a set of indicators (in total 81 in release 3.0) Based on this definition the 6 key fields describe the city's specific urban profile indicating a city's performance in an integrative way. Through this approach one can easily discuss whether (1) a city's development is well-balanced across all key fields, and (2) which assets and deficits currently exist in urban development. (Giffinger, et al., 2007)

The performance of a city is empirically defined by a set of indicators in the TU Wien model. In the concept of the Smart City, six key fields (dimensions) are distinguished: smart economy, smart mobility, smart environment, smart people, smart living, and smart governance. Importantly, in this approach it is acknowledged that urban performance depends not only on the city's endowment with infrastructure ('physical capital'), but in particular on its user-oriented provision and high acceptance of endowments from a citizens' point of view.

From a methodological point of view one can resume:

In the socially driven understanding the object of description and analysis is the city as an entity characterized in different domains or services. Of course, certain indicators are related to specific objects like green space, buildings or infrastructure networks within the cities due to functional criteria but usually aggregated on the city level. Due to the socially driven understanding – and different to most other approaches –indicators are based on representative surveys reflecting citizens' opinions, assessments, and appraisal of their city.

On the one hand indicators are describing – similar to other approaches – the endowment related capacities, intensities or densities in certain fields or domains. A wide range of different dimensions of urban development is covered by such indicators. Some indicators try to describe specific participatory aspects (in a relatively poor way), but indicators from surveys focusing on citizens are reflecting perceptions, attitudes and assessments of certain domains. Of course, most indicators are based on official European statistical sources. Hence, reliability of data has to be controlled as well as possible. And trends and changes in urban development can only be assessed in case longitudinal data exists. Obviously, the 3 issued releases of the TU Wien approach which had been worked out are not comparable. Changes in statistical sources and newly defined indicators based on more valid data make a comparison impossible.

Hence, urban performances are not only described through economic-functionalistic 'objectified' indicators but also by cognitive and subjective representations of the citizens.

Integration of socially and governance driven understanding

Based on the European Smart City model of TU Wien, release 3.0, a strategic planning approach is developed and applied in two specific European projects in which learning processes for specific stakeholders groups are enforced.

A clearly problem-oriented and place-based approach is defined in the project PLEEC (2014) with a focus on energy efficient urban development. In this approach key fields and domains are assumed to be of relevance for energy efficient development and were defined by experts from universities, planning institutions, and stakeholders from six cities (Jyväskylä, Turku, Eskilstuna, Stoke-on-Trent, Tartu and Santiago de Compostela). The 5 key fields are 'green buildings', 'mobility and transport', 'technical infrastructure', 'production and consumption' and 'energy supply' – all defined according to the respective experiences of the different expert groups.

Based on this classification of key fields and domains two different processes had been started:

First, a list of relevant indicators for the cities' monitoring system was defined . In total, 49 performance indicators were identified for describing the 5 key fields of energy efficiency. The majority of data for calculating indicator values were available in each city, although data coverage varied between 47% of operationalized indicators in Santiago de Compostela and 88% of all indicators in Jyväskylä.
Second, the PLEEC project (Giffinger, et al., 2014) elaborated an indicator of innovation potentials as a basic requirement for future decisions on activities and investments. The idea is the detection of innovation potentials as the result of a repeated stakeholder survey in the 6 PLEEC partner cities. Consequently, an indicator is operationalizing the innovation potential by local stakeholders who had been asked (online questionnaire) for an assessment of the recent energy efficient status and of an potentially improved status in future in respective key fields and domains. Importantly, innovation is not only related to technical but also to social and structural innovations. In fact, the results show very specific profiles of innovation potentials for each city.
Even in the project SMART_KOM Kraków (2014) a distinct adaptive governance approach is followed. In this project 7 workshops with about 170 local stakeholders of the city-region of Kraków, Poland, had been organized for the identification of strengths and weaknesses. Then, an indicator-based European Smart City model (release 4.0 will be issued in a few weeks) for larger European cities between 300.000 and 1 million inhabitants was realized. Currently, local stakeholders are discussing assets and deficits, resp. strengths and weaknesses in the performance of Kraków and will elaborate a road map for most important urban innovations.
From a methodological point of view one can resume:
In the socially driven understanding with a special focus on governance the objects of information are different: In a spatial perspective objects are predominantly defined as spatial entities (for instance, city, city-region, district, block and infrastructure). At the same time indicators are developed from assessments of interviewed citizens in a Europe-wide survey or focused workshops collecting experts' knowledge regarding energy efficient developments.
In this combined understanding, indicators 'objectively' describing urban phenomena are dominant. But, the quality of indicators is sometimes poor because of missing valid information on the local disaggregated level or specific information on energy consumption and provision as the PLEEC project is showing. In addition, this approach is using information gained from surveys, which reflect the perception and attitudes of citizens or stakeholders. However, the results as outcome of cognitive representations are rather sensitive against the composition of involved stakeholders.
Again, urban performances are not only described by economic-functionalistic and 'objectified' indicators but also by cognitive and subjective representations of individual actors in their different roles.

4. Conclusions

To conclude, the different understandings of the Smart City ask for specific types of indicators exemplified through corresponding approaches. Performance indicators are used in all understandings but predominantly in data driven approaches. ICT has become the strong and powerful driving force for the production of objectively measured information and operationalization of corresponding indicators. Based on more or less powerful data models indicators are delivered for completely different objects bearing relevant information.
Hence, objects of measurements and description have become increasingly disaggregated and specialized in urban planning. As experiences in different projects with cities show, the big challenge to organize information in a hierarchical and clearly structured way currently confronts many cities implementing open data concepts. Due to traditional organizational structures and parochial administrative thinking data had been organized within specific administration units, now challenging cities to find a consistent and powerful data model which allows a better integration than before. Hence, open data concepts implemented by cities in recent years are the more user-friendly the better and more integrative facilities are due to powerful data models.
Obviously, content and quality of information and related indicators are varying across cities and in particular across countries due to different traditions of national statistical efforts. Hence, approaches

which try to compare performances and to benchmark specific issues of smart urban development show deficits in comparable and valid information. Approaches to unify data production making information comparable are challenging, long-lasting efforts.
Against approaches of 'objectively' measured phenomena on the city level, approaches focusing on information reflecting perceptions, attitudes and assessments of actors and citizens still make only a small but growing number. Data sources are scarce but increased recently through the 'Urban Audit Perception' which provides representative European surveys on the city level. However, they cover not all domains or services which are affected by smart urban development.
In the context of strategic planning, geo-referenced data of individual objects is necessary for internal use (administration, analysis, modelling) but individual information should be controlled and not published through an intelligent aggregation procedure on grid basis. For instance, trends and activities concerning the density in different neighborhoods within an urban-regional area are of crucial importance regarding district heating and resilient energy provision based on renewable sources.
Despite all efforts realized in the different smart city approaches we can conclude with Fontana (2014, p. 144) *"The performance measurements identified in the different models do not appear to be exhaustive. Indeed, outcome indicators alone cannot be considered enough in terms of participatory government for adequate external accountability; this requires a continuous interactive process between the various stakeholders, supported by a timely, accurate information system."*
Definitively, for an evidence-based understanding and integrative strategic planning we need better, and the most recent information as outputs of adequate monitoring systems. But this remains one of the most challenging questions from an ethical point of view – how far sensoring and storing of individual information should/could be dealt with in order to produce and provide new public services. Hence, we do not only need more real time information. For many issues of urban development we also need new ideas and methods of production and dissemination of information, improving the awareness for a sustainable urban development. Together with Nam and Pardo (2011, p. 288) one can conclude: "*Leading a smart city initiative requires a comprehensive understanding of the complexities and interconnections among social and technical factors of services and physical environments in a city*."

References

Acatech – Deutsche Akademie der Technikwissenschaften (Hrsg.) (2012) Smart Cities - Deutsche Hochtechnologie für die Stadt der Zukunft. Nr. 10, Berlin: Springer.
Batty, M. et al. (2012): "Smart Cities of the Future". European Journal of Physics Special Topics 214: 481–518.
Begg I. (1999): Cities and Competitiveness, in Urban Studies, Vol. 36, Nos 5-6, pp. 795-810.
Caragliu, A; Del Bo, C.; Nijkamp, P (2009). "Smart cities in Europe". Serie Research Memoranda 0048 (VU University Amsterdam, Faculty of Economics, Business Administration and Econometrics).
Dameri R. P. and Rosenthal-Sabroux C. (2014) Smart City and Value Creation. In R.P. Dameri and C. Rosenthal-Sabroux (Eds) Smart City - How to Create Public and Economic Value with High Technology in Urban Space, p. 1 – 12, Cham, Heidelberg, New York, Dordrecht, London: Springer.
Dameri R. P. (2014) Comparing Smart and Digital City: Initiatives and Strategies in Amsterdam and Genoa. Are They Digital and/or Smart?. In R.P. Dameri and C. Rosenthal-Sabroux (Eds) Smart City - How to Create Public and Economic Value with High Technology in Urban Space, p. 45 – 88, Cham, Heidelberg, New York, Dordrecht, London: Springer.
Dammann S. (2013) Smart Cities and Communities Perspective of DG Energy – C2. Paper presented at FORUM, Stoke-on-Trent, 6th of November, 2013.
Diamantini D. and Borrelli N. (2014) theoretical questions for analysing contemporary city. Fondazione Giangiacomo Feltrinelli: E-Book – series.
Florida, R. (2002): The rise of the creative class. New York: Basic Books.
Fontana, F. (2014) The Smart City and the Creation of Local Public Value. In R.P. Dameri and C. Rosenthal-Sabroux (Eds) Smart City - How to Create Public and Economic Value with High Technology in Urban Space, p. 117 – 138, Cham, Heidelberg, New York, Dordrecht, London: Springer.

e5-Approach (2015) http://www.e5-gemeinden.at/index.php?id=3; accessed 31 of March 2015.
Giffinger, R. et al. (2007): "Smart cities – Ranking of European medium-sized cities". http://www.smart-cities.eu/download/smart_cities_final_report.pdf, accessed on 24th of January, 2015.
Giffinger, R. (2008) Territorial Capital – Understanding and challenges for a knowledge based strategic approach. Territorium, No.8, p. 7 – 15.
Giffinger, R. et al. (2014): "PLEEC report: WP2 Deliverable 2.4 Methodology for monitoring" http://www.pleecproject.eu/downloads/Reports/Work%20Package%202/wp2_d24_methodolgy_for_monitoring.pdf accessed on 24th of January, 2015
Komninos, N. (2008). Intelligent Cities and Globalisation of Innovation Networks. New York: Taylor & Francis.
Nam, T; Pardo, T. (2011) "Conceptualizing Smart City with Dimensions of Technology, People, and Institutions." The Proceedings of the 12th Annual International Conference on Digital Government Research, June 2011.
PLEEC (2014) Planning Energy Efficient Cities: http://www.pleecproject.eu/; accessed at 6th of April, 2015
Zuccardi Merli M. and Bonollo E. (2014) Performance Measurement in the Smart Cities. In R.P. Dameri and C. Rosenthal-Sabroux (Eds) Smart City - How to Create Public and Economic Value with High Technology in Urban Space, p. 139 – 156, Cham Heidelberg New York Dordrecht London: Springer.
Sanz, L. (2014) Hacia la Barcelona 5.0: ciudad inteligente. Presentation at Seminar 'Smart Cities: Urbanismo y Tecnologías'. UPC Universidad Polytècnica de Catalunya, 19 de Junio 2014.
SMART_KOM Kraków (2014) SMART_KOM. Kraków in Smart Cities Network: http://www.sse.krakow. pl/en/krakow-technology-park/projects.html; accessed at 6th of April 2015.
United Nations (2014): World Urbanization Prospects-The 2014 Revision: http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf, accessed on 24th of January, 2015.