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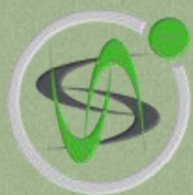


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Digital City towards Smart City: a theoretical overview

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Abstract— In recent years urban and metropolitan contexts are labelled in several ways that sometimes overlap one another. When scanning literature it is possible to observe that the most relevant labels are 'digital city' and 'smart city', especially as it regards the different governance of these contexts and the management of territories, resources, and service; these two topics are frequently considered as connected by some authors, as they state 'smart city' is an evolution of 'digital city'.

The aim of this work is to depict the usage of both terms among the scholars and the connections among the different scientific fields. In order to achieve this goal we perform a bibliometric analysis based on literature contributions in a time span from 2000 to 2014.

The results show that 'digital city' emerged before 'smart city' and representing part of its development from different scientific fields and thanks to the contributions of several authors. In addition, it is possible to observe that 'digital city' is still today the most cited issue keeping its own relevance in spite of the development of 'smart city', that today is one of the hottest topic in the domain.

Keywords —*smart city; digital city; bibliometric analysis, governance of urban context; territorial management*

I. INTRODUCTION

The current debate around the composition and definition of the modern urban contexts is even more increased in recent years because of the growing opportunities in improving people quality of life offered by new technologies [1]. The *informatization* and *digitalization* [2, 3] of the modern society is one of the most representative features of the global development, notably accelerated from 70s, because of the advent of modern communication and transport infrastructures that have often replaced the traditional ones.

Obviously, each country has undertaken a different technological development and a different path toward the digitalization and the smartization [2, 4]. This aspect, together with the rich number of contributions about the domain and the connected themes, has made even harder to identify a clear and unambiguous path toward the urban and metropolitan development.

With the aim to describe all the different configurations acquired by the local contexts under the engine of the globalization, scholars, Central and Local Institutions, and big corporations have offered lots of contributions and proposed several definitions (i.e. *digital*, *intelligent*, *ubiquitous*, *wired*,

hybrid, *information*, *creative*, *learning*, *humane*, *knowledge*, and *smart* [4]).

It is not easy to describe each of the proposed labels, neither to depict a connection to relate all of them or some of them, but it is possible to state which is the feature that links these conceptualisations to one or more topics. More in detail ICT plays a central role in most of them (i.e. *digital*, *intelligent*, *wired*, and *information* city); anyway the human factor remains pivotal in *learning*, *knowledge*, and *humane* city [5].

Even among these various definitions, today 'digital city' and 'smart city' are the hottest topics in this domain of literature [6]; it is important to observe that scanning literature the concept of 'digital city' is still today the most cited. Bringing back a previous research [2] carried on by searching the terms on the web through Google search engine, it is possible to observe how today, whilst the strength acquired by the 'smart city' conceptualization, the 'digital city' is still much discussed.

TABLE I. WEB OCCURRENCES ABOUT 'DIGITAL CITY' AND 'SMART CITY'

Terms	Web occurrences ^a (May 2005)	Web occurrences ^a (May 2014)
Digital city	799.000	1.670.000.000
Smart city	393.000	758.000.000

a. Source: Our elaboration from Moriset, 2005 [2] and google.com

Looking at the table above, the first evidence is that the number of themes concerning the 'digital city sphere' is notably bigger than the themes concerning the 'smart city domain'; anyway, both of the two topics are now cited about 2.000 times more than in 2005 due to their more recent development.

These data show that the importance gained by the digital domain started from 70s and increased from 2000s under the definition of 'digital city', keeping its strength also after the new theories about *smartness*.

Most of the current and recent contributions and thesis about the smart cities are strictly connected with the forerun scholars [7]; this is the reason why it is not uncommon to meet some difficulties in the definition of the two concepts leading, sometimes, to the overlapping between the two labels [8, 9].

In order to investigate such overlapping - that emerges in scholars, Central and Local Institutions, and big corporations contributions - we want to pinpoint which are the most reliable literature publications since the first contributions on both

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issues, in order to offer a guideline to compare the contributions of other kinds too.

I. THEORETICAL FRAMEWORK

A. The definition of the "Digital city"

One of the first definitions about the 'digital city' talks about a kind of city that is "substantively an open, complex and adaptive system based on computer network and urban information resources, which forms a virtual digital space for a city. It creates an information service marketplace and information resource deployment center" [10].

The development of this shape of urban context is strictly connected to the widespread of technological infrastructures and ICTs starting from 2000s which led to the definition of 'digital city'.

Referring to the more cited definitions, the 'digital city' could be described as originated by an urban strategy that aims to improve quality of life for citizens [8] through the agency of new technologies that acquire a pivotal role in city's development connecting different stakeholders and offering a better service (*informatization and digitalization*) [2]. Thanks to inclusion on ICTs in urban context, citizens participate even more in urban decision-making becoming *cre-actors* [9] of their city, leading to a multi-stakeholder approach [11].

The following table summarizes our description.

TABLE II. MOST RELEVANT DEFINITIONS ABOUT DIGITAL CITY

Concept	Authors	Definitions ^b
Digital City	Ishida and Isbister 2000 [12]; Ishida 2002 [13]; Qi and Shaofu, 2001 [10]; Anthopoulos and Tougountzoglou, 2012 [14]	<i>The concept of Digital City is to build an arena in which people in regional communities can interact and share knowledge, experiences, and mutual interests. Digital City integrates urban information (both achievable and real time) and create public spaces in the Internet for people living/visiting the city (Ishida, 2002)</i>

b. Source: Our elaboration from Ishida, 2002

In detail, it is possible to describe such kind of urban area as the intersection of three features: the physical elements of the urban context, the social communities, and the technological infrastructures [15] mainly represented by ICT (such as Internet of Things, cloud and ubiquitous computing, Web 2.0, etc.) [14].

B. The definition of the "Smart city"

In recent years the debate about the *smartization* of the society is even more increased and 'smart city' is, today, one of the hottest topics in this domain of literature.

The attention around this domain started from 70s when new technologies and innovation system began to represent instruments and resources to create more open and innovative urban context through the participation of citizens, enterprisers, organizations, etc., in decision making processes in order to improve the quality of life of people [4, 12].

Referring to the previous paragraph, the discussion around the theme was originally focused on the *digital* conceptualization of the urban context [12, 16, 17], typical of the era of Globalization when the use of technology has become an essential instrument in managing a city.

More recently, the integration of new aspects brought to take into account different and innovative factors in governance and management of the urban areas turned the focus on more complex conceptualizations such as the 'smart city' [18, 19] in which human and social capital and traditional and modern communication infrastructures are combined to carry on the sustainable economic growth and a higher quality of life through a proper management of available resources [18].

The following table summarizes our description.

TABLE III. MOST RELEVANT DEFINITIONS ABOUT SMART CITY

Concept	Authors	Definitions ^c
Smart City	Caragliu et al., 2009 [18]; Schaffers et al., 2011 [19]	<i>We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructures fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance (Caragliu et al., 2009)</i>

c. Source: Our elaboration from Caragliu et al., 2009

Referring to the table above, the first evidence is that while 'digital city' considers mainly the technological features, the 'smart city' concerns all the aspects everyday life - such as transport infrastructures, communication infrastructures, energy savings, urban green areas care, reduction of air pollution, sustainable growth - aiming to improve the quality of life of citizens [18].

It is important to observe that ICTs keep a main role also in the 'smart' idea of the city; this is one of the reason why the definition about the two concepts often overlap, or even, they are used as synonyms [20, 21].

Anyway, when scanning literature contributions it is possible to notice that in the digital perspective ICT represents all the infrastructures shaping the city, while in the *smartization* process, it should represent an instrument in governance and management of the urban context, in order to implement a better urban space and offering new services through innovative technologies [2, 22].

III. RESEARCH METHODOLOGY

A. Aim of the research

The literature review shows an active debate about the definition of 'digital city' and 'smart city' conceptualizations. This feature, associated with the great number of contributions about these two topics, makes complex and difficult a clear definition of them. Moreover the literature review led us to focus on two topics – digital city and smart city – as something emerging in the same time by different research domain.

Moreover these two issues developed on two paths with some overlapping and lots of ties. We want to depict which are the research streams depicting both of them and we want to understand if and how they merge too. In order to do this we decided to focus on the literature contributions from different domains for both of them and to take into account the years in which the scholars made their efforts to define, spread, and improve the definitions of the two topics.

B. Data collection and analysis

As our research aim is a definitory issue we have to deeply focus on the literature and we even have to select a suitable methodology to perform this kind of investigation. The most fitting research methodology to investigate scholars' investigations is a bibliometric analysis [23], first of all as it is an objective method [24], as the researchers perform the analysis with no cognitive limitations, personal influences or opinions. Moreover this methodology is suggested for emerging trends [25], as clusters usually support the identification of research trends.

The data were collected through Web of Knowledge as it is one of the most used dataset for this kind of analysis [26 - 27]; we used 'digital city' and 'smart city' as keywords for this research. The contributions were scouted on a time span from 2000 to 2014, as our literature review suggested us to start from 2000 and in order to use a similar period for both definitions. These choices led us to an accurate control of the range of time, in line with suggestions from the first contributions on bibliometric analysis [28]. The articles collected thanks to the query through the keyword 'digital city' were 733, whilst the ones linked to 'smart city' were 410.

We decided to carry on a co-authorship analysis as it is suggested as a mean to depict the structure of a scientific field [29, 30]. Among the options we could have chosen a co-citation analysis, but it would have given us a temporary perspective, due to variations over the time [31]; as our aim is to define a conceptual issue, we preferred a co-authorship analysis to achieve a static perspective on the contributions published in 15 years on the two topics. The software we used to perform the above cited typology of investigation is Cite Space [32]. This choice is linked to the chance to focus on 'turning point' authors [32, 33], namely authors leading research streams. The software renders graphs useful to highlight the relations among the units of analysis and "co-authorship implies a temporal and collegial relationship that places it more squarely in the realm of social network analysis" [34].

IV. FINDINGS

A. Co-authorship analysis on "digital city"

The analysis was performed through more than 5.000 iterations carried on by the software we chose before reaching a satisfying level of data optimization. The contributions on 'digital city' are several and mainly grouped in lots of sets, known as *clusters*. Most of these groups are composed by few authors or even just one author; by the way there are several relevant insights from the bigger groups.

The most important cluster is shaped by more than 30 authors and their contributions have been published in the range between 2000 and 2005 (see Figure 1); moreover they are all linked to the investigation by Ishida, acting as the hub of this net of scholars, with his most frequent co-author, viz. Isbister, as the second most relevant contributor.

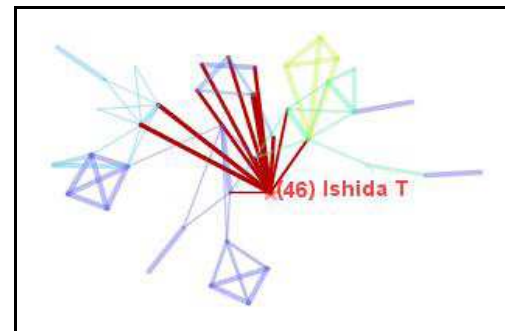


Figure 1. The most relevant cluster from co-authorship analysis on 'digital city' (our elaboration through CiteSpace)

One more cluster to be taken into account is slightly wider as it regards the authors composing it, and it covers a longer period, as the first contribution has been observed in 2001, while the last is a recently publication in 2013. The core of this cluster consists of the publications by Li Q. and a high number of authors coming from the Eastern Asia (Chi, Chen, Wang, Zhang, and Zhou above all). It is interesting to underline that about all of the authors in this cluster are from the same geographical area, leading us to define Li Q. as the beginner of a research stream on digital cities in Asia.

The third relevant cluster from the analysis performed by the software is similar to the previous one as it is located in Asia too, as it regards about all authors, but it is not easy to understand who is the beginner of this stream as there are two authors leading it and lots of others with just a few contributions. The two leaders of this research stream are Li C. and Wu.

We moved on in the investigation and there are two other relevant clusters to be analysed. Firstly the one is led by Fan and it groups about 20 authors both from Asia and Europe in a very narrow range of time, as the first article was published in 2005 and the most recent went back to 2009. Secondly there is the one built around the contributions by Chova and other seven authors linked to his works. This cluster is totally different from the previous ones in terms of time extension, as the contributions are recent and they have been published from 2010 to 2012; moreover most of them were created by Spanish-speaking authors.

TABLE IV. MOST RELEVANT DEFINITIONS ABOUT SMART CITY

Cluster ^d	Leading author(-s) ^d	Nr. of authors ^d	Time span ^d	Geographical origin(-s) ^d
1	Ishida	36	2000-2005	several
2	Li Q.	57	2001-2013	Asia
3	Li C., Wu	54	2002-2014	Asia

4	Fan	20	2005-2009	Asia, Europe
5	Chova	8	2010-2012	Europe

d. Source: Our elaboration

An overview on this first part of the analysis let us highlight the following summarizing results:

- the authors publishing the higher number of researches on 'digital city', shown in the following table:

TABLE V. TOP RELEVANT AUTHORS ABOUT DIGITAL CITY

Authors	Geographical origin ^e	Number of researches published ^e
Ishida T.	Japan	46
Li Q.	China	32
van den Besselaar P.	Netherlands	30
Isbister K.	USA	22
Tanabe M.	Japan	14

e. Source: Our elaboration

- a set of 220 clusters and 109 out of them composed by more than one author; the high number of clusters composed by just one author is due to the wide set of scientific domains related to the topic of digital city.

B. Co-authorship analysis on "smart city"

The second part of the analysis consists of the contributions on the topic of 'smart city'. Differently from the previous case, more than 1.100 iterations were needed before achieving a result optimized by taking into account the settings of the software. The researches performed on 'smart city' are grouped in a different way from the ones on 'digital city' and they are closer than the others in the whole representation. This representation means a lower number of different domains involved in the debate on smart cities, with a more focused approach on management and ICT. As a consequence of the lower number of domains emerging from the analysis, the number of clusters is lower, they are wider than in the analysis of 'digital city' contributions, and they are based on the same range of time, viz. between 2000 and 2014.

The most important cluster groups 30 authors with at least two researches published on the topic of 'smart city' (see Figure 2); the range of time of their papers is very narrow as it lasts just two years, namely from 2013 to 2014. The authors playing a crucial role in this cluster are Xhafa and Barolli, and due to their geographical origin, the cluster is mainly shaped, respectively, by Spanish and Japanese scholars. The number of times authors are contributing to this cluster is very high (166) and this is the widest group of the whole investigation, regarding both 'digital city' and 'smart city'.



Figure 2. The most relevant cluster from co-authorship analysis on 'smart city' (our elaboration through CiteSpace)

The second bigger cluster is composed by a lot of contributions and scholars, too; there are 28 authors and more than 50 contributions, but it is hard to describe the leader of this research stream, as just Karnouskos has quite a relevant number of researches, while the other ones just have one or two papers. The time of publications ranges from 2009 to 2011, while the geographical origin of authors is various, even if most of them are from Europe.

One more cluster to be considered as relevant is shaped by more than 10 authors and led by Xiong, in quite a long time span, as the first research goes back to 2006 and the last one has been published in 2014. The scholars in this cluster are all from Asia and most of them appears with a few contributions.

The fourth cluster to be considered is built around a European scholar, namely Nijkamp, and it groups authors from Europe, publishing their researches between 2009 and 2012. Lots of the scholars appear with one or two contributions, but about all the researches belonging to this group are related to management issues. The description of this group is quite comparable to another cluster, led by Vasseur, with researches from 2008 to 2014. Even in this case the scholars contribute with a couple of researches, but differently from the previous cluster they are not all from Europe, as there are some among them from Asia.

Similar considerations can be done with another cluster, centred on Apduhan investigations, and grouping a dozen of authors with recently published papers (2012 and 2013). The geographical origin of this cluster is various as there are authors from both Europe and Asia. One of the most important features of this group is the presence of Ishida, the author cited when describing the most relevant cluster about the topic of 'digital city'.

The last cluster to be taken into account as significant is interesting due to its unique composition in the investigation both on 'digital city' and 'smart city'. More in detail there are just few authors (Pfeifer, Jayasumana, Turgut), but all of them with a high number of researches and in a time span taking place just in 2012. The authors are both European and Asian and they group about 30 publications.

TABLE VI. MOST RELEVANT DEFINITIONS ABOUT SMART CITY

Cluster ^f	Leading author(-s) ^f	Nr. of authors ^f	Time span ^f	Geographical origin(-s) ^f
1	Xhafa, Barolli	30	2013-2014	several
2	Karnouskos, several others	27	2009-2011	several
3	Xiong	13	2010-2014	Asia
4	Nijkamp	8	2009-2012	Europe
5	Vasseur	13	2008-2014	Europe, Asia
6	Apduhan	11	2012-2013	Europe, Asia
7	Several	4	2012	Europe, Asia

f. Source: Our elaboration

An overview on this second part of the analysis is useful to sum up the following results:

- the authors publishing the higher number of researches on 'digital city' shown in the following table:

TABLE VII. TOP RELEVANT AUTHORS ABOUT SMART CITY

Authors	Geographical origin ^g	Number of researches published ^g
Xhafa F.	Spain	20
Barolli L.	Japan	19
Enokido T.	Japan	14
Hsu H. H.	Taiwan	14
Takizawa M.	Japan	14

g. Source: Our elaboration

- a set of 91 clusters and 51 out of them are shaped by more than one scholar; most of the clusters composed by just one author are very recent.

C. Co-authorship analysis on "digital city" and "smart city"

The first two parts of this investigation described above were coupled in to be aligned with the aim of our research, namely to depict the linkages between two topics: digital city and smart city.

The clusters emerging from the analysis of both datasets are lower than the sum of clusters from the two previous stages of this investigation, as they are 218, while the clusters for 'digital city' were 220 and the ones for 'smart city' were 91, so a total of 311.

The scattering of the clusters is wider than it happened for the contributions on 'smart city' and they are more similar to what emerged for the papers on 'digital city'; by the way the clusters are bigger as they group a higher number of authors.

The most relevant cluster groups about 40 authors and 170 contributions (see Figure 3); even if the features of this cluster seem similar to the ones of the first cluster about 'digital city', when looking at its composition, it is possible to notice some

differences, as there are different authors and even because there are scholars with papers both from the 'digital city' dataset and from the 'smart city' dataset. The range of time of this cluster is from 2000 to 2010 and there are different geographical origins of the authors, with most of them from Asia. A pivotal role in this cluster is played by Ishida, due to the high quantity of his papers and to his linkages with lots of authors.

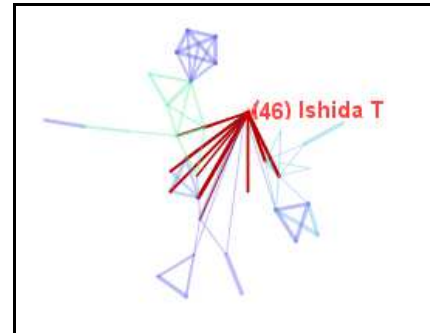


Figure 3. The most relevant cluster from co-authorship analysis on 'digital city' and 'smart city' (our elaboration through CiteSpace)

The second cluster to be considered is full of insights about the intertwining of the two topics, as the leader of this cluster is Xiong; similar results appeared when analysing papers on smart city, but a larger number of authors shapes the group. This depends on the merger between authors writing about the two topics. Indeed this cluster is composed by more than 30 authors instead of the 10 shaping the cluster led by Xiong about the issue of 'smart city'. Moreover the time of publication spans from 2002 to 2014 and about half of the authors has contributed with more than one paper.

The third cluster has Wu as main scholar, but its contribution to this research stream is halved compared to what happened when investigating 'digital city' dataset; so his role in the group has to be shared with other authors, like Che, Liu, and Zhong. This cluster is all composed by Asian authors and the papers range from 2002 to 2012 as it regards the year of publication.

The author with a pivotal role in the fourth cluster is Li C., whose contributions were connected to the ones by Wu L. in the analysis of 'digital city' dataset; the marks of the previous group is still undeniable as lots of authors converged into it, while authors from 'smart city' dataset are few and they have a little quantity of papers. The range of time of the papers in this group is from 2002 to 2011 and even this group is all composed by Asian authors.

One more cluster to be taken into account is centred on the papers of Fan and it is really interesting to observe the mix of authors from clusters previously considered both in the domain of 'digital city' and in the one of 'smart city'. The authors are from Asia and Europe and their contributions started in 2005 and last for 8 years.

The last relevant cluster from the analysis is led by Li Q., one of the authors emerging from the first part of the investigation, due to his wide range of contributions on digital

city. Its contributions are lower than the one in the cluster on 'digital city' and he is joined by other authors. A total of 30 authors shapes this cluster with about 100 contributions on a period from 2001 to 2010. Most of the authors are from Asia and just some of them contribute to this group with only one paper.

TABLE VIII. MOST RELEVANT DEFINITIONS ABOUT DIGITAL CITY AND SMART CITY

Cluster ^h	Leading author(-s) ^h	Nr. of authors ^h	Time span ^h	Geographical origin(-s) ^h
1	Ishida	38	2000-2010	several
2	Xiong	31	2002-2014	Asia
3	Wu	38	2002-2012	Asia
4	Li C.	24	2002-2011	Asia
5	Fan	21	2005-2013	Asia, Europe
6	Li Q.	30	2001-2010	Asia

h. Source: Our elaboration

An overview on this last part of the investigation is suitable to synthesize the findings:

- the scholars publishing the largest number of researches on both 'digital city' and 'smart city', depicted in the following table:

TABLE IX. TOP RELEVANT AUTHORS ABOUT SMART CITY AND DIGITAL CITY

Authors	Geographical origin ⁱ	Number of researches published ⁱ
Ishida T.	Japan	46
Li Q.	China	31
van den Besselaar P.	Netherlands	30
Isbister K.	USA	22
Xhafa F.	Spain	20

i. Source: Our elaboration

- a set of 218 clusters arisen from the analysis and 104 out of them consisting of more than one scholar.

V. DISCUSSION

The bibliometric analysis led us to make some consideration from the achieved results about the connection among the contributors to 'digital city' and 'smart city' domains. This investigation can be useful to favour the understanding in the international debate among scholars dealing with these two topics.

The most relevant authors emerged from the analysis on the digital cities are about the same as the ones from the analysis on both 'digital city' and 'smart city'; this is useful to confirm what has emerged from our literature review as they conveyed the topic of 'digital city' towards its evolution in 'smart city'.

The relevance of these authors is not just something due to having papers going back to the beginning of 2000s as they

have a pivotal role both in 'digital city' and 'smart city' domain.

Anyway, the debate on 'digital city' kept its own relevance in spite of the development of 'smart city', as this latter did not replace the former, as the digital approach can be part of a path towards *smartness* of a city. This consideration is confirmed by the higher number of publications related to 'digital city' even if this issue started before 'smart city'. Such a detail is one of the features stating that the digital domain is more multidisciplinary than the smart domain.

The representations obtained by the software used to perform our analysis, clarifies the mix of scientific fields contributing to the development of the research on 'digital city', since the scattering is wider in 'digital city' than in 'smart city'.

The results obtained gave us the chance to depict 'digital city' as a conceptualization emerging before 'smart city' and representing part of its development from different scientific fields and thanks to the contributions of several authors. In the end, a focus on 'smart city' can be better performed when starting from its evolution namely from studies on 'digital city'.

VI. LIMITATIONS AND FURTHER RESEARCH

The bibliometric analysis can be coupled with a *peer review* analysis [24], in order to better focus on the content of the definitions collected. By using this approach the choice of data sources became crucial so a replication of the study with different databases than the one we used could lead us to empower the results.

Moreover, this further step of the research can be done by selecting the definition on the basis of two criteria: the relevance in the bibliometric analysis and the contribution to a specific domain of research, as it can be managerial issues for us.

One more analysis to be done is the processing of the achieved results through a statistical software, in order to acquire a higher significance of the evidences we highlighted until now [35].

Finally, one more interesting point of view to be investigated is the usage of 'digital city' and 'smart city' labels in Official Reports issued by Public Institutions and Big Corporations.

REFERENCES

- [1] J. Bélissent, "Getting clever about smart cities: new opportunities require new business models", Forrester, 2010.
- [2] A.-V. Anttiroiko, P. Valkama, and S. J. Bailey, "Smart cities in the new service economy: building platforms for smart services", Artificial Intelligence & Society, available online June 2013.
- [3] N. Komninos, "Intelligent Cities and Globalization of Innovation Networks", Routledge, London, 2008.
- [4] T. Nam and T. A. Pardo, "Smart city as urban innovation: focusing on management, policy, and context", ICEGov 2011, Tallinn, Estonia, 26-28 September, 2011.
- [5] N. A. Streitz, "Smart cities, ambient intelligence and universal access". In Universal Access in Human-Computer Interaction. Context Diversity (pp. 425-432). Springer Berlin Heidelberg, 2011.

- [6] B. Moriset, "Logiques métropolitaines: modèles, acteurs et processus", IFRESI – CNRS, Lille, June, 2-3 Juin, 2005.
- [7] L. Anthopoulos, P. Fitsilis, "Using Classification and Roadmapping techniques for Smart City viability's realization". *Electronic Journal of e-Government*, 11(2), 2013.
- [8] R. P. Dameri and A. Cocchia, "Smart City and Digital City: twenty years of terminology evolution" Available at: www.cersi.it, 2013.
- [9] A. D'Auria, M. Tregua, F. Bifulco, "From digital city to smart city: different perspectives overlapping or misinterpreted?", in *Proceedings of The 2nd GV Conference*, 2014.
- [10] L. Qi and L. Shaofu, "Research on Digital City Framework Architecture", *IEEE International Conferences on Info-Tech and Info-Net*, Volume 1, pp. 30-36, 2001.
- [11] F. Bifulco, M. Tregua, and C. C. Amitrano, "Smart Cities and Innovation: a multi-stakeholder perspective", in *Journal of Management and Marketing*, Volume 2, Issue 1, 2014.
- [12] T. Ishida and K. Isbister, (eds.), "Digital cities: technologies, experiences, and future perspectives", New York: Springer, 2000.
- [13] T. Ishida "Digital city Kyoto" *Communications of the ACM* 45.7, pp. 76-81, 2002.
- [14] L. Anthopoulos and T. Tougountzoglou, "A viability model for Digital Cities: economic and acceptability factors", *Web 2.0 Technologies and Democratic Gov*, Volume 1, pp. 79-96, 2012.
- [15] H. Couclelis, "The construction of the digital city". *Environment and Planning B*, 31(1), pp. 5-20, 2004.
- [16] W. Mitchell, "City of Bits", Cambridge, MA: MIT Press, 1996.
- [17] G. Dupuy, "Networks and Urban Planning: The Evolution of a Two-way Relationship, in *Shifting Sense – Looking back to the future in spatial planning*", E. D. Hulsbergen, I. T. Klaasen, I. Kriens (eds.) *Techné Press*, 2005.
- [18] A. Caragliu, C. Del Bo, and P. Nijkamp, "Smart cities in Europe", in *Proceedings of the 3rd Central European Conference in Regional Science* (Košice, Slovak Republic, Oct 7-9), 2009.
- [19] H. Schaffers, H., Komninos, N., Pallot, M., Trousse, B., M. Nilsson, A. Oliveira, "Smart cities and the Future Internet: towards cooperation frameworks for open innovation", Springer, 2011.
- [20] R. E. Hall, "The vision of a smart city", in *Proceedings of the 2nd International Life Extension Technology Workshop* (Paris, France, Sep. 28), 2000.
- [21] J. Hartley, "Innovation in governance and public services: Past and present", *Public Money & Management*, 25(1), pp. 27-34, 2005.
- [22] J. H. Lee, M. G. Hancock, and M.-C. Hu, "Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco", *Technological Forecasting & Social Change*, available online October, 2013.
- [23] A. Pilkington, T. Teichert, "Management of technology: themes, concepts and relationships". *Technovation*, 26(3), 288-299, 2006.
- [24] A. F. J. Van Raan, "The use of bibliometric analysis in research performance assessment and monitoring of interdisciplinary scientific developments", in *Technikfolgenabschätzung-Theorie und Praxis/Technology. Assessment-Theory and Practice*, 2003.
- [25] L. Cindrella, H. Z. Fu, Y. S. Ho, "Global thrust on fuel cells and their sustainability – an assessment of research trends by bibliometric analysis", *International Journal of Sustainable Energy*, 1-16, 2013.
- [26] C. C. Chao, J. M. Yang, W. Y. Jen, "Determining technology trends and forecasts of RFID by a historical review and bibliometric analysis
- [27] J. Yao, "Recent Developments in Granular Computing: A Bibliometrics Study". In *GrC* (pp. 74-79), (2008, August).
- [28] F. Narin, "Evaluative bibliometrics: The use of publication and citation analysis in the evaluation of scientific activity" (pp. 206-219). Washington, D. C: *Computer Horizons*, 1976.
- [29] H. P. F. Peters, A. F. J. van Raan, "Structuring scientific activities by co-author analysis an exercise on a university faculty level". *Scientometrics*, 20(1), 235–255, 1991.
- [30] W. Gänzel, "National characteristics in international scientific co-authorship relations". *Scientometrics*, 51(1), 69–115, 2001.
- [31] B. Jarneving, "A comparison of two bibliometric methods for mapping of the research front". *Scientometrics*, 65(2), 245–263, 2005.
- [32] C. Chen, "Searching for intellectual turning points: Progressive knowledge domain visualization". In *Proceedings of the National Academy of Sciences, USA*, 101 (Suppl.), 5303–5310, 2004.
- [33] N. Mustafee, "Evolution of IS research based on literature published in two leading IS journals-EJIS and MISQ". In *ECIS* (2011, June)..
- [34] X. Liu, J. Bollen, M. L. Nelson, H. Van de Sompel. Co-authorship networks in the digital library research community. *Information processing & management*, 41(6), 1462-1480 (2005).
- [35] S. Samiee, B. R. Chabowski. Knowledge structure in international marketing: a multi-method bibliometric analysis. *Journal of the Academy of Marketing Science*, 40(2), 364-386 (2012).

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