Knowledge Distribution on Smart City Research:

An Overview of Systematic Literature Reviews

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Abstract

The proliferation of smart cities around the globe has attracted research communities in academic debates. As a fast-growing research subject, huge amounts of studies are available in documenting smart cities. While literatures provide many review papers synthesizing knowledge from empirical and case studies, systematic review dedicated for review papers is still rare. This paper aims to fill this gap by identifying knowledge distribution in smart city scholarships drawing from review papers including systematic literature reviews, bibliometric and scientometric. To achieve the objective, a Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) protocol was conducted filtering 86 review papers to 16 final selected papers. The underlying concepts and knowledge distributions of smart city research such as research focus and scientific domains were summarized. This present study identifies research lacunae in smart city research thus future research agenda is proposed accordingly.

Keywords: *Smart Cities, Systematic Literature Review, PRISMA, Bibliometric, Urban Growth*

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Introduction

Smart city has gained tractions since its emergence in the urban development literature. The first study of smart cities can be dated in 1994 (Cocchia, 2014) which previously known as 'smart growth' (Susanti et al., 2016). Different timeline was claimed by Ingwersen & Serrano-López (2018) who argued that it was in 1999 when Mahizhnan (1999) put 'smart cities' in the title of his academic publication to report Singapore as a nation city state implementing smart urban initiative. A decade later, since 2010, the topic has been a fast-growing subject and more publications flourishing within academic fore from various research communities (Mora, Bolici and Deakin, 2017). The average annual growth reached 175 papers between 2014-2018, indicating a booming in publications during that period known as rapid development stage (Zhao, Tang and Zou, 2019).

To test 'the water,' a simple algorithmic query through Web of Science (WoS) and Google Scholar using the key word "smart city*" or "Intelligent city*" or "digital city*" or "ubiquitous city*" or "information city*" or "knowledge city*" from 2000-2020 was conducted on January 7, 2019. From WoS database, 5985 records were acquired of which more than half belong to computer and engineering subjects. The amount of available information was even much higher in Google Scholar reaching 1,530,000 results. This indicates there is a huge interest in studying smart city as a research subject in the last 20 years. Given these numbers, it is relatively difficult to thoroughly map and identify the states of smart city research due to its plethora. Other issues deal with subjectivity, transparency and time-consuming within the process of literature review.

The present study addresses these challenges by narrowing down the analysis to the selection of works which capture general picture of smart city research. This can be done by focusing the analysis on review paper consists of systematic literature review, bibliometric and scientometric articles. It allows us to grasp and identify the knowledge domain, theories and concepts development and academic debates in smart city research without conducting any new study or exhaustive literature review from available in the database. In other words, review papers scrutinize and summarize the state of knowledge of given topics sourced from available literatures.

Exploiting these three types of paper, I wish to maximize their merits to achieve my objectives: (1) obtain a holistic perspective smart city research by identifying and mapping the themes and spatial locus of smart city research (2) hinder information overload from huge amount of literature available in the database (3) maintain objectivity and minimalized bias and (4) set a new research agenda for future study in order to address research lacunae in smart city studies. One may ask a basic question on what state of knowledge can be acquired from smart city research provided by literature. Referring to the objective of review, I frame the main inquiry related to the underlying concepts and knowledge distribution informed by review papers. Thus, I can identify smart city research lacunae and propose future research agenda. The main inquiry can be elaborated into three

review questions which will shed the light on research gap and lead to the new avenue of further studies.

1. What are the underlying concepts, drivers and outcomes of smart cities informed by literature?
2. Where are the studies of smart cities loci? In which countries or regions did smart city research were conducted?
3. What scientific domains do smart city researches based on?

The remaining section of this paper will present the method and procedure of the review. It describes the overview of reviews rationale, source of reviewed papers and how the final pool of papers selected. The next section reports the descriptive analysis of selected reviewed papers, distribution of study locus from geographical perspective, research domains and other important findings structuring smart city body of knowledge. The final section exposes the smart city research lacunae, conclusion and suggested future research agenda.

Review Methods and Procedures

An overview of reviews was conducted to summary general knowledge and identifies the progress, major theory development and academic debates of smart city scholarships. The terminology of 'reviewing' review paper has various labels such as systematic review of systematic reviews, umbrella review, review of reviews, summary of systematic reviews and synthesis of reviews, review of systematic reviews, a review of reviews, review of meta-analyses, meta-review and systematic meta-review (Temple University Library, 2020). As Blackwood (2016) argues, the review of reviews is best designed to get new knowledge and possibility to combine relevant data from existing systematic review. This may offer potential of opening new direction of research by identifying the research blind spots and unexplored research areas.

The main sources of review were systematic literature review papers, bibliometric and scientometric papers. Originated from medical science (Cochran, 1972; Greenhalgh and Peacock, 2005; Chalmers, Hedges and Cooper, 2002) and later applied in the social science (Petticrew and Roberts, 2006), a systematic literature review is the effort to get evidence in science. By doing a systematically procedure on relevant publications, researchers could make sense of huge numbers of information to understand the state of the art for particular body of knowledge. Similar with systematic review, bibliometric and scientometric are methodological approaches in which the researchers use the research products as their focus of the study.

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) as a Working Protocol

The overview of reviews provides the outline of knowledge and constellation which is presented in the summary of reviews. In so doing, I conducted systematic literature review protocol by adopting PRISMA procedure developed by Moher, Liberati, Tetzlaff, Altman & PRISMA Group, (2009). Previously used for randomized controlled trial in the medical science and healthcare, PRISMA have been applied

in many other disciplines such as public management (De Vries, Bekkers and Tummers 2016), policy studies (Minkman, van Buuren and Bekkers 2018), urban governance (Tomor et al., 2019), agriculture and food policy (Poulsen et al., 2015), environmental studies (Tobi et al., 2019) and even humanities and translation studies (Wang, Hoon Ang and Halim 2020).

The basic steps of PRISMA consist of four flow of information analysis. These are identification, screening, eligibility and inclusion of study in the systematic review. I limit the literature search only peer-reviewed articles published by academic journal or peer-review books and excluded grey literatures. Also, I want to grasp the academic sense of smart city scholarship through academic endeavors. As such, I primarily built my literature search from Web of Science (WoS) as a scientific database and Google Scholar as a supplementary source (Gusenbauer and Haddaway, 2020). The decision on Web of Science is driven by its reputable and high quality of literature (Jacso, 2005; Zhao, Tang and Zou, 2019).

Firstly, I started the identification phase through database searching from WoS using the Boolean search: "smart cit*" AND ("systematic review*" OR bibliometric* OR scientometric*) in topic search from the time span 1990 to 2020 from February to March 2020. Instead of using similar word such as intelligent, digital, ubiquitous, information and knowledge, I only used the word 'smart.' This follows Ingwersen & Serrano-López (2018) finding that 'smart city (ies)' has dominated in the literature for the last decade. An alternative outlet from Google Scholar was used as a complementary source. This free scientific search engine allows to find and access known publications or to do a quick search on a topic or skim any topics published in academic journals. However, the systematic literature search using Google Scholar brings some drawbacks (Wageningen University and Research, 2020). Firstly, the Boolean operators (like AND, OR, NOT) is limited in the Google Scholar search which may lead to irrelevant articles for further analysis. Secondly, it searches for full text of publications and could not call the high quality non-open access articles behind the pay wall publishers. Thirdly, its algorithm may change frequently depending on location, search rank, language used and any other technical parameters. Thus, it may reduce transparency in the beginning of literature search. To address this issue, I conducted advance-manual search in Google Scholar to complement the articles found in WoS database.

I conducted three searching processes for each type of study includes systematic literature review, bibliometric and scientometric study. For systematic literature review paper, I used advance search with the exact phrase: systematic literature review, with at least one of the words: "smart city" or "smart cities" ranging from 1990 to now. I limit the words occurrence in the title of the article to narrow down the survey for more accurate finding and minimize the information overload in the Google Scholar search. Using this algorithm, I found 21 articles including patent but exclude citations since they only cite the words and phrases used in the searching process. In bibliometric study I found 15 articles in Google Scholar database. To do so, I searched exact phrase: bibliometric, with at least one of the words: "smart city" or "smart cities" ranging from 1990 to now in the title of the

article. While for scientometric type of publication, I conducted advance search using exact phrase: scientometric, with at least one of the words: “smart city” or “smart cities” ranging from 1990 to now in the title of the article resulting 3 articles. In total, I found 39 articles in Google Scholars Database representing systematic literature review, bibliometric and scientometric studies.

I analyze the result by sorting and coding articles in tabular views and then identify which are listed in both database and which are not included accordingly. To elude double record, I deleted one of the identical papers resulting 34 papers in total to be further analyzed. From the simple tabular analysis, I found 7 duplications, thus, 79 total articles were eligible for screening process.

The next step was screening stage. As prescribed by Jesson et al. (2011) and Khan et al. (2003) that quality assessment of the literature matters to achieve authoritative knowledge. Thus, the screening process deliberates the quality of articles valuing rigorous reviewed papers published in academic journal or peer-reviewed book rather than non-peer reviewed papers published in the conference proceedings will benefit the review process. As such, the non-peer reviewed papers and conference proceedings were excluded for further analysis. There were 2 conference proceeding papers in the Web of science index, leaving 50 papers included in further step. While Google scholar indexed-papers excluded 12 conference proceeding papers resulting 15 papers to be included in the eligibility step. Consolidating both sources, there were 65 papers that can be further analyzed in eligibly process. To do so, some criteria were set as a basis of judgment include: Consolidating both sources, there were 65 papers that can be further analyzed in eligibly process.

- Study Approach – The articles should consist of smart city and systematic review or bibliometric or scientometric whether in the title, abstract, or keywords. Albeit the search algorithm has been set to identify that parameter at the beginning, a human cognitive checking by reading manually is beneficial as triangulation procedure to strengthen the scientific method of systematic review.
- Focus/Topic- The articles should address the general knowledge and holistic view of smart city. Neither partial dimensions of smart city initiative nor technical application such as Internet of Thing (IOT), block chain, big data, smart parking and other hard aspects of smart cities will not be included in the review.
- Time and Scope- The article should address the research in global scale to expose the world-wide proliferation of smart city in the global level. The national level of systematic review has an implication on narrow perspective which hinders the continental gap of research. Also, it is required that the papers specify the time span of literature included in their study.

On the following two pages is figure 1, a table of the eligibility checklist.

No	Title	Approach	Focus	Scope	Inclusion
1.	The dual effects of the Internet of Things (IoT): A systematic review of the benefits and risks of IoT adoption by organizations	√	X	X	No
2	Security and the smart city: A systematic review	X	X	√	No
3	Investigating the entrepreneurial perspective in smart city studies	√	X	√	No
4	Dynamic pricing techniques for Intelligent Transportation System in smart cities: A systematic review	X	X	√	No
5	Blockchain and Internet of Things: A bibliometric study	√	X	√	No
6	A Review of Blockchain-Based Systems in Transportation	√	X	√	No
7	Blockchain for 5G-enabled IoT for industrial automation: A systematic review, solutions, and challenges	√	X	√	No
8	Mapping the knowledge domain of smart-city research: A bibliometric and scientometric analysis	√	√	√	Yes
9	Applied sciences Smart Parking: A Literature Review from the Technological Perspective	√	X	X	No
10	Smart Governance for Sustainable Cities: Findings from a Systematic Literature Review	√	√	√	Yes
11	Business, innovation and digital ecosystems landscape survey and knowledge cross sharing	X	X	X	No
12	Systematic review of smart cities and climate change adaptation	√	X	X	No
13	Smart Cities and Healthcare: A Systematic Review	√	X	X	No
14	Systematic Review of the Literature on Big Data in the Transportation Domain: Concepts and Applications	√	X	√	No
15	Smart city big data analytics: An advanced review	√	X	X	No
16	QoS mechanisms for MAC protocols in wireless sensor networks: a survey	√	X	X	No
17	Visualizing the studies on smart cities in the past two decades: A two-dimensional perspective	√	√	√	Yes
18	Bibliometric analysis on smart cities research	√	√	√	Yes
19	Review on V2X, I2X, and P2X Communications and Their Applications: A Comprehensive Analysis over Time	√	X	√	No
20	Block chain in the built environment and construction industry: A systematic review, conceptual models and practical use	√	X	X	No
21	Combining co-citation clustering and text-based analysis to reveal the main development paths of smart cities	√	√	√	Yes
22	Participatory energy: Research, imaginaries and practices on people' contribute to energy systems in the smart city	√	X	√	No
23	Success factors of smart cities: a systematic review of literature from 2000-2018	√	√	√	Yes
24	Can volunteer crowdsourcing reduce disaster risk? A systematic review of the literature	√	X	√	No
25	A systematic review of living lab literature	√	X	X	No
26	Data mining and machine learning to promote smart cities: A systematic review from 2000 to 2018	√	X	√	No
27	Can cities become smart without being sustainable? A systematic review of the literature	√	√	√	Yes
28	Internet of Things applications: A systematic review	√	X	√	No
29	The advent of practice theories in research on sustainable consumption: Past, current and future directions of the field	√	X	√	No
30	Smart cities and 5G networks: An emerging technological area?	√	X	X	No
31	Urban governance in Latin America: Bibliometrics applied to the context of smart cities	√	√	X	No
32	Understanding autonomous vehicles: A systematic literature review on capability, impact, planning and policy	√	X	X	No
33	A systematic review for smart city data analytics	√	X	√	No
34	Visualizing the Hotspots and Emerging Trends of Multimedia Big Data through Scientometrics	√	X	X	No
35	Towards smart florianópolis: What does it take to transform a tourist island into an innovation capital?	√	X	X	No
36	A bibliometric perspective of learning analytics research landscape.	√	X	√	No
37	Understanding 'smart cities': Intertwining development drivers with desired outcomes in a multidimensional framework	√	√	√	Yes
38	Smart city research 1990–2016	√	√	√	Yes
39	Evaluation on construction level of smart city: An empirical study from Twenty Chinese cities	X	X	√	No
40	Modern conceptions of cities as smart and sustainable and their commonalities	√	X	√	No
41	Smart and sustainable? 5 tensions in the visions and practices of the smart-sustainable city in Europe and North America.	√	X	X	No
42	Managing supply chain resources with Big Data Analytics: a systematic review.	√	X	X	No
43	A semantic similarity analysis of Internet of Things	√	X	X	No
44	New bibliometric indicators for prospectivity estimation of research fields.	√	X	X	No

Figure 1. Eligibility checklist. Continued on the next page. Source: Author 2020.

41	Smart and sustainable? 5 tensions in the visions and practices of the smart-sustainable city in Europe and North America.	√	X	X	No
42	Managing supply chain resources with Big Data Analytics: a systematic review.	√	X	X	No
43	A semantic similarity analysis of Internet of Things	√	X	X	No
44	New bibliometric indicators for prospectivity estimation of research fields.	√	X	X	No
45	Analysing the scientific evolution of e-Government using a science mapping approach	√	X	X	No
46	Trajectory of urban sustainability concepts: A 35-year bibliometric analysis	√	X	√	No
47	The First Two Decades of Smart-City Research: A Bibliometric Analysis	√	√	√	Yes
48	Smart Governance: Using a Literature Review and Empirical Analysis to Build a Research Model	X	√	X	No
49	Sustainable-smart-resilient-low carbon-eco-knowledge cities; Making sense of a multitude of concepts promoting sustainable urbanization	√	X	√	No
50	Scientometric cognitive and evaluation on smart city related construction and building journals data.	√	X	√	No
51	Smart and Digital City: A Systematic Literature Review	√	√	√	Yes
52	The governance of smart cities: A systematic literature review	√	X	√	No
53	Addressing big data challenges in smart cities: a systematic literature review	√	X	√	No
54	Smart city indicators: A systematic literature review	√	√	√	Yes
55	Sustainable development of smart cities: a systematic review of the literature	√	X	√	No
56	Role of Smart Cities in Creating Sustainable Cities and Communities: A Systematic Literature Review	√	X	X	No
57	Smart cities Application of Decision-Making Methods in Smart City Projects: A Systematic Literature Review	√	X	√	No
58	Smart city governance in developing countries: A systematic literature review	√	√	√	Yes
59	Identifying the results of smart city development: Findings from systematic literature review	√	√	√	Yes
60	Determining the Internet of Things (IOT) Challenges on Smart Cities : A Systematic Literature Review	√	X	√	No
61	Scientific Landscape of Smart and Sustainable Cities Literature: A Bibliometric Analysis	√	√	√	Yes
62	Some aspects and the bibliometric analysis of the sustainable smart city concept	√	X	√	No
63	Assessing the Impact of Smart Cities on Local E-government Research: A Bibliometric Study	√	X	√	No
64	Smart and sustainable cities: bibliometric study and patent information	√	X	X	No
65	From digital to sustainable: A scientometric review of smart city literature between 1990 and 2019	√	√	√	Yes

Figure 1 Continued. Eligibility checklist. Source: Author 2020.

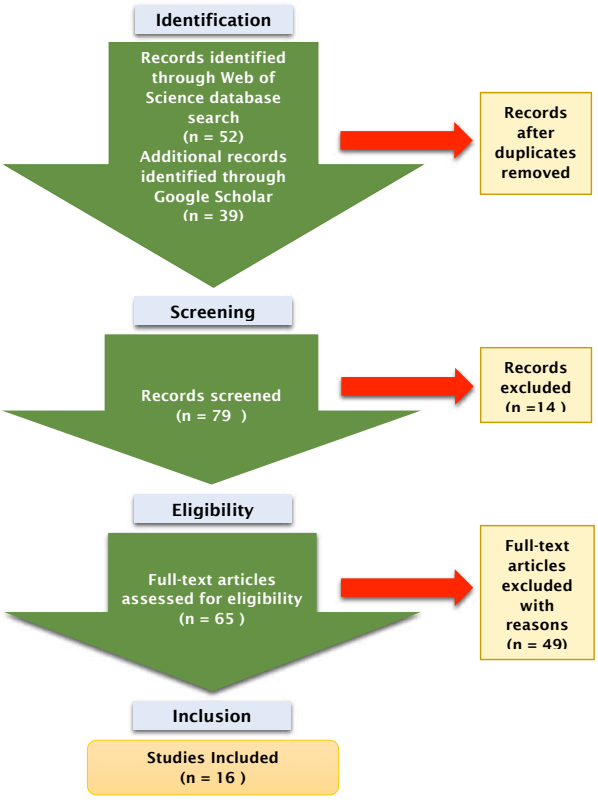

Figure 2. Flowchart adapted from PRISMA (Moher et al., 2009). See table on next page.

No	Title	Author(s)	Year	Publication Type	Publication Outlet	Discipline	Number of Papers Reviewed	Time Frame	Methods of Analysis
1	Mapping the knowledge domain of smart-city research: A bibliometric and scientometric analysis	Zhao, Tang & Zou	2019	Journal Article	Sustainability	Cross-disciplinary	2920	All years (until 4 October 2019)/74	Scientometric
2	Smart Governance For Sustainable Cities: Findings from a Systematic Literature Review	Tomor et al.	2019	Journal Article	Journal of Urban Technology	Multi-disciplinary	114	2006-2016/10	Systematic literature review
3	Visualizing the studies on smart cities in the past two decades: A two-dimensional perspective	Li	2019	Journal Article	Scientometrics	Interdisciplinary	4667	1992 -2012/10	Bibliometric analysis
4	Bibliometric analysis on smart cities research	Guo et al.	2019	Journal Article	Sustainability	Cross-disciplinary	4409	1998-2019/21	Bibliometric analysis
5	Combining co-citation clustering and text-based analysis to reveal the main development paths of smart cities	Mora, Deakin & Reid	2019	Journal Article	Technological Forecasting and Social Change	Interdisciplinary	2,273	1992-2018/26	Bibliometric analysis
6	Success factors of smart cities: a systematic review of literature from 2000-2018	Aldegheishem	2019	Journal Article	Journal of Land Use, Mobility and Environment Review	Interdisciplinary	84	2000-2018/18	Systematic literature review
7	Can cities become smart without being sustainable? A systematic review of the literature	Yigitcanlar et al.	2019	Journal Article	Sustainable Cities and Society	Cross-cutting multidisciplinary	35	Not set-2018/73	Systematic literature review
8	Understanding 'smart cities': Intertwining development drivers with desired outcomes in a multidimensional framework	Yigitcanlar et al.	2018	Journal Article	Cities	Interdisciplinary	78	January 2000-January 2018/18	Systematic literature review
9	Smart city research 1990–2016	Ingwersen & Serrano-López	2018	Journal Article	Scientometrics	Interdisciplinary	4725	1990–2016/26	Scientrometric
10	The First Two Decades of Smart-City Research: A Bibliometric Analysis	Mora, Bolici & Deakin	2017	Journal Article	Journal of Urban Technology	Multidisciplinary	1067	1992-2012/22	Bibliometric Analysis
11	Smart and Digital City: A Systematic Literature Review	Cocchia	2014	Book Chapter	Smart City How to Create Public and Economic Value with High Technology in Urban Space	Interdisciplinary	705	1993-2012/19	Systematic Literature Review
12	Smart city indicators: A systematic literature review	Purnomo, Meyliana & Prabowo	2016	Journal Article	Journal of Telecommunication, Electronic and Computer Engineering	Electronic and Computer Engineering	30	2004-2015/11	Systematic literature review
13	Smart city governance in developing countries: A systematic literature review	Tan & Taeihagh	2020	Journal Article	Sustainability	Cross-disciplinary	56	2009-2019/10	Systematic literature review
14	Identifying the results of smart city development: Findings from systematic literature review	Lim, Edelenbos & Gianoli	2019	Journal Article	Cities	Interdisciplinary	55	2005-2017/12	Systematic literature review
15	Scientific Landscape of Smart and Sustainable Cities Literature : A Bibliometric Analysis	Janik, Ryszko & Maerek	2020	Journal Article	Sustainability	Cross-disciplinary	539	1983–2020/37	Bibliometric study
16	From digital to sustainable: A scientometric review of smart city literature between 1990 and 2019	Zheng, Yuan, Zhu, Zhang & Shao	2020	Journal Article	Journal of Cleaner Production	Interdisciplinary	7840	1990-2019	CiteSpace, co-occurrence analysis, co-word analysis d document co-citation analysis

Figure 3. Table of articles, publication type, outlet, discipline and analysis type.

According to the assessment, I included 16 papers which are eligible for further review. These comprise 8 systematic review papers, 5 bibliometric studies and 3 scientometric papers which address the general knowledge of smart city and do not specifically discuss the partial urban services and technical element of smart

such as smart mobility, smart building, smart energy, Internet of Thing (IOT), block chain, big data, smart parking and other technical aspects of smart cities. In short, these selected publications satisfy the criteria to be included in further analysis. Now there are 16 selected publications filtered by criteria-based judgment which leads to analytical section.

Results

Descriptive Analysis

The basic descriptions of publications included in the review provide contextual information through which the information of smart city research derived. The descriptive attributes such as authorship, year of publications, type of publications, publication outlets, disciplinary scope, time-frame of publications reviewed and type of analysis is evaluated quantitatively. The review articles on general discussion of smart city research from peer-reviewed process were started in 2014 by Cocchia (2014) who wrote a book chapter on smart and digital city and its intersection of conceptualization and the development of both concepts. The systematic literature review, bibliometric and scientometric studies on smart city research then continue steadily each year from 2016 to 2017, albeit there was an absent in 2015. It then significantly increases in 2019 by 8 articles in 2018. The highest number of reviewed papers were 47725 publications from 1990-2016 conducted by Ingwersen & Serrano-López (2018) and the smallest one is the paper that reviewed smart city indicators covering 30 papers from 2004-2015 (Purnomo, Meyliana & Prabowo, 2016).

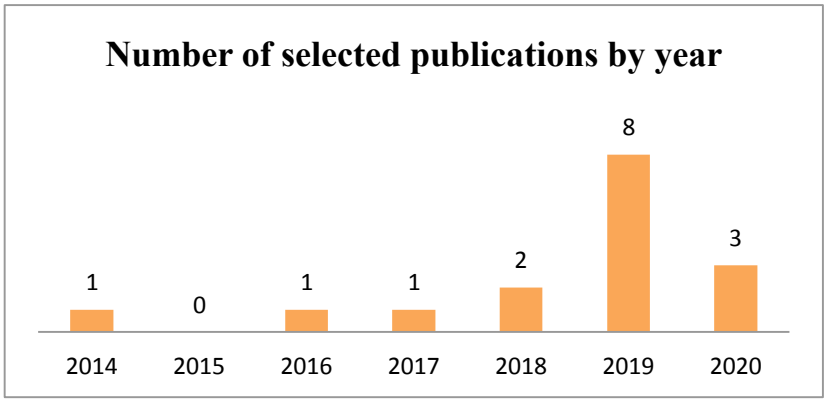

Figure 4. Number of selected publications by year.

The publication outlet indicates the scholarly domain or disciplinary field of study on smart cities. To investigate this, I browsed the journals' official website and observe their aims and scopes to infer the disciplinary scope. Most of the academic journals as the publication channels fall into interdisciplinary science, therefore, smart city research is not mono-disciplinary instead it combines various perspective of science to address the smart city issues. Only 1 systematic reviews journal article published in Journal of Telecommunication, Electronic and Computer Engineering and 1 book chapter as part of Progress in Information Science likely fall into mono-disciplinary avenue which comes from information science.

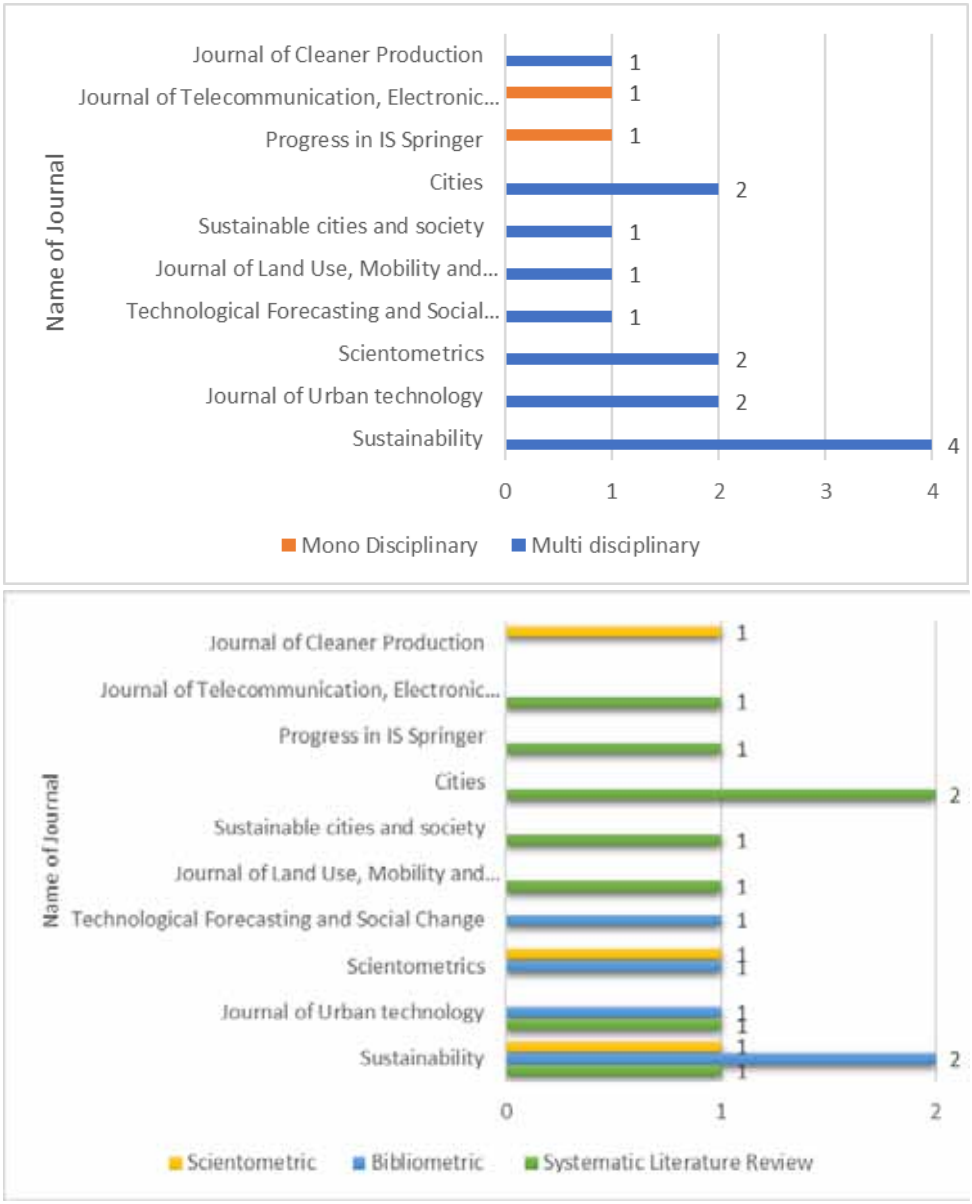

Figure 5. Two graphs covering publication outlets, disciplinary domains and review types.

Underlying Concepts: Definitions, Conceptualizations and Indicators

The bulk of researches in smart city literature focusing on conceptualization mostly come from public administration, information science and urban development (Tomor et al., 2019). This provides some of the rudimentary elements in understanding smart cities including definitions, origin and indicators. Firstly, most of the reviewed papers agree that there is no single definition to designate smart cities. There were numerous of definitions found depending on various point of scientific departure. For instance, Yigitcanlar et al (2018) present 20 different definitions and 22 different definitions (Yigitcanlar et al., 2019) in their publication, Cocchia (2014) record 11 definitions and 9 most cited definitions and Mora et al (2017) compile 11 different definitions in which overlapping concept

emerged. Most of these definitions lean on technology, livability, governability and sustainability. Guo et al (2019) argue that its fuzzy concept in labeling smart cities has resulted inconsistency both in academic and practical realm. In the real-world application, many urban development programs which utilized (mostly) sophisticated technology can be associated in smart cities with no clear boundary whether these are truly developing smart cities or not. This may relate to the different conceptualization and point of departure to frame the smart city label.

Secondly, smart city concept as a platform can be traced back in mid-1800 when self-governed American West successfully navigated the urbanization excess (Tan and Taeihagh, 2020; Yigitcanlar et al., 2018). It then flows into modern conceptualization of 'smart growth' in the 1990 (Albino, Berardi and Dangelico, 2015). Since then, the smart city has emerged in the beginning of 2000 within its similar terminologies such as intelligent city (Mulay et al., 2013; Komninos, 2006), ubiquitous city (Anthopoulos & Fitsilis, 2010), digital city (Rezende et al., 2014; Cocchia, 2014), city information (Piro et al., 2014) and knowledge city (Yigitcanlar, 2008). The triads of technology, policy and community as the essential pillars of smart cities have dominated the smart city research. It means not only the determinism on technological side but also smartness in policy making, governance mode and engaging communities (Lim, Edelenbos and Gianoli, 2019). The pattern of publication has shown to the tendency of highlighting digitalization of service until 2009 and sustainability issues from 2010 onwards (Cocchia, 2014; Ingwersen and Serrano-López, 2018).

As such, sustainability issue is an important concept in contemporary academic debates. The discussion whether 'smart' as evolutionary concept is linked with sustainable practice of urban development is still disputed. Some argue that both are identical (Cugurullo, 2018) but others see the concept of smart and sustainability differently. Cocchia (2014) explored smart and digital city state of research and found that sustainability constructs the smart city concept. This can be traced back in the 90's when Kyoto Protocol and 2010's Europe 2020 Strategy. Thus, the smart and sustainable city emerges to amplify the latter argument. However, most of the reviewed papers suggest that smart city should be directed as integrative effort in marrying smartness and sustainability in urban planning. The principle designates to compromising future generation through environmental and technological means in urban development (Bibri and Krogstie, 2017; Tomor et al., 2019).

Thirdly, the literatures documented several indicators of smart cities. The indicators determined in the smart cities varied according to either academic or pragmatic interest. There were two review papers attempting to synthesize this subject. Purnomo et al (2016) expose the smart city main indicators based on systematic literature review of 30 Papers published from 2004 to 2015. There were public transportation systems, environmental sustainability, social and cultural plurality, education system and facilities information technology infrastructure, healthcare services, entrepreneur and innovation, social security and safety, economy vitality and planning, information, communication, technology and

e-government, housing quality and transparent government and open data. These indicators represent concrete applications through which cities can develop. Similarly, but in more abstract concept, Aldegheishem (2019) synthesizes 12 indicators categorized as smart living, smart economy, smart environment, smart education, smart governance, smart energy, smart safety, smart mobility, smart technology and smart buildings. His finding based on systematic literature review of 84 papers published between 2000 and 2018. He then advocates the comprehensive viewpoint to successful smart cities by not leaving non-technological indicators.

Drivers and Outcomes

A systematic literature review by Yigitcanlar et al (2018) has informed the synthesis of drivers of smart city development. Drawing from interdisciplinary investigation, they develop a conceptual model linking the key drivers to desired outcomes of smart city into multidimensional framework. The basic premise is transforming cities into better societal and environmental condition. According to them, there are three key drivers of smart cities: community, technology and policy. Their three key drivers are analogue with three dimensions of smart city namely technology, people and institution (Nam and Pardo, 2011) which highly cited in academic debates and adopted in smart city practices. In the context of developing countries, Tan & Taeihagh (2020) offer more elaborated eight driving forces including technology, improving human capital inside and outside government, financial power to improve governance capacity, consolidating regulatory framework and public participation and engagement. These associate with the contextual factors such as political, institutional, socio-economic, cultural and spatial conditions in which city governments have to deal with.

In regards to smart city outcomes, a conceptual-based proposition is emerged. Yigitcanlar et al (2018) consider five desired outcomes: productivity, sustainability, accessibility, wellbeing, livability, governance. These outcomes address the main objectives of implementing smart city characterized by people-centered approach and realizing sustainable development integrating economic, social and environmental aspects (Zhao, Tang and Zou, 2019). These outcomes do not address unintended consequences of smart cities. Differentiating from the conceptual outcomes, Lim et al (2019), conducted a systematic review of 55 papers extracted from 2005 to 2017 publication years find an interesting synthesis regarding the result of smart city development. They categorized both positive-negative results characterized by empirical finding versus hypothetical.

The six positive results with evidences found in empirical studies are: (a) facilitating economic development, (b) increasing public service efficiency, (c) increasing quality of life, (d) improving good governance, (e) empowering citizen, (f) fostering innovation and six positive hypothetical results : (a) enhancing citizen involvement, (b) protecting environment, (c) facilitating social development, (d) facilitating sustainable development, (e) fostering innovation and (f) increasing social capital. Not only bring progressive results, smart city may lead to undesirable effects which found in the empirical studies includes (a) hiding existing urban problems and (b) polarization and inequality. Two negative hypothetical impacts may

be proposed: (a) privacy and security issues and (b) diminishing freedom of speech and democracy. One strong message from their studies is that the smart city has promise several positive outcomes, but do not forget its unintended consequences.

Research Loci and Setting

Research sites matter to understand and identify the map of global knowledge distribution and contextual features espousing smart cities development. Political, economic, social and cultural circumstances contribute to the ways smart projects executed. Given the various political economics system, almost every jurisdiction has its own strategy and approach in realizing smart cities (Caragliu, Bo and Nijkamp, 2015; Mora, Deakin and Reid, 2019). To mitigate the locus of smart city study, I consider the scientists' research outputs which indicate research productivity and its impacts. The residency of researchers and study areas where researchers conducted their studies indicate the geographical distribution of smart city research.

Available literatures inform that Asia and Europe are among the most productive continent in smart cities publications (Cocchia, 2014). This is analogous with Mora et al (2017) who report that cities in the Europe have advanced in smart city which make this region as the largest contributor to the growth of smart-city research. In term of knowledge hub, Asia is overtaken by North America (Mora, Bolici and Deakin, 2017). The pivot of knowledge exchange of Europe and North America is likely parallel with the academic focus of European Universities and technology enterprises publications from the United States of America (USA). In country level, most of reviewed papers present similar results where China, Italy, USA, Spain and England placed as the top five smart city research loci (Guo et al. 2019; Ingwersen and Serrano-López 2018; Janik, Ryszko and Maerek 2020; Mora, Bolici and Deakin 2017; Zhao, Tang and Zou 2019).

Beside the continents and countries level, special emphasis was given to the ways smart cities were initiated from the developmental stage perspective. This follows proposition that there are differences between developed and developing countries. From the systematic literature review, Tan & Taeihagh (2020) argue that western hemispheres have different ways in governing smart city comparing to their counterparts in other continents. Consequently, it also associated with the process of implementation and the impact of urban development between the two categories. Evidence showed that smart cities situated in high income countries tend to achieve more positive outcomes than their colleagues in the developing economies (Lim, Edelenbos and Gianoli, 2019). The configuration of smart city research from this perspective demonstrates that mega-cities in the developed countries dominate the research landscapes. For instance, Li (2019) highlights the urbanization trend in North America and Europe has triggered smart city development in those regions, especially to tackle the insufficient energy and environmental damages. This is in line with the investigation of developmental path proposed by Mora et al (2017, 2019). A bibliometric analysis of 2,273 publications divided into 18 thematic clusters published between 1992 and 2018 exposes five main developmental paths including experimental path; ubiquitous path; corpo-

rate path; European path; holistic path (Mora, Deakin and Reid 2019). This reveals that European and North American perspectives are prevalence as the central paradigms of smart city development.

Either the quantity or the quality, less developed nations were surpassed by developed countries in developing smart cities. Various smart city global rankings which assess the successful smart cities initiatives confirm this argument. This table shows top 10 smart cities in the world from three different institutions (Institute for Management Development from Switzerland and Singapore, IESE Business School from Spain and Roland Berger GMBH from Munich, Germany). Most cities come from Global North and cities from Africa, Middle East, Latin America and developing Asia, including BRIC countries (excluding Russia): Brazil and India (except China) were absent in this ranking.

Institute for Management Development (2019)	IESE Business School (2019)	Roland Berger GMBH, (2019)
Singapore	London	Vienna
Zurich	New York	London
Oslo	Amsterdam	St. Albert (Canada)
Geneva	Paris	Singapore
Copenhagen	Reykjavík	Chicago
Auckland	Tokyo	Shanghai
Taipei City	Singapore	Birmingham
Helsinki	Copenhagen	Chongqing
Bilbao	Berlin	Shenzhen
Dusseldorf	Vienna	Paris

Figure 6. Comparative Global Smart City Index compiled by Author 2020.

Scientific Domains: Natural and Social Sciences Dichotomy

Smart city research has scattered in various domain of studies (Zheng et al., 2020; Li, 2019; Yigitcanlar et al., 2018, 2019). There were some attempts to systematize the domain of smart city research. Zheng et al (2020) reveal ten domains of smart city research consist of (1) performance measurement and improvement for smart city (2) smart city governance, (3) big data and IoT, (4) smart computing architecture and system (6) pilot projects, (7) smart sustainable cities, (8) security and privacy, (9) conceptual model/framework and (10) corporate smart city model. These lists were based on co-cited references from scientometric analysis. Although the domain listing captures the wide range of research area in smart cities, it seems fail to address a synthesis from the disciplinary point of views.

More systematically, Li (2019) applied two-dimensional perspective consisting Science, Technology and Engineering (STE) and Social Science and Humanities (SSH) to map smart city research in the last two decades. The STE and SSH notions are not attributed as level, rather the perspective posits a dimensional frame through which academic territories and trajectories can be traced. In his bibliometric study, smart city research as a theme emerged early in the SSH research domain. However, STE seems to be more productive and fast growing in the recent years. The literature also shows that STE-based publication in smart cities has greater

number than SHS. The citation has also indicated the dominance of STE in which top 30 citations sourced from IoT, cloud computing and big data (Li, 2019:686). The themes like as cloud computing, the Internet of Things and big data from computer science, science and technology and engineering dominate literature.

This finding is relevant with other scholars studying the state of research in smart cities. Ingwersen & Serrano-López (2018) for instance, documented the domination of ICT, environmental and energy related field in smart city research 2008-2016. His finding is based on clustering analysis using SNA technique to identify the thematic cluster of research within the mentioned time frame. Likewise, Janik et al (2020) concluded that Computer, Engineering and Telecommunications were the top 3 research area in smart cities based on Web of Science and Scopus database which also identical of the use WoS metrics by Zheng et al (2020) who found that engineering electrical electronics, computer science information systems, telecommunications and computer science are the most abundant field. Similarly, Zhao et al (2019) emphasized on publication outlets in which Computer Science, Information Systems, Engineering, Electrical & Electronic and Sustainability among the top 10 journals for smart-city papers. In sum, smart city research has been highly dominated by natural science especially technological discipline compared to those from social sciences.

Conclusion

This section presents concluded reports addressing research questions and proposing future studies. To sum up, the states of global smart city scholarship can be elucidated in four points of synopses. First of all, review papers were mostly published by interdisciplinary academic journals. However, this is not the case with empirical studies which mostly published in the specific disciplinary academic journal. This indicates the fragmentation of smart city research and lack of intellectual discussion among disciplines. The second important point deals with underlying concept that smart cities are a fuzzy and evolving concept. No universal definition can be made due to its different academic departures. In addition, smart city as a concept is evolutionary in nature dated back from urban planning platform addressing urbanization in the 90's. The conceptualization swings from digital solution to sustainability issue with technology, policy and communities lay in the central tenet of smart cities. Literatures have also underlined smart cities not only deliver positive outcomes but also negative impacts. The next point highlights the smart cities geographical setting that verifying the domination of cities in the developed nations. Not only in academic sphere, global ranking and assessment of smart cities also put developed cities as the top performers. The last point relates to the scientific discipline. Natural sciences have dominated the research output and impact compared to social sciences. The technological determinism is evident both in academic debates and empirical world. This can cause dryness in smart city research with less sociocultural artifact and humanity attributes. Evading technology determinism and techno-singularity (Sovhyra, 2021), insight from humanity and social science may enrich the smart city research landscape.

From the summary, some of research avenues can be proposed in studying smart

cities. Firstly, available literature shows that smart city empirical studies were dominated by mono-disciplinary perspective. Thus, conventional academic tradition is in the forefront in researching smart cities in real worlds. Alternative approaches from interdisciplinary or trans-disciplinary may offer fruitful insights which may enrich smart city scholarships. Secondly, while attentions are likely given to mega-cities (most of them are capital cities) situated in the developed countries, researching smart city in the small-medium cities from developing world is necessary to balance the discourse and academic debates. Another issue dealing with the learning capacity from cities and inhabitants' is also rarely analyzed by scholars who studying smart cities. As such, learning capacity can be addressed by empirical research focusing on the experience of smart city stakeholders and citizens dealing with smart projects and see how these projects lead to behavioral and social order (and change).

Last but not least, I acknowledge some limitations of this present study. The analysis only considers peer reviewed journal and review paper that address general picture of smart cities. Thus, it ignores grey literatures by excluding them in the review selection process. This may restrict the discussion to academic sphere but it neglects the views from non-academic domain. In addition, the criteria used in this study only selects review papers include: systematic review, bibliometric and scientometric papers that report general issue and address the surface knowledge in smart city scholarship. As such, it cannot capture any particular and detailed topics of smart cities. Future review may enlarge the samples by including grey literatures to expand the scope of review by analyzing empirical papers.

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