International Journal of Urban Planning and Smart Cities
Volume 3 • Issue 1

A Systematic Text-Analytics-Based Meta-Synthesis Approach for Smart Urban Development

Mani Dhingra, Indian Institute of Technology, Kharagpur, India*
Subrata Chattopadhyay, Indian Institute of Technology, Kharagpur, India

ABSTRACT

'Smart' has become a leitmotif that is widely assumed to reach the goals of urban sustainability and improve the living standards of people. Though there is an exponential increase in the smart city research during the last two decades, there is still silent about the importance of existing cities and communities to achieve smart urban development (SUD). The authors propose a systematic literature search and review framework coupled with deductive text computational and inductive grounded theory methods for the meta-synthesis. This study contributes to the present research landscape by facilitating urban professionals for framing integrated strategies instead of blindly fixing the urban spaces with technological components. The automated text analysis for meta-synthesis is a novel approach for analyzing a diverse concept like smart cities by eliminating the chances of human errors. The findings conclude that the three-dimensional objectives of SUD achieve sustainable development, high quality of life, and inclusive development.

KEYWORDS

Quality of Life, Smart Urban Development, Sustainability, Systematic Literature Search and Review

1. INTRODUCTION

Cities are increasingly becoming larger and complex, exposed to many physical, social, environmental, and economic risks (Selvakanmani, 2015; Nam & Pardo, 2011). The United Nations project the world's urban population to reach 68%, with India alone having 53% urban population by 2050 (UN-DESA, 2019). Assuming that the Smart Cities will tackle the accompanying challenges of urbanization, it has become a leitmotif in the global political arena and scientific discourses (Anthopoulos, 2017; K. Harrison, 2017; Martin et al., 2018). In India, an ongoing Smart Cities Mission represents a utopian vision of the Modi regime to impact a total urban population of more than 99,000,000 (Government of India, 2020). India's initial approach has an elite-oriented and urban-led techno-managerial focus (Hoelscher, 2016; Datta, 2015). Its long history, diverse cultural setting, and dominating informal sector demand an indigenous tailor-made framework instead of an imported scheme of actions from its western counterparts (Das, 2020; Rajput & Arora, 2017).

Despite extensive literature on smart cities, the concept is still in a nascent stage of research and practice (Ahvenniemi et al., 2017; Mora et al., 2017; Castelnovo, 2016; Ojo et al., 2016). The existing smart cities research is unconnected, fragmented, divergent, and incoherent (Prado et al.,

DOI: 10.4018/IJUPSC.302131 *Corresponding Author

2016; Renata Paola Dameri, 2013). Moreover, there is a growing criticism against this concept and its strategies because of top-down approach, poor adaptation to accommodate the local needs, tendencies to focus on neoliberal economic growth, and privileging affluent sections of the society (Angelidou, 2017; Martin et al., 2018). One of the first critical articles about this concept was authored by Hollands (2008), urging real smart cities to stand up (Kummitha & Crutzen, 2017). The scholars mostly criticize the market-oriented, techno-centric, and utopian visions of smart cities and question whether they can deliver sustainable and socially equitable results (Martin et al., 2018). One of the reasons for such criticisms is the explicit attention given to the positive hypothetical results of smart interventions. On the contrary, the research in urban studies and geography shows more of negative outcomes of smart interventions (Lim et al., 2019).

Majority of the scholars support the vision of a rationalist and balanced approach for Smart Urban Development (SUD), and so do the authors of this study. However, it is only possible if we understand the lacunae in the current development framework and formulate a holistic vision to fill the prevailing gaps. This study's objectives are framed upon the preliminary research on the subject, highlighting the overlooked and undervalued goals and purpose of smart cities. A strategic SUD framework must chalk-out a roadmap for building future smart cities in such a manner that all existing urban components such as social, economic, political, cultural, institutional, physical, and geographical are well integrated. This study aims to highlight the critical factors essential for formulating such a cohesive framework. This paper targets future researchers, urban professionals, and policymakers who must make informed decisions and strategies for SUD. Authors have proposed a novel Systematic Literature Search and Review (SLSR) framework, coupled with text-analytics-based content analysis and grounded theory methods for meta-synthesis.

2. NEED FOR THE STUDY

Conceptually, the smart city notion can be perceived as a derivative of futuristic urban planning ideologies of the mid-20th century, ranging from the urban analytics of the 1970s to the smart growth movement of the 1990s (Glasmeier & Christopherson, 2015; Kitchin, 2015). During the 1960s and 1980s, many prominent architects, planners, and geographers embraced technological advancement at an urban scale, with ideas such as P. Cook's 'Plug-in-City' and R. Herron's 'Walking City'. Kummitha & Crutzen (2017) classified the reviewed smart cities literature into restrictive articles that give higher importance to technology, reflective articles that give more attention to human elements, rationalist articles that favour the technological adoption and enhanced human capital, and critical articles that find the whole idea as neoliberal utopian promises.

Most of the literature review on smart cities either focuses on an overall understanding of this idea or attempts to establish relationships with other concepts **(Table 1)**. Authors observe a missing urban planner's perspective from the present bundle of knowledge. Some of the scholars with urban planning focus include Lim et al. (2019) who assessed the hypothetical and observed results of smart cities interventions, Kummitha & Crutzen (2017) who classified existing literature into four schools of thought, Aurigi & Odendaal (2020) who emphasized the importance of social-sustainability over digital urbanism and Caragliu & Del Bo (2016) who studied the interrelationship between urban development policies and smart cities.

3. MATERIALS AND METHODS

The existing Smart Cities literature is mostly qualitative and diverse, and hence, its extensive review requires a systematic and comprehensive approach. Grant & Booth, (2009) provides an analytical insight into the fourteen literature review typologies using a SALSA framework (Search, AppraisaL, Synthesis and Analysis). Authors have adopted the Systematic Literature Search and Review (SLSR) method for this study as it combines the strengths of critical review with a comprehensive search

Table 1. Studies that reviewed smart cities literature

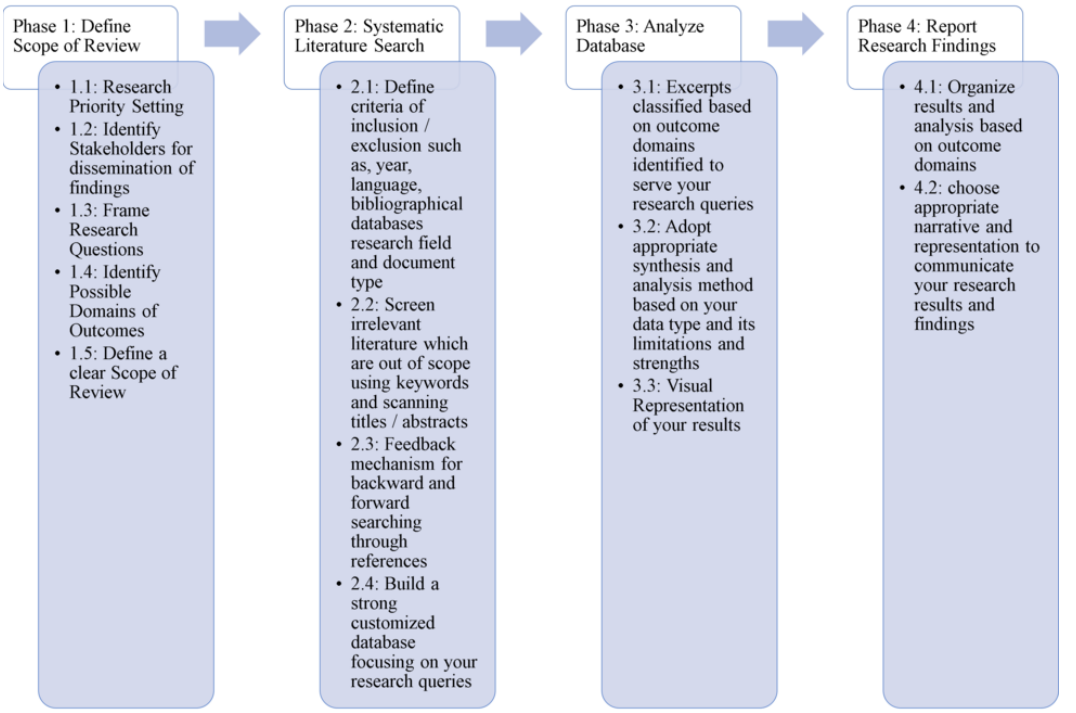
Study	Objective	Approach	Outcome
(Kummitha & Crutzen, 2017)	To find the conflicting views in smart city research	Content Analysis of peer-reviewed journals	Classified available research into four schools of thought
(Lim et al., 2019)	To identify and analyze the results of smart city development	Systematic literature review for peer-reviewed articles from the urban planning field	Classified results into four categories based on positive or negative and hypothetical or observed
(Mora et al., 2017)	To provide an overall picture of the first two decades of smart city research	Bibliometric analysis	Characterization by their geographical origins, knowledge domains and development paths
(Loo & Tang, 2019)	To explore smart mapping means for Spatio-temporal data	Systematic overview	Major challenges, directions of change, and implications with respect to data collection and analysis
(Cocchia, 2014)	To investigate the origin, development and features of smart and digital cities	Literature review using Vom Brocke et al., (2009) model	Characterization by time analysis, terminology analysis, definitions analysis, typology analysis and geographical analysis
(Trindade et al., 2017)	To analyze the relationship between environmental sustainability and smart city	Systematic literature review	Discusses the nature of articles with both the terms
(Purnomo et al., 2016)	To summarize potential indicators for implementing smart cities	Systematic Literature Review	Highlights most frequently used keywords and indicators
(Ismagiloiva et al., 2019)	To analyze the role of smart cities on creating sustainable cities and communities	Synthesis of the relevant literature	Categorizes studies into six environment-focused themes
(Chauhan et al., 2016)	To provide a holistic view of using big data in smart cities	Systematic literature review and synthesis	Classifies into eight broad challenges
(Ruhlandt, 2018)	To analyze the defining components of smart city governance	Systematic Literature Review	Clustered under four categories
(Jong et al., 2015)	To investigate the interrelationships between twelve city categories	Bibliometric analysis using spring embedded algorithm	Produced a conceptual meshed network

process for producing a rational synthesis. This method assumes all included articles being assessed and valued against the same underlying criteria (Grant & Booth, 2009). This section details out the SLSR framework and Meta-Synthesis approach applied for this study.

3.1. SLSR Framework

Vom Brocke et al. (2009) identifys a literature search as the most fundamental step to synthesize the findings of a large skeleton of research. The proposed SLSR framework integrates the systematic review frameworks suggested by Webster & Watson (2002), Vom Brocke et al. (2009), Wolfswinkel et al. (2013) and Higgins et al. (2019). **Figure 1** shows the four phases of the proposed SLSR framework.

Figure 1. Proposed SLSR framework



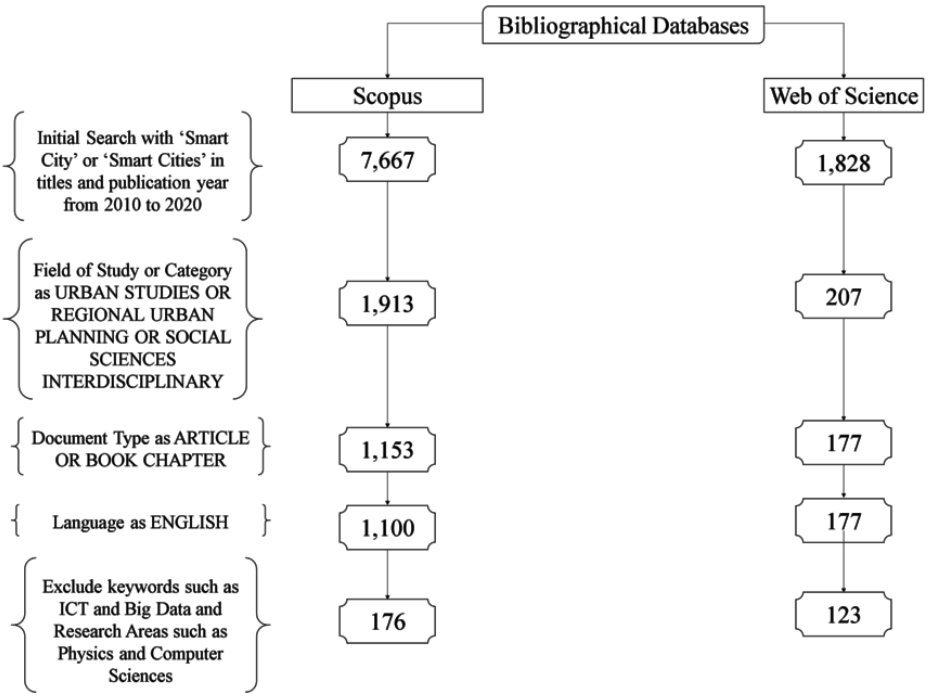
In phase 1 of SLSR, we set our priorities, identify the stakeholders and objectives of our research to prepare a focused scope of review. This study targets everyone who is associated with the broad domain of urban planning, such as planners, architects, and policymakers. Preliminary research helped us to formulate two research objectives. The first is to identify the key terms associated with objectives of SUD and the second is to recommend critical factors for inclusion in the SUD strategic framework.

For phase 2, we conducted a Systematic Literature Search on the two bibliographical databases, i.e., Web of Science and Scopus. The initial criteria for selection of literature are documents with 'smart city' or 'smart cities' in their titles and published from 2010 to 2020. The successive search criteria include English as language, urban planning as field of study and peer-reviewed academic publications as document types. The search results in both the databases is given below in **Figure 2**. After a careful scan of the title, abstract, introduction, and conclusion sections of the resulting 299 documents, we removed 92 duplicate documents and 142 irrelevant documents. The remaining 65 articles form our final database for the systematic meta-synthesis process.

3.2. Meta-Synthesis

In phase 3 of proposed SLSR framework, we reviewed each document in our final database thoroughly and iteratively with backward and forward searches. The extracted relevant excerpts form corpora for our further analysis (Wolfswinkel et al., 2013). For our first objective, we adopted a deductive content analysis method that uses text-computational algorithms (Fabbrizzi et al., 2016; Lee et al., 2020; Sebestyén et al., 2020; Wehnert et al., 2018) and for our second objective, we adopted an inductive grounded-theory method that uses concept matrix (Finfgeld-Connett, 2018; Wolfswinkel et al., 2013). For the grounded theory method, all the extracted excerpts highlighting the gaps are

Figure 2. Literature search results



coded in the excel workbook and further distilled into conceptual themes. For the content analysis method, the extracted excerpts with objectives component are loaded into the Matlab R2019b version with Text Analytics toolbox.

Analysis of recurrent terms and their clustering tendencies in our corpus can help us identify the key-terms associated with the objectives of SUD. We have used term frequencies, topic modeling, and visualization algorithms to serve this purpose. Term Frequency of a term *t* in a document *d* measures its relative frequency in a document and can be given by **equation 1.** Topic modeling is another machine-learning algorithm, which is used to cluster words into a finite number of topics, assuming their probabilistic measures. Latent Dirichlet Allocation (LDA) is the most common topic modeling technique, which uses statistical Dirichlet distributions to infer relevant topics from a set of documents based on their word patterns.

$$TF\left(t,d\right) = \frac{number\ of\ times\ a\ term\ appears\ in\ the\ document}{total\ number\ of\ terms\ in\ the\ document} \tag{1}$$

First, pre-processing is done by dividing the entire corpus into 3,754 meaningful textual units called tokens. These tokens are further screened to 1,900 tokens by removing English stop-words, punctuations, too long or too short words, infrequent and irrelevant words to avoid biased results. These tokens are normalized by stemming to retain the root forms of inflected words. All these pre-processed words are further transformed into numeric vectors using Bag of Words (BoW) and Bag of N-grams (BoNgrams) model or, in simple words a Document Frequency Matrix (DFM).

A DFM is nothing but a matrix with each cell entry corresponding to the occurrences of a term in a document. **Figure 3** shows a visual representation of raw dataset (848 words), a cleaned dataset after pre-processing (76 words), and a bigrams dataset with paired words (1,248 bi-grams). Around 91.03% of textual data is reduced with the pre-processing process as calculated by **equation 2**. This cleaned dataset is used for our further analysis.

$$\% \ reduction = \left(1 - \frac{number \ of \ words \ in \ cleaned \ Bag \ of \ Words}{number \ of \ words \ in \ raw \ Bag \ of \ Words}\right) * 100 \quad (2)$$

Figure 3. Word clouds for the raw and cleaned dataset

4. RESULTS AND DISCUSSIONS

This section elaborates the existing theories about the origin, evolution, terminologies, and characteristics of the 'Smart City' concept and discusses the results obtained from the applied meta-synthesis.

4.1. Characteristics of Literature Database for Review

Our entire database is categorized into six domains based on their research coverage. **Figure 4** shows that around 75% of the total documents correspond to the gaps identified, followed by objectives (68%), dimensions (31%), evolution (15%), general theory (10%), and assessment schemes (4%). According to keyword search in the Scopus database, overall smart cities literature spanning over the last decade is dominated heavily by the USA (24.76%) followed by China (16.60%) and the UK (10.62%) **(Figure 5).** The concept is multidisciplinary, with research fields ranging from Computer Sciences to Neurosciences, as shown in **Figure 6**. In terms of research publications, Elsevier's Cities has the maximum share, followed by Taylor and Francis's Journal of Urban Technology and Sage's Urban Studies.

Figure 4. Database classified into outcome domains

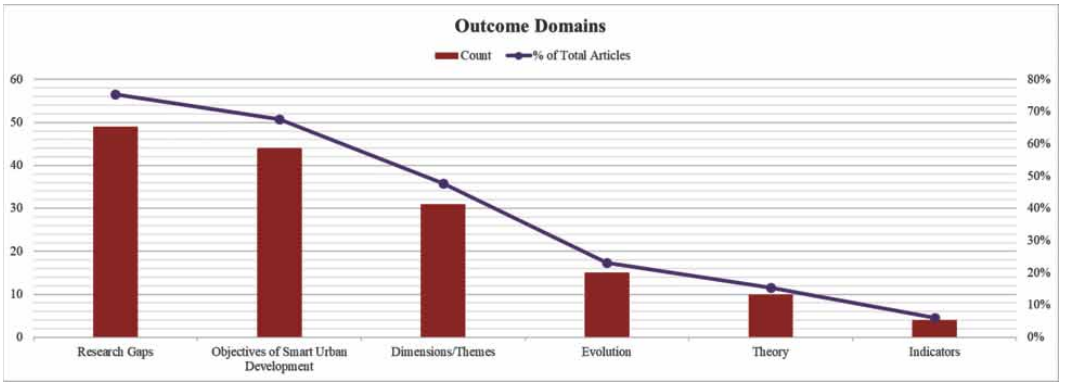


Figure 5. Research production by country

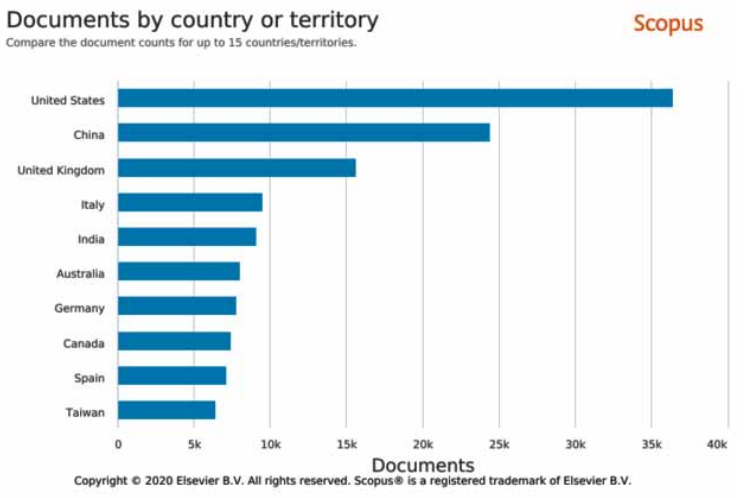
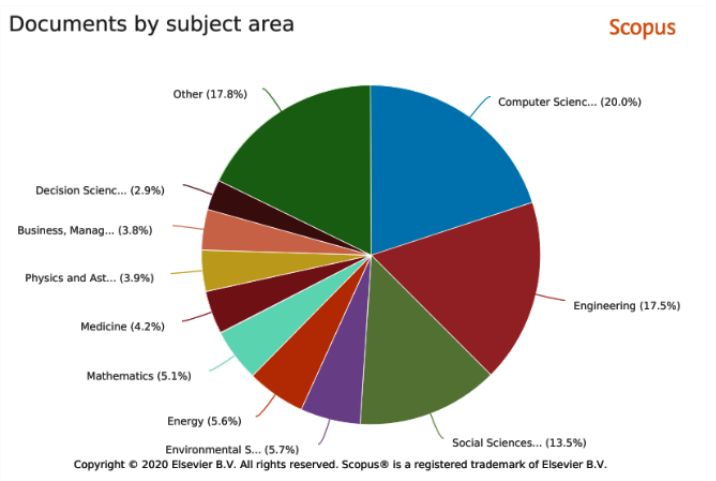


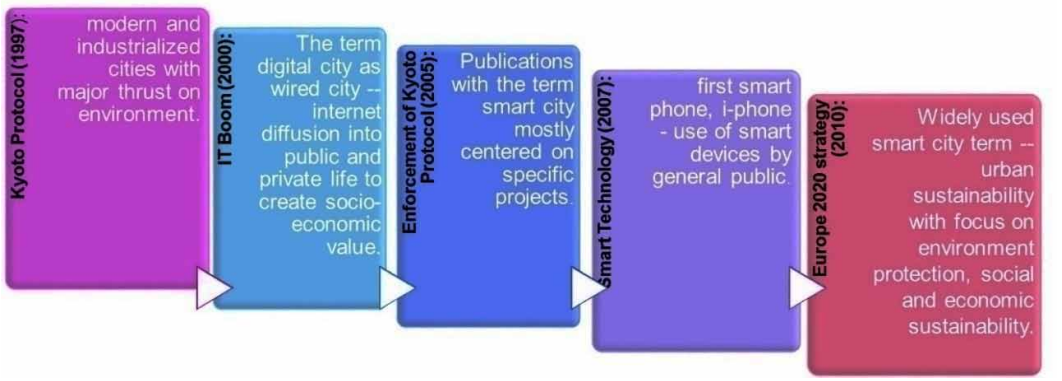
Figure 6. Research production by research field



4.2. Origin and Evolution

Technology-driven urban development and management are believed to be essential instruments to address socio-economic, spatial, and environmental challenges (Deakin & Al Waer, 2011; Nam & Pardo, 2011; Hollands, R. G., 2008). However, a constant shift and confusion have prevailed over the last few decades regarding its stated objectives and adopted approaches. Dhingra & Chattopadhyay (2016, 2017) and Cocchia (2014) have identified five external driving events that kept shifting the focus of this concept **(Figure 7)**. In 1998, Kyoto Protocol first communicated this idea with a significant thrust on environmental issues to address industrialisation's negative impacts. However, post-2000, there was a shift in focus towards digital incorporation into existing urban systems. In 2010, with the Europe 2020 strategy, the concept again came under the aegis of sustainable urban development. The last decade observed a shift of the overall narrative of smart city from the digital notion to the sustainability agenda (Aurigi & Odendaal, 2020).

Figure 7. Evolution of smart city concept

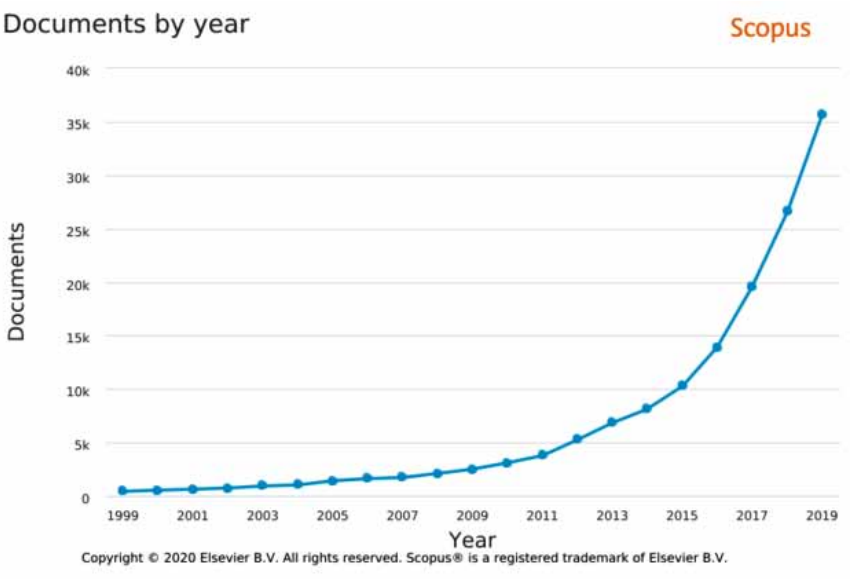


The overall research on this concept shows an exponential increase since 2009, so much so that it over-shadowed the term 'Sustainable City' to a great extent (Alderete, 2020; Jong et al., 2015; Joss et al., 2019; Mora et al., 2017). According to a bibliometric analysis conducted by Mora et al. (2017), smart cities research follows two development trends. The first comprises the peer-reviewed publications produced by European universities supporting an integrated framework.The second consists of the grey literature produced by the American MNCs supporting an ICT-driven development approach. Scopus search on 'Smart Cities' published during the last two decades results in more than 146,000 documents, with approximately 92% produced over the last decade **(Figure 8).** Authors have limited this study to peer-reviewed research produced over the last decade.

4.3. Terminologies and Characteristics

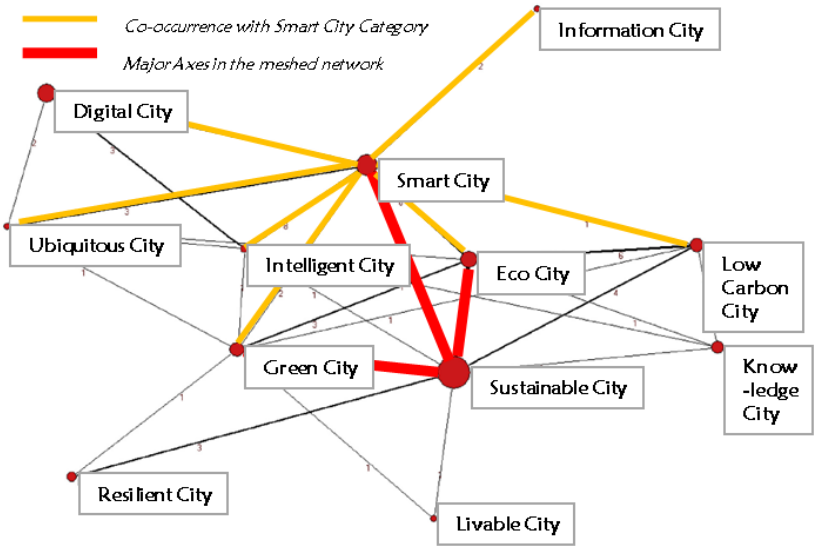
A widely acknowledged definition of Smart Cities is given by Caragliu et al. (2011), describing them as the ones in which investments in human and social capital coupled with traditional and modern ICT infrastructure generates sustainable economic development and high quality of life while promoting prudent management of natural resources (Albino et al., 2015; Mora et al., 2017; Ojo et al., 2016; Yigitcanlar, 2015). From a more neutral perspective, Prado et al. (2016) defined a smart city as a community that systematically promotes the overall well-being of its residents, flexible enough to proactively and sustainably become an increasingly better place to live, work, and play.

Figure 8. Documents produced over the last two decades on smart cities research (source: Scopus)



This concept tends to adopt images of many of its conceptual variants, such as digital cities and intelligent cities (Alderete, 2020). Jong et al. (2015) developed a meshed-network as shown in **Figure 9** to showcase the inter-relationships between the twelve most frequently used city categories. It indicates the 'Sustainable City' node as a focal umbrella term with other city categories as its neighbouring nodes. Their proximity to each other in the network shows their mutual co-occurrences, while their sizes indicate their overall frequencies. The findings of this study report a relatively higher frequency of 'Digital City' category but with location far from the 'Sustainable City' category. On the contrary,

Figure 9. Inter-relationship between popular city categories



the 'Smart City' category forms robust and closer axes with the 'Sustainable City', 'Green City', 'Intelligent City' and 'Eco-city' categories but distant axes with 'Digital City', 'Information City' and 'Ubiquitous City' categories, illustrating a closer relationship between smart and sustainable city categories than smart and digital city categories.

United Nation's ITU-FG on SSCs (2014) defined a new concept of Smart Sustainable City as the one which leverages the ICT infrastructure to improve citizens' quality of life and well-being, ensures sustainable economic growth, streamlines city services, reinforces prevention of disasters, and provides effective government mechanisms (Ibrahim et al., 2018; L. G. Anthopoulos, 2017; Castelnovo, 2016). Dhingra & Chattopadhyay (2016) also defined Smart Sustainable City as the one which improves the quality of life of its citizens, ensures economic growth with better employment opportunities, improves the well-being of its citizens, establishes an environmentally responsible and sustainable approach to development, ensures efficient delivery of basic urban services, addresses climate change and environmental issues and provides an effective regulatory mechanism (Romanelli, 2020; Bednarska-Olejniczak et al., 2019; Garau & Pavan, 2018; Trindade et al., 2017).

The six most commonly discussed characteristics of a Smart City are Smart Economy, Smart Mobility, Smart Environment, Smart People, Smart Living, And Smart Governance (Al Nuaimi et al., 2015; Anthopoulos et al., 2016; Lombardi et al., 2012; Sharifi, 2020). Based on their implementation, smart cities can characterised into hard and soft infrastructure oriented strategies focussing either on the tangible components such as buildings and roads or the intangible components such as people and governance, respectively (Albino et al., 2015; Anthopoulos, 2017; Lombardi et al., 2012; Neirotti et al., 2014).

4.4. Text Analytics

As discussed, the Text Analytics toolbox is used for pre-processing and analysis of our dataset. The absolute and relative frequencies of words in the corpus are calculated using the BoW model, as shown in **Figure 10** and **Figure 11,** respectively.

Both absolute and relative frequencies show almost similar words occurring the most number of times, corresponding to sustainability, quality of life, social aspects, urban services, efficiency. **Table 2** compares the top 20 occurring words and the top 20 occurring bi-grams. These words are corresponding to 'sustainability', 'quality', 'social', 'life', 'services', efficiency', 'urban', 'improvement', 'citizens' and 'economic' rank higher than rest of the words such as 'governance', 'development', and 'environment'. On the other hand, paired words such as 'quality-of-life', 'social-environmental', 'social-economic', 'improve-quality', 'urban-development', 'environmental-sustainability', 'economic-sustainability', 'citizen-life', 'social-inclusion' rank higher than paired words such as 'natural-resources', 'mobility-

Figure 10. Absolute Term Frequencies

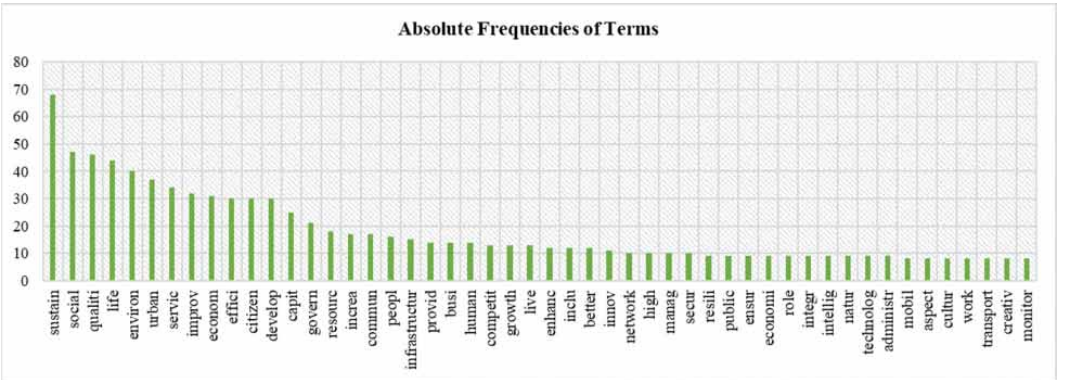


Figure 11. Relative Term Frequencies

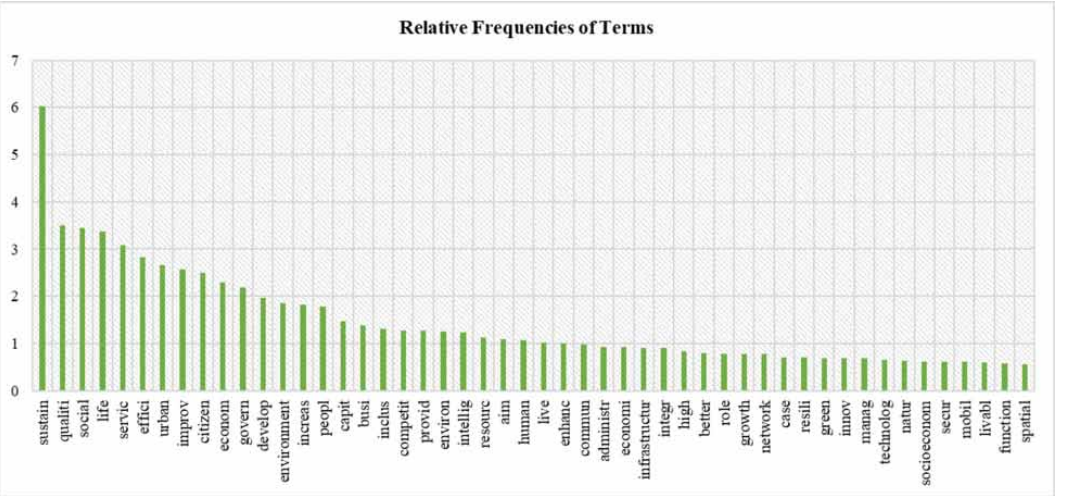


Table 2. Individual words vs paired words

Rank	Words	Bi-grams	
1	sustain	qualiti	life
2	qualiti	social	environ
3	social	econom	social
4	life	improv	qualiti
5	servic	urban	develop
6	effici	environ	sustain
7	urban	sustain	econom
8	improv	human	capit
9	citizen	econom	growth
10	econom	life	citizen
11	govern	social	inclu
12	develop	natur	resourc
13	environment	life	qualiti
14	increas	effici	sustain
15	peopl	high	qualiti
16	capit	improv	econom
17	busi	mobil	environ
18	inclus	effici	servic
19	competit	sustain	resili
20	provid	manag	natur

environment' and 'efficient-services'. Overall, the bi-grams give more comprehensible results than individual words by retaining their context. A word cloud in **Figure 12** visually summaries the distribution of words in our corpus with 'Sustainability', 'Quality of Life', 'Social' and 'Urban' as dominant words.

Figure 12. Word cloud for objectives of SUD

Another technique used for text analytics is LDA topic modelling to cluster similar words under a single topic. A machine-learning algorithm is used to compare LDA models for their computed perplexities of the held-out test **(Figure 13).** The number of topics with lower perplexity and computation time correspond to better goodness of fit.

Figure 13. Goodness of fit algorithm to identify the optimum number of topics

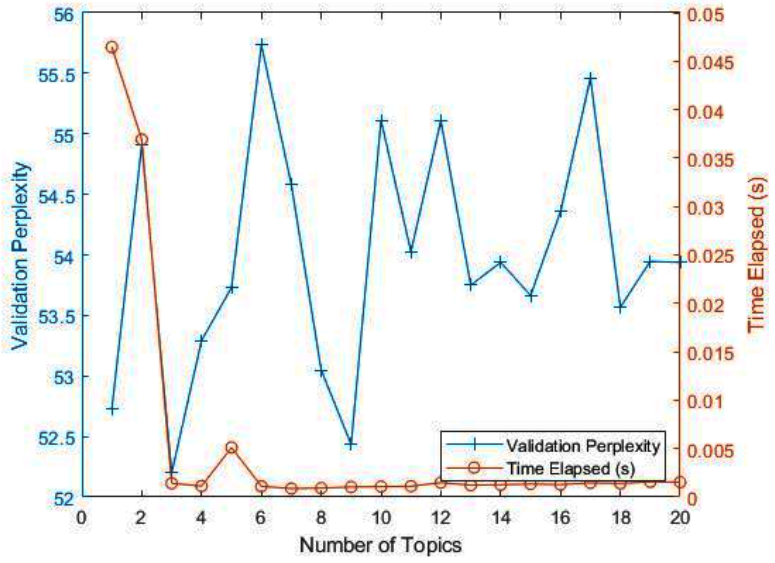


Figure 14 shows word-clouds generated for four topics using the output of the BoW model. Topic 1 highlights the improvement of quality of life and economic sustainability; topic 2 highlights social capital, communities, and environmental efficiencies; topic 3 highlights people, citizens, governance, services, and environment; and topic 4 highlights sustainable resources and innovative networks.

Figure 14. Results of LDA topic model for individual words

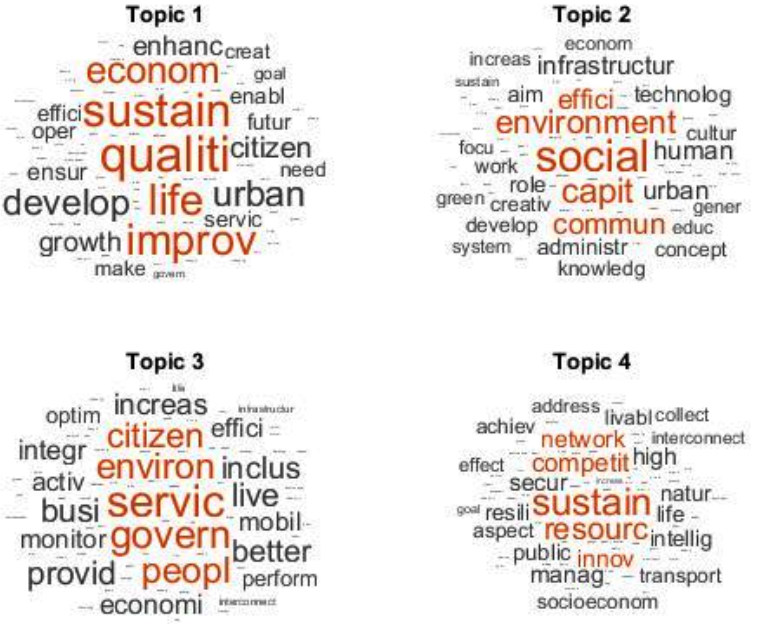


Figure 15 shows the results of the LDA model for five topics applied to the generated bi-grams. Topic 1 covers the quality of life; topic 2 covers sustainable economy and economic growth; topic 3 covers human capital, urban development, social environment, sustainable environment and socio-economic aspects; topic 4 covers social inclusion and administrative efficiency; and topic 5 covers citizen services and people's life-work integration. Overall, this analysis finds key-terms such as quality of life, sustainability, social inclusion, urban development, citizens' services, environment, socio-economic, governance, and human capital as relevant aspects for formulating SUD strategies.

4.5. Gaps Identified

The second corpus consists of the critical insights produced under various studies. We applied a grounded-theory method by coding and classifying 120 excerpts into six themes of discussion. **Figure 16** shows 30% excerpts covering issues with approach, 34% covering recommendations, 16% covering issues with terminologies, 15% covering issues with implementation, and 5% covering issues with existing research. **Figure 17** shows that out of all the documents in our corpus, 30% discuss issues with approach, 16% discuss issues with terminologies, 15% discuss issues with implementation, 5% discuss issues with existing research, and 34% highlight recommendations to fill these gaps. **Table 3** and **Table 4** show the concept matrix and summary under each of the six discussion themes in our corpus.

The areas of future research, which are highly recommended tobe included in the SUD strategies, are listed in **Table 5.** As a holistic vision for smart cities, it is imperative that urban planners and policy

Figure 15. LDA topic model results for paired words

Figure 16. Themes of discussion covered in database

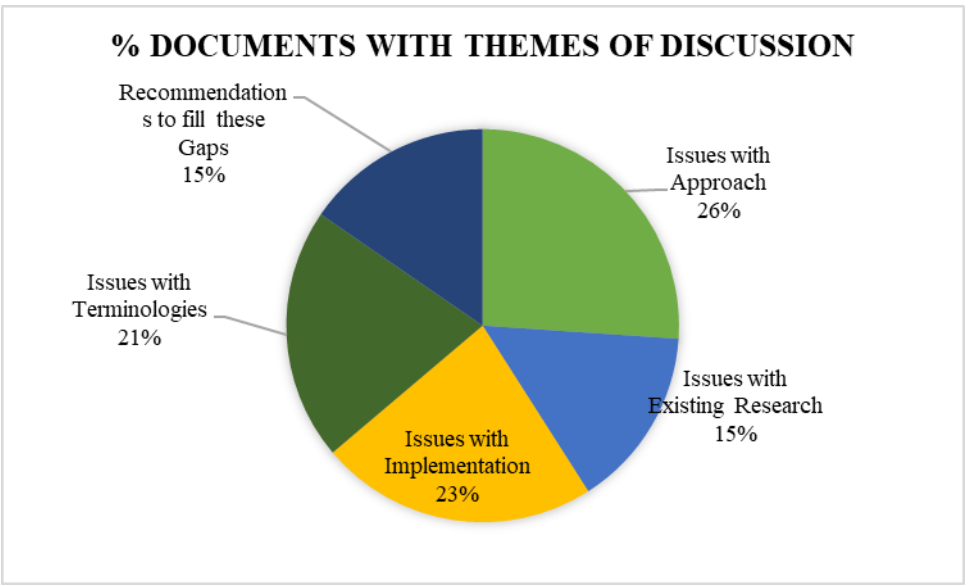


Figure 17. Themes of discussion covered in extracted excerpts

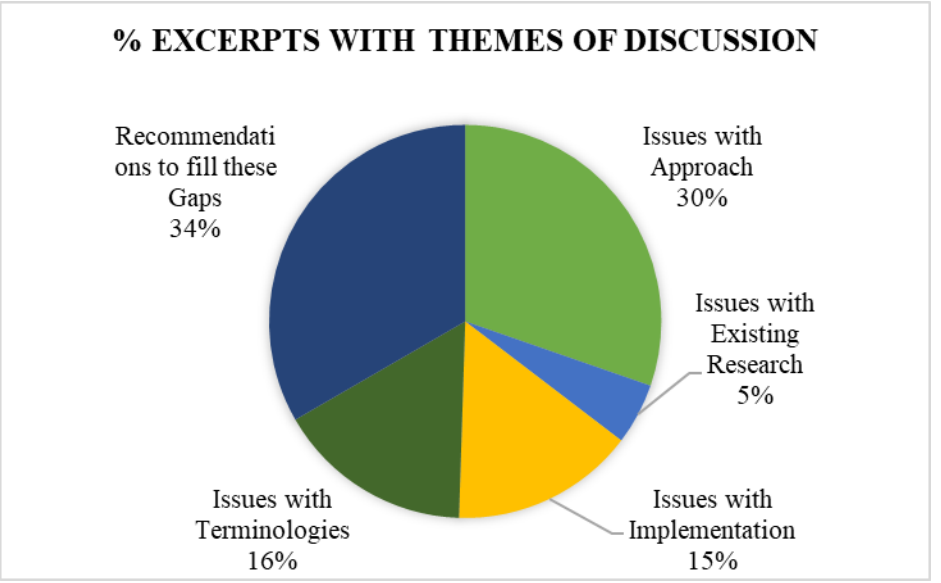


Table 3. Concept matrix

References	Discussion Themes				
	Issues with Approach	Issues with Existing Research	Issues with Terminologies	Issues with Implementation	Recommendations to fill Existing Gaps
(Ahvenniemi et al., 2017)	X	X	X	X	
(Al Nuaimi et al., 2015)			X	X	
(Alawadhi et al., 2012)			X		
(Albino et al., 2015)	X	X	X	X	X
(Alderete, 2020)	X	X	X	X	X
(Allwinkle & Cruickshank, 2011)	X	X	X		X
(Angelidou, 2014)	X	X	X	X	X
(Angelidou, 2015)	X	X	X	X	X
(Angelidou, 2017)	X	X	X	X	X
(Aurigi & Odendaal, 2020)	X	X	X	X	X
(Baron, 2012)			X		X
(Batty et al., 2012)				X	
(Ben Letaifa, 2015)	X			X	
(Bibri, 2018)	X		X	X	
(Caragliu & Del Bo, 2016)	X	X		X	X
(Caragliu et al., 2011)	X		X	X	
(Castelnovo, 2016)	X	X	X		

References	Discussion Themes				
	Issues with Approach	**Issues with Existing Research**	**Issues with Terminologies**	**Issues with Implementation**	**Recommendations to fill Existing Gaps**
(Chourabi et al., 2012)	X	X	X	X	
(Claire. & Catherine., 2014)	X	X	X		X
(Cocchia, 2014)	X	X	X	X	X
(Datta, 2015)	X		X		X
(Deakin & Al Waer, 2011)	X		X		X
(Garau & Pavan, 2018)	X				
(Garcia-Ayllon & Miralles, 2015)	X	X	X	X	X
(Glasmeier & Christopherson, 2015)	X	X		X	X
(Harrison & Donnelly, 2011)	X	X	X		X
(Höjer & Wangel, 2015)	X		X		
(Ibrahim et al., 2018)			X		
(K. Harrison, 2017)	X		X	X	
(Kitchin, 2014)	X				
(Kitchin, 2015)	X	X	X	X	X
(Joss et al., 2019)			X		
(Khansari et al., 2014)	X		X		
(Kourtit & Nijkamp, 2012)		X		X	X
(Lam & Ma, 2019)	X			X	X
(Lazaroiu & Roscia, 2012)				X	
(L. G. Anthopoulos & Vakali, 2012)	X				
(L. G. Anthopoulos et al., 2015)				X	
(L. Anthopoulos et al., 2016)				X	
(L. G. Anthopoulos et al., 2016)	X		X	X	
(L. G. Anthopoulos, 2017)	X		X		
(L. Anthopoulos, 2017)	X		X	X	
(Lim et al., 2019)				X	
(Lombardi et al., 2012)	X	X	X	X	X
(Martin et al., 2018)	X			X	
(Meijer et al., 2015)	X	X	X	X	X
(Mora et al., 2017b)	X	X	X	X	X
(Nam & Pardo, 2011)	X		X		X

References	Discussion Themes				
	Issues with Approach	Issues with Existing Research	Issues with Terminologies	Issues with Implementation	Recommendations to fill Existing Gaps
(Neirotti et al., 2014)	X	X	X	X	X
(Odendaal, 2016)	X			X	
(Ojo et al., 2016)	X	X	X		
(Prado et al., 2016)		X	X	X	X
(Dameri, 2013)	X	X	X	X	
(Santoso & Kuehn, 2013)	X			X	X
(Shelton, Zook, et al., 2014)	X		X	X	X
(Söderström et al., 2014)	X		X		X
(Trindade et al., 2017)		X			
(Thite, 2011)	X		X		
(Vanolo, 2013)	X	X	X		
(Winters, 2011)	X	X	X	X	X
(Yigitcanlar, 2015)	X			X	
(Zygiaris, 2013)	X				

Table 4. Summaries under each theme

Theme of Discussion	Summary
Approach	The concept is theoretical, market-oriented, and business-led. The approach is inconsistent, lacking the needs of its communities, culture, human capital, environmental and socio-economic aspects; privileging some people, places, and activities over others. There is no one size fits all approach, which can reach its goals by blindly relying on ICT. Disconnected spatial technological fixes can aggravate urban issues of segregation, polarization, class inequality, and digital divide.
Existing Research	Existing research on smart cities is fragmented, divergent, and lacks cohesion. It does not discuss the pros and cons of sector-based and geographical strategies of development. A systematic theoretical study about this phenomenon is missing.
Implementation	There is a singular focus on ICT based technology oriented strategies, not taking into account the existing conditions. Isolated pieces of empirical evidence exist, which are mostly hypothetical. Most of the smart interventions are too ambitious and demand tremendous investments, and large-scale expansion.
Terminologies	The term is too broad, elusive, ambiguous, and fuzzy with no universal consensus. Word Smart is mostly used as an instrumental concept and not as a normative concept. The foundation of capital accumulation and branding is laid down around building new urban utopias.
Recommendations	The concept of smart communities and smart territories is more consistent with SUD's goals. There should be more focus on social, physical, environmental, cultural, spatial and territorial dimensions of people, places and communities.

Table 5. Research areas to fill the current gaps

SNo	Critical Factors	Source
1	Environment	(Ahvenniemi et al., 2017; Albino et al., 2015; Allwinkle & Cruickshank, 2011; Caragliu et al., 2011; Claire. & Catherine., 2014; Cocchia, 2014; Glasmeier & Christopherson, 2015; K. Harrison, 2017)
2	Physical aspects	(Ahvenniemi et al., 2017; Angelidou, 2014, 2015a; Baron, 2012; K. Harrison, 2017; Sharifi, 2020; Shelton, Matthew., et al., 2014; Vanolo, 2013; Yigitcanlar, 2015)
3	Local context, history and culture	(Albino et al., 2015; Allwinkle & Cruickshank, 2011; Angelidou, 2014, 2015b; Baron, 2012; Castelnovo, 2016; Claire. et al., 2014; Cocchia, 2014b; Dameri, 2013; Deakin & Al Waer, 2011; Garcia-Ayllon & Miralles, 2015; Glasmeier & Christopherson, 2015; K. Harrison, 2017; Mora et al., 2017b; Neirotti et al., 2014; Prado et al., 2016; Shelton, Matthew., et al., 2014; Winters, 2011)
4	People, and community	(Albino et al., 2015; Allwinkle & Cruickshank, 2011; Angelidou, 2014, 2015; Aurigi & Odendaal, 2020; L. G. Anthopoulos et al., 2016; L. G. Anthopoulos, 2017; Baron, 2012; Caragliu & Del Bo, 2016; Castelnovo, 2016; Claire. & Catherine., 2014; Cocchia, 2014; Deakin & Al Waer, 2011; Garcia-Ayllon & Miralles, 2015; K. Harrison, 2017; Lombardi et al., 2012; Mora et al., 2017b; Nam & Pardo, 2011; Neirotti et al., 2014; Ojo et al., 2016; Prado et al., 2016; Söderström et al., 2014; Taylor. et al., 2014; Vanolo, 2013; Winters, 2011)
5	Human capital	(Caragliu & Del Bo, 2016; Claire. & Catherine., 2014; Garcia Silva et al., 2016; K. Harrison, 2017; Mora et al., 2017b; Nam & Pardo, 2011; Neirotti et al., 2014; Shelton, Matthew., et al., 2014)
6	Territory	(Angelidou, 2014, 2015; Aurigi & Odendaal, 2020; Claire. & Catherine., 2014; Renata Paola Dameri, 2013; Deakin & Al Waer, 2011; Garcia-Ayllon & Miralles, 2015; Neirotti et al., 2014; Taylor. et al., 2014)
7	Urban form and planning	(Albino et al., 2015; Allwinkle & Cruickshank, 2011; Angelidou, 2014, 2015a; Caragliu et al., 2011; Chourabi et al., 2012; Deakin & Al Waer, 2011; Glasmeier & Christopherson, 2015; K. Harrison, 2017; Kitchin, 2015; Mora et al., 2017a; Neirotti et al., 2014; Prado et al., 2016; Shelton, Matthew., et al., 2014; Söderström et al., 2014; Vanolo, 2013; Yigitcanlar, 2015; Zygiaris, 2013)
8	Economics	(Ahvenniemi et al., 2017; Albino et al., 2015; Allwinkle & Cruickshank, 2011; Claire. & Catherine., 2014; Cocchia, 2014a; Glasmeier & Christopherson, 2015; Mora et al., 2017; Neirotti et al., 2014; Winters, 2011)

makers do not adopt piecemeal strategies but rather focus on an integrated approach. Such cohesive approach should include all the essential urban components while designing our cities, whether it be environmental goals or socio-cultural goals or economic goals.

Most of the scholars have recommended including communities and social aspects (23%) into SUD framework, followed by cultural aspects/local context/background conditions (17%), urban planning (17%), environmental aspects (12%), and built environment/physical aspects (9%). A word cloud generated using the BoW model as given in **Figure 19** illustrates higher importance to be given to urban and physical spaces and their social components for inclusion in the SUD framework. **Figure 18** and **Figure 20** show that socio-cultural and physical aspects are the critical factors that should be included while framing SUD strategies to meet its objectives.

5. CONCLUSIONS

Urbanism is a way of life (Santoso & Kuehn, 2013), and city making is a process in which varied urban experiences and cultural patterns result in social, economic, political, and physical urban components unique to a human settlement system (Tonkiss, 2013). However, there is a global tendency to overlook

Figure 18. gaps to be filled

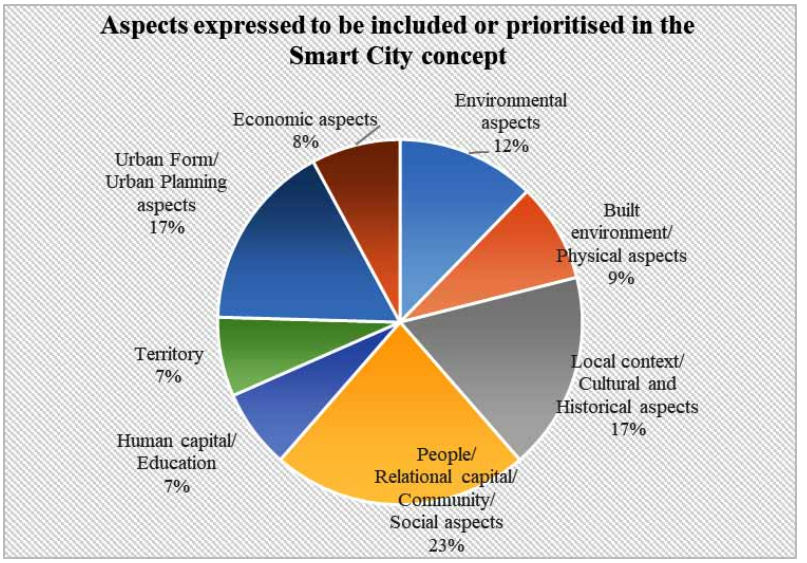
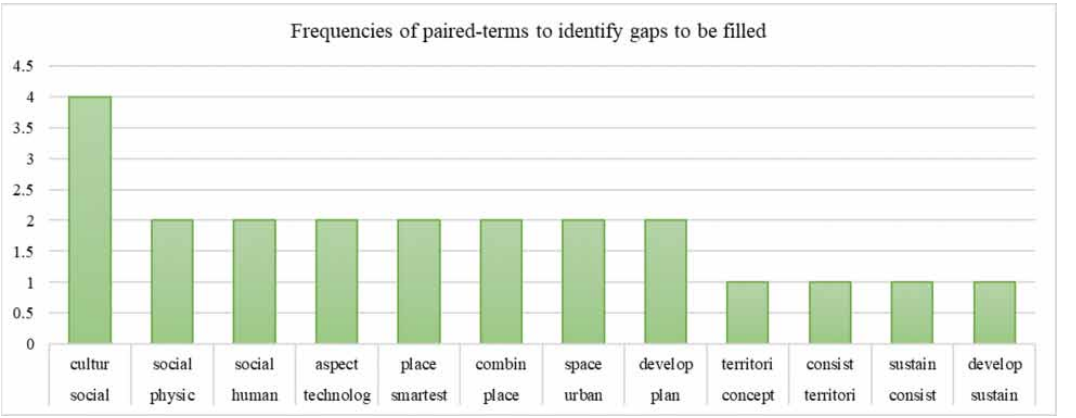


Figure 19. word cloud showing gaps

the 'City' component from the concept of 'Smart Cities' and easily get allured by the grandiose visions of modernisation (Castelnovo, 2016). incorporating a digital vision and technological fixes may give skewed results to critical urban issues (Aurigi & Odendaal, 2020)

Smart city initiatives mostly emphasise the ICT-based infrastructure, neglecting the role of social capital, local culture, built-up environment, and spatial characteristics (K. Harrison, 2017; Mora et al., 2017; Caragliu, et al., 2011; Nam & Pardo, 2011). However, the physical and socio-cultural geography should be the common denominator to define the scope of such initiatives at the level of buildings or neighbourhoods or cities (Garcia-Ayllon & Miralles, 2015). The two research objectives

Figure 20. Frequencies of paired-words to identify gaps to be filled



of this study are to identify the key-terms associated with the objectives of SUD and to understand the gaps for formulating a holistic and integrated SUD framework.

Grounded-theory and text-analytics are used for the meta-synthesis of 65 peer-reviewed academic publications produced over the last decade. The automated text analysis algorithm for meta-synthesis is a novel approach for analyzing a diverse concept like smart cities, by eliminating chances of human biases and errors. The text analytics cluster the key-terms associated with the objectives of SUD under five themes-quality of life, sustainable economic growth, overall urban sustainability, social inclusion, and integrated citizen services. The gaps stated in the current research point towards integrating critical factors such as socio-cultural and territorial dimensions into a strategic SUD framework.

Although the methodology adopted for the systematic literature review and meta-synthesis is novel in its approach, it has few limitations. The approach is quite exhaustive, data intensive and requires an expert domain knowledge to substantiate the overall findings. People interpret the term smart in different ways- for some it is just the environmental goals while for others it is an ICT-driven urban solution. The study explicitly limits the focus of the study to their goals irrespective of the means of achieving these goals, whether it be by means of urban design interventions or technological spatial fixes. Future research on smart cities should explore non-technical attributes of a city and find practical ways to capitalise on its existing resources.

ACKNOWLEDGMENT

The study was undertaken with the constant funding support of the Ministry of Human Resources Development (MHRD). We thank all the reviewers and editors for their expert suggestions and comments.

REFERENCES

Al Nuaimi, E., Al Neyadi, H., Mohamed, N., & Al-Jaroodi, J. (2015). Applications of big data to smart cities. *Journal of Internet Services and Applications*, *6*(1), 1–15. doi:10.1186/s13174-015-0041-5

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology*, *22*(1), 3–21. doi:10.1080/10630732.2014.942092

Alderete, M. V. (2020). Exploring the Smart City Indexes and the Role of Macro Factors for Measuring Cities Smartness. *Social Indicators Research*, *147*(2), 567–589. doi:10.1007/s11205-019-02168-y

Angelidou, M. (2014). Smart City policies: A Spatial approach. *Cities (London, England)*, *41*, 3–11. doi:10.1016/j.cities.2014.06.007

Angelidou, M. (2017). The Role of Smart City Characteristics in the Plans of Fifteen Cities. *Journal of Urban Technology*, *24*(4), 3–28. doi:10.1080/10630732.2017.1348880

Anthopoulos, L. G. (2017). The Rise of the Smart City. In *Understanding Smart Cities: A Tool for Smart Government or an Industrial Trick?* (Vol. 15). Springer International Publishing. doi:10.1007/978-3-319-57015-0

Anthopoulos, L. G., Janssen, M., & Weerakkody, V. (2016). A Unified Smart City Model (USCM) for smart city conceptualization and benchmarking. *International Journal of Electronic Government Research*, *12*(2), 77–93. doi:10.4018/IJEGR.2016040105

Aurigi, A., & Odendaal, N. (2020). From "Smart in the Box" to "Smart in the City": Rethinking the Socially Sustainable Smart City in Context. *Journal of Urban Technology*, *0*(0), 1–16. doi:10.1080/10630732.2019.1704203

Caragliu, A., del Bo, C., Nijkamp, P., Del Bo, C., & Nijkamp, P. (2011). Smart Cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82. doi:10.1080/10630732.2011.601117

Caragliu, A., & Del Bo, C. F. (2016). Do Smart Cities Invest in Smarter Policies? Learning From the Past, Planning for the Future. *Social Science Computer Review*, *34*(6), 657–672. doi:10.1177/0894439315610843

Castelnovo, W. (2016). Co-production makes cities smarter: Citizens' participation in smart city initiatives. In *E-Participation in Smart Cities: Technologies and Models of Governance for Citizen Engagement* (pp. 97–117). Springer., doi:10.1007/978-3-319-30558-5_7

Cocchia, A. (2014). Smart City: How to Create Pubic and Economic Value with High Technology in Urban Space. In R. P. Dameri & C. R. Sabroux (Eds.), *Smart City How to Create Public and Economic Value with High Technology in Urban Space* (Vol. 8). Springer International Publishing., doi:10.1007/978-3-319-06160-3

Dameri, R. P. (2013). Searching for Smart City definition: A comprehensive proposal. *International Journal of Computers and Technology*, *11*(5), 2544–2551. doi:10.24297/ijct.v11i5.1142

Das, D. (2020). In pursuit of being smart? A critical analysis of India's smart cities endeavor. *Urban Geography*, *41*(1), 55–78. doi:10.1080/02723638.2019.1646049

Datta, A. (2015). A 100 smart cities, a 100 utopias. *Dialogues in Human Geography*, *5*(1), 49–53. doi:10.1177/2043820614565750

de Jong, M., Joss, S., Schraven, D., Zhan, C., & Weijnen, M. (2015). Sustainable-smart-resilient-low carbon-eco-knowledge cities; Making sense of a multitude of concepts promoting sustainable urbanization. *Journal of Cleaner Production*, *109*, 25–38. doi:10.1016/j.jclepro.2015.02.004

Deakin, M., & Al Waer, H. (2011). From intelligent to smart cities. *Intelligent Buildings International*, *3*(3), 133–139. doi:10.1080/17508975.2011.586673

Dhingra, M., & Chattopadhyay, S. (2016). Advancing Smartness of Traditional Settlements- Case Analysis of Indian and Arab old cities. *International Journal of Sustainable Built Environment*, *5*(2), 549–563. doi:10.1016/j.ijsbe.2016.08.004

Dhingra, M., & Chattopadhyay, S. (2017). Exploring the Real Smartness in an Urban Context through a deductive the Real Urban Smartness). In H. Wang & S. Ledwon (Eds.), *53rd ISOCARP Congress* (pp. 642–652). ISOCARP.

Fabbrizzi, S., Maggino, F., Marinelli, N., Menghini, S., Ricci, C., & Sacchelli, S. (2016). Sustainability and Food: A Text Analysis of the Scientific Literature. *Agriculture and Agricultural Science Procedia*, *8*, 670–679. doi:10.1016/j.aaspro.2016.02.077

Finfgeld-Connett, D. (2018). *A guide to qualitative meta-synthesis*. Routledge Journals, Taylor & Francis Ltd.

Garau, C., & Pavan, V. M. (2018). Evaluating urban quality: Indicators and assessment tools for smart sustainable cities. *Sustainability*, *10*(3), 575. Advance online publication. doi:10.3390/su10030575

Garcia-Ayllon, S., & Miralles, J. L. (2015). New Strategies to Improve Governance in Territorial Management: Evolving from "smart Cities" to "smart Territories.". *Procedia Engineering*, *118*, 3–11. doi:10.1016/j.proeng.2015.08.396

Glasmeier, A., & Christopherson, S. (2015). Thinking about smart cities. *Cambridge Journal of Regions, Economy and Society*, *8*(1), 3–12. doi:10.1093/cjres/rsu034

Grant, M. J., & Booth, A. (2009). A typology of reviews : An analysis of 14 review types and. *Health Information and Libraries Journal*, *26*(2), 91–108. doi:10.1111/j.1471-1842.2009.00848.x PMID:19490148

Harrison, C., & Donnelly, I. A. (2011). A Theory of Smart Cities. *Proceedings of the 55th Annual Meeting of the International Society for the Systems Sciences*, 1–15.

Harrison, K. (2017). Who Is the Assumed User in the Smart City? In V. Angelakis, E. Tragos, H. C. Poehls, A. Kapovits, & A. Bassi (Eds.), Designing, Developing, and Facilitating Smart Cities (pp. 17–33). Springer International Publishing. doi:10.1007/978-3-319-44924-1_2

Higgins, J., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M., & Welch, V. (Eds.). (2019). *Cochrane Handbook for Systematic Reviews of Interventions version 6.0 (updated July 2019)*. Cochrane. Available from www.training.cochrane.org/handbook

Hoelscher, K. (2016). The evolution of the smart cities agenda in India. *International Area Studies Review*, *19*(1), 28–44. doi:10.1177/2233865916632089

Hollands, R. G. (2015). Will the real smart city please stand up? *City*, *12*(May), 303–320. doi:10.1080/13604810802479126

International Telecommunication Union Focus Group on Smart Sustainable Cities. (2014). *Overview of key performance indicators in smart sustainable cities*. Author.

Kitchin, R. (2015). Making sense of smart cities: Addressing present shortcomings. *Cambridge Journal of Regions, Economy and Society*, *8*(1), 131–136. doi:10.1093/cjres/rsu027

Kummitha, R. K. R., & Crutzen, N. (2017). How do we understand smart cities? An evolutionary perspective. *CITIES, 67*(July), 43–52. 10.1016/j.cities.2017.04.010

Lee, P., Kleinman, G., & Kuei, C. (2020). Using text analytics to apprehend urban sustainability development. *Sustainable Development*, *28*(January), 1–25. doi:10.1002/sd.2045

Lim, Y., Edelenbos, J., & Gianoli, A. (2019). Identifying the results of smart city development : Findings from systematic literature review. *Cities (London, England)*, *95*(July), 102397. Advance online publication. doi:10.1016/j.cities.2019.102397

Lombardi, P., Giordano, S., Farouh, H., & Yousef, W. (2012). Modelling the smart city performance. *Innovation (Abingdon)*, *25*(2), 137–149. doi:10.1080/13511610.2012.660325

Martin, C. J., Evans, J., & Karvonen, A. (2018). Smart and sustainable? Five tensions in the visions and practices of the smart-sustainable city in Europe and North America. *Technological Forecasting and Social Change*, *133*, 269–278. doi:10.1016/j.techfore.2018.01.005

Mora, L., Bolici, R., & Deakin, M. (2017). The First Two Decades of Smart-City Research: A Bibliometric Analysis. *Journal of Urban Technology*, *24*(1), 3–27. doi:10.1080/10630732.2017.1285123

Nam, T., & Pardo, T. A. (2011). Conceptualizing Smart City with Dimensions of Technology, People, and Institutions. *The Proceedings of the 12th Annual International Conference on Digital Government Research*, 282–381. doi:10.1145/2037556.2037602

Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., & Scorrano, F. (2014). Current trends in smart city initiatives: Some stylised facts. *Cities (London, England)*, *38*, 25–36. doi:10.1016/j.cities.2013.12.010

Ojo, A., Dzhusupova, Z., & Curry, E. (2016). Smarter as the New Urban Agenda. In J. R. Gil-Garcia, T. A. Pardo, & T. Nam (Eds.), Smarter as the new urban agenda: A comprehensive view of the 21st century city (Vol. 11, pp. 73–85). Springer International Publishing. doi:10.1007/978-3-319-17620-8

Prado, A. L., Da Costa, E. M., Furlani, T. Z., & Yigitcanlar, T. (2016). Smartness that matter: Towards a comprehensive and human-centred characterisation of smart cities. *Journal OfOpen Innovation: Technology, Market, and Complexity*, *2*(8), 1–13.

Rajput, S., & Arora, K. (2017). Sustainable Smart Cities in India: Challenges and Future Perspectives. *Springer*. doi:10.1007/978-3-319-47145-7_23

Romanelli, M. (2020). Towards Cities as Communities. In Y. Baghdadi, A. Harfouche, & M. Musso (Eds.), *ICT for an Inclusive World: Industry 4.0—Towards the Smart Enterprise* (pp. 125–132). Springer International Publishing. doi:10.1007/978-3-030-34269-2_10

Santoso, S., & Kuehn, A. (2013). Intelligent urbanism: Convivial living in smart cities. *IConference*. Advance online publication. doi:10.9776/13278

Sebestyén, V., Domokos, E., & Abonyi, J. (2020). Focal points for sustainable development strategies—Text mining-based comparative analysis of voluntary national reviews. *Journal of Environmental Management*, *263*, 110414. Advance online publication. doi:10.1016/j.jenvman.2020.110414 PMID:32174539

Selvakanmani, S. (2015). Smart City – The Urban Intelligence of India. *International Journal for Research in Applied Science and Engineering Technology*, *3*(6), 302–307.

Sharifi, A. (2020). A typology of smart city assessment tools and indicator sets. *Sustainable Cities and Society*, *53*, 101936. doi:10.1016/j.scs.2019.101936

Tonkiss, F. (2013). Cities by Design: the Social Life of Urban Form. In *Polity Press*. Polity Press.

Trindade, E. P., Hinnig, M. P. F., da Costa, E. M., Marques, J. S., Bastos, R. C., & Yigitcanlar, T. (2017). Sustainable development of smart cities: A systematic review of the literature. *Journal of Open Innovation*, *3*(11), 11. Advance online publication. doi:10.1186/s40852-017-0063-2

United Nations Department of Economic and Social Affairs. (2019). *World Population Prospects 2019: Highlights*. Author.

Vom Brocke, J., Simons, A., Niehaves, B., Riemer, K., Plattfaut, R., & Cleven, A. (2009). Reconstructing the giant: On the importance of rigour in documenting the literature search process. *17th European Conference on Information Systems, ECIS 2009*, 161.

Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *Management Information Systems Quarterly*, *26*(2), xiii–xxiii. doi:10.1016/j.freeradbiomed.2005.02.032

Wehnert, P., Kollwitz, C., Daiberl, C., Dinter, B., & Beckmann, M. (2018). Capturing the bigger picture? Applying text analytics to foster open innovation processes for sustainability-oriented innovation. *Sustainability (Switzerland)*, *10*(10), 3710. Advance online publication. doi:10.3390/su10103710

Wolfswinkel, J. F., Furtmueller, E., & Wilderom, C. P. M. (2013). Using grounded theory as a method for rigorously reviewing literature. *European Journal of Information Systems*, *22*(1), 45–55. doi:10.1057/ejis.2011.51

Yigitcanlar, T. (2015). Smart cities: An effective urban development and management model? *Australian Plants*, *52*(1), 27–34. doi:10.1080/07293682.2015.1019752

Mani Dhingra received her Ph.D. from the Department of Architecture and Regional Planning at Indian Institute of Technology, Kharagpur, India in 2022. Her specialization is in sustainable urban planning, traditional urban systems, computation for social sciences, fuzzy logic in urban planning, spatial analysis and urban policymaking. She has over ten years of experience in dealing with issues and datasets concerning urban sustainability, climate change, social sciences, disaster resilience, inclusive cities, traditional settlements and smart cities. She has also worked as a research scholar in Research unit "Urban Housing and Development" of Institute Entwerfen von Stadt und Landschaft (ISEL) at Karlsruhe Institute of Technology (KIT) under DAAD scholarship. The present study is a part of her Ph.D. research.

Subrata Chattopadhyay received his PhD from the Department of Architecture and Regional Planning at Indian Institute of Technology, Kharagpur, India. He studied housing at University of Lund, Sweden and Newcastle University, UK. He has worked on diverse research and consultancy projects over a span of more than 35 years. Currently, he is the Professor and Dean (Alumni Affairs) at Indian Institute of Technology, Kharagpur, India. His broad research areas are housing and community planning, peri-urban dynamics, energy efficient and affordable housing, mixed-use development, and urban heat island impacts.