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Smart Cities: A Review and Analysis of Stakeholders' Literature

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Abstract Recent literature on smart cities stresses the role of digitization in tackling urban issues such as environmental degradation and poverty. The wicked nature of these issues gives rise to the need to understand the diverse perspectives of relevant stakeholder groups on smart cities. However, existing research that compares these perspectives tends to exclude the beliefs of those living in smart cities. Integrating these beliefs in smart city discourses is paramount to increase the likelihood that these systems will be accepted. With the view that the literature consumed by an audience will influence that audience's perspectives, the main aim of this study is to compare and contrast the pertinent topics found in various types of literature on smart cities. Using an innovative approach of literature comparison, based on a semantic entity annotator and keyword analysis, this article extracts and compares topics in news media (for citizens), trade publications (for businesses), academic articles (for research organizations) and government reports (for governments). The findings suggest that citizens tend to be under-represented in discussions on smart cities and highlight those topics considered relevant only by smart city citizens. Increased understanding in this area can help guide discussions and policies that are relevant for all stakeholders.

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1 Introduction

As cities worldwide become ever larger and more complex, planning bodies of cities around the world have begun to view digitization as a solution to pressing urban issues (Hollands 2008, 2015). In this context, the development of smart cities has been increasingly viewed as a way to achieve the needs for long-run economic growth, high quality urban services, improved transportation linkages and mixed land-use (Albino et al. 2015). As discussions about smart cities have increasingly influenced the development of cities around the world, the concept has become ever more popular in scientific literature and international policies (Albino et al. 2015).

Recent literature on smart cities (Nam and Pardo 2011; Goodspeed 2014) stresses the role of digitizing cities to tackle some of the wicked problems currently faced in large urban environments. Wicked problems are characterized by evolving requirements and constraints, complex interactions among subparts of the problem, malleable design processes and artifacts, and a critical dependence upon human cognitive abilities (for example, creativity) and social abilities (for example, teamwork) to develop effective solutions (Hevner and Chatterjee 2010). These aspects can all be applied to the issue of smart cities. As a result of the wicked nature of the problems that smart cities seek to address, such as poverty and environmental degradation, their solutions cover many different areas of urban life, including administration, transport, education, and energy (Chourabi et al. 2012). Both the problems and

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the proposed solutions are interconnected, impact many different stakeholder groups, including both the public and private sector, and often change rapidly. Understanding a phenomenon such as smart cities also demands knowledge not only of the technical artifacts (such as the digital resources that are to be developed) but also of contextual and organizational influences (including human influences) and how these aspects are interconnected (Hollands 2008).

In this context, the importance of understanding the diverse perspectives of relevant stakeholder groups is emphasized. Such an understanding increases the potential for future discourse on smart cities to incorporate a greater range of relevant perspectives. However, the existing attempts to examine and compare the various beliefs about smart cities tend to either only focus on citizens (Thomas et al. 2016) or to focus on other stakeholder groups instead (Dameri 2013). Moreover, a branch of the literature argues that the current discourse on smart cities is often not inclusive, particularly with regards to the perspectives of the people living in smart cities (Hollands 2008; Vanolo 2014). In response, this study aims to compare and contrast the topics of relevance to different stakeholder groups, namely citizens, businesses, research organizations and governments, by analyzing the types of literature consumed by these groups. These stakeholder groups are, of course, closely interrelated; however, this article begins with the distinction that citizens are "all persons who live in the city either permanently or in transit" (UNESCO 2014, p. 2). A part of these citizens' lives may then be spent in a larger organization such as a business, research organization, or government group. The study also seeks to understand the extent to which the topics that are relevant for citizens are currently being incorporated in other discourses on smart cities.

As the literature aimed at a particular audience will likely influence their thoughts and behaviors (McCombs and Shaw 1972; Carroll and McCombs 2003), it follows that one way of identifying the perspectives of the diverse smart city stakeholder groups is to explore relevant types of literature. With this background, we argue that news media, trade publications, academic articles, and government reports can represent the views and perspectives of citizens, businesses, research organizations, and governments, respectively. To extract the relevant topics in these literature types, the study first uses a semantic entity annotator. Keyword analysis is then applied to identify the similarities and differences in the extracted topics and, by extension, in the perspectives of relevant stakeholder groups on the topic of smart cities. Throughout the study, emphasis is placed on understanding how the topics considered of relevance to citizens contrast with those deemed important for other stakeholder groups.

The following sections commence with a literature review focused on exploring smart cities in terms of existing perspectives on the topic and the key stakeholders. In the methodology section, we discuss the novel methodology used to compare their perspectives. The results section comprises three distinct stages. First, we use the methodology to identify lists of relevant topics for each of the stakeholder groups. A first examination of these topic lists reveals the topics that are considered relevant by all groups. The framework devised by Giffinger et al. (2007) then enables us to understand the extracted topics in terms of broader domains central to smart cities. Finally, we examine the views of citizens in detail by exploring topics that are systematically under-represented or excluded from other literature. The article concludes with a discussion of the main findings.

2 Literature Review

2.1 Discussions of Smart Cities

Several definitions for smart cities exist, with the term being called a fuzzy concept and used in ways that are not always consistent (Caragliu et al. 2011; Angelidou 2015). However, according to Angelidou (2015), there exist two main streams in current smart city discussions: the technology-oriented approach and the people-oriented approach. Extensive literature highlights the first approach, based primarily on Information and Communication Technology (ICT) (Jucevičius et al. 2014; Paroutis et al. 2014). In this literature, the term smart cities is used to refer to implementing and using ICTs to analyze and respond to city activities (Kitchin 2014). Smart cities are argued to be equipped with digital devices and a digital infrastructure that produces extensive amounts of big data (Jucevičius et al. 2014). This part of the literature focuses on such aspects as the use of innovative transport systems and efficient energy systems (Lombardi et al. 2012), arguing that the digital dimension dominates other features of smart cities (Jucevičius et al. 2014). The emphasis is primarily placed on corporations, with technologies understood as a strategic option for meeting corporate needs (Paroutis et al. 2014) and as a way of fostering increased prosperity, competitiveness and effectiveness (Angelidou 2014).

Compared with this view, the people-oriented approach focuses more on the role of human capital, including the needs of people and communities (Albino et al. 2015), in advancing smart cities, resulting in enhanced social, economic and environmental sustainability (Giffinger et al. 2007; Hollands 2008; Nam and Pardo 2011; Neirotti et al. 2014; Hollands 2015). Caragliu et al. (2011), for instance,

argue that smart cities use participatory governance approaches to invest in human and social capital as well as transport and ICT infrastructure, with the aim of achieving economic growth, a high quality of life and responsible management of natural resources. This part of the literature on smart cities is broader in its approach, encapsulating both urban planning and urban development. Whereas urban planning is associated with initiatives taken by cities to become smart (in which technology plays a role) (Albino et al. 2015), urban development is concerned with creating designs for future urban regions (Angelidou 2015).

For the purpose of this article, we use the definition of smart cities proposed by Giffinger et al. (2007). In this definition, a smart city is viewed as one that is effective and efficient in the following six domains: smart economy, smart people, smart governance, smart mobility, smart environment and smart living. Rather than simply being characterized by new technological developments, we view "true" smart cities to also take into account the importance of education, culture, governance and quality of life. The smart city domains identified by Giffinger et al. (2007) are explained in more detail below.

- *Smart economy* Competitiveness, including innovation, entrepreneurship, productivity, the labor market and international commerce linkages.
- *Smart governance* Participation in decision-making, with a focus on political strategies and perspectives.
- *Smart mobility* ICT and transport, including IT-infrastructure availability, local, national and international accessibility and transport systems.
- *Smart environment* Natural resources, such as sustainable resource management, environmental protection, pollution and attractiveness of environmental conditions.
- *Smart living* Quality of life, such as cultural, housing and education facilities, health conditions, tourism, social cohesion and safety.
- *Smart people* Social and human capital, including qualifications and learning as well as creativity, cosmopolitanism, community participation and flexibility.

To understand the complexity of smart cities, there is a need for broader discussions on the topic, involving a wide range of stakeholder groups (Nam and Pardo 2011), such as citizens, businesses, research organizations and governments. However, critical attempts to understand the perspectives of diverse stakeholder groups is lacking in the literature on smart cities. To identify the perspectives and beliefs of citizens on smart cities, Thomas et al. (2016) surveyed citizens living in three smart cities in the UK. The hope of the authors was to initiate a discussion regarding the necessity of considering the perspectives of citizens in

designing smart cities. However, this study is based on an extremely small sample size and lacks a comprehensive discussion of how the identified perspectives compare with the views of other smart city stakeholders. While some other papers seek to compare different literature types, there are only a few publications of this type and none incorporate the views of citizens. For example, in an attempt to propose a definition for smart cities, Neirotti et al. (2014) compare academic and practitioner literature while Dameri (2013) examines academic literature, publications from such public organizations as the EU and the OECD and reports from private sector vendors and consultants. Further, Lombardi et al. (2012) measure the performance of smart cities by using a triple helix model to understand the relationships between key stakeholders. In this article, universities, industries and governments form the main stakeholders: the role of citizens is not included.

Together, the studies included in this literature review indicate that there is a need for an increased understanding of the various perspectives on smart cities, including those held by citizens.

3 Methodology

3.1 Motivation for the Methodology

Several academic papers explore the role of different types of literature, such as news media, in influencing both the topics that are of importance to their respective audiences and how their audiences think about these topics (McCombs and Shaw 1972; Carroll and McCombs 2003; McCombs et al. 2014; Vargo et al. 2014). Instead of being a passive distributor of information, the literature read by an audience can shape its audience's beliefs and behaviors (Carroll and McCombs 2003; McCombs et al. 2014). This process may occur through the literature placing prominent attention on certain subjects, such as public issues, public figures and institutions, and discussing these objects in a particular way. The audience may then use these prominence cues to decide which issues, persons or other objects should be thought about and in which way (McCombs and Shaw 1972).

As a result, it can be argued that the discussions evident in different types of literature on smart cities reflect the topics of relevance for their respective audiences. These literature types can be argued to be news media (for citizens), practitioner publications (for businesses), academic articles (for research organizations) and government reports (for governments). It follows that an understanding of the perspectives of these stakeholder groups on smart cities can be gained by examining how such literature frames smart cities.

3.2 Application of the Methodology

The methodology used in this study involved two main stages. The first stage, the application of a semantic entity annotator (SEA), involved extracting key topics from news media articles, practitioner publications, academic articles and government reports on the topic of smart cities. Using keyword analysis, the lists of topics were compared with the aim of determining the topics that are salient in one literature when compared with the other types of literature. For this study, the term 'salient' refers to topics that are mentioned a statistically significant number of times by a particular literature and can thus be considered as relevant for that literature.

Figure 1 provides an overview of the stages involved in our methodology. The following section explores the different stages involved in the methodology.

3.2.1 Identification and Screening

The stakeholders included in our study are citizens (the people who use the smart city services), businesses (those who create smart city services), research organizations (those who research smart city services) and governments (those who develop the policies on smart cities). The term citizens is used in this study as it is the term used by other academic articles on the topic (Lee and Lee 2014; Thomas et al. 2016). For each literature, we used the terms "smart city" and "smart cities" in our keyword search. Although various authors have proposed links between "smart" cities and other adjectives, such as wired, intelligent and digital cities, these can be argued to focus more on one aspect of smart cities without being broad in their approach and therefore fail to encapsulate all aspects of smart cities (Hollands 2008; Nam and Pardo 2011). We sought only those articles written in English and published between 1994-01-01 and 2017-03-31 as the smart city concept was first introduced in 1994 (Dameri and Cocchia 2013).

Given that we would manually check all publications downloaded from the databases to confirm that they discussed the topic of smart cities before including them in our study, we limited our literature sources for news media, trade publications and government reports to only those published in the United States, the United Kingdom and Australia. We decided to include all academic literature.[1] For all literature sources, we eliminated any duplicates or similar publications after downloading. We also manually checked all downloaded publications and removed those that discussed non-relevant topics such as Smart City cars (a brand and model of cars).

The process we applied to obtain the literature for each stakeholder group is explained below.

- *Citizens* To better understand the perspectives and beliefs of citizens about smart cities, popular newspapers were drawn upon. We based our understanding of the five most popular newspapers for each country on recent measures of annual circulation statistics (Statista 2015, 2016; Roy Morgan 2016). This list included such newspapers as The New York Times, The Washington Post and The Sydney Morning Herald. All 15 sources (five from each country) are available in the database Factiva, from which we downloaded the relevant newspaper articles. We initially downloaded 1090 articles and, after removing advertisements and articles that did not relate to smart cities, we were left with 570 articles.

- *Businesses* We sought to identify practitioner publications on the topic of smart cities as these are aimed at informing specific practitioner communities about topics of relevance to their work (Raub and Rüling 2001), enabling a greater understanding of how these topics are perceived and interpreted by these communities (Juravle and Lewis 2008). As businesses are faced with intense time constraints and an increasingly wide availability of information, they are more likely to use practitioner publications than academic sources for up-to-date advice (Brennan 2004). The use of the database ABI/Inform enabled us to select "trade journals" as the source type. Examples of sources include Computer Weekly News, Business Wire and Wireless News. Our search for practitioner literature yielded 944 publications. After removing duplicates and any articles not related to smart cities, 836 publications were included in our study.

- *Research organizations* Academic research was included in our study because of its capacity to contribute towards the development of societal aims and the understanding of how they can be achieved (Weiss 1977). The impact of research, whether academic, economic or social, can be either instrumental or conceptual (Economic and Social Research Council 2018). Applied to smart cities, research may have the potential to influence the development of relevant policy or practice, shaping legislation and altering behavior (instrumental) and/or contribute to the understanding of relevant policy issues and the reframing of debates (conceptual). With the view that the abstracts of academic articles are likely to contain only the most important aspects of the articles they describe (Crawford et al. 2006), we decided to only include academic abstracts rather than entire articles. When comparing the keywords found in both abstracts and full-length

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[1] The results obtained do not depend on the relative number of sources from each literature type.
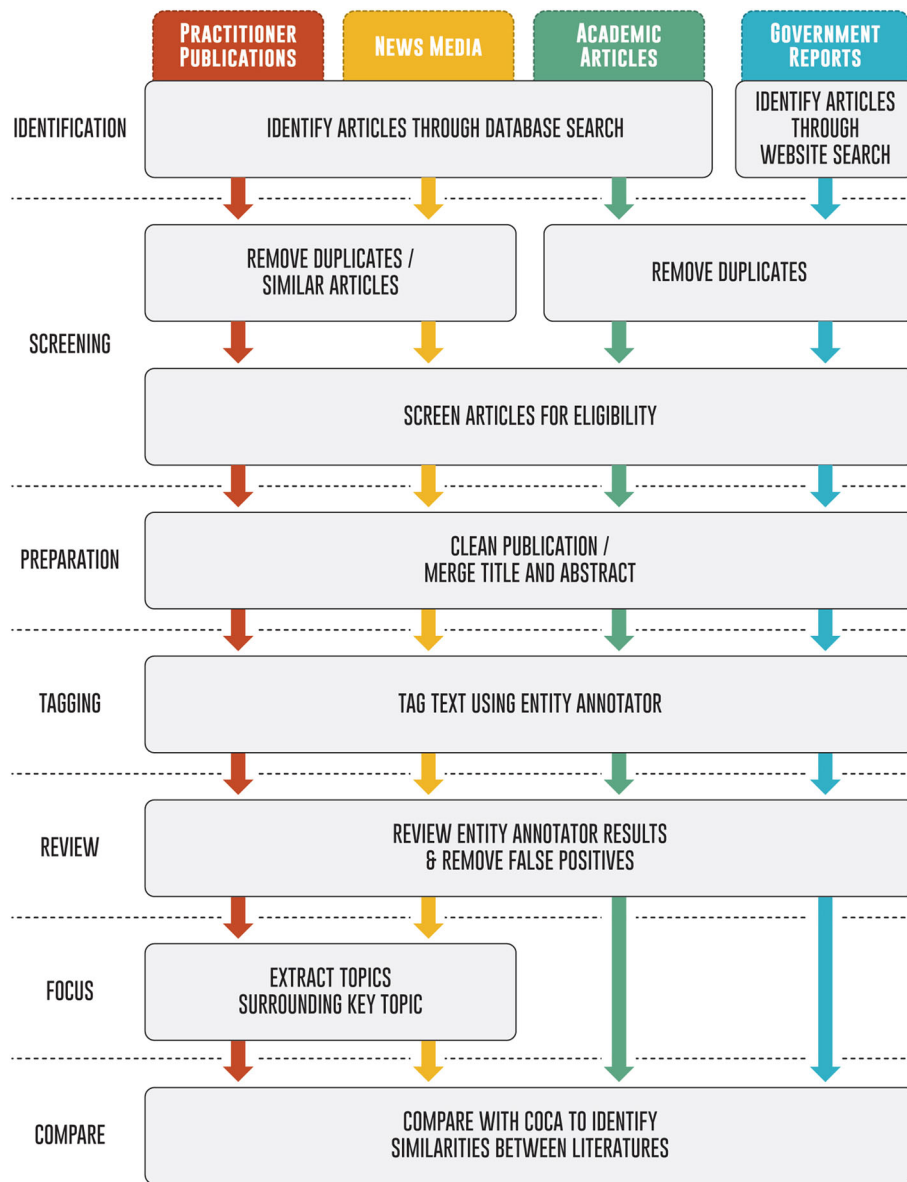
Fig. 1 Application of the methodology

articles, Crawford et al. (2006) were unable to find a clear advantage of using the full-length versions. In downloading the relevant academic literature from Scopus, we expanded our search to include any relevant article from any field rather than only including IS journal and conference articles. For example, publications from the MIS Quarterly, Cities and Lecture Notes in Computer Science as well as from conferences such as the European Conference of Information Systems, the ACM International Conference Proceeding Series and the Institution of Engineering and Technology Conference were considered for inclusion. To help ensure we were only including articles published in

quality outlets, we only considered sources with a Source-Normalized Impact per Paper (SNIP) greater than or equal to zero (Moed 2010). Of the 4999 articles that were originally downloaded, 2764 articles were included in our study. Any organizing keywords from structured abstracts and copyright information was removed.

- *Governments* The government reports used for this study were identified using a two-stage process. The first stage involved visiting the websites of each of the federal governments of the USA, the UK and Australia. After entering our search terms in each of the website search boxes, we identified the relevant government

departments in each country that have published on smart cities. The second stage then involved conducting a similar search of the websites of the identified departments, finally enabling us to download relevant government reports. The types of government reports extracted include government research papers, digital agendas, policy documents and reports, including for example from transportation, industry, science and technology, trade and infrastructure government departments. We focused specifically on those government reports that discussed domestic, rather than international, developments in the smart city space. In all, we identified 23 relevant government reports.

Supplementary Appendix A (available online via http://link.springer.com) summarizes the sources and years of publication for the different literature types.

3.2.2 Preparation and Tagging

Once all relevant publications were downloaded, the output was exported to four separate Comma Separated Values files, one for each of the literature types. The titles of the publications from each literature type were then merged with their respective bodies of text.

As in Marrone and Hammerle (2016, 2017), the tool TAGME was then used to annotate the text in these files. A semantic entity annotation (SEA), such as TAGME, is used to identify meaningful mentions or term sequences in a publication, designating annotations to them from a large catalogue (Piccinno and Ferragina 2014). By using a SEA, strings that describe the same concept, such as U.S., USA and United States of America, are able to be merged (Khalid et al. 2008). This provides a distinct advantage over Computer-Assisted Qualitative Data Analysis Software (CAQDAS) such as Leximancer. Unlike Leximancer, the methodology applied in this paper is able to overcome issues of homography, where words can assume a multitude of different literal meanings, and of context, where the meanings of words are altered by the context in which they appear (Hobolt and Klemmensen 2005). The application of a SEA overcomes these issues by merging words with the same meaning.

TAGME was used to perform semantic entity annotation as it is easily accessible and viewed as highly effective (Cornolti et al. 2013; Cuzzola et al. 2015). TAGME identifies single and multiple-word mentions in texts and links these to Wikipedia entries (Ferragina and Scaiella 2010). While the success of the approach depends on the catalogue choice, Ferragina and Scaiella (2010) write that several tools currently use Wikipedia to annotate texts. Wikipedia is argued to offer the ideal trade-off between a catalogue with a rigorous structure but low coverage (for

example, the high-quality entity catalogues WordNet and CYC) and a large collection of texts with broad coverage but unstructured and noisy content (for example, the worldwide web). Although TAGME was specifically designed to be used for short, unstructured texts, it has also been shown to be useful for longer texts, annotating fragments of text on-the-fly and with high precision (Ferragina and Scaiella 2010).

In applying TAGME, the values for the area-under-the-curve F-measure were set as the stochastic setting of tuneable parameters (long_text 10, epsilon 0.427, $\rho = 0.1613$), as suggested by Cuzzola et al. (2015). These values help to define the annotation process. The value of long text specifies the shifting window (comprising the number of surrounding topics that are used to annotate a particular mention in the text), the value of epsilon defines whether the annotation process will favor more the context (a lower value) or the most common surrounding topics (a higher value) and the value of ρ is used to indicate those annotations above and below a given confidence score threshold. These confidence scores are assigned by TAGME and represent the likelihood that the annotations are appropriate given their context in the input text (Cuzzola et al. 2015). Although the precision of the annotation process depends on the parameter choices by the researchers, the values we used helped to reduce annotation errors while also ensuring that the output, the number of topics identified in the respective texts, was large enough to be useful.

The application of TAGME identified 2524 unique topics in news media, 2905 in practitioner publications, 6806 in academic articles and 5550 in government reports.

3.2.3 Review and Focus

After running the publications through TAGME, all false positives, topics that make little meaningful sense given the context in which they are used, were deleted. The decision was also made to filter out any names of people, places or businesses as we wished to focus on how smart cities are discussed in general. As other authors have done, we also applied collocation analysis to practitioner and news media publications to address the issue that these publications may discuss more than one central topic (Gabrielatos and Baker 2008; Baker et al. 2008). Concept collocation refers to the process of identifying and extracting only those topics that surround a mention of the main topic, smart cities in this case, in the text. These surrounding topics, as compared with topics located further away are more likely to be related to the main topic, thus yielding more reliable and reproducible results (Faro et al. 2011). As in Marrone and Hammerle (2016, 2017), whenever the topic "smart city" appeared in the news media and practitioner

publications, we only examined the five topics to the left and right of this topic. For this process, the program AntConc was used as it is widely available, cost-effective and easily applicable for corpus analysis (Anthony 2005). Given that the abstracts of academic articles tend to be more precise and that only government reports specifically on the topic of smart cities were included in the study, all topics identified by TAGME in these publications were included in the keyword analysis. The output of this stage was four topic lists containing the frequently mentioned topics for each literature.

3.2.4 Comparison

To determine the significance of the topics extracted by TAGME, a keyword analysis was conducted. According to Scott and Tribble (2006), key topics in a literature are identified by comparing topic frequencies within a text or body of texts with the frequencies of these topics in a 'reference corpus'. In making these comparisons, frequencies are normalized by taking into account the total number of topics in the literature bodies. A topic appears as a keyword if it appears unusually frequently (or unusually infrequently) in the text of interest in comparison with the 'reference corpus'. Here, we focus only on those keywords that appear unusually frequently and thus are salient for that literature type. The final analysis depends on whether the keyness of the term, identified by using either a Chi square test of significance or a log-likelihood test, is less than or equal to a specified p-value (Seale et al. 2006).

Keyword analysis allows for meaningful comparisons to be made between different types of literature, whether or not the literature types are of comparable length (Baker 2006). The methodology has been widely applied to better understand the similarities and differences between the keywords used in a wide range of text types (e.g., Crawford et al. 2006; Seale et al. 2006; Gabrielatos and Baker 2008). Through keyword analysis, researchers are directed towards statistically significant differences in the topics in an extremely quick and useful manner, thereby decreasing the possibility of researcher bias (Baker 2006). The process can be contrasted with qualitative thematic analyses based on manual coding and retrieval, which tend to be less economical, reliable and replicable (Seale et al. 2006).

To identify the statistically significant similarities in the literature types, the topic list extracted by TAGME for each literature was separately compared against the reference corpus, the Corpus of Contemporary American English (COCA). The COCA is a large, balanced corpus of English that contains literature sources that are similar to those examined in this study in regards to time period and genre. This process is identified by Baker (2006) as being an efficient way of conducting keyness comparisons of

multiple corpora. As each literature source is compared with the same reference corpus, lists of keywords are identified that are unique to each of the different literature types being examined. Comparing these lists enabled us to identify similarities (common keywords) between the literature types. The lists of keywords extracted by TAGME were compared using AntConc and a default cut-off log-likelihood value of 15.13 (corresponding to a p-value of less than 0.0001) was applied.

To identify the differences between multiple types of literature, Baker (2006) suggests two possible methods. The first method is similar to that described above of comparing each of the corpora separately against an external reference corpus. However, instead of seeking to identify the similarities (common keywords shared by the different literature types), the aim is to understand the differences (keywords that are not shared by all the literature types) in the topic lists of different text types. The other method is to compare the topic list for one of the corpora with a merged list containing the topics from the other literature types. As our aim was to understand how the perspectives of citizens contrast with other perspectives on smart cities, we followed the second method and compared topics from news media with a merged list of topics from practitioner publications, academic articles and government reports. A default cut-off log-likelihood value of 15.13 (corresponding to a p-value of less than 0.0001) was applied.

3.2.5 Contextual Analysis of Topics

After identifying the differences in the topics frequently discussed by news media and the other literature types, we closely examined those topics that only appear frequently in the news media. The first stage of this process was to read the newspaper articles that were tagged with these topics. By considering the context in which specific topics are used, we aimed to better understand how these topics are discussed (Hsieh and Shannon 2005) and the key themes associated with each topic (Eisenhardt 1989). After we analyzed the articles individually, we conducted cross-article analysis, in which we sought to identify the overarching themes shared by the news media publications in regards to these topics. The final stage involved understanding whether other literature types also discussed these topics, albeit less frequently, and how.

4 Results

This study aims to understand the salient topics in the four types of literature, namely news media, trade publications, academic articles and government reports, that represent

the perspectives of key smart city stakeholders. We commence this section by examining the topics identified as key for each of the literature types with the aim of identifying any similarities in the literature on smart cities. Using the six domains of smart cities developed by Giffinger et al. (2007), we then categorize the identified topics to better understand the broad themes that are prominent in the texts. Finally, we concentrate on the citizen's perspective by examining those topics that are frequently discussed in the news media, however, are not salient in other texts.

4.1 Similarities

Table 1 highlights the top 25 most salient topics for each of the types of literature. These topic lists are the result of separately comparing each of the literature types with the reference corpus COCA. Those topics that appear in bold are shared by all the types of literature.

The topics below were identified as key for all literature types. The following list is ranked in order of the keyness of these topics in the news media.

- Internet of Things
- Technology
- Infrastructure
- Smart grid
- Urban planning
- Energy
- Transport
- Innovation
- Sustainability

Overall, there is considerable overlap among the topics frequently discussed by all stakeholder groups. Notwithstanding those topics listed above, there are also topics that are shared by either two types of literature (for example, public transport is shared by news media and government reports) or three types of literature (for example, smart phone is shared by news media, trade publications and academic articles), contributing to the argument that there exists a considerable extent of similarity between the literature types.

However, these shared keywords do not always appear in the same order of importance for each of the types of literature. As perhaps the most striking example, the topic "Internet of Things" has the highest keyness score for all types of literature apart from government reports, where it has the 25th highest score.

As can be seen in this Table, there are, however, key differences between the literature types. For example, while the news media places much focus on such topics as "home automation", "privacy" and "Wi-Fi", which are focused on the home, practitioner publications focus more

on "market economics", "building automation" and "economic growth", with academic articles focusing on "data" and "algorithm" and government publications focusing on "investment", "economic development" and "public transport". These topics are arguably more relevant for the stakeholder group that serves as the main audience of that particular literature than for other stakeholder groups.

Another interpretation of the Table is that the breadth of topics covered by the news media is greater than for the other types of literature. This interpretation can be understood from the lower keyness statistics for each of the top 25 topics for news media as compared with the other literature types. A lower keyness statistic suggests that this topic appears relatively less frequently than a topic with a higher keyness statistic.

4.2 Categorization of Key Terms for Different Stakeholder Groups

Using the smart city domains of Giffinger et al. (2007) that were introduced in the literature review, we sought to categorize the key topics for each of the types of literature. This categorization helps to understand the salience of topics associated with technology (smart mobility) as compared with people (smart people) in the literature on smart cities. We focus here only on the top 25 keywords for each literature, as indicated in Table 1. Two researchers read the descriptions of the six domains and then proceeded to code all key topics individually before a discussion was held and any differences in thinking were addressed. A Krippendorff's α inter-rater reliability coefficient, which statistically measures the extent of agreement between researchers when coding (Krippendorff 2004), of 0.93 was achieved.

For each disagreement, the literature or types of literature for which the topic was key was studied to better understand how the topic was discussed in context and to help link the topic to one of the domains. For example, while the topic "privacy" may, at first glance, appear to be associated with the smart people domain, it is better coded to the smart living domain, which is based on factors associated with quality of life such as safety. Similarly, the topic "smart phone" best fits the smart mobility domain as it is an ICT infrastructure.

Table 2 shows the correspondence between the domains and the different literature types. For each literature, the number of topics listed in Table 1 that were mapped into each of the domains is shown as a percentage. By examining the literature, we found that the topics system (for academic articles and government reports) and algorithm, mathematical optimization and simulation (for academic articles) were too general to be mapped into a domain.

Table 1 25 most salient topics in the types of literature

News media	Practitioner publications	Academic articles	Government reports
Internet of Things (360.504)	**Internet of Things (1321.267)**	**Internet of Things (1709.009)**	**Technology (1007.786)**
Technology (286.265)	**Technology (799.291)**	Data (951.311)	**Infrastructure (932.999)**
Internet (243.491)	**Infrastructure (489.558)**	System (907.607)	**Transport (870.077)**
Autonomous car (180.252)	**Transport (419.607)**	**Technology (901.233)**	**Innovation (626.541)**
Infrastructure (146.414)	Market economics (363.863)	Sensor (670.698)	System (444.759)
Smart grid (144.201)	Machine to machine (331.633)	**Infrastructure (627.051)**	**Smart grid (435.808)**
Big data (140.196)	Building automation (300.049)	Information and Communications Technology (605.03)	**Energy (412.240)**
Open data (108.151)	Compound annual growth rate (292.153)	Cloud computing (574.028)	Investment (366.798)
Urban planning (104.750)	Economic growth (292.013)	**Urban planning (547.673)**	Industry (344.063)
Energy (102.546)	Information and Communications Technology (287.184)	Application software (526.562)	Information and Communications Technology (339.810)
Privacy (96.697)	**Smart grid (273.729)**	Internet (503.923)	Service economics (323.484)
Transport (96.697)	Internet (247.384)	Big data (487.728)	Market economics (314.392)
Public transport (81.942)	Big data (228.984)	Wireless sensor network (475.960)	**Sustainability (307.769)**
Sensor (78.598)	Wireless (221.275)	**Sustainability (443.380)**	Economic development (285.608)
Smart phone (74.935)	**Sustainability (221.003)**	Algorithm (436.290)	Efficient energy use (264.342)
Architecture (74.402)	Cloud computing (207.928)	Information (404.789)	Public transport (246.783)
Industry (62.464)	**Energy (201.910)**	**Energy (389.165)**	Waste management (234.559)
Innovation (61.562)	**Innovation (190.967)**	**Innovation (372.422)**	Quality of life (217.711)
Efficient energy use (56.078)	Home automation (178.976)	**Transport (365.806)**	Automation (216.191)
Data (52.275)	Application software (170.632)	Computer network (364.147)	Data (214.705)
Start-up company (52.073)	Smart phone (164.636)	Mathematical optimization (359.520)	Private sector (208.023)
Greenhouse gas (52.057)	**Urban planning (161.088)**	Simulation (334.741)	Smart meter (207.187)
Electricity (51.931)	Wi-Fi (153.539)	Communication (304.574)	Public utility (201.829)
Sustainability (50.604)	Sensor (148.475)	**Smart grid (299.436)**	**Urban planning (201.450)**
Wi-Fi (49.020)	Industry (144.910)	Smart phone (283.264)	**Internet of Things (194.685)**

Bold topics are common to all literature types

These are the topics that are indicated in the general column.

From Table 2, several notable findings become apparent. Firstly, the smart mobility domain (which includes ICT) is extremely prominent in the literature, with 44 percent of topics being mapped into this domain. This emphasis is common among the literature types, highlighted by the large percentages of topics for each literature mapped into this domain. In contrast, there appears to be less discussion of topics associated with smart people. This finding is made evident by the column of zeroes for the smart people domain, indicating that none of the topics mentioned frequently by any of the literature types was most highly related to the smart people domain. Similarly, although the smart living and smart governance domains may also be associated with the citizens living in smart cities, these domains are also under-represented in terms of topic coverage.

Table 2 Categorization of topics using Giffinger et al. (2007)'s smart city domains

	Smart economy (%)	Smart mobility (%)	Smart governance (%)	Smart environment (%)	Smart living (%)	Smart people (%)	General (%)	Total (%)
News media	12	40	8	24	16	0	0	100
Practitioner publications	20	52	4	12	12	0	0	100
Academic articles	4	60	4	12	4	0	16	100
Government reports	28	24	12	2	12	0	4	100
Total	16	44	7	17	11	0	5	100

Upon examining the literature and the concepts further, it is evident that most of the concepts that have been mapped into smart mobility are linked with communication and the integration of systems through technology. Examples of topics are Internet of Things, smart phone and Wi-Fi. This finding further stresses the emphasis of different literature types on the technological aspects of smart cities.

4.3 A Voice for the Citizens

What follows in this section is an exploration of the topics that are frequently discussed only by news media. Although these topics might appear in other literature types, they are not addressed as frequently. In order to be considered, we required the topic to appear at least ten times in the news media. For this section, as described in the methodology, the topic list identified by TAGME for news media was compared with a merged list of the topics extracted for all other literature types. We focus here on the three keywords with the highest keyness score based on this analysis.

The keywords, and the relevant keyness statistic, are:

- Autonomous car (108.852).
- Hackers (26.781).
- Start-up company (25.707).

Each of the topics will be addressed in order of its keyness rank, with each subsection including, first, an analysis of the context in which this topic appears in the news media, and second, how this contrasts with mentions of the topic in other literature types. Through this process, insights can be gained into how the perspectives of citizens differ from other perspectives on smart cities.

4.3.1 Autonomous Car

4.3.1.1 Newspaper Articles In considering autonomous cars, the media offers a number of diverse perspectives,

surrounding their assumed advantages, risks and the extent to which people may be involved in their use.

Several advantages are noted by this literature, including safety (Abrams 2016), greater mobility (Arieff 2013; Adhikari 2016), relief from boredom and monotony (Adhikari 2016), reduced time for travel (Heath 2015) and efficiency (Arieff 2013; Yoo 2016). Driverless cars are expected to go mainstream, "tearing up the way we live and work" (Heath 2015).

However, while these advantages may be evident, other media articles stress the potential dangers of autonomous cars, including the risks associated with drivers relinquishing all control over their vehicles (Adhikari 2016) and the potential for cyber-attacks (The Guardian 2015). Further, conflicting messages are also presented about whether or not the use of these vehicles will reduce the distance travelled (Wheeland 2016) and whether cars might be better replaced by other forms of transport (Arieff 2013).

Media presents a range of views concerning whether the involvement of citizens with regards to driverless vehicles is necessary. According to Brooks Rainwater, director of City Solutions and Applied Research Center at the National League of Cities, full benefits will only be derived with completely autonomous vehicles that eliminate the need for humans (Abrams 2016). However, Nissan CEO, Carlos Ghosn, argues that autonomous vehicles still require humans, as complicated traffic situations may confound their artificial intelligence, suggesting that people will still want to decide when to drive manually (Snider 2017).

4.3.1.2 Other Publications Other literature types also focus on the advantages of using autonomous cars. Trade publications, for example, suggest that autonomous cars can be viewed as an innovative and creative tactic that help solve everyday infrastructure problems (Microdesk 2013) and as a part of making the transportation industry more capable, intelligent and efficient (Baker 2015). According to Chris Penrose, President of Internet of Things Solutions at AT&T, the connected car will increase safety,

convenience and entertainment (Richardson 2016). The one government document that explored the topic of autonomous cars in relation to smart cities suggests that autonomous vehicle technology enables vehicles to execute safe and efficient commands based on an understanding of the environment in which they are operating (Cuddy et al. 2014). Finally, an academic article suggests that autonomous cars can respond instantaneously to situations with high efficiency and flexibility (Lam et al. 2016).

Trade and government publications also place emphasis on how the movement towards autonomous cars might happen. For example, the government document suggests that the drive towards autonomous vehicles is likely to occur incrementally, with more tasks being automated over time (Cuddy et al. 2014). Trade papers suggest that the necessary technological tools are already available (Microdesk 2013), but the law must change first (Saunders 2014). Gartner has suggested that "the proliferation of vehicle connectivity will have implications across the major functional areas of telematics, automated driving, infotainment and mobility services" (Richardson 2016).

Finally, the government report also discusses some of the complications associated with the use of autonomous vehicles. The document argues that autonomous vehicles may be vulnerable to remotely executed attacks due to their reliance on a central computing system that controls many of their physical components and their ability to communicate with vehicles and infrastructure nearby (Cuddy et al. 2014). This argument is similar to the safety concerns addressed by news media.

4.3.1.3 Comparison A comparison of the topic autonomous cars in news media and other literature types produces some interesting results. While all literature types address the benefits of autonomous cars, news media tends to also describe this transportation method as disruptive whereas other literature types focus more on how a reliance on autonomous vehicles might come about, rather than on the risks associated with this process. The news media is also the only literature source to focus on how people might be involved in the use of autonomous cars.

4.3.2 Hackers

4.3.2.1 Newspaper Articles The news media raise concerns about the potential for hackers to cause damage in smart cities and the limited attempts thus far to curb the increasing potential for smart cities to be hacked. In a way that involves the audience directly through the use of a personal pronoun, Mika Majapuro, F-Secure product manager, suggests that hackers may 1 day be able to "crack your smart door lock remotely and sell access to local thieves or take your fridge and demand a ransom to get it back" (Kobie 2015a). Echoing this sentiment, Cerrudo, chief technology officer at IOActive Labs, suggests that "what I found is that cities are filled with security problems that could have a very direct and physical impact on our lives" (Perlroth 2015a). The extent of uncertainty and fear surrounding hackers is evident in the suggestion that 18% of consumers who purchased connected devices later returned them as they feared their sensitive information might be stolen by hackers (Tsukayama 2016). Several newspaper articles also report on the simplicity of hacking smart city systems, with security researchers emphasizing the abundant opportunities for maliciously minded hackers or governments (Perlroth 2015b) and the vulnerabilities of smart city systems that leave them open to hackers (Kobie 2015b).

The news media also emphasize that not enough is currently being done to prevent hackers. Although the Internet of Things (IoT) has been described as "the next big hacking target" (Kobie 2015c), city authorities often may not test the security of the systems they buy (Kobie 2015b). Indeed, although voluntary guidelines were established in the US to help companies prevent cyberattacks, US critical infrastructure is reported as still being "wide open to attack" (Perlroth 2015c). Currently, hackers are reported to pay little attention to smart cities. However, as James Lyne, head of security research at Sophos, adds, "I suspect this is predominantly because it has not met their financial or political goals" (Kobie 2015b). Hacking may instead become more prevalent as smart city services become more widespread and there are distinct benefits to hacking, such as financial gain (Kobie 2015c). Due to the lack of response from authorities and companies, some news articles stress the importance of individuals becoming more aware of the issues surrounding the potential for hacking in smart cities and placing pressure on authorities to respond (Kobie 2015a; Perlroth 2015a).

4.3.2.2 Other Publications Besides trade publications, other literature types make little mention of hackers. Only two academic articles and two government reports refer to hackers. In trade publications, the main issues associated with hackers are the risks that they pose and the necessity for companies and governments to develop the capacity to protect against them. Anthony Townsend, Director of the Institute of the Future, stresses that there are inherent flaws in managing an entire city as a single business (Rascón 2014). Another trade publication compares smart city systems to Internet of Things devices, highlighting the shared potential for hackers to gain access to large databases of vital information and services. However, the publication argues that any attacks on smart city systems have much more serious consequences, affecting, for example, the energy and water supplies of entire regions. In

response, trade publications stress the importance of companies being realistic about the threats associated with smart city innovations and being proactive about preparing for attacks (Avanessian 2017).

4.3.2.3 Comparison   In comparison with other publications, news media appear to be much more detailed about the intricacies of hacking. Suggestions are made about why hackers have not yet become widespread in smart cities and the importance of preventing hacking to protect the people who use smart city services is stressed. The lack of action on the part of companies and governments, leaving smart city services open for attack, is also emphasized only by the news media.

4.3.3 Start-up Company

4.3.3.1 Newspaper Articles   Start-up companies are often viewed as the main drivers of smart city initiatives. Start-up companies may be fundamental for developing smart city innovations to solve such urban issues as urban waste (Ramirez 2016), greenhouse gases (Halsey 2015) and healthcare (Marsden and Fallon 2016). Such start-ups are perceived as socially and environmentally conscious, sustainable and engaged with local communities (Douglas 2016) as well as important for understanding and applying open data for economic and social benefit (Scott 2017). As Marvin Rees, mayor of Bristol, suggests, "we need to navigate a new world. We need to rebalance sovereignty". Start-ups, and entrepreneurship in general, are viewed as essential for this process, with their ability to harness the opportunities presented by the Internet of Things (IoT) (Jervis 2016).

The news media also cover some more intricate topics associated with start-up companies. These topics include the importance of programs in connecting entrepreneurs with the tools, mentors and investors they require (Scott 2017) and the types of firms that may stand to benefit more. It is argued that smaller firms, rather than large corporations, might benefit most from IoT, with most innovations being simple in nature (O'Donnell 2016).

4.3.3.2 Other Publications   When discussing start-ups and their association with smart cities, both trade publications and government reports stress the opportunities for economic growth that smart cities present and the importance of linkages between diverse groups. Innovations in smart cities are pursued by both start-ups and larger companies that wish to "grow and succeed in the global marketplace" (The PR Office Limited 2017) and "grab discernible positions in smart cities markets" (Persistence Market Research Pvt Ltd 2017). Cited in a trade publication, Gilo Cardozo, founder of Gilo, stresses that

"investing in British start-ups and technology companies in the growth stage is a key part of our long-term strategic plan to invest in the most exciting, disruptive and innovative technologies around the world" (The PR Office Limited 2017). This opportunity is also acknowledged in a government report, which suggests that both larger and start-up companies are pursuing smart grid innovations to capitalize on expected future investments from utility companies and governments (Cuddy et al. 2014). Government reports further highlight the perceived importance of links between governments and start-ups to solve public issues, such as transportation, using smart city solutions (U.S. Department of Commerce 2016).

4.3.3.3 Comparison   All the literature types, including news media, highlight the importance of start-ups in the development of smart cities and of fostering connections between different groups for start-ups to be successful. However, only the news media specifically highlights how the innovations that are brought about by start-ups may help to serve people and impact their everyday lives. Instead, a major emphasis of other types of literature, particularly government reports and trade publications, is on the opportunities for economic growth and profits brought about by developments in the smart city space.

5 Discussion

This article presented an in-depth analysis of the salient topics found in various types of literature on smart cities, including news media, trade publications, academic articles and government reports. These literature types are argued to represent the main perspectives of their respective audiences, the key stakeholders of smart cities. The main aim of this article was to better understand the key topics that frame discussions on smart cities. It is posited that a greater understanding of the diverse perspectives that exist is essential in tackling the wicked nature of the issues smart cities seek to address. As existing academic research suggests that the perspectives of citizens are often ignored in the development of smart cities (Hollands 2015), a secondary aim of this paper was to explore the validity of these claims and to understand how the perspectives of smart city citizens compare with other discussions. The importance of considering the perspectives and concerns of citizens is stressed by the view that it is necessary for citizens to feel involved and that their input is valuable if they are to be accepting of systems, such as smart cities (Markus and Mao 2004).

In the first section of the results, we sought to identify the topics that are frequently associated with smart cities by all the literature types. We argue that emphasis should be

placed on these topics for mutually beneficial discussions to occur between stakeholders. The analysis next concentrated on using the domains developed by Giffinger et al. (2007) to categorize the most salient topics for each of the types of literature. The final section of the results involved identifying those topics that are only frequently discussed in news media. The aim in the final section was to uncover key themes in news media and to understand how the news media compares with the other literature types in regards to discussions of these topics.

Existing literature suggests that the importance of citizens in the development of smart cities is often overlooked (Hollands 2008; Vanolo 2014; Hollands 2015). The role of the user as being a static entity (Vanolo 2014) is also reflected elsewhere in IS literature (Iivari et al. 2010) where citizens may be regarded as being an "inferior party" by other stakeholders (Leonard 2004). At first glance, several of the findings in this study seem to support these claims. In categorizing the frequently discussed topics of each literature type using Giffinger et al. (2007)'s domains, for example, no topic could be best linked with the smart people category. Instead, the categorization of topics served to emphasize the importance placed on technology in smart city discussions; this is reflected in the large number of topics that fit into the smart mobility domain. The final part of the results section also revealed a tendency of the other literature types, besides news media, to focus on aspects other than the importance of involving citizens in developing smart cities. This finding was common to all three topics explored in greater detail in this section; namely, autonomous cars, hackers and start-up companies. A closer examination of how autonomous cars are explored reveals that only news media seek to understand whether and how individuals might be involved in the operation of autonomous cars. The section on hackers also asserts this tendency, revealing that the complex concerns and fears held by citizens surrounding smart city solutions tend to only be explored superficially by other literature types. Finally, while the news media focus on how start-ups may be able to assist citizens to increase their quality of life, government reports and trade publications focus instead on how smart cities can help start-ups create profit and grow.

However, closer examination of the findings reveals that citizens may simply be being under-represented in other literature types rather than completely ignored. This argument is stressed both by the number of salient topics that are shared by all the literature types, including news media, and the fact that several of the topics frequently discussed by other literature types, such as privacy, may be coded into domains such as smart living and smart governance that may also be of relevance for citizens.

The findings of this study stress the importance of involving citizens in discussions on smart city developments and of establishing a more collaborative approach to such developments. A main premise of inclusive management is that bringing people together from different backgrounds and of different perspectives in ways that encourage them to understand each other's perspectives helps enhance the design and implementation of policies (Feldman and Khademian 2007). According to Feldman and Khademian (2007), the three foundational perspectives that are important for formulating and implementing successful programs are the political, the scientific or technical and the local or experience-based perspective. In the context of smart cities, these perspectives can arguably be linked with governments, businesses and research organizations and citizens, respectively. For example, while citizens possess necessary practical understanding, they often lack the insight into new technical possibilities that is held by developers (Ehn 1993). In turn, the practical understanding, encompassing such elements as knowledge of the application domain, the activities of citizens and their behaviors and preferences, is often tacit and therefore difficult to capture using traditional research methodologies (Bano and Zowghi 2015). Indeed, while focusing mainly on technologies may increase simplicity in designing IS systems, such as those used in smart cities, it ultimately ignores more complex social, organizational and technical factors (Eichhorn and Tukel 2015).

6 Conclusion

The main finding of this study is an extensive focus by governments, businesses and research organizations on the technological aspects of smart cities. In contrast, topics associated with citizens, such as "autonomous cars" and privacy concerns such as "hackers" tend to be discussed less often. Existing research stresses the understanding that the perspectives of citizens are often ignored in smart city discussions and developments (Hollands 2008; Thomas et al. 2016) and that there needs to be a movement from focusing only on technical possibilities to a more human perspective (Giffinger et al. 2007; Caragliu et al. 2011; Angelidou 2015). However, the findings of the present study suggest that the situation may not be as dire as predicted. Instead of being completely ignored, citizens instead appear to be under-represented in discussions. The present study builds upon this understanding by highlighting some of the differences between the perspectives of citizens and other smart city stakeholder groups. By providing increased clarity into which aspects of the citizen perspective are less commonly addressed, the study serves to highlight where future research on smart cities might best be conducted. This study thus both clarifies the need for collaboration among stakeholders and identifies some of the topics that are pertinent only for citizens and should

be addressed in developing and marketing smart city services (practitioner-centric) and producing smart city policies (government and academic -centric).

This study has several limitations that also provide grounds for future research. First, the collection of more direct data on the perspectives of different stakeholder groups, ascertained through interviews or surveys, may help to validate and strengthen our results. However, the study by Thomas et al. (2016) highlights that a clear definition of smart cities is still missing from everyday vocabulary, suggesting that it is difficult to conduct interviews with citizens about this topic. Therefore, we use the approach taken by existing research on smart cities (Dameri 2013; Neirotti et al. 2014) and examine different literature types to understand the perspectives of diverse stakeholder groups. Once the topic of smart cities is more commonly discussed by citizens, researchers may wish to take a more direct approach to identify relevant perspectives. Second, the success of TAGME, like other SEAs, depends on the catalogue used for annotation. However, existing research stresses the usefulness of Wikipedia in providing a balance between catalogues with rigorous structure but low coverage and those that offer high coverage but are noisy and unstructured. Third, by examining all relevant texts, the collection of practitioner publications used in this study might over-represent larger industries and companies that are more likely to engage with public relations or have more frequent (or shorter) publishing cycles, such as the automotive or financial industry. These limitations indicate the potential for future research to understand how a more restrictive selection of sources may influence the results. Fourth, in applying Giffinger et al.'s (2007) smart city domains to better understand the topics extracted by TAGME, only the top 25 keywords for each literature were coded. Another plausible way to conduct a similar analysis would be to define a keyness threshold up to which a topic is considered relevant. However, choosing an applicable keyness threshold is complicated by the fact that the literature types had different keyness statistics, indicating either a broader or narrower coverage of topics. Finally, future research may wish to examine publications from other nations besides our three focus countries. It may also be possible that multiple perspectives exist within one stakeholder group, due to different contexts. Thus, it would also be interesting to use the methodology in this study for cross-country comparisons of different stakeholder groups.

Despite these limitations, we believe the main contribution of this article lies in its ability to provide a way to better understand the perspectives that underpin smart cities. Our methodology has enabled us to understand how the news media, a proxy for the perspectives of citizens, compares and contrasts with other literature types, representative of the views of businesses, research organizations and governments. This knowledge serves to highlight where future research into understanding the citizen perspective would be best directed. As Feldman and Khademian (2007) argue, inclusive management involves engaging in informational and relational work that brings different communities together and enables them to be effective. While relational work creates connections between communities in ways that legitimize differing perspectives, this study can be more closely related to informational work. This study helps to identify and disseminate information about different ways of comprehending smart cities, transfer ideas between stakeholder groups and encourage a new way to understand the public problem. These aspects form the core components of informational work as identified by Feldman et al. (2006). Based on the results of this study, we encourage IS researchers to conduct further research into the areas that are frequently discussed by news media but not yet widely discussed by academic articles, practitioner publications or government reports. Research into topics such as "autonomous cars", "hackers" and "start-up company" will help to create a more inclusive understanding of smart cities.

Based on the findings of this study, we recommend that future research into smart cities should ensure a consideration of the viewpoints of all stakeholders, including citizens. There is a need for future research to study topics of importance for different groups and how they may be integrated into an improved understanding of the nature of smart cities. In particular, through further exploration of the nuanced perspectives of citizens, research may better support the responsible advancement of smart city developments.

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