Mapping research trends on disruptive technologies in the public administration: A bibliometric approach

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***Abstract*—The recent trends and challenges emphasize the need to exploit the potential of disruptive technologies in public administration. Accordingly, the main aim of the paper is to examine this issue over the last two decades. The results of bibliometric analysis on 3595 documents from Scopus reveal the growth of disruptive technologies research in public administration over time, especially in the last decade, as accelerated by several of the most relevant documents published in reputable journals such as Government Information Quarterly, Sustainable Cities and Society and Sustainability by several prominent authors. Most research has been conducted in the United States, followed by the United Kingdom and China and focused especially on artificial intelligence, followed by the internet of things, social media and blockchain, with the smart city being an important concept in disruptive technologies research in public administration. Finally, the results suggest that different public administration areas have different implications for disruptive technologies. The findings may be of benefit to not only the scientific community to serve as an important source for detecting associated research gaps but also to evidence-based policymaking to fully address the issues related to disruptive technologies in public administration in the future.**

I. Introduction

Recent globalization and digitalization trends, which the Covid-19 pandemic has further emphasized, have revealed the existing digital deficiencies and emphasized the importance of leveraging digitalization and disruptive technologies in the public administration to improve public value [1,2]. Nevertheless, to some extent, public administration stayed a certain distance from technological change. However, interest in public administration in disruptive technologies like the internet of things, artificial intelligence, blockchain, social media, robotics and drones is rising. There is ever more literature and nascent applications in the public administration to support the re-design of internal service delivery processes and policymaking mechanisms [3,4].

Despite recognized benefits of disruptive technologies in public administration from the theoretical perspective [5], recent scientific literature focused especially on the implications of their potential for mitigating Covid-19 or similar pandemics in the future [4]. However, comprehensive and in-depth insights on the implications of disruptive technologies in public administration are still missing. Accordingly, the main aim of the paper is to fill this research gap by mapping research trends on disruptive technologies in public administration. The specific objectives of the bibliometric analysis include: 1) examining descriptive indicators; 2) assessing the scientific production over time; 3) investigating the relationship between relevant concepts; and 4) identifying characteristic public administration concepts related to essential disruptive technologies.

The paper is structured as follows. After the introduction section, the next section explains the materials used and the methods applied. The following section presents the main results of the bibliometric analysis. The paper ends with a discussion and conclusion in which the main findings and implications are summarized.

II. Methodology

The comprehensive bibliometric data on disruptive technologies research in public administration were obtained from Scopus on 1 January 2022, a world-leading bibliographic database of peer-reviewed literature. Scopus was preferred because it is considered a larger database than other competitive databases such as Web of Science [5]. This was further confirmed with the initial search using the same search query in both databases, revealing that Scopus provided more relevant documents than Web of Science. Moreover, compared to Scopus, Web of Science has been found as a database that significantly underrepresents scientific disciplines of the Social Sciences and Arts and Humanities [6]. Accordingly, Scopus appears to be a more relevant bibliographic database meeting the specifics of disruptive technologies research in public administration.

The search query was set to include the title, abstract and keywords and covered all relevant keywords related to public administration (i.e., public administration, public sector, public service, etc.) and disruptive technologies (i.e., artificial intelligence, blockchain, internet of things, etc.). The search was limited to documents published between 1 January 2001 and 31 December 2021 and covered the following subject areas: Social Sciences; Business, Management and Accounting; Economics, Econometrics and Finance; Arts and Humanities; and Psychology.

Based on the corresponding keywords, all obtained documents were classified into six essential disruptive technologies: the internet of things, artificial intelligence, blockchain, social media, robotics and drones, and virtual

and augmented reality. Following this classification (where possible), several innovative bibliometric approaches were applied, such as descriptive overview, scientific production analysis, network analysis and regression analysis, performed by using different Python libraries, such as Pandas, Matplotlib, Pyvenn, NetworkX and Statsmodels [8].

III. RESULTS

A. *Descriptive Overview*

Disruptive technologies research in public administration during the period 2000–2021 was published in 3595 documents. Most of them were journal articles (45%), followed by conference papers (40%) and books, reviews and editorials (15%). The development of the research in terms of the number of documents is presented in Figure 1. It reveals the exponential growth of the research over time, except in the last two years (2020 and 2021) when Covid-19 affected scientific research. The significant drop in the number of documents can be explained by the non-optimal redistribution of research funds [9] or the focus on Covid-19 related research [10].

Nevertheless, an obvious growth of the research can be observed especially after 2010, a year, which is considered the beginning of so-called e-government 4.0, covering smart, ubiquitous infrastructure, public service user-driven government, personalized and eased access to real-time public service interactions, key ICT areas – cognitive systems and advanced analytics [11].

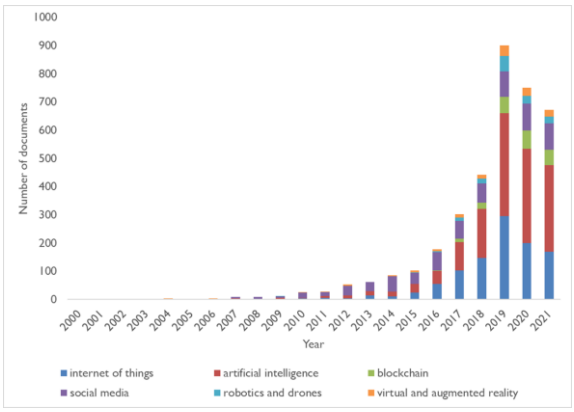

Figure 1. Development of disruptive technologies research in public administration (2000–2021).

Further examination reveals the following sequence of individual disruptive technology occurrences over time (the year of the first occurrence is presented in parentheses), namely: social media (2000), artificial intelligence (2001), virtual and augmented reality (2004), internet of things (2007), robotics and drones (2009) and blockchain (2016). Despite social media having an important role in the context of public administration throughout the observed period, in recent years, artificial intelligence, the internet of things and blockchain are gaining increasing prominence. Accordingly, these four disruptive technologies are identified as the most predominant in public administration.

The distribution of the research across the most predominant disruptive technologies in public administration and all possible sets that can be made from them is presented in Figure 2. The remaining two disruptive technologies, i.e., robotics and drones and virtual and augmented reality, are excluded from this presentation as each covers less than 5% of all documents. This overview allows identifying documents that exclusively address just one disruptive technology, i.e., pure disruptive technology (without intersecting with other disruptive technologies) and documents that address several disruptive technologies at the same time (number of documents is presented in parentheses). Accordingly, most documents are related to artificial intelligence, followed by the internet of things, social media and blockchain. Interestingly, there are no documents focusing only on blockchain or documents addressing all disruptive technologies at the same time.

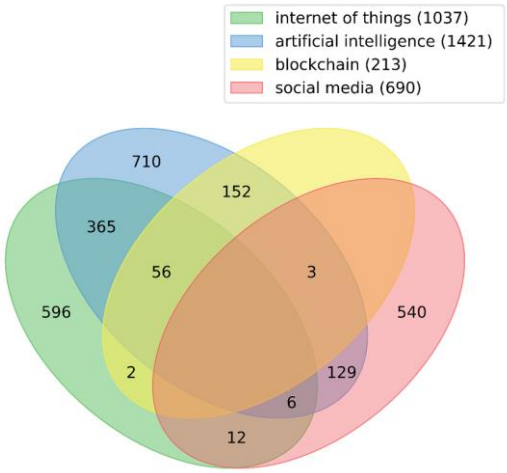

Figure 2. Distribution of the research across the most predominant disruptive technologies in public administration (2000–2021).

The most relevant (top 3) highly-cited documents for each disruptive technology group are presented in Table 1. Relevant topics addressed in these documents are as follows. The conception of the internet of things has founded smart cities, which support city operations intelligently with minimal human interaction. Thus, the internet of things may facilitate addressing the challenges that arise with the exponential growth of urbanization and population [12], such as environmental sustainability [13] and security [14]. Since the internet of things leads to the generation of massive amounts of data, it represents the main input for artificial intelligence, which offers the potential for smart cities to obtain valuable insights from big data collected through various sources [15]. Therefore, it is not surprising why leading expert contributors emphasize that artificial intelligence technology will significantly affect the future of industry and society [16]. Moreover, big data processing through artificial intelligence can greatly contribute to the urban fabric, sustainability, and liveability [17].

TABLE I

MOST RELEVANT DOCUMENTS IN DISRUPTIVE TECHNOLOGIES RESEARCH IN PUBLIC ADMINISTRATION (2001–2020).

Authors	Year	Document title	Source title	Cited by
Internet of things				
Silva B.N. et. al	2018	Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities	Sustain Cities Soc	502
Bibri S.E.	2018	The IoT for smart sustainable cities of the future: An analytical framework for sensor-based big data applications for environmental sustainability	Sustain Cities Soc	254
Hammi M.T. et. al	2018	Bubbles of Trust: A decentralized blockchain-based authentication system for IoT	Comput Secur	248
Artificial intelligence				
Hashem I.A.T. et. al	2016	The role of big data in smart city	Int J Inf Manage	539
Dwivedi Y.K. et. al	2021	Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy	Int J Inf Manage	266
Allam Z. et. al	2019	On big data, artificial intelligence and smart cities	Cities	220
Blockchain				
Ølnes S. et. al	2017	Blockchain in government: Benefits and implications of distributed ledger technology for information sharing	Gov Inf Q	328
Dagher G.G. et. al	2018	Ancile: Privacy-preserving framework for access control and interoperability of electronic health records using blockchain technology	Sustain Cities Soc	275
Sun J. et. al	2016	Blockchain-based sharing services: What blockchain technology can contribute to smart cities	Financ Innov	245
Social media				
Bertot J.C. et. al	2010	Using ICTs to create a culture of transparency: E-government and social media as openness and anti-corruption tools for societies	Gov Inf Q	1279
Linders D.	2012	From e-government to we-government: Defining a typology for citizen coproduction in the age of social media	Gov Inf Q	711
Bonsón E. et. al	2012	Local e-government 2.0: Social media and corporate transparency in municipalities	Gov Inf Q	562
Robotics and drones				
Thing V.L.L. et. al	2017	Autonomous Vehicle Security: A Taxonomy of Attacks and Defences	IEEE Proceedings	77
van Pinxteren M.M.E. et. al	2019	Trust in humanoid robots: implications for services marketing	J Serv Mark	65
Nikitas A. et. al	2020	Artificial intelligence, transport and the smart city: Definitions and dimensions of a new mobility era	Sustainability	51
Virtual and augmented reality				
Garau C.	2014	From Territory to Smartphone: Smart Fruition of Cultural Heritage for Dynamic Tourism Development	Plan Pract Res	51
Torres-Sospedra J. et. al	2015	Enhancing integrated indoor/outdoor mobility in a smart campus	Int J Geogr Inf Syst	49
Dembski F. et. al	2020	Urban digital twins for smart cities and citizens: The case study of Herrenberg, Germany	Sustainability	44

Generally, blockchain refers to a range of general-purpose technologies to exchange information and transact digital assets in distributed networks. Blockchain will lead to innovation and transformation of governmental processes and can present the next step in e-government development, as it enables reduced costs and complexity, shared trusted processes, improved discoverability of audit trials and ensured trusted recordkeeping [18]. Moreover, blockchain technology can be leveraged in the healthcare domain to achieve the delicate balance between privacy and accessibility of electronic health records [19]. Finally, the blockchain may facilitate smart cities to develop sharing services [20]. Furthermore, social media is very popular in the public administration context. Social media can be used as openness and anti-corruption tools for societies [21], allowing for greater transparency and citizen coproduction on both state [22] and local [23] levels.

Finally, the most relevant documents addressing robotics and drones are focused especially on autonomous vehicle security [24], trust in humanoid robots [25] and smart mobility initiatives [26], while documents addressing virtual and augmented reality on how advanced visualization can be used in tourism [27], smart mobility [28] and smart cities [29].

B. Scientific Production

The scientific production across countries, sources, and authors is presented in terms of the number of documents and citations. Additional information is provided by the size of a circle, revealing the h-index as a measure of the scientific impact [30] and by the colour of a circle (or circular section), presenting the time dimension in scientific production (or shares of documents related to individual disruptive technology).

The most relevant highly-cited countries in disruptive technologies research in public administration are presented in Figure 3. While the United States stands out among all countries (according to the total number of documents and citations), the United Kingdom and China are also considered the most relevant countries in disruptive technologies research in public administration, whereas China is identified as a country with more recent research. Moreover, India seems to be an important emerging player in the research, as shown by the highest average year of published documents. Similar findings are comparable with the general digital era governance research [31].

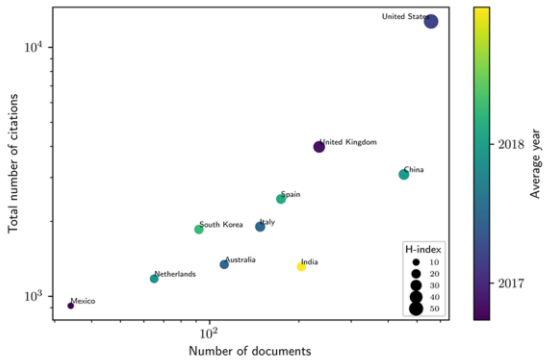

Figure 3. Most relevant countries in disruptive technologies research in public administration (2001–2021).

Moreover, the most relevant highly-cited sources in disruptive technologies research in public administration are presented in Figure 4. These are Sustainability (predominantly addressing artificial intelligence), Sustainable Cities and Society (predominantly addressing artificial intelligence and the internet of things) and Government Information Quarterly (predominantly addressing social media). The remaining disruptive technologies are not much discussed in the context of public administration yet, except blockchain, which appears in Sustainable Cities and Society, Sustainability, and IEEE proceedings and journals.

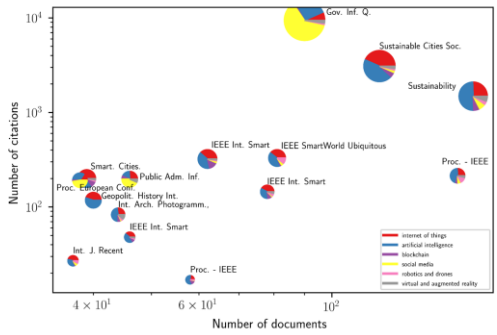

Figure 4. Most relevant sources in disruptive technologies research in public administration (2000–2021). Note that the size of a circle is in proportion to the h-index.

Finally, the most relevant highly-cited authors in disruptive technologies research in public administration are presented in Figure 5. Some of the most relevant authors are focused on artificial intelligence (e.g., Janssen M. and Nesi P.) and some of them on social media (e.g., Reddick C.G., Criado J.I.). There are also authors who address several disruptive technologies in their research (e.g., Gil-Garcia J.R.).

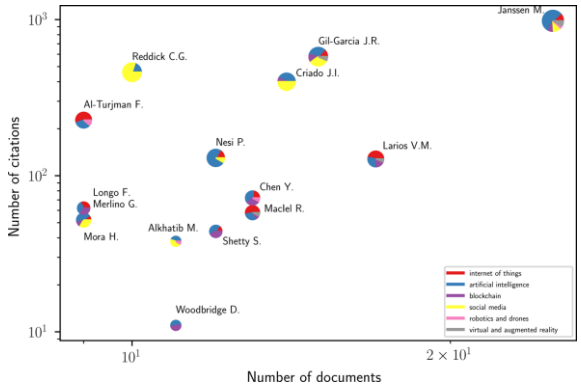

Figure 5. Most relevant authors in disruptive technologies research in public administration (2000–2021). Note that the size of a circle is in proportion to the h-index.

C. *Network Analysis*

The network analysis, i.e., keyword co-occurrence network in disruptive technologies research in public administration, is presented in Figure 5. It is conducted on the most relevant keywords, where the nodes represent the keywords and links as well as the co-occurrence relations between keywords. Note that the node size is in proportion to the number of keyword occurrences, showing research intensity (node degree), the link width is in proportion to the co-occurrences between keywords (edge weight), while the node colour indicates the development of key concepts over time [31,32]. The keyword co-occurrence network reveals that smart city is an important concept in disruptive technologies research in public administration.

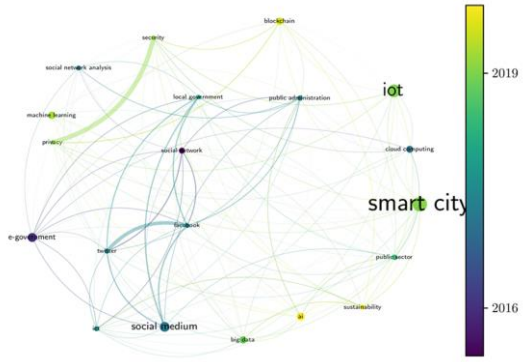

Figure 5. Keyword co-occurrence network in disruptive technologies research in public administration (2000–2021).

D. *Regression Analysis*

Binary logistic regression was used to empirically predict disruptive technology based on the most relevant public administration keywords. Therefore, every disruptive technology has a corresponding indicator variable (as indicator variables Y_1, Y_2,...,Y_6), which takes values 1 (a document is related to a disruptive technology) and 0 (otherwise). Thus, the indicator variables are considered separate dependent variables for logistic regression models. Moreover, p=55 keywords (as indicator variables X_1, X_2,...,X_{55}) were identified as important for the public administration context and used as predictor variables in the models. Accordingly, six different binary logistic models with 55 predictors were tested for each individual disruptive technology. Based on the results, binary logistic regression also provides information on which words are most characteristic for a particular disruptive technology (which discriminate the most between two subject areas) [33]. The formula of binary logistic regressions corresponds to:

$$P(Y_i = 1 \mid X_1, X_2, \ldots, X_p) = \frac{exp(\beta_{0i} + \beta_{1i} \cdot X_1 + \beta_{2i} \cdot X_2 + \cdots + \beta_{pi} \cdot X_p)}{1 + exp(\beta_{0i} + \beta_{1i} \cdot X_1 + \beta_{2i} \cdot X_2 + \cdots + \beta_{pi} \cdot X_p)} \text{ for i} = 1,2,3,4,5,6$$

The results of the binary regression analysis are presented in Table 2. They reveal that general public administration issues are relevant to social media (local government, public administration, government, political communication), blockchain (public service, sustainability, government) and artificial intelligence (public administration, sustainability). Further, good governance principles seem to be relevant to the blockchain (transparency, consensus) and artificial intelligence (transparency). Moreover, digitalization principles are relevant to the blockchain (privacy, trust, cybersecurity, automation, authentication), internet of things (privacy, cyber security), artificial intelligence (privacy, data protection), robotics and drones (trust, automation) and social media (communication). Finally, e-government initiatives are relevant to social media (e-government, e-participation), virtual and augmented reality (digital government, e-participation) and artificial intelligence (digital government).

TABLE I

MOST RELEVANT DOCUMENTS IN DISRUPTIVE TECHNOLOGIES RESEARCH IN PUBLIC ADMINISTRATION (2001–2020).

	IoT	AI	BC	SM	RD	VAR
	(1=Yes, 0=No)	(1=Yes, 0=No)	(1=Yes, 0=No)	(1=Yes, 0=No)	(1=Yes, 0=No)	(1=Yes, 0=No)
General public administration						
local government	-1.780**	-1.197***		3.226***		
public service			1.220**			
public administration	-2.075***	0.419*		1.542***		
sustainability		7.632*	0.994***			
government			1.102*	1.244***		
political communication				1.391**		
Good governance principles						
transparency	-1.691**	1.338***	1.840***			
consensus			2.205**			
Digitalization principles						
privacy	1.324***	0.990***	1.298***			
trust			1.561***		2.075***	
cybersecurity	0.815**		1.263***			
automation					1.381*	
communication		-2.026**		1.464***		
authentication			1.812**			
data protection		1.635*				
E-government initiatives						
digital government		1.498***				2.272***
e-governance		-1.152*				
e-government		-0.356**		1.068***		
e-participation		-1.473**		1.531***		1.609**
open government	-1.432*			1.949***		
Smart government initiatives						
citizen engagement				1.301**		
citizen participation				1.042*		
smart government	0.994*					
smart city	1.505***	0.654***	0.488***	-0.919***		0.921***

Note: Significance: * $p < 0.1$; ** $p < 0.5$; *** $p < 0.01$. The binary logistic model is performed on 55 predictors (public administration keywords) for each disruptive technology. Only statistically significant results are presented. Abbreviations: IoT – internet of things, AI – artificial intelligence, BC – blockchain, SM – social media, RD – robotics and drones, VAR – virtual and augmented reality.

IV. DISCUSSION AND CONCLUSION

The recent trends and challenges emphasize the need to exploit the potential of disruptive technologies in public administration. However, comprehensive and in-depth insights on the implications of disruptive technologies in public administration are still missing. Therefore, the paper tries to fill this research gap by mapping research trends on disruptive technologies in public administration.

The results reveal the growth of disruptive technologies research in public administration over time, especially in the last decade, as accelerated by several of the most relevant documents published in reputable journals such as Government Information Quarterly, Sustainable Cities and Society and Sustainability by several prominent authors. Most research has been conducted in the United States, followed by the United Kingdom and China and focused especially on artificial intelligence, followed by the internet of things, social media and blockchain, with the smart city being an important concept in disruptive technologies research in public administration. Finally, the results suggest that different public administration areas have different implications for disruptive technologies.

Namely, several practical applications can be already found around the world. Internet of things plays a very important role in real-time monitoring, allowing for more optimal use of resources [3], especially on the smart city level. Singapore launched a Smart National Program in 2014, providing a foundation for artificial intelligence. Through sensors and cameras deployed throughout the island, they have collected an unprecedented amount of data on daily life in the city. This has allowed them to closely monitor how the nation is functioning in real-time. Their transport networks, for example, make use of road sensors, smart parking, and phased traffic lights to improve traffic flow and solve congestion problems [34].

Artificial intelligence (in combination with big data) is used to strengthen citizen engagement with public institutions, increase operational efficiency, free up resources for higher value-adding tasks, and enable greater predictive capabilities for smarter policymaking and service provision [35]. Latvia introduced the Chatbot UNA in 2018, which is used to help answer frequently asked questions regarding the process of registering a company [36].

Blockchain's security and other specific features are relevant to many functions of government and public administrations. There would be a case to use blockchain if there is a strong desire to ensure the integrity of the data record (e.g., in case of electronic voting, public tender, citizen records) or eliminate dependency upon a third-party organization that may not be trustworthy [35]. Estonia introduced Keyless Signature Infrastructure in 2022, which became the first blockchain system to carry eIDAS accreditation - the EU trust mark for qualified trust services with legal power for electronic transactions in the European Single Market [37].

Social media is often used in the context of the dissemination of information, allowing for increased citizen engagement [3] at both local and state levels. Ireland established the Dublin Beat, through which public tweets are collected and analyzed in order to give a regular overview of citizens' most pressing concerns in the Dublin Area [38].

Robotics and drones, despite their issues related to trust and their applications, refer especially to smart mobility and humanoid robots (creating a long-lasting experience, collecting feedback, optimizing administration processes, assuring social distancing in the case of a pandemic, etc.) [39]. In the United Arab Emirates, the Dubai Police in 2017 employed the world's first operational robot policeman - Robocop, having special features, such as its facial recognition software with which it can identify offenders. With this tool, the Robocop can also broadcast live video feeds to the police command room [40].

Virtual and augmented reality, besides their wide use in heritage applications, can be used to make a virtual version of physical public administration space, including public servants, represented by avatars [41]. South Korea is currently working on Digital Twin-based Land Administration in selected regions and cities. These are virtual replicas of the real world, which will facilitate land administration [42].

This bibliometric study is limited only to documents indexed in the Scopus database. Although Scopus is considered a world-leading database of peer-reviewed literature, it might not cover the entire collection of disruptive technologies research in public administration. Therefore, the inclusion of other databases, e.g., Google Scholar or Web of Science, may have disclosed additional insights not revealed by this bibliometric study.

Regardless of this limitation, the findings may be of benefit to not only the scientific community to serve as an important source for detecting associated research gaps but also to evidence-based policymaking to fully address the issues related to disruptive technologies in public administration in the future.

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