Collaborative Governance in the Digital Transformation Age: A Systematic Literature Review with Bibliometric Mapping

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ABSTRACT

Purpose: The article aims to provide an updated and comprehensive overview of academic research in the field of collaborative governance and digital transformation, with an emphasis on the emerging topic of collaborative digital transformation. Digital transformation is a recurrent theme in today's society, fuelled by events such as the Covid-19 pandemic, global climate challenges, and other crises reshaping the world. As societies increasingly rely on digital platforms and online communication, the prime urge and necessity of the human race – i.e., to communicate and collaborate in tackling these challenges – puts collaborative governance in digital transformation high on the agenda of governments, the private sector, and citizens.

Design/Methodology/Approach: To address this topic, we performed a bibliometric analysis using various analytical and visualisation tools to evaluate and visualise existing scientific bibliographic materials. The analysis covers 286 articles published in the Scopus and Web of Science databases over the past two decades in the area of collaborative governance and digital transformation, employing established and innovative bibliometric approaches. Graphical analyses are used to illustrate co-authorship, keywords co-occurrence, research topics evolution, and the network of influential researchers within collaborative governance and digital transformation.

Findings: The results show that the relationship between collaborative governance and digital transformation is still limited and needs further study, considering that these two concepts have been emerging trends in public administration over the past two decades. In addition, the findings reveal a significant growth in research of these topics over time, although not specifically focused on collaborative digital transformation.

Practical Implications: The article provides a summary of key aspects of collaborative governance and digital transformation research and helps lay the foundations for shaping the future of this evolving field of public administration. Thus, it helps researchers understand the development of collaborative digital transformation research over the past two decades, as collaborative digital transformation is a relatively new field of research characterised by rapid growth and evolution.

Originality/Value: The research contributes to the understanding of collaborative digital transformation as a distinct research area within the broader concepts of digital transformation and collaborative governance, which is still seeking its own identity in academic literature, and offers a definition of collaborative digital transformation (CDT).

Keywords: digital transformation, e-governance, collaborative governance, collaboration, collaborative digital transformation, bibliometric mapping, literature review

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1 Introduction

The rapidly evolving digitalisation of our societies and economies, driven by data and digital tools has impacted people's lives on an individual and societal level, also bringing noticeable changes to the public sector and public governance. Transformational power has fundamentally impacted not only internal government operations, but also the government-citizen and the government-business relationship. Much of the literature has explored the concept of collaborative governance, which examines the relationships and participation of the government, citizens, and stakeholders in the decision-making process. However, the new technological disruption is paving the way for a different approach to public administration science, which emphasizes that digital transformation can accelerate and merge with existing collaborative processes and create the potential for new ones to erupt. However, the way this rapidly growing phenomenon in collaborative governance research has been labelled and has been subject to change over the last 20 years creates confusion about the delineation between core concepts, especially when it comes to digital transformation.

Collaborative governance (CG) is, as the name suggests, a type of governance that is heavily based on collaboration between a variety of stakeholders. Ansell and Gash (2008) define collaborative governance as the coordination of standards and rules jointly determined and projected to govern individual behaviour in a group context. In collaborative governance, the focus is on

governance processes that blur public, private, and community boundaries in response to the interconnected challenges that governments face today (Bradford, 2016). It is one of the main approaches towards a collaboration between the community, the private sector, and the government, and eases the state's burden in providing the community's goods and services and welfare (Kim & Grant, 2010). Within collaborative governance, collaboration can be defined as a situation where a group of autonomous stakeholders from different sectors engages in an interactive process (Hajnal & Jeziorska, 2021). Research in this field is growing rapidly and is being adopted not only in public administration, but also in various other disciplines, and has appeared in studies and practices in the American, European and Australian literature; therefore, constant improvements and clarification are needed. Several holistic frameworks and empirical studies have been published about collaborations (e.g. Agranoff, 2012; Ansell and Gash, 2008; Emerson et al., 2012). The use of multi-actor collaboration to advocate for policies, deliver services, and create public value has also led to a larger body of literature on public sector collaboration (Mischen, 2015), which has revolved around terms such as collaborative public management, network governance (Emerson et al., 2012; Rhodes, 2017), cross-sector collaboration (Bryson et al., 2015), governing collaborations (Vangen et al., 2015), and collaborative governance (Ansell and Gash, 2008).

In the context of collaboration, digital technologies have been recognised to play an important role (Bryson et al., 2015). Although not many have made digital technologies the centre of attention in this emerging literature of collaboration, the contribution of collaboration to the creation of public value and the role of structures and processes embedded in key areas has been identified across different models of collaboration: technology, leadership, governance, and collaborative capacity (Bryson et al., 2015).

Previous studies have identified two distinct roles that technology can play in interagency collaborations (Bryson et al., 2015). The first role considers technology as a tool or equipment, and thus as a facilitator of collaboration. This traditional view of technology has been thoroughly explored in the literature on digital government (Gil-Garcia, 2012; Gil-Garcia et al., 2018; Luna-Reyes & Gil-Garcia, 2014), and to a lesser extent by scholars of public administration (Bryson et al., 2011). The second role views technology as a 'nonhuman actor' (Bryson et al., 2011; Gasco-Hernandez et al., 2022), capable of providing solutions and presenting a systematic understanding of complex interactions that surpass the perceptions of individual actors (Bryson et al., 2015). This idea of technology as an actor has been elaborated in actor-network theory (Latour, 2007), which distinguishes between human and nonhuman actors and advocates for treating them equally under the principle of generalised symmetry. Despite this, the notion of technology as an actor has not been widely integrated into cross-sector collaboration or collaborative governance frameworks.

Nevertheless, in line with the development of collaborative governance trends, the intersection with technological disruption is unavoidable today. The concepts and research field of digital transformation (DT) has become well-estab-

lished, due to the widespread adoption of digital technologies in society, industries, and organisational management (Nadkarni and Prügl, 2021; Verhoef et al., 2021; Vial, 2019). DT is a process that occurs at the intersection of products, services, and media, and is centred around the use of digital technologies to transform and create value. As a research field, DT is constantly evolving and adapting to changes within the relevant area (Roth, 2019). Examining the existing literature, Vial (2019) found great inconsistency in existing research on digital transformation and, therefore, tried to define digital transformation as a process that aims to improve an entity by triggering significant changes in its properties through combinations of information, computing, communication, and connectivity technologies. Related to the digital transformation in the public sector, many recent works discuss the era of digital governance, such as e-government and digital government (Ravšelj et al., 2022). Governance in the digital era, or "digital era governance," could be considered a contemporary umbrella term for all recent initiatives to modernise governance in public administration, based on the implementation of digital transformation.

In this review, we systematically explore the topics of CG and DT in the most cited articles from the last two decades, to observe and uncover the main trends, summarise the progress that research has achieved over the past years, and outline the limitations of the research. Furthermore, we want to provide the definition of collaborative digital transformation (CDT) as a fusion of the above-mentioned topics. The review focuses on the following research questions:

1. How are CG and DT defined in the existing literature?
2. What are the characteristics commonly used to fully define them?
3. What were the main research purposes, methodologies, and results on the most cited studies on these topics over the past 20 years?
4. If and how can we detect the concept of CDT?

This article argues that CDT is a missing and important concept that can improve research in the area of public governance in the future, enabling a better outcome of digital transformation.

Researchers emphasise the significance of categorising the literature of a particular research field based on primary development patterns to enhance comprehension of the extensive literature on the topics mentioned above. Bibliometrics is one of the most frequently utilised techniques for this purpose. Science mapping, or bibliometric mapping, is a crucial research area in bibliometrics. It monitors the scientific field, defines its cognitive structure and development, and acts as a spatial representation of how disciplines, fields, researchers, and individual documents are interrelated (Cobo et al., 2012). Despite the significance of identifying key elements in specific areas of interest, there is a lack of bibliometric studies on collaborative governance and digital transformation issues. Therefore, the goal of this paper is to conduct a literature review of the existing research on collaborative governance and digital transformation, as well as the correlation between the two. Additionally, our goal is to define the collaborative digital transformation as a new

research area that would merge the two mentioned topics. The literature review further employs bibliometric mapping to analyse the bibliographic characteristics and content of articles written by various authors from various countries, covering the period from 2002 to 2022. The objective is to collect data from the SCOPUS and Web of Science (WoS) databases and perform a bibliographic mapping using Biblioshiny tool for evaluation and visualisation. The objective is to establish a robust foundation for the concept of collaborative digital transformation. By analysing authors, research topics, keywords, journals, countries, and institutions, using a set of bibliometric indicators such as productivity, citations, H-index values, and total link strength (TLS) values, a comprehensive examination of the work conducted over the past two decades is conducted. This analysis enables a thorough exploration of the field and provides a solid basis for future research.

2 Background

The challenge for governments today is to fulfil public expectations in the era of digitalisation, where most of the population is using digital technologies as their main tools of living. Therefore, governments must adapt public service delivery and policy making to a new era of digitally driven and collaborative governance, since citizens increasingly expect to be active participants, not passive recipients in the process. Ansell and Gash (2008) explain the meaning of *collaboration* as "a governing arrangement where one or more public agencies directly engage nonstate stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative, aiming to make or implement public policies or manage public programmes". Multiple benefits are expected. First, bringing citizens actively on board through collaboration in the design and implementation of policies and services could increase their legitimacy and effectiveness and create the feeling of ownership. Second, citizens' and other stakeholders' engagement could help to gain knowledge about needs, solutions, and impacts that could otherwise be overlooked by governing actors. Third, inclusive processes could help to address the differential impacts of various policies on outcomes that address different segments of society and their effects on growth and well-being. And finally, citizens and other stakeholders can bring new knowledge and new innovative ideas to the table.

Collaboration therefore refers to the process of joint decision making (Stoker, 2004). Emerson et al. (2012) define collaborative governance broadly as the processes and structures of public policy decision-making and management that engage people in collaboration constructively, across the boundaries of public agencies, levels of government, and/or the public, private, and civic spheres, to carry out a public purpose that could not otherwise be accomplished. In the realm of collaborative governance, this approach differs from other forms of governance and decision-making processes that seek consensus due to its targeted approach to resolving complex issues and problems within the public sphere (Ansell and Gash, 2008; Emerson and Nabatchi,

2015). This is in response to the limitations and inability of governments to unilaterally address these issues (Agranoff, 2012; Bodin, 2017). Collaborative governance involves joint decision-making activities between public and private agents to increase public value by creating policies and managing resources, services, and public goods. It also aims to balance conflicting interests among the agents involved to achieve the aspirations of all parties and minimize the power asymmetries and influence of coalitions that may arise in the process (Agranoff, 2012; Ansell and Gash, 2008; Bardach, 2001; Emerson et al., 2012; Torfing, 2016).

Today's governments should make use of digital technologies as a strategic component of their efforts to modernise the public sector. The concept of digital government entails using digital technologies as an integrated aspect of government modernisation strategies and activities aimed at creating public value. This approach involves a digital government ecosystem that comprises government actors, non-governmental organisations, businesses, citizen associations, and individuals, which facilitate the production of and access to data, services, and content through interactions with the government (OECD, 2014). Consequently, there has been considerable research on digital technologies in various aspects of digital transformation in the public sector. The term "transformation" is often used to indicate significant changes, modernisation efforts, or innovation based on the integration of digital technologies into government business processes, service delivery models, and culture. This restructuring alters how government performs basic functions and governance (OECD, 2016). Other authors describe digital transformation as a means of rebuilding business models based on customer needs by using new technologies (Berman, 2012; Shi et al., 2022). Transformation can also be viewed as the process of transitioning from traditional government through the initial forms of e-government to digital government (Vlahović and Vračić, 2015).

According to McLoughlin et al. (2013), digital transformation results in digital government, which can sometimes be found as a synonym to e-government (American studies), or as a next evolution phase of e-government. Electronic government or e-government in its most generic form was defined as the use of IT in the public sector to ensure access to and delivery of government information and user-centric services (Silcock, 2001), and/or to transform government and its relationship with various stakeholders (Spirakis et al., 2010). The essence of e-government is embodied in efforts to make service delivery more efficient and accessible to citizens (Meijer and Bekkers, 2015; Meijer et al., 2009). However, the development of new literature focuses specifically on what we define as digital government, which emphasises digital innovations as something more than their digital bits: technologies drive transformations that go deeper into public organisations and their relationships with the public. Vlahović and Vračić (2015) claim that the shift from e-government to digital government requires the introduction of the initiatives needed to make deeper changes in the provision of online services through government portals into a broader government business. Janowski et al. (2018) view this move as a potential of empowering citizens and other stakeholders to con-

tribute to or lead the creation of public value, often recognised as one key feature of digital government transformation.

So, digital transformation should potentially transform citizens to government interactions in two ways: by improving service delivery and by improving relations between citizens and government (Fountain, 2004; Seifert and Petersen, 2002). Governments are progressively utilising the capabilities of digital technologies to foster a network culture that is crucial for digital transformation. In this context, collaborative governance is facilitated by digitalisation, but the digital transformation itself also depends on the collaboration between government actors and private entities. This emphasises the significance of public administrations' ability to collaborate and jointly create outcomes by sharing and pooling resources, both within and across different sectors. This means collaboration serves as a fundamental pillar for digital transformation (Vial, 2019). It is not surprising that governments are increasingly adopting inter-organisational and inter-sectoral collaboration as a crucial approach to effectively carry out the digital transformation (Edelmann, 2019).

However, following the path of digital transformation, governments often forget that in some social groups access to digital technologies and digital skills is limited at the point of digital inequality. The government should rethink policy design and public service delivery to achieve a more inclusive approach, which refers not only to citizens' access to technology but also to digital literacy. Social equity is only possible if institutional barriers to citizen inclusion are removed and opportunities for their participation through digital technologies are equitably distributed (Anderson et al., 2015). For this reason, a strategic, collaborative and all-inclusive approach to digital transformation is needed, and requires a strategy that establishes strategic and practical steps to mobilise state and non-state stakeholders to use digital technologies for a more collaborative, open and innovative government. The use of digital technologies can enable positive changes in the way public administrations conduct their work, communicate, and provide services. It can also have far-reaching impacts such as changing organisational structures and cultures, or engaging and integrating citizens and other partners in the co-design and co-delivery of public policy making (Bretschneider and Mergel, 2011; Sivarajah et al., 2015; Weerakkody et al., 2012).

The existing literature reveals a significant lack of studies that address collaborative governance on digital transformation issues simultaneously. It is mainly focused on the collaborative governance concept in general, while much less effort has been made to examine collaborative governance research on digital transformation issues. Furthermore, the literature review shows a significant lack of bibliometric studies on the topic related to the fusion of these two concepts, thus hindering a comprehensive understanding of collaborative governance on digital transformation issues. The existing paper therefore addresses these issues and contributes to the research of collaborative digital governance.

3   Materials and Methods

In recent years, bibliometric analysis has become an increasingly widespread method for the evaluation of research work (Mukherjee et al., 2022; Radu et al., 2021). In this research, we collected data from the SCOPUS and WoS databases to retrieve the documents for bibliometric analysis. The search strategy was based on the title, abstract, and keyword search. Accordingly, we use the following search queries that were utilised for SCOPUS:

1. CDT: (TITLE-ABS-KEY("e-government" OR "digital*" OR "digital transformation") AND TITLE-ABS-KEY(collaborative AND governance)) AND PUBYEAR > 2001 AND PUBYEAR < 2023 AND (LIMIT-TO (DOCTYPE,"ar") AND (LIMIT--TO (LANGUAGE, "English")),

2. DT: (TITLE-ABS-KEY("e-government" OR "digital*" OR "digital transformation")) AND PUBYEAR > 2001 AND PUBYEAR < 2023 AND (LIMIT-TO (DOCTYPE,"ar")) AND (LIMIT-TO (LANGUAGE, "English")),

3. CG: (TITLE-ABS-KEY(collaborative AND governance)) AND PUBYEAR > 2001 AND PUBYEAR < 2023 AND (LIMIT-TO (DOCTYPE,"ar") AND (LIMIT-TO (LANGUAGE, "English")),

and for WoS:

1. CDT: TS=("e-government" OR "digital*" OR "digital transformation") AND TS=(collaborative) AND TS=(governance) AND LA=(English) AND PY=(2001-2023) AND DT=(Article)

2. DT: TS=("e-government" OR "digital*" OR "digital transformation") AND LA=(English) AND PY=(2001-2023) AND DT=(Article)

3. CG: TS=(collaborative) AND TS=(governance) AND LA=(English) AND PY=(2001-2023) AND DT=(Article).

By using this queries it was ensured that all relevant and corresponding documents were captured in the search query. For the analysis, we filtered the results to articles only, whereas other forms of publication, such as book chapters, conference proceedings, and white papers, were excluded. Additionally, the search was limited to English, since it is among the most widely used languages in publications worldwide. The selected articles that were retrieved and analysed were restricted to the period 2002–2022. Finally, because of large number of the results and the limitations of the download process, we limited the selected results to the top 2,000 most cited documents from each database.

Table 1: The number of search results in SCOUPS and WoS queries focusing on digital transformation, collaborative governance, and collaborative digital transformation.

	WoS	SCOPUS
DT	392,492*	591,966*
CG	5,003*	4,410*
CDT	193	194
*Only 2000 top cited documents used		

Based on the search query, we obtained a broad set of documents from the SCOPUS and WoS databases that are associated with collaborative governance, digital transformation, and collaborative governance in digital transformation research (Table 1). First, we merged the SCOPUS and WoS databases and deleted duplicate documents matching in title. For collaborative digital transformation research, which was the focus of our research, the relevance of the results was tested by manually reviewing the documents retrieved in two consecutive steps (Figure 1). For collaborative digital transformation research, 286 documents were identified as relevant (Figure 1). Although 5 of these articles focused on the literature review of different topics (3 include a keyword review and only 2 more articles indicate a literature review as a primary research method), we included them in the analyses.

Figure 1: The flow of the bibliometric research process for collaborative digital transformation research.
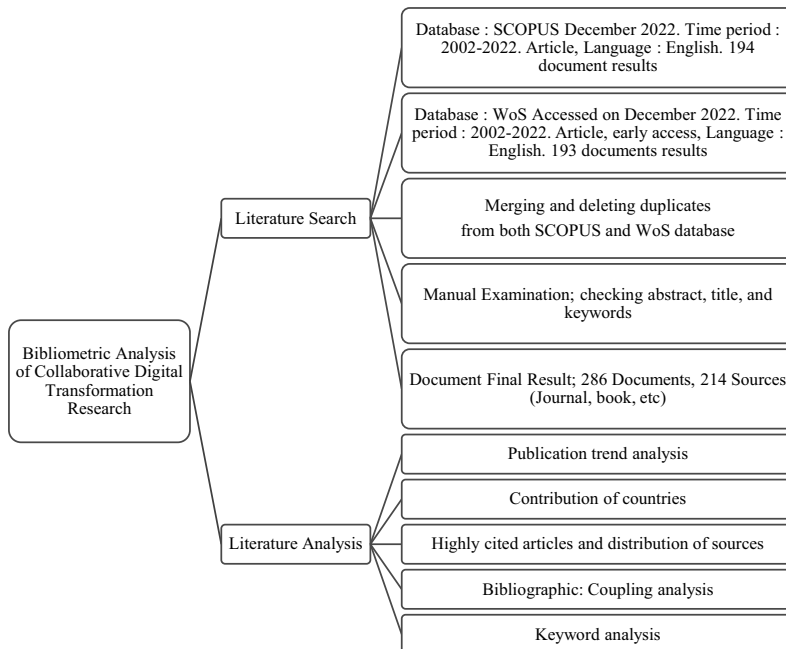
In the next step, aiming at data analysis and visualisation, we used Biblioshiny, which is the Bibliometrix R package that allows coding-less bibliometric analysis without coding and enables visualisation (Aria & Cuccurullo, 2017). This tool can use data such as journal names, article titles, author and journal keywords, authors' data, their home countries, research organisations, etc., and allows analysis based on citation, co-authorship, co-occurrence, co-citation, bibliographic coupling links, etc. When practicing with Biblioshiny, it is important to understand the terminology provided by this software (Moral-Munoz et al., 2020; Ravšelj et al., 2022). The maps built, visualised, and analysed using this analytical and visualisation tool consist of different elements. Among them, we focused on the results that prove the relationship of items, such as: co-author links for researchers, and co-occurrence links for terms and ideas.

## 4   Results

4.1   Publication Trends

To begin with, a descriptive overview of the bibliometric analysis was conducted. We explored the characteristics of the scientific literature on collaborative governance and digital transformation, linking it to collaborative digital transformation (CDT) research. Table 2 presents an overview of the characteristics of the most cited scientific literature on collaborative governance (CG), digital transformation (DT), and collaborative digital transformation (CDT) research between 2002 and 2022, taken from the SCOPUS and WoS databases. Research on CDT has developed quite significantly. There are 286 documents written by 835 authors and 66 individual authors, and published in 214 sources, with an average citation per document of 17.05.

The search results on the topic of collaborative governance and digital transformation provid a comprehensive initial picture. As mentioned above, for the CG and DT result set the number of search query results was too large to analyse (Table 1), so we had to limit it to 2000 articles, selecting the highest citation order, since these documents make a major contribution to the queried research field. The number of citation rates per document is 33.76 for CG and 612.3 for DT. The huge difference is caused by a large standard deviation, since the most cited paper in the CG group has 2,924 citations, while in the DT group this number is 30,891. If we juxtapose the development of these two concepts with the topic of CDT, the analysis shows that CDT has established itself as a new area of scientific inquiry and has since been a fast-growing area (Figure 2).

Table 2: Overview of the comparative characteristics of the top 2000 most cited scientific literature on Collaborative Digital Transformation (CDT), Collaborative Governance (CG), and Digital Transformation (DT) research (2002-2022) in the SCOPUS and WoS databases.

Bibliometric Items	Collaborative Digital Transformation Research (CDT)	Collaborative Governance (CG)	Digital Transformation (DT)
Database	SCOPUS and WoS	SCOPUS and WoS (2000 top cited were from each source)	SCOPUS and WoS (2000 top cited were from each source)
Timespan	2002-2022	2002-2022	2002-2022
Sources	214	1219	905
Documents (without duplicates)	286	3,102	2,809
Document Average Age	3.96	8.68	13.1
Average citations per doc	17.05	33.76	612.3
References	16,161	146,420	142,035
Single-authored documents	66	769	177
Authors	835	8,166	26,613
Author's Keywords (DE)	1,129	7,038	6,512
Co-authors per document	3.33	3.26	14.6

Figure 2: Annual number of papers – results of the collaborative digital transformation query
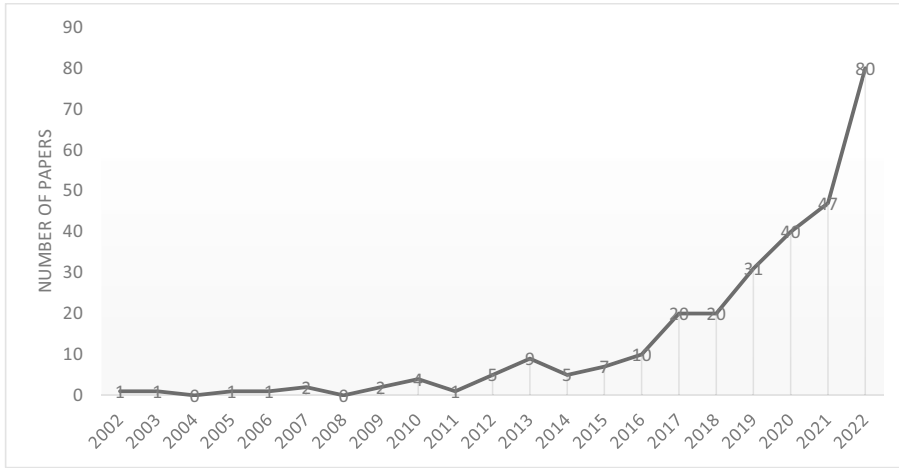
4.2 Distribution of journals and highly cited articles

Tables 2, 3 and 4 list the data of the 10 most relevant documents by the number of citations in the CG, DT, and CDT area of research. The most cited article for DT (Table 5) is the article written by Wang et al. (2004) entitled 'Image quality assessment: from error visibility to structural similarity,' published by IEEE Transactions on Image Processing, with a total of 30,891 citations, or an average of 1,544 per year. In the article, a different approach to quality assessment that relies on the deterioration of structural information is examined. The authors introduce a structural similarity index and provide several examples to demonstrate its potential. They also compare the index to subjective ratings and other objective methods using an image database. The article is among the top ten articles that highlighted the diverse areas that have been impacted by DT in recent times.

The variety of journals is much lower among the top ten cited articles in the CG domain, covering themes of public administration, environment, and ecology. The most cited article in the CG domain (Table 4) is an article by Ansell and Gash (2008), entitled 'Collaborative Governance in Theory and Practice', published by the Journal of Public Administration Research and Theory. It has been cited 2,864 times, with an annual average of 190.93. It discussed how collaboration brings public and private stakeholders together in collective forums with public agencies to engage in consensus-oriented decision making. They found that a virtuous cycle of collaboration tends to develop when collaborative forums focus on small victories that deepen trust, commitment, and shared understanding. This article is the main reference for scholars in various scientific fields to understand collaborative governance.

Table 3: Top 10 most relevant documents by number of citations in Collaborative Digital Transformation (CDT) (2002–2022).

Authors	Document Title	Sources	DOI	Total Citations	TC per Year
(Meijer et al., 2015)	Governing the Smart City: A Review of the literature on smart urban governance	International Review of Administrative Sciences, Volume 82, Issue 2.	10.1177/0020852314564308	728	91.00
(Fung, 2015)	Putting the Public Back into Governance: The Challenges of Citizen Participation and Its Future	Public Administration Review, 75: 513-522	https://doi.org/10.1111/puar.12361	386	42.89
(Harrison et al., 2012)	Open government and e-government: Democratic challenges from a public value perspective	Information Polity, vol. 17, no. 2, pp. 83-97, 2012	10.3233/IP-2012-0269	227	18.92
(Özdemir & Hekim, 2018)	Birth of Industry 5.0: Making sense of Big Data with Artificial Intelligence, 'The Internet of Things" and Next-Generation Technology Policy	Omics: a Journal of Integrative Biology 22(1)	10.1089/omi.2017.0194	185	30.83
(Meijer, 2015)	E-Governance innovation: Barriers and strategies	Government Information Quarterly Volume 32, Issue 2, April 2015, Pages 198-206	10.1016/j.giq.2015.01.001	123	13.67
(Alreshidi et al., 2017)	Factors for effective BIM governance	Journal of Building Engineering Volume 10, March 2017, Pages 89-101	10.1016/j.jobe.2017.02.006	103	14.71
(Ismail & Materwala, 2019)	A Review of Blockchain Architecture and Consensus Protocols: Use Cases, Challenges, and Solutions	Symmetry 2019, 11(10), 1198	10.3390/sym11101198	95	19.00
(Fung et al., 2013)	Six Models for the Internet + Politics	International Studies Review, Volume 15, Issue 1, March 2013, Pages 30-47	10.1111/misr.12028	81	8.10
(Nam & Pardo, 2014)	The changing face of a city government: A case study of Philly311	Government Information Quarterly, Volume 31, Supplement 1, June 2014, Pages S1-S9	10.1016/j.giq.2014.01.002	77	7.70
(Klievink et al., 2016)	The collaborative realization of public values and business goals: Governance and Infrastructure of public–private information platforms	Government Information Quarterly Volume 33, Issue 1, January 2016, Pages 67-79	10.1016/j.giq.2015.12.002	71	8.88

The most cited publications on the CDT topic is the article 'Governing the smart city: a review of the literature on smart urban governance', by Meijer et al. (2015) with a total of 707 citations and an average annual citation of 101 This article provides a framework on how various smart city governance processes should craft new forms of human collaboration through the use of digital technologies to obtain better results and more open governance processes.

Table 4: A comprehensive overview of the 10 most relevant documents by number of citations in collaborative governance research (2002-2022).

Authors	Document Title	Sources	DOI	Total Citations	TC per Year
(Ansell & Gash, 2008)	Collaborative Governance in Theory and Practice	Journal of Public Administration Research and Theory, Volume 18, Issue 4, October 2008, Pages 543–571	10.1093/jopart/mum032	2864	190.93
(Emerson et al., 2012)	An Integrative Framework for Collaborative Governance	Journal of Public Administration Research and Theory, Volume 22, Issue 1, January 2012, pages 1–29	10.1093/jopart/mur011	1278	116.18
(Olsson et al., 2004)	Adaptive Co-management for Building Resilience in Social–Ecological Systems	Environmental Management volume 34, pages 75–90 (2004)	10.1007/s00267-003-0101-7	1234	64.95
(Berkes & Ross, 2013)	Community Resilience: Toward an Integrated Approach	Society & Natural Resources An International Journal Volume 26, 2013 - Issue 1	10.1080/08941920.2012.736605	827	82.70
(Pahl-Wostl et al., 2007)	Social Learning and Water Resources Management	Ecology and Society 12(2): 5.	10.5751/ES-02037-120205	728	45.50

Authors	Document Title	Sources	DOI	Total Citations	TC per Year
(Zollo et al., 2002)	Interorganizational Routines and Performance in Strategic Alliances	Organization Science, Jg. 13 (6), S. 701-713	10.1287/orsc.13.6.701.503	725	34.52
(Meijer et al., 2015)	Governing the Smart City: A Review of the literature on smart urban governance	International Review of Administrative Sciences, Volume 82, Issue 2.	10.1177/0020852314564308	707	101.00
(Armitage et al., 2008)	Adaptive co-management and the paradox of learning	Global Environmental Change Volume 18, Issue 1, February 2008, Pages 86-98	10.1016/j.gloenvcha.2007.07.002	693	46.20
(Sundaramurthy & Lewis, 2003)	Control and Collaboration: Paradoxes of Governance	Academy of Management Review Vol. 28, No. 3	10.5465/AMR.2003.10196737	679	33.95
(Newig & Fritsch, 2009)	Environmental Governance: Participatory, Multilevel, and effective?	Environmental Policy and Governance Volume19, Issue3	10.1002/eet.509	626	44.71

Table 5: A comprehensive overview of the 10 most relevant documents by number of citations in Digital Transformation Research (2002–2022).

Authors	Document Title	Sources	DOI	Total Citations	TC per Year
(Zhou Wang et al., 2004)	Image quality assessment: from error visibility to structural similarity	IEEE Transactions on Image Processing, Volume: 13 Issue: 4	10.1109/TIP.2003.819861	30891	1,544.55
(Robinson et al., 2010)	edgeR: a Bioconductor package for differential expression analysis of digital gene expression data	Bioinformatics, Volume 26, Issue 1, January 2010, Pages 139–140	10.1093/bioinformatics/btp616	20172	1,440.86
(Donoho, 2006)	Compressed sensing	IEEE Transactions on Information Theory, Volume: 52 Issue: 4	10.1109/TIT.2006.871582	17685	982,50
(Akyildiz et al., 2002a)	A survey on sensor networks	IEEE Communications Magazine, Volume: 40 Issue: 8	10.1109/MCOM.2002.1024422	11128	505,82
(Mortazavi et al., 2008)	Mapping and quantifying mammalian transcriptomes by RNA-Seq	Nature Methods volume 5, pages621–628	10.1038/nmeth.1226	9451	590,69
(Akyildiz et al., 2002b)	Wireless sensor networks: a survey	Computer Networks Volume 38, Issue 4, 15 March 2002, Pages 393-422	10.1016/S1389-1286(01)00302-4	9250	420,45
(Gubbi et al., 2013)	Internet of Things (IoT): A vision, architectural elements, and future directions.	Future Generation Computer Systems Volume 29, Issue 7, September 2013, Pages 1645-1660	10.1016/j.future.2013.01.010	7805	709,55
(Bruzual & Charlot, 2003)	Stellar population synthesis at the resolution of 2003	Monthly Notices of the Royal Astronomical Society, Volume 344, Issue 4, October 2003, Pages 1000–1028	10.1046/j.1365-8711.2003.06897.x	7433	353,95
(Kottek et al., 2006)	World Map of the Köppen-Geiger climate classification updated	Meteorologische Zeitschrift Vol. 15 No. 3 (2006), p. 259 - 263	10.1127/0941-2948/2006/0130	6795	377,50
(Komatsu et al., 2011)	Seven-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Cosmological Interpretation	The Astrophysical Journal Supplement Series, Volume 192, Number 2	10.1088/0067-0049/192/2/18	6386	491,23

The tables above provide a comprehensive overview of the top ten research publications on the three topics. Interestingly, most of the CDT research focuses on developing the concept of modern governance using digital technology, institutional capacity, open innovation research, and citizen participation in public governance (Harrison et al., 2012; Meijer et al., 2015). In a comparison of the citation numbers with the number of documents published on these three topics, we see that the intersection or link between the concepts of collaborative governance and digital transformation is very clearly illustrated in the top CDT article. Meijer's (2015) article (Figure 3) successfully merged the aspect of collaboration with the use of digital government in the smart city concept and, according to the number of citations, caused wide interest within the reader community.

Figure 3: Most cited documents on collaborative governance in collaborative digital transformation.
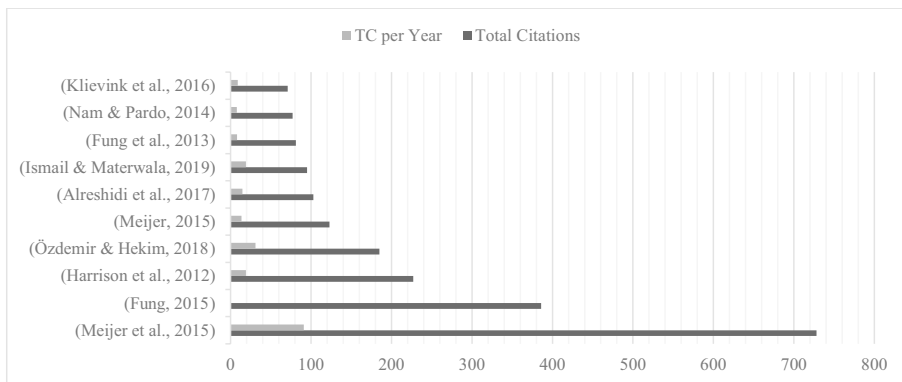
4.3 Countries with the highest scientific production based on the corresponding authors.

Based on metadata obtained from the SCOPUS and WoS databases, Figure 4 shows the 10 universities with the most articles published in CDT research between 2002 and 2022, based on the corresponding authors. KU Leuven, Belgium, has the most documents, producing 8 papers, followed by Delft University of Technology, The Netherlands, with 7 papers. The following are The University of Manchester, UK with 6 papers, Santa Catarina State University, Brazil with 5 papers, and The University of Nebraska, U.S. with 5 papers, and Utrecht University, Netherlands with 5 papers. The European countries dominate the chart.

Figure 4: Top 10 countries with the highest scientific production for collaborative digital transformation
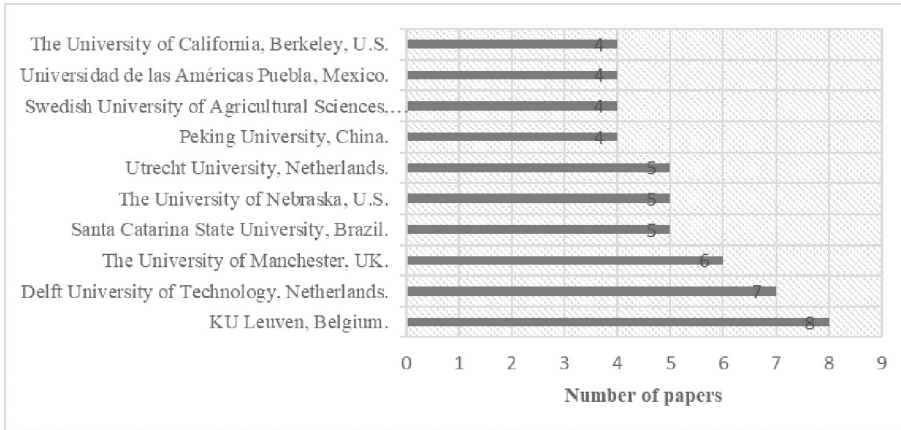

Figure 5 represents a three-field plot that explains the relationship between the authors (left column), keywords (middle column), and sources/journal (right column). The elements are also shown in rectangles of different colours and sizes. According to Janik and Ryszko (2018), the size depends on the value of the total relationship that appears between the rectangular elements. Therefore, if a component has many relations, the rectangle will be taller. Furthermore, the figure also shows in which sources CDT research authors most frequently publish, which authors, and which keywords are most frequently used. Based on Figure 5, it can be seen that the relationship between the author, the keywords, and the sources has a unique correlation. Various sources (i.e. government information quarterly, public performance and management review, international journal of public administration) are linked to various keywords of CDT topics (i.e. e-government, smart city, collaboration, collaborative governance) that are further linked to authors who used them as author keywords. For example, Chen is the author who covers wider CDT issues with the spread of the keywords used and published in journals that have a major influence on CDT issues.

Figure 5: Three-Field Plot: Relationship between main authors (left), keywords (middle) and sources (right) for collaborative digital transformation research.
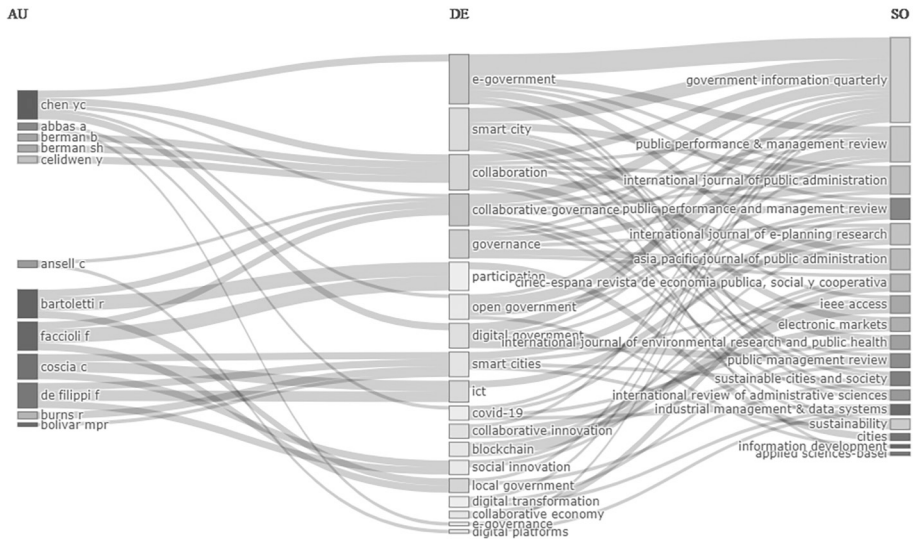
To analyse the main topics emphasised in CDT research, a strategic diagram (Figure 6) is used. The diagram groups highly relevant author keywords into clusters that represent the main themes, with the size of each cluster indicating the proportionality to the number of associated documents. Using Callon's centrality and density method, the core themes are divided into four quadrants that represent different types of themes. The clusters highlight the themes of the research, while the size of each cluster indicates their significance based on the number of keywords. The upper-right quadrant contains themes with high centrality and density, indicating well-developed internal and external ties, and these themes are considered motor themes. The upper-left quadrant contains themes with low centrality but high density, indicating strong internal but weak external ties, and these themes are considered highly developed and isolated. The third quadrant contains themes with low centrality and low density, indicating weak internal and external ties, and these themes are considered emerging or declining. Finally, the lower-right quadrant contains themes with high centrality but low density, indicating weak internal but strong external ties, and these themes are considered basic and transversal themes (Horvatinović & Matošec, 2022; Ravšelj et al., 2022; Wang et al., 2020).

Figure 6. Thematic map of collaborative digital transformation.
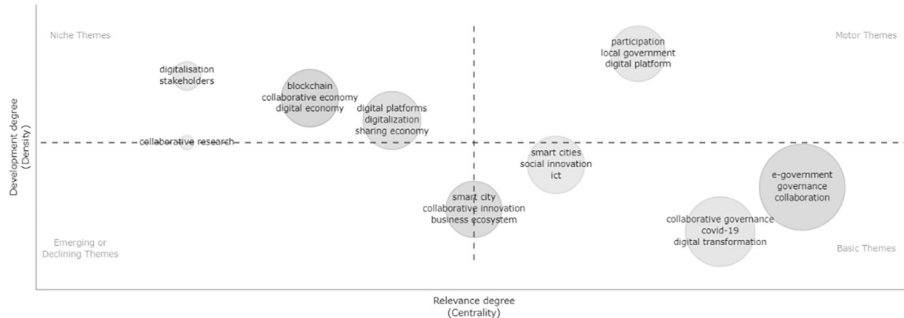
The results show that the focus of CDT research between 2002 and 2022 has varied. There are three drivers of niche themes related to CDT research: blockchain (including collaborative economy and digital economy), digital platforms (including digitalisation and sharing economy), and digitalisation (linked to the stakeholders perspective); these keywords appear more influential within the digital transformation research. Keywords participation (related to local government and digital platforms) appear as motor themes, which means that these keywords are well covered and important for the structure of the CDT research field.

Meanwhile, in the emerging and declining themes, the keywords smart city, collaborative innovation, and business ecosystem are in a position that intersects with the basic themes. For keywords that appear in basic themes, there is one major grouping on collaborative governance topics covering keywords smart cities (including social innovation and ICT), e-government (including governance and collaboration) and collaborative governance (including covid 19, and digital transformation). These keywords are in line with the development of the number of citations that emphasise relevant studies in CDT.

5   Discussion and Conclusions

The bibliometric analysis presented above reveals that CDT has begun to receive attention from scholars amid the development of the concepts of DT and CG which have gained a place in the field of public administration research in the last two decades. The results of the DT topic showed it as a broad and influential concept in the current times of the digital revolution. Titles, keywords, and journals of the analysed DT documents indicate a wide variety of research areas and therefore encourage many fields of science to develop their interest following technological advances, including public administration, which is "transforming from bureaucratic analogue public services to citizen-oriented digital services, incorporating dimensions of collaboration through CG" (Ansell & Gash, 2018). DT is identified as a universal and revolutionary concept that emphasizes contemporary technologies as drivers of innovative, sustainable, and competitive public administration, including new public governance, as indicated by the vast amount of DT query results

and high-citation indicators. On the other hand, the CG documents analysed bring together public actors and private stakeholders in a joint effort to solve complex social problems in a volatile world and to create governance solutions and outcomes that have high public value (Ciesielska & Janowski, 2019; Vial, 2019). In line with the development of digital transformation and collaborative governance trends in the literature, the intersection with technological disruption and government practices is unavoidable. The presented bibliometric study advances knowledge of the concept of collaborative digital transformation (CDT) by emphasizing the research areas of collaborative governance and digital transformation, stressing that these two concepts are frequently discussed in the literature (see Table 6) but have never been thoroughly explored from the viewpoint of the potential fusion between them.

Since the CDT concept only grew recently, the scientific literature on CDT has been very limited, although the topic of CG and DT developed rapidly in the same period. However, the interception of the two shows great potential in the fast-developing digital society, where global wicked problems demand further development of this study in the future. Furthermore, CDT is the subject of constant change and rapid evolution, also influenced by developments in other studies in public administration like the paradigm of the new public governance. Its emphasis is on a modern approach to public governance driven by multi-stakeholder participation to jointly produce an "all-win" collective policy, exploiting the potential of emerging technologies to ensure public administration is successfully transformed. Therefore we suggest 5 core dimensions of CDT presented in Table 7.

Table 6: The links between CG and DT in the 4 most cited CDT literature.

No	Authors	Relation between CG and DT
1	(Meijer et al., 2015)	The authors focused on the concepts of smart city governance, crafting new forms of human collaboration through the use of ICTs to obtain better outcomes and more open governance processes. Good administration and good policies may result in strong interactions at the urban level, whereas a focus on smart collaboration may result in more attention to issues of collaboration than actually making things work. The most transformative level of conceptualisation stresses that smart governance is about smart urban collaboration between the various actors in the city. We qualify this conceptualisation at the highest level of transformation, since it is not only about the transformation of the internal organisation but also of the external organisation.
2	(Fung, 2015)	The author focused on participatory governance, where increasing citizen participation is sometimes seen as a way to increase the effectiveness of regulation and improve the provision of public goods and services. Author expects that the demand from citizens for greater engagement with the institutions that affect them and a shift towards digital technologies that can make information more accessible, would increase the development of the avenues for collaboration.
3	(Harrison et al., 2012)	The authors discuss transparency, participation, and collaboration as democratic practices in administrative agencies through open government (OG) within the context of e-government and its broader implications for the future of public administration. The authors conclude that open government reconciles the divergent paths of e-democracy and e-government. While transparency, participation, and collaboration may initially take more time and resources, they bear the promise of ultimately improving policy performance by creating shared understandings of current performance and generating pressure to improve, increasing the pool of applicable ideas, tapping into new sources of expertise, and building civic capacity. All these may ultimately turn out to be the key to concrete improvements in policy outcomes and the quality of public services.
4	(Meijer, 2015)	The author presents a theoretical framework of the different barriers to e-governance innovation and presents strategies. 'Fixing' and 'framing' are presented as the main strategies for realizing e-governance innovation research and later developed a theoretical model of e-governance innovation. The research discussed the system to engage citizens in the coproduction of safety in The Netherlands, Citizens Net, using a database with geographical and personal information about citizens and a system for sending voice and text mail messages based on geographical characteristics. The system can be characterised as an interesting form of e-governance since new technologies are being used both within the organisation and in contacts with citizens to strengthen collaboration between government and citizens and produce public value, in this case the production of safety.

Table 7: Main dimensions of CDT.

Dimension	Description	Guidelines
Collaborative mindset	Ali included stakeholders, especially stakeholders from the public sector should shift their mindset and organisational culture towards collaboration for better public policies and services.	Sharing ideas, knowledge, and expertise freely is an integral part of the collaboration process. The process must include employees, customers, suppliers, and partners.
Cross-functional teams by default	Collaboration teams should include various organisations and stakeholders from different backgrounds and departments.	Working together to identify digital opportunities, incorporate new technologies, and implement transformative initiatives.
Digital tools and platforms	Various advanced digital tools and platforms that facilitate communication, information sharing, and collaborative work should be incorporated, with a focus on security and data protection.	Tools like project management software, collaboration tools, cloud-based platforms, big data, AI and social networks should be used to maximise the benefits of collaborative digital transformation.
Agile methods	Due to the constant changes in the world, fast development and advances in technology and wicked problems, agile methods should be used to enable constant and dynamic collaborative digital transformation.	Use agile methodologies with the support of digital tools for iterative collaborative development using quick feedback loops and continuous improvements to adapt to changing requirements during the transformation process.
Continuous learning and adaptation	Collaborative digital transformation is an ongoing process, and the public sector needs to continuously learn, adapt, and refine its policies and services.	Continually gather information, evaluate outcomes, and make informed decisions for future transformations.

In this paper, this picture of CDT research development is based on articles published in the Scopus and WoS databases between 2002 and 2022. It offers an understanding of the CDT research area in the concepts of DT and CG, which is still seeking its own identity in the academic literature. Referring to our findings, the article by (Meijer et al., 2015) is an example of a meeting point between DT and CG, with the smart city concept, an emphasis on collaboration, and the application of digital technologies in various aspects, including decision-making processes, coordination, electronic administration, and policy outcomes. In the changing and developing literature, the CDT concept continues to seek the best formula and the most ideal form. In view of its initial conception, and to support the definition we propose the 5 dimensions of CDT, namely: collaborative mindset, cross-functional teams by default, dig-

ital tools and platforms, agile methods, continuous learning and adaptation (Table 7). , We conclude that CDT could therefore be interpreted as *a joint effort between authorities at different levels of government, private organisations and civil society to drive change and innovation in public policies and services based on collective decision-making through the use of digital technologies.* CDT involves leveraging digital tools and technologies to streamline processes, improve efficiency, and enhance overall business performance, while fostering collaboration and knowledge sharing across all stakeholders that can benefit to the process.

Our research provides bibliometric support for CDT research to emerge as a new approach in the public administration field. This study helps to understand the development of collaborative digital transformation research in the last two decades, as CDT research is a relatively new field characterised by rapid growth and evolution. Since CDT focusses not only on the implementation of digital technologies but mainly on fostering a culture of collaboration and empowerment of teams to work together toward shared objectives, combining the power of digital tools with effective collaboration, it will enable organisations to drive meaningful change and achieve successful digital transformations.

Nevertheless, we encourage future studies to further examine this emerging approach on CDT. For instance, it would be valuable to investigate and compare the factors that contribute to the success of CDT in particular contexts. This could involve studying more literature in countries with similar administrative traditions. By conducting these studies, we can enhance our understanding on the CDT. This knowledge will be instrumental in guiding scholars, governments, and organisations as they navigate the complexities of the digital era.

6   Limitations

There are some limitations to the current research that should be acknowledged. Firstly, the bibliometric analysis is limited to CG, DT, and CDT related documents indexed in the Scopus and WoS databases. Although these are highly regarded peer-reviewed literature databases, they may not encompass all of the research available. Furthermore, since the topic itself pertains to national governments as well as non-governmental stakeholders influenced by national political systems, many ideas and changes are communicated and explored in domestic or native languages. Therefore, these resources might contain information that may provide either different or additional insight in this research topic. Another limitation is that only titles, abstracts, and keywords in English were included in this study, which could introduce publication bias. However, it could also be argued that English is widely used for publishing research globally, suggesting that all significant scientific contributions should be detectable in databases such as the one used. Despite the aforementioned shortcomings, the results could be beneficial not only for the scientific community, but also for evidence-based policymaking to com-

prehensively address CDT-related issues. Moreover, the findings could be an essential resource for identifying related research gaps in the field of CDT in the future.

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