



Uncovering the organizational, environmental, and socio-economic sustainability of digitization: evidence from existing research

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Abstract

Sustainability and digitization have become significant parts of the global economy in recent years. Numerous studies examine the relationship between sustainability's environmental concerns and digitization. In contrast, few studies address the topic of organizational, environmental, and socioeconomic sustainability's integration with digital technologies. This paper intends to fill this void by conducting a bibliometric analysis of the relevant literature. Along with descriptive insights, we explain the area's social, intellectual, and conceptual structures, its evolution, and its future agenda. The article discusses how technology adaption improves individuals' and companies' efficacy, performance, and profitability. Second, the article suggests more funding to produce environmentally friendly, greener technologies that can promote inclusive economic models and spur sustainable growth. Third, the article explores explore technology's social and ethical implications, highlighting the need to consider gender, race, ethnicity, and location when digitizing the world. By drawing on extant evidence and integrating findings, the research concludes by providing a fresh academic and policy contribution to the twin fields of digitalization and sustainability.

Keywords Bibliometric review · Digitalization · Ethics · IT adoption · Sustainability · Co-citation analysis

JEL Classification Q56

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1 Introduction

The digitalization process began with the introduction of diodes and accelerated with the development of silicon-based microprocessors comprising millions of transistors (Arnold et al. 2015). Microprocessors need software to operate while computing power is required to solve equations and problems related to human society, and technological systems. The human ability to address highly complex problems has considerably expanded due to cloud and parallel distributed computing. Our reliance on digital services to solve daily problems has increased dramatically, where technology is intertwined into every area of human life, possibly jeopardizing the environment and personal privacy (Kramer et al. 2005). The omnipresent aspect of digitalization and advancements in computers and problem-solving have created several concerns. These concerns range from privacy, digital integrity, digital footprint, environmental sustainability, digital ethics and digital human rights.

As the next generation of computing, artificial intelligence emerged and upended the whole digital environment. While debates over artificial intelligence (AI) ethics have raged since the dawn of modern management, industry 4.0 relies entirely on AI digitalization to automate activities (Agrawal et al. 2018; Kumar et al. 2020; Sharma et al. 2020). Presently, artificial intelligence is infiltrating white-collar occupations, automating procedures such as legal research and human resource operations, and escalating conflicts between humans and technology. Once believed to be a human responsibility, ethical decision-making is on the verge of being outsourced to artificial intelligence and digitalized decision-making tools (Müller et al. 2018). These contentious issues raise worries about technology's general human-centricity, its sustainability, and its ethics in the context of human life. Given the fast spread of industry 4.0, the growing disparity between the wealthy and poor, the climate change catastrophe, and global regulations embodied in the sustainable development goals, the development of scholarship on sustainability and digitalization is critical, urgent, and timely (Ordieres-Meré et al. 2020).

The intersections of digitalization, artificial intelligence, sustainability, and ethics are not entirely novel or revolutionary. Scholars have long examined these issues from a life cycle, cost–benefit, computational and data science, and ethical standpoint. The scholarship in this field is quite rich, from science fiction to commentary by Bill Gates (Clifford 2019), Stephen Hawking (Camaréna 2020) and Elon Musk (Metz 2018). Still, the research directions are primarily fragmented, divergent, and topical, with scholars from different fields rarely collaborating on one platform. The studies are evenly divided between those who advocate for more digitalization and artificial intelligence and those who advocate for the integration of sustainable standards and ethics among players on the digital battlefield. Despite the absence of common ground, experts believe that sustainability, ethics, and consumer rights cannot be compromised in the pursuit of increased profitability or firm success. With the introduction of cloud computing, digitization has expanded significantly (Shaikh et al. 2017; Hou et al.

2017). Digitalization's new wave has democratized supercomputing and made it accessible to even modest start-ups (Innovation Finance Advisory; and European Investment Bank Advisory Services 2018). Consequently, the level of innovation is astounding, yet it is unchecked, unregulated, and without any self-censorship (Mahieu et al. 2018). In this context, digital sustainability and ethics gain prominence and require greater research, review, and public oversight.

This paper addresses the sustainability implications of digitalization by synthesizing the findings of the existing research. By drawing on extant evidence and integrating findings, the article provides a fresh academic and policy contribution to the twin fields of digitalization and sustainability. Our findings are based on an integrative review of 134 publications, retrieved from the Scopus database and analyzed using bibliometric software(s). Along with some descriptive insights into the area, the findings explain its social, intellectual, and conceptual structures, inform future scholars about the field's evolution, and offer a future agenda for its advancement. We touch upon the implications and advantages of technology adaption to improve individuals' and organizations' efficacy, performance, and profitability. Second, the research suggests for an increased scholarship to produce environmentally friendly and greener technologies capable of supporting inclusive economic models and acting as catalysts for sustainable development. Thirdly, we discuss technology's social and ethical implications, emphasizing the importance of considering intersectional differences such as gender, color, ethnicity, and region while digitizing the world (Kraus et al. 2019).

2 Literature review

The world is increasingly relying on digitalization and the world is increasingly facing issues of climate change (where NETZERO is a policy norm), global inequality, AI-based racial profiling and possible financial crimes (The World Bank 2022; IFRS 2022). The Paris Climate Deal, COP 26, COP 27 and G 20 meet, all have climate change and sustainable development on their agenda alongside the ethics and sustainability of digitalization (The World Bank 2022; IFRS 2022). The expansion of sustainability reporting measures such as GRI, TCFD, SASB, MSCI and ISO standards incorporating digitalization and sustainability all point towards overlapping space between sustainability and digitalization. Therefore, in our opinion, it is important to draw attention towards the sustainability and ethicality related to digitalization, artificial intelligence and related democratization across the world. Although, not long ago, these fields were quite independent and limited in use and impact, only recently are they converging, and we believe that interdisciplinary scholarship is one of the ways forward as society heralds greater digitalization (Harari 2019; Sharma et al. 2020).

While digitalization started, post the development of microprocessors, its applications are spreading worldwide and will continue to spread as society moves in the era of 5G communications. The intended consequence of widespread worldwide use of digital technologies may be noble and justified but the unintended consequences on sustainable development, the digital divide, financial crimes and ethics have the

potential to harm social harmony and individual human rights. Therefore, through this review, we intend to draw the attention of scholars towards the intertwining and overlapping spaces of digitalization and sustainability. Furthermore, the development of ISSB sustainability standards and the incorporation of technology in those standards further raise our acknowledgement of the importance of studying the interrelationship between digitalization and sustainability (Alonso et al. 2021).

Ethics and productivity have long been researched by philosophers, and sustainability took off as a field since the beginning of the global climate change conferences. The focus of scholarship increased on these fields since the beginning of the 2010s when the widespread use of cloud-computing micro-services and the resulting big-data applications started to influence human decision-making quite dramatically (Agrawal et al. 2018). However, the increasing influence of digitalization on the environment, especially when most electric energy is now consumed by servers and digital devices needs greater research, reflection and possibly self-censorship (Mahieu et al. 2018) towards the use of energy-intensive devices. The widespread use of these divides makes privacy an issue of moral and legal dispute. Along with privacy, the hacking of digital devices and digital financial crimes further makes it urgent for studying digitalization from the lens of sustainability. In this context, our review study attempts to understand the extant scholarship at the shared intersection of digitalization, sustainability and ethics (Abdou et al. 2022).

We posit that by conducting interdisciplinary research on digitalization, sustainability and ethics, both at the national level and the organizational (corporate level), countries and companies would be able to drive greater sustainable benefits from the incessant use of digital technology while they would be able to decrease the risks related to environmental damage, data hacking, ethical implications of machine over humans. As a software programmer, one is taught to solve complex mechanical (productivity) oriented problems but rarely are these engineers taught to incorporate ethical or sustainability-related dimensions into their coding activities. In this context, through our review, the research hopes to highlight a few pressing clusters of issues and research directions which may motivate scholars, practitioners and policymakers to channel their resources such that digitalization is sustainable, ethical, robust and strongly protects human rights, data, privacy and create greater environmental impact.

3 Methodology

The research conducted an integrative review, which is ideally suited for studying a topic across many research designs and methodologies to acquire a more comprehensive understanding of the phenomenon under study (Kraus et al. 2022). The study utilised bibliometric analysis to analyse the literature and personally evaluated the retrieved literature in order to comprehend the present state of the topic and propose a research and policy agenda. We gathered data for this study in December 2021, from the Scopus database, which is used to analyse scientific papers because

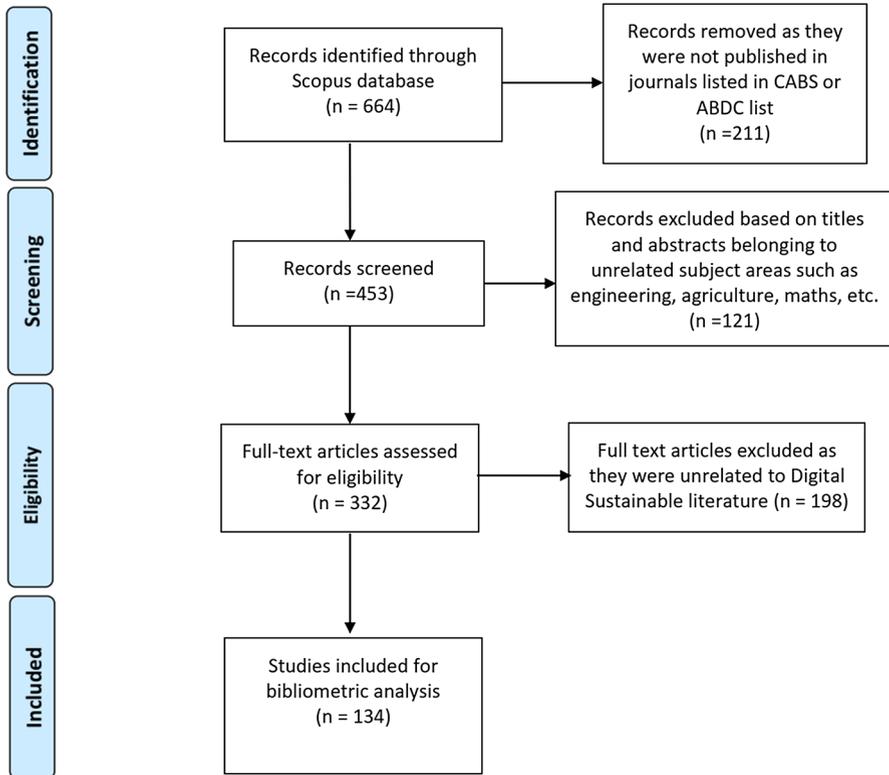


Fig. 1 Study flow diagram

of its widespread acceptance, high frequency of use, and multidisciplinary nature (Yang et al. 2013). The most thorough overview of research output in the fields of science, technology, social science, humanities, and the arts are provided by the well-recognised database, Scopus.¹ Numerous operational aspects in the Scopus database, such as the journal title, the number of citations, the type of document, the authors and their connections, the year of publication, and h-index metrics, make bibliometric analysis easier. The vast feature coverage of Scopus, which has 21,000 journal titles, enables faster examination of orphaned and erroneous entries (Agarwal et al. 2016). Keywords such as “sustainab*” OR “SDG*” AND “digital*” OR “artificial intelligen*”, OR “information technolog*” OR “internet of things” OR “IoT” (where the asterisk (*) represents any character, group of characters or no character) along with Boolean operators (AND, OR, NOT, NEAR, “W/n”) were used to fetch documents 664 documents initially. These papers are retained only if the searched keywords correspond to the title, abstract, and/or author keywords in

¹ Scopus: <https://www.elsevier.com/solutions/scopus/content>.

the publications (Kraus et al. 2020), and the period is specified between 1990 and 2021. We made certain to clean the fetched data first and to describe the process and present the PRISMA diagram in Fig. 1.

Additionally, to ensure the quality of the papers included in our study, we confined our search to journals that were featured in the most recent Australian Business Deans Council (ABDC) Journal Quality List for 2019 and the Chartered Association of Business Schools' (CABS) Academic Journal Guide for 2021. This yielded 453 documents, which were evaluated on the basis of their title, abstract, and full text, resulting in the final selection of 134 papers (Fig. 1). To gain a deeper understanding, the study manually reviewed each of the shortlisted articles, based on which we outline the directions for future research and policy. Among these scientific publications, 91% of documents are scholarly articles in academic journals, and the remaining 9% are editorials and review papers. The average number of citations per document is 8.727, and the average number of citations per document per year is 2.847. The study derived a detailed data file (CSV file) comprising information on the 134 articles, including title, keywords, abstract, authors, authors' addresses, source journal, publication year, references, and subject categories, after shortlisting the documents (van Nunen et al. 2018). Later on, this data file is used for bibliometric analysis. Additionally, each article was summarised separately in the table to ensure that we completely understood its scope, focus, design, and conclusions prior to doing the automated bibliometric analysis.

Bibliometric techniques use the comprehensive bibliographic data obtained from the database for constructing structural maps of scientific areas. These bring objectivity into the assessment of the scientific literature and identify the informal research networks (Zupic and Čater 2015). Bibliometric methods bring quantitative rigor to the subjective evaluation of literature and provide evidence of the theoretically obtained categories or themes in a literature review study (McCain 1990). The study uses VOS viewer (Visualization of Similarities) and Bibliometrix package of R to analyze and visualize the inter-relationships of authors, journals, countries, keywords, and co-citations. The VOS map is used to compute and identify each analytical unit (keywords, authors, journals, organizations, and documents) on a two-dimensional map, where the distance between any two items indicates their relatedness or similarity. The clustering technique of the VOS viewer helps group or cluster items into varied categories, depicted in different colors (Yang et al. 2017). The node size and font size of the labels depict the number of occurrences, while the length between two nodes depicts the similarity or relatedness among those two items, and different colors present varied groupings (Khalil and Gotway Crawford 2015). Bibliometrix R-Tool is an open-source R-package developed for comprehensively performing bibliometric analysis. This article applies this package for obtaining deeper insights into the analysis (Rodríguez-Soler et al. 2020). Figure 2 depicts the stages of carrying out the bibliometric review.

The study organizes the findings in terms of general description, social structure, intellectual structure, and conceptual structure of the publication corpus (Aria and Cuccurullo 2017). The general description of the publication corpus gives a glimpse of publication output and growth trend, keywords analysis, top

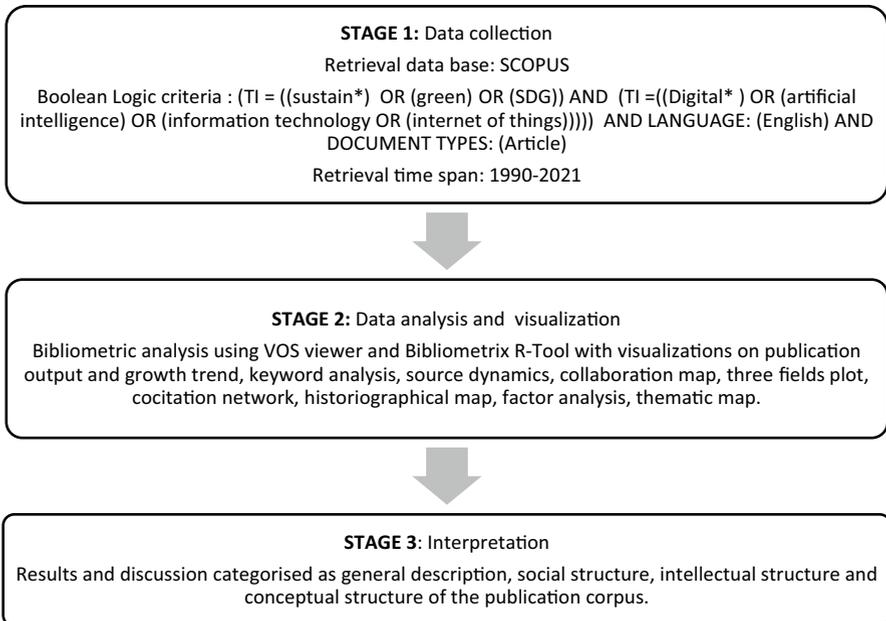


Fig. 2 Bibliometric stages

ten productive authors, and sources. The social structure focuses on the collaboration between authors and countries; the intellectual structure displays how specific works influence a scientific community, while the conceptual structure highlights significant themes and trends in the area of ‘digital sustainability’.

4 Results and discussion

4.1 General description of publication corpus

The quality of the publication is an important indicator to understand the development trends of scientific research. Figure 3 displays the growth trend of the number of publications per year and the sum of times cited per year in the digital sustainability area since 1990. The 134 papers have an average of 15.24 citations per document, an average of 2.006 citations per year per document, and a total of 20,002 references. Sustainability and digitalization are increasingly intensifying as topics of academic and policy debates. Just two decades back (see Fig. 3), sustainability and digitalization were hardly seen or studied together. Since 2016, we observe an increase in the scholarly interest in examining digitalization and sustainability via a shared epistemological lens. The reason can be the growing interest of researchers and academicians in the area of digital sustainability after the adoption of the

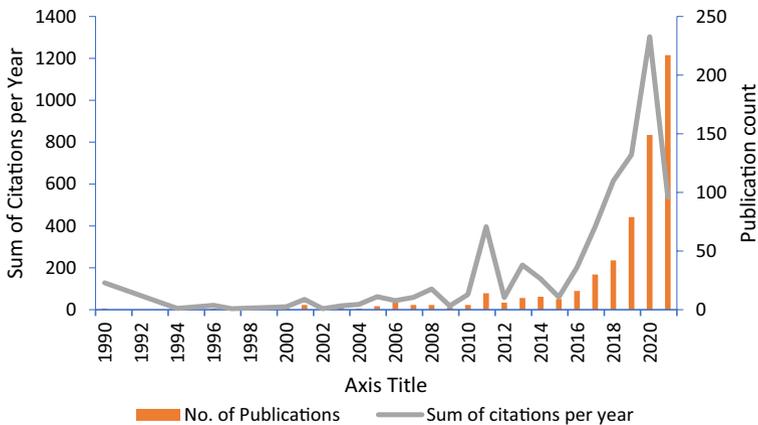


Fig. 3 Publications and sum of times cited per year growth trend

Table 1 Top ten cited articles in digital sustainability area

S no	Publications	Citations
1	Mata et al. (1995)	964
2	Richardson et al. (2007)	345
3	Dao et al. (2011)	216
4	Jenkin et al. (2011)	159
5	Zhu et al. (2015)	157
6	Chen et al. (2015)	146
7	Yoon (2011)	110
8	Yang et al. (2018)	100
9	Chen et al. (2014)	97
10	Laliberte et al. (2007)	89

Sustainable development goals (SDGs) by the united nations (UN) in the year 2015 (Del Río Castro et al. 2020).

The research on digital sustainability is likely to intensify further. In the aftermath of the COVID-19 pandemic outbreak, containment measures such as lockdowns, and the resulting work-from-home practices, the world is seeing a higher reliance on digital technology than at any point in history. The critical questions on ethics, sustainability, privacy, and socio-economic division in light of digitalization are also coming to the fore in such an environment. Additionally, the deteriorating climate change scenario necessitates a more considerable emphasis on sustainability, due to which worldwide resources are being devoted to this cause. The top ten cited publications and top ten productive authors in the field are shown in Tables 1 and 2, respectively.

Table 2 Top ten most productive authors

Rank	Author	PC	h_index	g_index	m_index	TC	PY_start
1	Liu, Anfeng	4	4	4	0.8	134	2017
2	Reamer, F. G	3	3	3	0.333	112	2013
3	Jiang, L	3	2	3	0.5	87	2018
4	Shao, G. F	3	2	3	0.154	61	2009
5	Bai, C. G	2	2	2	0.222	88	2013
6	Jin, K. G	2	2	2	0.133	87	2007
7	Li, Z. T	2	2	2	0.4	95	2017
8	Lin, L	2	2	2	0.182	5	2011
9	Maharjan, S	2	2	2	0.5	85	2018
10	Ordieres-Mere, J	2	2	2	1	9	2020

PC Publication count; TC Total Citations; PY Publication year

Table 2 arranges the top ten most productive authors in the field from highest to lowest. The h-index quantifies a scholar's output and citation effect (Hirsch 2005), while the g-index assesses an author's citation distribution, considering his/her top papers (Mazurek 2017), and the m-index represents the h-index per year since the first publication of the researcher (Mazurek 2017). 'Liu, Anfeng' is ranked first with leading publications (4), h-index (4), g-index (4), m-index (0.8), and the total number of citations in the field of digital sustainability (134).

4.1.1 Keyword analysis

The sample publication shows that 2151 keywords were used for this research. In order to visualise digital sustainability in the technology sector, keywords occurrence is analysed by the VOS viewer (as given in Fig. 4). The co-occurrence threshold: was five, which makes 85 items for the visualisation. The term 'sustainability', 'internet of things', 'artificial intelligence' and 'digitalization' have the highest number of occurrences in the publications. Five clusters are formed when the keywords are analysed as highlighted in Fig. 4.

The red colour focuses on *sustainability types* (Butler 2011; Feroz et al. 2021) and it includes 12 items namely, 'industry 4.0', 'innovation', 'circular economy', 'digital libraries', 'social sustainability', 'economic sustainability', 'environmental sustainability', 'big data analytics', 'technology', 'sustainable supply chain management', 'digital', and 'china'. The green colour cluster can be named as *businesses, digitalisation and sustainability* (Bharadwaj et al. 2013; Joyce and Paquin 2016). It has a total of 12 items which are 'sustainable development', 'digitalization', 'sustainable development goals', 'digital transformation', 'information technology', 'digital economy', 'social media', 'digital technology', 'business model', 'digital government', 'e-government', and 'sustainable business model'. The blue colour revolves around the theme *digital literacy* (Sharma et al. 2016; Radovanović et al. 2020) and it also includes 12 items which are, 'sustainability', 'Iot', 'Ict', 'digital

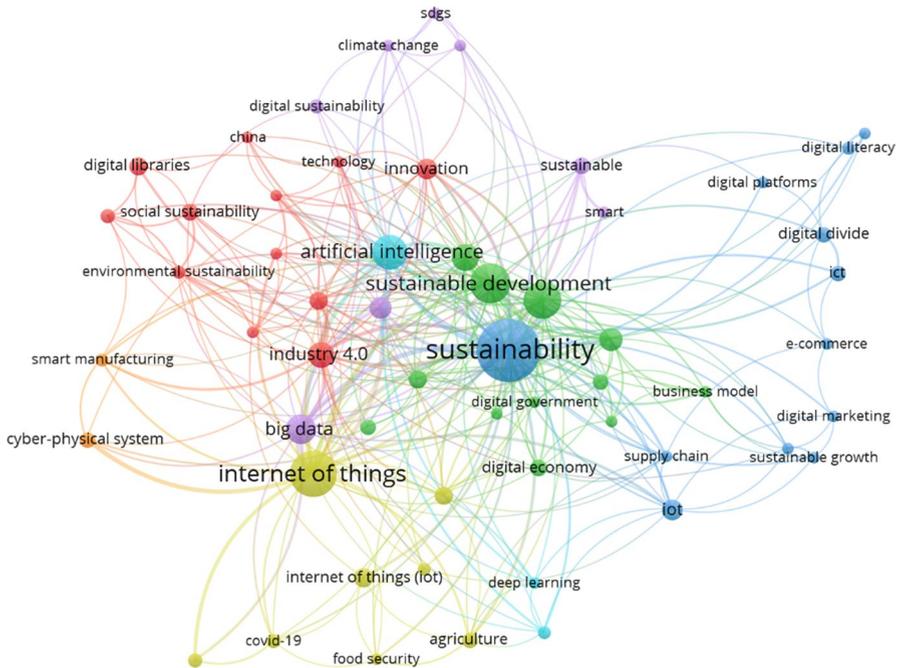


Fig. 4 Keyword co-occurrence map

divide', 'digital literacy', 'supply chain', 'sustainable growth', 'digital marketing', 'Sme', 'higher education', 'e-commerce' and 'digital platforms'. The yellow colour cluster focusses on *digital technologies, energy efficiency and agriculture*. It has 9 items which are 'internet of things', 'Iot', 'digital technologies', 'agriculture', 'smart sustainable city', 'covid-19', 'energy efficiency' and 'food security'. The purple colour cluster can be named as *smart digitisation and SDGs* (Del Río Castro et al. 2021). It contains keywords such as 'big data', 'smart city', 'sustainable', 'digital sustainability', 'climate change', 'smart', 'digitization' and 'SDGs'. The light blue colour cluster highlights the AI-based techniques and it includes keywords such as 'artificial intelligence', 'machine learning' and 'deep learning'. The last cluster is coloured orange and includes 2 items such as 'cyber-physical system' and 'smart manufacturing'. The keywords show that digital sustainability features are getting popular where the keywords such as performance, technology and big data indicate the future research direction. The low number of occurrences and items indicates that the subject is emerging and still open to further research.

4.1.2 Source dynamics

Source dynamics represents the most relevant sources publishing maximum studies on the topic 'digital sustainability'. The three most prominent journals publishing research from this field are 'Sustainability' (publication count—109, total citations—305, h-index—9, g-index—13 and m-index—1.125), 'Journal of Cleaner

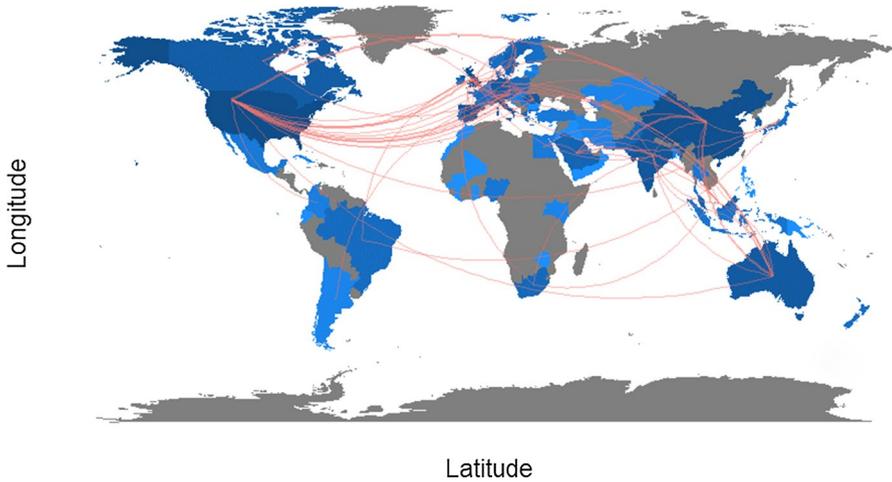


Fig. 5 Country collaboration map

Table 3 Top ten productive countries

S No	Country	Articles frequency	Single co-authored publications	Multi co-authored publications	Citations
1	China	10	20	8	174
2	Spain	8	20	4	206
3	USA	8	18	4	565
4	United Kingdom	8	14	9	245
5	Italy	6	14	4	239
6	Korea	5	13	2	94
7	India	5	11	3	32
8	Germany	4	10	1	77
9	Australia	4	6	4	71
10	Romania	14	12	2	65

Production’ (publication count—19, total citations—345, h-index—8, g-index—17, and m-index—0.471), ‘IEEE Access’ (publication count—13, total citations—219, h-index 4, g-index—13, and m-index—0.571). These are followed by ‘Journal of Business Ethics’, ‘Ethics and Information Technology’, ‘Science and Engineering Ethics’, ‘IEEE Internet of Things Journal’, and ‘Journal of Mass Media Ethics’.

4.2 Social structure of publication corpus

4.2.1 Country collaboration network

Figure 5 presents the country publication and collaboration map, wherein a lighter blue color signals low productivity, and darker blue indicates high productivity (Nita

2019). Between 1990 and 2021, the publications based on ‘digital sustainability’ are affiliated with 50 countries; the most productive country from this point of view is China (number of published articles = 42, ~ 11%). As summarized and illustrated in Table 3, the study observes that most multiple co-authored publications are from the United Kingdom (9), followed by China (8), while China is the most productive country (7% of the total publications). China’s supremacy is illustrated by it being one of the leading countries in manufacturing (Eloot et al. 2013).

Twenty-five² countries exclusively hosted single-country publications by authors on the subject of ‘digital sustainability’ (ergo, isolated countries in collaboration aspect). This illustrates that authors from these disciplines may be working separately on the subject of digital sustainability, rather than collaboratively. To summarise, authors from various countries must interact to improve prospects for work on pertinent subjects, as knowledge thrives only when it is shared (Wang et al. 2014). In comparison, the remainder had at least one study that was published in various countries. The most frequent research collaboration links are established between USA and Slovakia (5), China and USA (4) and Slovakia and the Czech Republic (3).

4.2.2 Country-author-keyword framework

Figure 6 presents the interactions of the 20 most relevant countries (left), authors (middle) and keywords (right) within the domain. The area of the rectangles is equivalent to the number of interconnections with the other field, for e.g., “China” (can also be observed in Fig. 6), “Jiang, L”, and “sustainability” have the greatest number of occurrences in terms of Country, Author and Keyword respectively. The work of corresponding authors from China focuses mainly on the Internet of Things (IoT) and sustainable development, while USA’s research focuses on ethical concepts, and United Kingdom’s work focuses on sustainable development. In general, European countries showed more interest in sustainability, digitalization, AI and digital transformation (Kerras et al. 2020; Lozano-Díaz and Fernández-Prados 2020).

4.3 Intellectual structure of the publications

4.3.1 Co-citation analysis

Co-citation analysis demonstrates how the literature is connected and evolves in knowable ways. The co-citation analysis links the published documents that help in understanding the evolution of a particular research area. The higher the number of citations of the two publications indicates the higher relatedness between them (White and McCain 1998). Co-citation analysis is a dynamic metric that changes

² Denmark, Mexico, Indonesia, Israel, Brazil, Hungary, Slovakia, Thailand, Armenia, Belgium, Chile, Croatia, Cyprus, Egypt, Estonia, Georgia, Iran, Kenya, Lebanon, Netherlands, Philippines, Qatar, Serbia, Trinidad and Tobago, Ukraine.

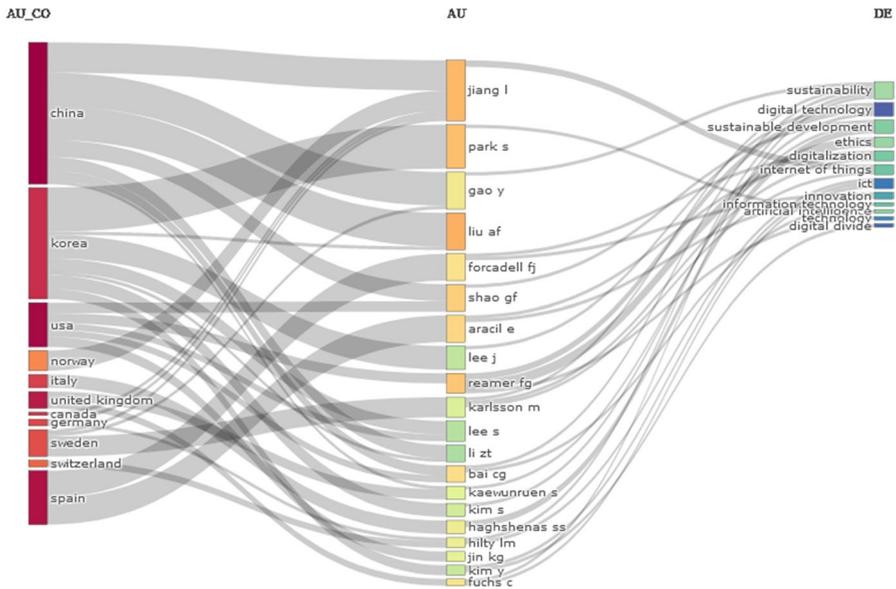


Fig. 6 Country-author-keyword framework

over time and helps identify the shift in paradigms and schools of thought (Zupic and Čater 2015). In Fig. 7, the node size signifies the number of citations, and the distance between the nodes represents the relatedness of the topic (Liu 2013). The visualization map contains two clusters, namely – red (12 documents) and green (9 documents). The clusters are automatically picked by VoS viewer software, mostly on the basis of topic relatedness or similarity of the keywords. Peters et al. (2020) is the article with the highest link strength (or relatedness to the topic) and it presents an empirical study on evaluating and analyzing sustainable Industry 4.0.

4.3.2 Historiographical map of the most influential publications

The historiographical map (see Fig. 8) depicts the idea’s journey throughout time through many sources of information (Bamel et al. 2020), with each node representing a publication and its placement on the x-axis indicating its relationship to previous publications. Hence, laying an understanding of developed and emerging paradigms and their shifts in a particular research area. Two metrics represent these nodes: local citation score (LCS) and global citation score (GCS), where LCS indicates the number of times other papers in the local collection have cited a paper, and GCS indicates the Citation Frequency based on the total number of records in a particular database (Saravanan and Baskaran 2019). Figure 8 uncovers links between the research contextualizing digital sustainability to human resources (GCS:23, LCS:1) (Lim et al. 2013), organizational sustainability (GCS: 3, LCS:1) (Abdul Karim 2004; Eschenfelder et al. 2019), decision-making including agenda-setting

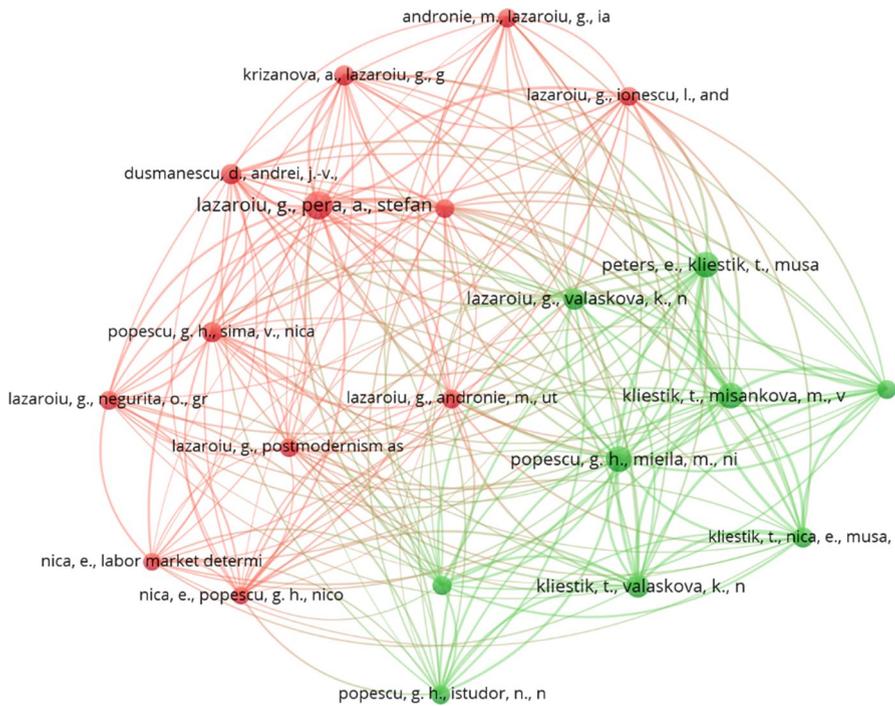


Fig. 7 Co-citation analysis

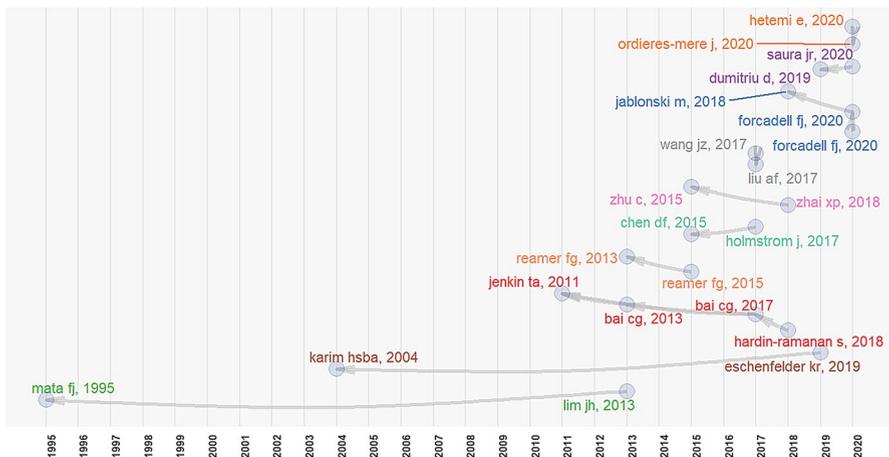


Fig. 8 Historiographical map

(GCS:159, LCS:7) (Jenkin et al. 2011); green/digital technologies (GCS: 36, LCS: 1) (Bai and Sarkis 2013), etc. The other growing themes include the digital age's ethical concerns, the sustainability of digital manufacturing firms, the green Internet

of Things (IoT), the impact of sustainability on the financial sector, and sustainable growth via digital marketing. It is observed that the concept developed from basic foundations to recent state art the concepts such as IoT, digital technologies and sustainability of digital firms. Digital industry 4.0 technologies like the Internet of Things, cloud computing, big data, and analytics have drawn a lot of interest from academics and industry professionals (Li et al. 2020). The impact of state art of technologies cannot be neglected. Therefore, it is understandable the increase in research that examines digital sustainability impacts within new domains.

4.4 Conceptual structure of the publication corpus

4.4.1 Factorial analysis using multidimensional scaling

Multidimensional scaling (MDS) is a quantitative method commonly used to produce maps utilizing proximity matrices to examine the underlying structure, displaying more similar objects to each other closer together (Fouroudi et al. 2020). The citation matrix of the original research articles uses the standardization of the squared Euclidean distance conversion process to present punctuations on the two-dimensional map (Shiau and Dwivedi 2013). One point represents a study on a two-dimensional graph. Figure 9 transforms the articles' relative emphasis on

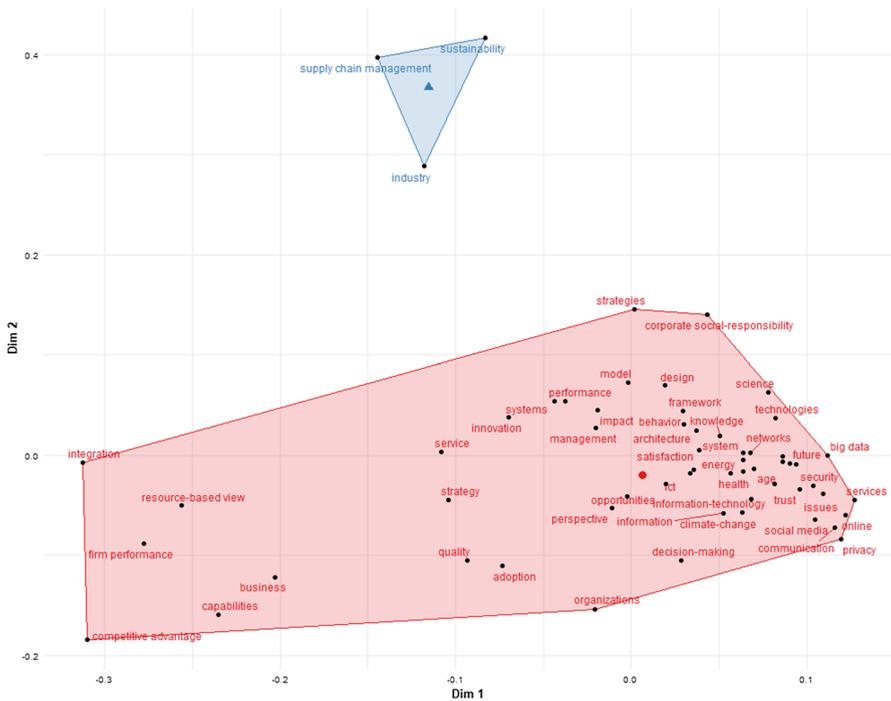


Fig. 9 Conceptual structure map-MDS method

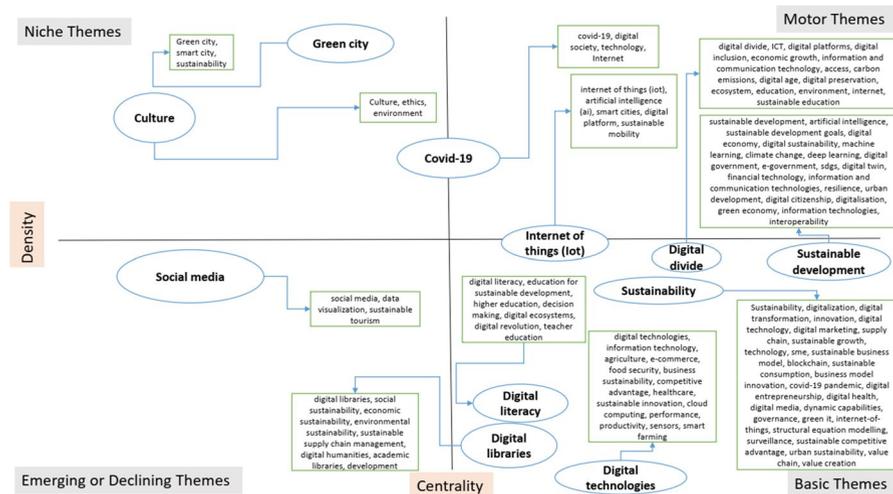


Fig. 10 Thematic map

sustainability, ethics, technology, AI, and IoT into distances represented in a multi-dimensional space.

The first cluster is particular to supply chain management, sustainability, and industry, suggesting that certain research specifically focused on applying technology to sustainability, industry, and supply chain management. In fact, this is true as businesses, particularly logistics-intensive businesses, become increasingly reliant on technological advances to manage their operations more effectively. The second cluster is relatively large and includes multiple concepts, terms and variables, which can be sub-categorized into theoretical frames and the firm's performance, risks (including sustainability, security, corporate social responsibility, privacy), strategy, and innovation. Within the theoretical frame, one would see the resource-based view, dynamic capabilities, competitive advantage, and firm performance as essential theoretical and conceptual frames. Furthermore, the subcategory 'risks' refers to topics such as sustainability (and unsustainability) transformation, climate change, security, and privacy, all of which influence business performance and competitive posture. The advent of risks in technology research is relatively new, and it reflects rising conflicts due to technology's widespread presence in our daily lives. Finally, the papers on organizational strategy and innovation focus on how organizations may reposition themselves in their present competitive landscape and assure success in a continuously changing business environment.

4.4.2 Themes and thematic areas

We create strategic theme maps to demonstrate the emergence of trends in digital sustainability, with each cluster depicted according to the centrality and density criterion (Fig. 10). The degree of interaction or strength of links between themes is denoted by centrality, whereas density measures the strength of

internal links within a topic. The mean of the Association of all exterior links is used to calculate centrality, while the mean of the cluster's internal linkages is employed to estimate density (also known as internal cohesion). The higher the density, the more cohesive the cluster and the likelihood of inseparable expressions. The greater the mean value, the more closely the cluster resembles a reference subject (center) in the corpus (Delecroix and Epstein 2004). The thematic map makes use of the Keyword field because it is a normalized field that can grasp the intensity and variability of an article's contents. The maximum amount of words is '250', while the minimum cluster frequency (per thousand documents) is '5'.

A strategic diagram depicts four types of themes based on their degree of centrality and density: motor themes (upper right quadrant, high centrality and density), peripheral themes (upper left quadrant, high density and low centrality), emerging or disappearing themes (lower left quadrant, low density and low centrality), and transversal, general, or basic themes (lower right quadrant, high density and low centrality) (Delecroix and Epstein 2004). The first quadrant contains the most central and visible clusters; quadrant two contains the densest topics, and quadrant three contains clusters that are weakly linked to the rest of the network, indicating topics that are becoming marginalized or are interesting for the future, but a structured vocabulary is not yet well-defined for those. Quadrant four contains peripheral domains (Delecroix and Epstein 2004). Since there are no themes in the upper right quadrant, we can assume that digital sustainability research is still at its novice stage of development. "Covid-19" is observed to be lying in between the upper right and upper left quadrants, indicating the gradual evolution of this theme. "Culture" and "Green city" are observed to be niche themes, whereas, "social media" is observed to be the emerging or declining theme. The greatest number of clusters are observed to be part of basic themes, including "Internet of things (IoT)", "Digital divide", "sustainable development", "sustainability", "digital libraries", "digital literacy", and "digital technologies", where "sustainability: and "internet of things" lead in the number of occurrences. Interestingly, the keywords in the red cluster (such as digital divide, digital literacy, Internet of things) in Fig. 4 match the themes or subthemes in lower left quadrant, signifying the growing importance of these themes.

5 Reflections and directions for future research and policy

To contribute to organizational, environmental, and societal conditions, we contextualize the preceding section's results and propose future research and policy agendas (in Fig. 11).

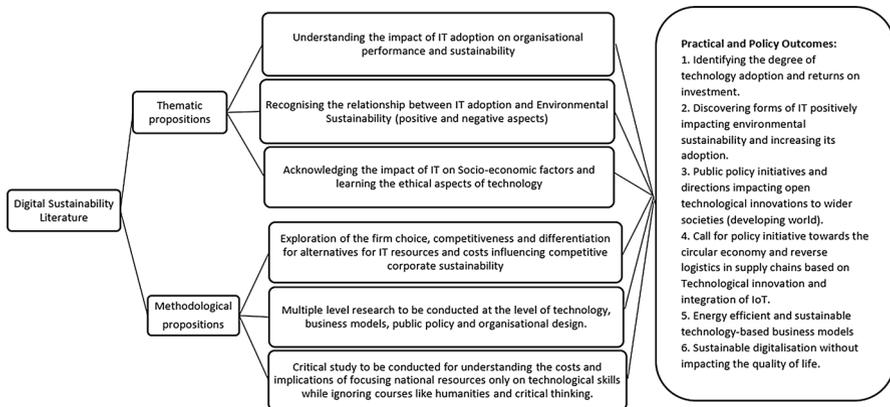


Fig. 11 Thematic and methodological propositions

5.1 Digitization, organizational performance and sustainability

Organizations use technology to manage organizational functions, control, expand, observe, and innovate to maintain their sustainable competitive advantage. IT and AI adoption have directly contributed to internationalization, localization, scaling, and overall competitive sustainability (Sharma et al. 2020). There is little discussion regarding the cost- and price-related aspects of digital sustainability. Future studies may examine the firm's selection of an IT resource and associated expenses and the impact on competitive corporate sustainability. Future research may investigate how business organizations fight for information technology resources and how this rivalry impacts overall organizational performance and the ability of the business to maintain its competitiveness.

The integration of technology into a business's fundamental activities has a significant influence on its success. However, the link between technology costs and their integration into businesses' fundamental operations is unstructured, with technology costs increasing faster than returns on investment. Researchers may investigate the link between the extent of technology adoption and the rate of return on investment.

5.2 Digitization and environmental sustainability

One section of the literature examined the positive correlation between technology adoption, technological innovation, and environmental sustainability, while another examined the role of technology in jeopardizing environmental sustainability and possibly contributing to climate change, carbon production, and unsustainable resource consumption. Future research must attempt to generate conclusive evidence on the positive and negative impact of digitization on environmental sustainability. Specific AI and technological innovations are greener, smarter, efficient and consume fewer resources but are copyrighted and patented (Rantala et al. 2018).

Scholars must explore the public policy initiatives and directions that could further impact and open technological innovations to wider societies (developing world). In particular, public-funded research on using AI and IoT to manage pollution may be planned to contribute to sustainable development goals.

After use, electronic items become garbage, putting tremendous strain on the environment, creating pollution and raising healthcare concerns (Bhutta et al. 2011). Technological innovation and integration of IoT in supply chains have furthered interest in circular economy and reverse logistics. Scholars may choose to investigate the integration of circular economic models and reverse logistics into information technology, the Internet of Things, artificial intelligence-based gadgets, and business models. Due to the tight relationship between technology, sustainability, circular economy, and reverse logistics, we foresee more research and policy initiatives focused on circular economy and reverse logistics (Bhutta et al. 2011).

Energy is required for technical products to operate, and growing reliance on technological innovation implies higher energy consumption. Cloud-based technologies have moved energy usage away from the consumer's house and toward the service provider's facilities. Further, the amount of energy required to create bitcoin and block chain-based documents is rapidly growing. To address these concerns, study on various levels is necessary, including technology, commercial models, public policy, and organizational design. Further investment and research are necessary to produce energy-efficient servers, energy-efficient algorithms, and energy-efficient designs at the technological level. At the business model level, academics must consider how service providers and customers may work together to improve sustainability. Future academics must investigate organizational structures and collaborative models to create energy-efficient and sustainable business models.

5.3 Socio-economic and ethical aspects of digitization

There are opposing thoughts on digitization's socio-economic and ethical aspects, with one being highly critical while the other being exceptionally positive. The positive stream of literature explores the impact of technology in improving people's lives, earning potential, and productivity and the critical stream explores the potential risks associated with IT, AI, and unregulated use of technology in everyday life and decision-making. Multiple studies show a direct relationship between technology skills, earning capacity, and socio-economic development (Avgerou 1998; Madon 2000; Hasan and Khan 2021). Public policy in the global south has shifted substantially in favor of equipping individuals with an advanced portfolio of technical skills in order to improve their capacity to compete in the labor market and contribute to national competitiveness. Scholars may assess the kind of skills to be given to school-aged children, non-technical schools, and technical schools to prepare future generations for a more technologically oriented global environment. However, more critical research should examine the costs and consequences of concentrating national resources exclusively on technical skills while disregarding humanities and critical thinking courses.

Technological advancements, notably in the fields of artificial intelligence and robotics, have aided people, particularly in the fields of geriatrics and chronic illnesses, by enabling low-cost continuous care and assistance. Greater research is necessary to comprehend the short- and long-term consequences of technologically intensive nursing, human care, and related services. Despite the benefits of digitization, human–computer interaction remains an understudied field, and the impact of digital technology on mental and physical well-being should be investigated. The digitization of routine activities increased efficiency while also transforming people into active users, to the point that they lost their work-life balance. Unfortunately, psychological and psychical disorders associated with technology, such as fear of missing out, digital rage, and phobia, have become commonplace. Scholars must pay attention to the safer use of technology. Finding the appropriate balance between technology benefits and sustainability is critical since widespread digital activities have begun to degrade living quality. Reduced life quality of human capital has a detrimental effect on an organization’s capability and overall sustainability. For subsequent eras, the appropriate question is whether people are securely utilizing technology or becoming victims of technology to be digitally sustainable.

6 Conclusion

Our study is one of the first attempts to draw the scholars of digitalization, artificial intelligence, sustainability and ethics on one platform. We conducted an integrative review of 134 papers drawn from the Scopus database to sketch the social, intellectual, and conceptual structure of the scholarship in the field. Using the strategic mapping method, these themes in seven basic themes (Sustainable development goals, Bioethics, Internet of things, sustainability, ethics, information technology, social sustainability), two emerging themes (electronic space, reliability), three motor themes (information and communication technology, smart city, social issues) and two emerging themes (green IT, circular economy). The following are the implications and limitations of the study.

6.1 Implications

The managers and practitioners should develop technology ethically and in a morally justified way. Managers, wherever possible, must work for energy efficiency and reduce carbon emissions. The materials used in developing and using digital technologies should have an element of circularity, recycling, and reuse. While the study lacks a discussion on the circular economy but given the domain we are in, and the intensity of digital devices being used, investors and managers must also focus on recycling and reuse. Culture and Green cities are niche themes. By culture, we assume that pop culture and creative industries are related to digitalization. Scholars

must explore the implications of digitalization on culture and cultural dynamics across countries and generations within the same family.

Our study overwhelmingly suggests that digitalization has a positive effect on environmental sustainability but remains indifferent to the questions of ethics. The fourteen themes outlined above serve as a roadmap for achieving this goal at the organizational level, thereby contributing to the policy implication of this study. The study emphasizes the internet of things. With higher internet speed, development in AI and the application of IoT for the automation of processes will increase. The proper use of IoT will lead to greater sustainability but also improper and unethical use of IoT may lead to financial crimes and loss of privacy. The managers when using IoT must ensure greater due diligence on issues of security and privacy.

6.2 Limitations

Our study suggests that digitalization has a positive effect on the environment. It does not talk in detail about the materials used in the manufacturing of digital products. The new ISSB international reporting requirements specifically call for the reuse and recycling of materials used in the manufacturing of digital products and devices. The new review should study digitalisation and its reporting requirements. A new study on the same topic must study how international standards like SASB and ISSB and digitalization interact and how firms need to report their digital footprint to sustainability standards. This study took some time to develop, and it is possible that the data is now much older. Therefore, we suggest scholars to further undertake new studies incorporating with greater detail the implications of ISSB standards, G20 and COP 27 implications on sustainability and climate change.

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