Challenges and Limitations of Pandemic Information Systems: A Literature Review

Nadja Damij, Zoran Levnajic, Dolores Modic, and Jana Suklan

***Abstract*—In this article, we investigate the role of information systems (IS) during the COVID-19 pandemic. By focusing on the limitations, challenges, and failures that IS faced as a consequence of swift and sometimes unsupported actions by organizations and governments, the aim of our study is to learn from these practices. IS and information technologies (IT), in general, played a pivotal role in mitigating the effects and consequences of the pandemic. Yet, rapid changes in their implementation amid crisis frequently led to unexpected or unwanted consequences. These triggered a deluge of heated debates in scientific literature. Combining cooccurrence analysis with narrative synthesis, we examine the recent research findings on IS/IT pandemic solutions. We identify a range of problems that can be traced to hasty introduction of new solutions. They often bring into question the actual benefits of introducing them and sometimes even raise serious questions about data safety and privacy. We show that common keywords and themes from this literature can be classified into five clusters and two groups. This classification reveals the effects of the pandemic on health, business, education, science, and technology, some of which are surprising.**

***Index Terms*—Content analysis, cooccurrence review, COVID-19 pandemic, information systems (IS), limitations, narrative review, systematic review.**

I. Introduction

INFORMATION systems (IS) contribute to the control and standardization of business functions [1] and encompass tools that help organizations manage their data [2]. For data management, IS help decision makers by providing accurate and timely information, which can be significant for authorities to make critical decisions in turbulent environments [3], [4]. The COVID-19 pandemic was one such unprecedented turbulent event, catching the world off-guard. Countries took a number of diverse steps to try to contain it. While the role of information technologies (IT) and IS was instrumental, we nonetheless need to remain cautious in terms of the development, adoption, and utilization of IS for, and in, pandemics and endemics.

In this line, critiques help to address potential bottlenecks, barriers, and other potential sources of controversies, both in the conceptualization and application of IS in connection to pandemics and endemics. Critiques can be seen as "a separation, a drifting-apart, a rupture—theoretical as well as practical, present as well as ideal" [5], while on the other hand are seen from a Foucauldian perspective [6] as a creative tool for transforming our ways of acting, as well as thinking and understanding. Critiques also bring to light incoherence, incompleteness, and hidden assumptions, and warn of less thought-out consequences [7]. Inspired by the role of critiques in pointing out issues for situations that are otherwise considered problem-free or where only the positives have been identified, this study brings together the critiques focused on the role of IS during and after the COVID-19 pandemic through a systematic literature review. Although the literature combining IS and the COVID-19 pandemic can still be seen as embryonic—albeit not for the lack of works connecting these two phenomena—the prevalent thinking at the time identified IS as an enabler of COVID-19-related solutions to various issues.

As the body of work increases, particularly in relation to COVID-19 where this increase is rapid, it is useful "to stop occasionally" and "take inventory of the work that has been done" [8]. For the IS literature, there is a call for "IS research to develop a cumulative tradition" [9]. Although literature reviews are mostly done to, e.g., provide an integrated, synthesized overview of the current state of literature, evaluate methodological approaches, develop conceptual frameworks to reconcile and extend past research, elaborate on research insights, and point out future research directions, they can also be used to provide more critical views, such as to identify existing gaps and inconsistencies in prior results and explanations [10]. We believe the systematic review can also be applied to showcase the criticisms of the literature. While scholars working on IS "might not be able to solve the crisis directly" [11], they can provide more insightful feedback for pandemics and endemics if care is taken to stop and take stock of what has (or has failed to be) addressed through a critical lens.

This article aims to evaluate how the pandemic escalated the use of IS in order to compensate for supply shortages, changed working environments, and to assist with the overall mental/physical health of citizens and employees, for example. Parra et al. [12] claimed that qualitative IS approaches have not yet addressed this question succinctly. We present in this

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article a reasoned account of the issues around the use of IS in the COVID-19 pandemic, in terms of the perceived limitations of IS in a pandemic situation, which we pose as our research question.

While doing so, we contribute to the literature by revealing the research status of the relationship between COVID-19 and IS. Our work offers a distinct advantage by integrating two approaches: cooccurrence analysis with a bibliographic and in-depth content analysis through a narrative synthesis. The latter delves deeper into the literature, extracting vital aspects and addressing its limitations. Together, these methods provide a comprehensive approach to analyzing the selected papers and provide deep insights into the research area. We follow the idea of cross fertilizing the results to provide a wider view of the scope and discussions within the topic of interest. Examining critical debates and controversies surrounding the role of IS during the pandemic and highlighting the usefulness of opinion-based evidence is a valuable source of understanding them.

Even though previous review studies offered a valuable understanding of IS and its roles (see, e.g., an overview of review papers in [9]) and some special editions invited contributions on the intersection of IS and COVID-19 (e.g., a special edition in IEEE TEMS [11]), prior research failed to comprehensively examine the literature on IS and COVID-19. Furthermore, there is a lack of literature on IS aimed to offer insights into criticisms and/or limitations as connected to turbulent situations, such as COVID-19, especially those that are relevant to business operations or increasing societal resilience. This article represents an effort to fill this gap.

II. Background

Since the 1960s, the development of IS as a scientific field is demonstrated by the solid body of research that has been built, which also includes increasing numbers of IS reviews [9]. The IS discipline has traditionally been characterized as the pursuit of knowledge pertaining to productivity and efficiency [13], improvement of these [14], and the facilitator of employee's and organization's performance progression [15], [16]. However, the recent COVID-19 pandemic, as an example of a turbulent circumstance, impacted and challenged the role of IS in everyday use, and shifted the primary focus of the perception of IS role. With panic setting in and a rapidly growing number of unanswered questions (particularly in 2020 and 2021), governments and organizations turned also to academia and researchers to try to quickly find the right answers among the exponentially rising amount of available data, and as such, IS became a tool to address various issues arising from and during the pandemic.

On one hand, the deployment and role of IS have been widely researched for decades, with most publications constructively addressing the topic [9], [17]. On the other hand, understanding IS limitations, or the dark side of IS [18], has only come to the forefront in the last decade [1]. Turbulent circumstances arise not only within the market but also in every aspect of one's life (such as the pandemic) and can result in suboptimal use of not only IS but also employee engagement [19], [20], [21]. To understand the role of IS and its limitations in transitioning through such turbulence require the examination of individual, societal, and organizational dangers [22]. As the organizations fought their way through the pandemic, the amount of available data on how to modify working processes grew exponentially on a daily basis; however, according to the underdetermination of scientific theory, the data were, at the same time, mostly too scarce to answer those questions successfully (ibid).

The business environment is prone to turbulence caused by various factors such as economic crises, regulatory changes, and technological disruptions [23], [24], [25]; hence, turbulence has a substantial impact on companies [26], [27]. The pandemic has had a profound impact on businesses worldwide, necessitating rapid adaptations to survive and thrive in the face of uncertainty. It is, therefore, important to understand the dynamic relationship between turbulence and IS by identifying the challenges and opportunities that arise in turbulent business environments. Recently, turbulence in the business environment has become increasingly prevalent and disruptive [27]. Companies needed not only to navigate uncertainties and disruptions effectively to remain competitive but also to navigate them swiftly. IS have held a crucial role in helping organizations adapt and respond to turbulence.

Turbulent environments necessitate organizational resilience, defined as the ability to anticipate, adapt, and respond to unexpected disruptions effectively [28]. IS facilitates resilience by providing real-time data and insights, enabling organizations to monitor, analyze, and respond to changes swiftly [29]. During the pandemic, this meant that organizations relied heavily on data-driven decision-making to assess the impact of lockdowns, supply chain disruptions, and shifting consumer demands. Furthermore, turbulent environments necessitate companies to embrace digital transformation to meet not only the evolving market demands [30] but also the evolving work requirements, such as remote working and virtual collaboration [31], to enable seamless remote work operations as well as to share the know-how to foster growth [32]. The COVID-19 pandemic drove organizations to rapidly assess their unique needs and challenges to tailor their IS practices accordingly. While turbulence impacted best practices depending on the specific industry, organizational context, and resources available, overlapping shifts toward IS management practices were witnessed, such as embracing digital processes for supply chain management, virtual customer service and online sales [33], facilitation of remote working and accelerated remote collaboration, communication, project management [34], [35], and data-driven decision making where IS facilitated ad-hoc and quick-response data collection, analysis, and visualization [33].

In such turbulent times, the literature review approach is particularly valuable [36]. Paré et al. [9] developed a typology of review types, based on their assessment of 139 review papers in the field of IS. They pointed out that the number of reviews is increasing; however, most of them are theoretical in nature. While critical and scoping reviews are the rarest type of review, we believe they can be very useful both in terms of triangulation of results (as in our case) as well as teasing out hidden assumptions, incompleteness, inconsistencies, and poorly considered consequences [7].

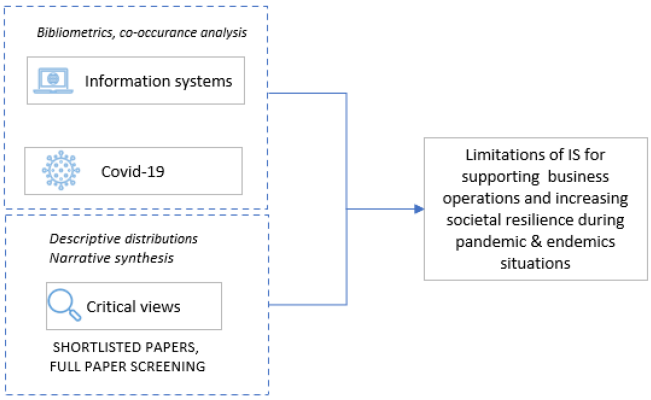


Fig. 1. Literature review model.

TABLE I
INCLUSION/EXCLUSION CRITERIA

Inclusion criteria	Exclusion criteria
a. must include a critique, research gaps, or future direction	a. does not cover COVID-19 related issues
b. must include an IS component	b. IS were marginally mentioned
c. must be a journal paper published in a peer-reviewed journal	c. individual perspective or specific focus (non-generalizable findings)
d. limited timeframe: 2020–2023	d. weak research methodology
	e. studies not written in the English language

III. METHODS

The significant contribution of this study is combining two approaches (the bibliographic and narrative synthesis) thus providing a deeper understanding of the academic literature by teasing out the critical aspects and limitations addressed in the literature (see Fig. 1). A wider scale review showcases a more comprehensive approach, as a contrast to a more fine-grained in-depth review focus via a narrative review. The two reviews have been executed in parallel and culminate in a synthesis of both. This ensures more robust results, as well as mitigates, for example, the deficiencies of one or the other approach, e.g., appraisals of typical (critical) in-depth approaches being subjective [9], [37].

A. Bibliometrics, Cooccurrence Analysis

The methods used in this analysis involve both the use of a software tool for constructing and visualizing bibliometric networks (VOSviewer) and the researchers' interpretation of the data. The top-level analysis consisted of running a keyword recurrence analysis in VOSViewer by importing the retrieved papers (see Appendix 1 for the search criteria, i.e., query, in detail). A bibliometric tool, VOSviewer, was used to conduct the keyword cooccurrence analysis as it can, through the clustering process, assess complex networks by evaluating the connection strength between the network nodes and presenting them in a network visualization format. The cooccurrence analysis included inspection of the frequency and patterns of occurrence of specific keywords within the shortlisted papers with the aim to get a general overview of the main emerging themes in the area of IS and the pandemic. By employing such an approach, we identified the most frequently used keywords in the academic literature as well as the relationships between them. Omitting this step, trends, patterns, and themes may not have been immediately apparent when reading the papers.

B. Descriptive Distributions and Narrative Synthesis

In addition, a scoping review was executed. This involved a literature search and selection process to identify all relevant studies, followed by a process of screening, validating, collating, and summarizing the data [38]. A narrative synthesis where we compared and contrasted the results and provided a high-level synthesis and overview was conducted on the selected papers.

1) Selection Process: The selection, i.e., the scoping process, enables us to identify the nature (and scope) of a particular field and is able to tease out the broader research gaps. Through the scoping process, our aim was to map the existing literature on a particular topic (i.e., pandemic IS solutions) as opposed to a more traditional systematic review that aims at answering a specific research question. In contrast, critical reviews are more in-depth and aim to critically analyze the extant literature on a broad topic to reveal weaknesses, contradictions, controversies, or inconsistencies [9]. Critical reviews also point out deficiencies, which we posit can also include an assessment of critical perspectives.

2) Search Strategy: Two electronic databases, Scopus and Web of Science (WoS), were used for the search, limiting the timeframe from 2020 until December 2022. Search terms covered the three identified concepts: 1) coronavirus pandemic; 2) IS and technologies; and 3) IS limitations or failures in a pandemic situation (see Appendix 1 for the search queries). We further applied filters to limit our search scope for papers written in the English language, and the papers as a publication type, period, and research area (management and business) with the aim to extract the most relevant sample of scientific papers.

3) Review Strategy: All records were independently reviewed by two people, and any disagreement was resolved by adding a third reviewer. In line with inclusion and exclusion criteria (see Table I), titles and abstracts were screened in Step 1, with full-text reviews carried out in Step 2 for those papers that met the Step 1 threshold. The studies included in the review highlighted one or more aspects of the lens of IS during the COVID-19 pandemic: 1) a critique; 2) research gaps; and/or 3) future directions. Table I lists the detailed lists of inclusion and exclusion criteria used to further filter the initial query results.

4) Data Extraction: We developed a data extraction form to record variables such as the country of the study, keywords used, research aims, research area, research question or hypothesis, methodology, results, findings, and conclusions. A narrative data

synthesis approach was then used to extract the results from the selected papers. Due to the heterogeneity of the retrieved papers and the broad research question, a meta-analysis was not conducted.

5) Descriptive Distributions: The descriptive analysis within the literature review papers can help map the field, as well as the contributors to the field, and the channels. Inter alia, the type of articles and the methods used therein can be detected, analyze the authors, and understand their embeddedness (in terms of location or field) or showcase the journals in which the debates are ongoing (whether domain or not).

6) Narrative Synthesis: This is a method that involves the interpretation of data to develop a coherent and integrated summary of the literature [39]. It involves synthesizing the findings from individual studies to generate new insights and understanding on a particular topic. Our goal was to provide an overview of the available evidence on pandemic IS solutions and identify limitations, challenges, and failures that arose, any gaps in the literature, critical views (i.e., shortcomings of COVID apps, privacy issues, lack of interdisciplinary cooperation, alienation of stakeholders from the pandemic reality, intentional or unintentional miscommunication) rather than to synthesize and analyze the data in a more focused way as in a traditional systematic review [39]. In our case, narrative synthesis was done by manual extraction of common themes from shortlisted papers. This provides an independent insight complementing other insights.

IV. Results

A. Bibliometrics, Cooccurrence Analysis

We first proceeded with a keyword cooccurrence analysis of the main topic distribution. VOSviewer was used on the full sample of retrieved papers to provide a visualization of the commonly used keywords and the connection between them. This type of analysis can provide suggestions for the development of themes for the subsequent narrative synthesis. The cooccurrence analysis showed that all papers retrieved from our search strategy revolved around five clusters. The clusters entail five distinct research areas: business; digital economy; healthcare and education; leadership, communication and media; and digital innovation. The clusters are constructed by several representative topics (see Appendix 2) and are formed based on the keywords that frequently appear together and, as such, are related to a certain topic or theme. We named each cluster based on the topic or theme represented by keywords included in each cluster.

Out of 3328 keywords appearing in the search results, 46 meet the threshold of six occurrences as a minimum frequency of keywords.

The keyword occurrence is reporting the total number of times a keyword is present in all the documents. The visual representation also includes the weight attributes in the form of links and circle sizes representing the importance of an item. Fig. 2 shows that there is a relationship between the keywords in each cluster and across the clusters, indicated by the thickness of the lines. The strength of these relationships is determined by the frequency with which they appeared together in the shortlisted papers (see Appendix 3 for the density visualization of keyword recurrence representation).

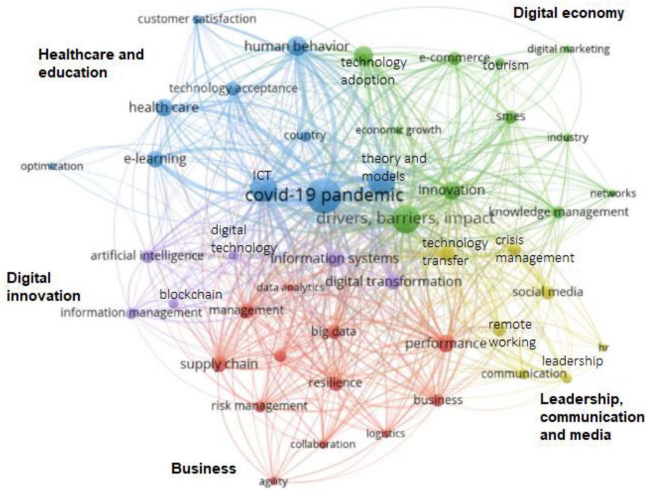


Fig. 2. Keywords cooccurrence network-overlay visualization.

Clusters were analyzed as follows (see Fig. 2).

1) Cluster 1 (red): *Business*: Agility, Big Data, Business, Collaboration, Data Analytics, Logistics, Management, Performance, Risk Management, Supply Chain, Sustainable Development (see Table III). The keywords Performance, Supply Chain, and Management appear in the highest volume of papers and are also well interconnected. Performance is linked with other 36 keywords, followed by Management. These are all keywords from the red cluster with the higher number of links related to other keywords, and as such, play a central role in this cluster. Performance as a node is embedded close to the keyword from the yellow cluster, linking with Leadership, communication, and media.
2) Cluster 2 (green): *Digital Economy*: Digital Marketing, E-commerce, Economic Growth, Industry, Innovation, Networks, SMEs, Technology Adoption, Tourism (see Table IV). The keywords clustered under Digital Economy share a strong thematic connection and are interconnected in research and discussions on this topic. Drivers, Barriers, Impact, Innovation, and Technology Adoption are the keywords that appear in the highest volume of papers and are also well interconnected. Drivers, Barriers, and Impact are linked with 44 other keywords, followed by innovation and technology adoption. These are all keywords from the green cluster with a higher number of links related to other keywords and, as such, play a central role in this cluster. They are highlighted because they are central to understanding the dynamics of the digital economy. Studying and understanding these keywords collectively provides insights into the complexities.
3) Cluster 3 (blue): *Healthcare and Education*: COVID-19 Pandemic, Customer Satisfaction, E-learning, Healthcare, Human Behavior, ICT, Optimization, Technology Acceptance, Theory and Models (see Table V). The keywords

COVID-19 Pandemic, ICT, and Theory and Models appear in the highest volume of papers and are also well interconnected. The COVID-19 pandemic is linked with 45 other keywords, followed by ICT and Theory and Models. These are all keywords from the blue cluster with a higher number of links related to other keywords, and as such, play a central role in this cluster. COVID-19 Pandemic, ICT, and Theory and Models are well connected with IS and AI—*Digital Innovation* and drivers, barriers, impact; innovation—*Digital economy*.

4) Cluster 4 (yellow): *Leadership, Communication and Media*: Communication, Crisis Management, Human Resources, Leadership, Remote Working, Social Media, Technology Transfer (see Table VI). Technology Transfer, Remote Working, and Social Media have the highest number of occurrences within the yellow cluster. Technology Transfer is linked with 40 other keywords, followed by Social Media and Crisis Management. These keywords have a higher number of links related to other keywords, and as such, play a central role in this cluster. The technology transfer node is well connected with drivers, barriers, impact and innovation—*Digital economy*; IS—*Digital Innovation;* as well as with Performance—*Business*.
5) Cluster 5 (purple): *Digital Innovation*: Artificial Intelligence, Blockchain, Digital Technologies, Digital Transformation, Information Management, IS (see Table VII). Digital Transformation and IS are the keywords that appear in the highest volume of papers and are also well interconnected. IS are linked with 40 other keywords, followed by digital transformation. These are both keywords from the purple cluster with the higher number of links related to other keywords, and as such, play a central role in this cluster. Both keywords are strongly connected to several of the keywords from the red cluster—*Business*.

The five clusters are all interconnected and reflect the complex and dynamic relationship between technology, business, and society. They show how different areas of research are converging and influencing each other and provide a useful framework for exploring the many different dimensions of digital transformation and innovation. The inner circle includes the COVID-19 pandemic, ICT, theory and models, as well as drivers, barriers, impact; and innovation nodes. There is an overlap between the digital economy and the digital innovation cluster. They both focus on the ways in which technology is driving innovation and change, with a particular emphasis on the impact of digital technologies. Healthcare and education, the digital economy, and the digital innovation cluster look at how technology is impacting society and human behavior, including topics such as e-learning, healthcare, and customer satisfaction. Effective leadership is a key part of any successful organization, and technology plays a role in how leaders manage their teams, communicate with their employees, and make decisions. The leadership, communication and media cluster also includes topics related to crisis management and remote working, which have become relevant in the wake of the COVID-19 pandemic. Data and analytics are increasingly being used in areas such as marketing, supply chain management, and risk management. The business cluster is focused on the ways in which data and analytics can be used to drive business performance and inform decision making. As we show later, these clusters are a good representation of the subsample of the 33 shortlisted papers.

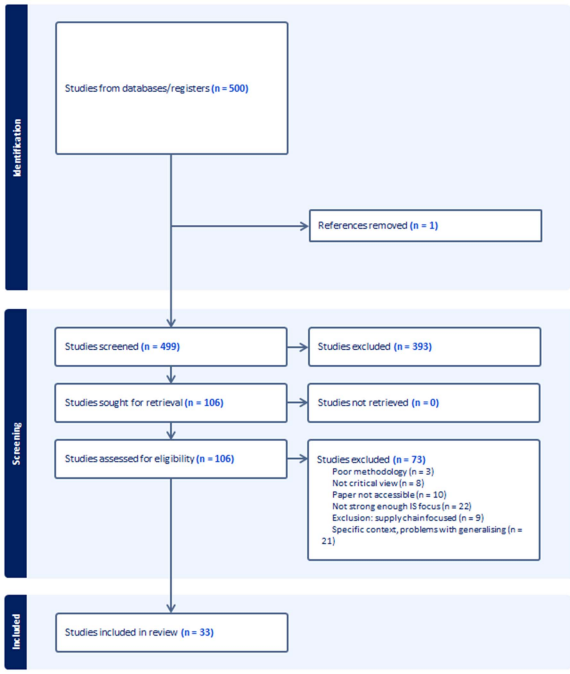


Fig. 3. PRISMA flow diagram.

B. Descriptive Distributions and Narrative Synthesis

1) Selection Process: The search identified a total of 593 papers (385 papers from Scopus and 208 papers from WoS), which were imported to Endnote and deduplicated. After deduplication, the remaining 500 papers were imported into Covidence. A total of 393 papers were excluded based on title and abstract content screening, and 73 further exclusions were made based on full-text content screening. The remaining 33 papers met the inclusion/exclusion criteria and were included in the final data extraction. Fig. 3 illustrates the elimination steps starting with the full selection of papers returned from the initial search results, initially imported to Covidence, to the final 33 papers whose content was then analyzed in further detail.

2) Descriptive Distributions: Type of papers and geographical spread: While it is not common practice, due to the nature of our investigation, we have included quite a few opinion papers, as seen in Fig. 4. Both qualitative and quantitative methods were used by authors as a backdrop for developing critical views and pointing out limitations**.**

Most papers were written by authors from Europe, followed by authors from Asia and North America (see Fig. 5). In the latter group, other than in one instance, the authors are from the U.S. Authors from Asia seem to be interested in the topic, which could imply that there might also be a strong body of literature in Asian languages. The strongest instances of collaboration are between authors from Europe and Asia (five papers), followed by authors from Europe and North America (two papers).

The total number of studies found within the selected journals that met all the inclusion criteria specified in the protocol

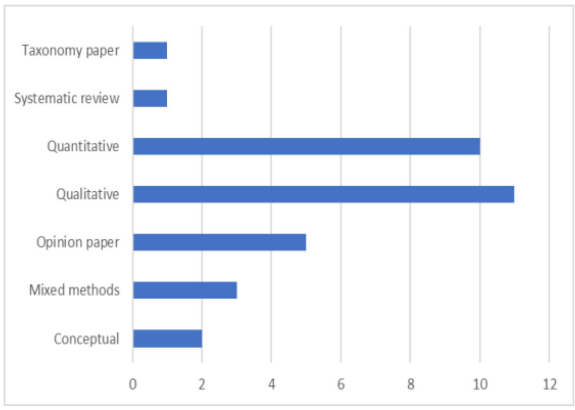


Fig. 4. Types of papers.

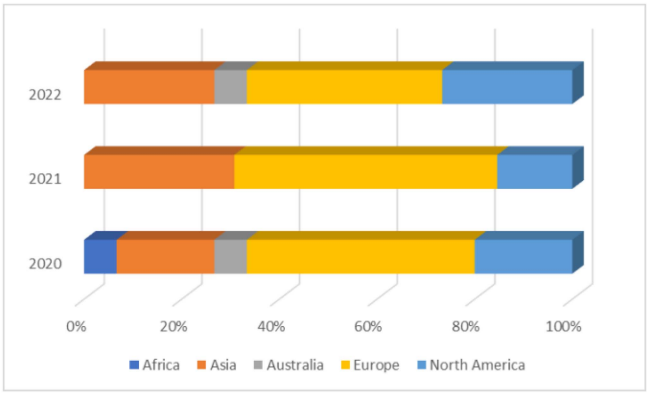


Fig. 5. Geographical distribution of authors over time.

ranged from only one to six per journal. Looking at where the criticism debate has been fostered, we can see three journals as the main sources: the *International Journal of Information Management* and the *European Journal of Information Systems*, closely followed by the *IEEE Engineering Management Review*. The complete list of all journals and the respective numbers of papers included in our study are available in Appendix 4. Hence, the critical views of IS in relation to its role during the pandemic are within the home domain, IS, and journals. Nonetheless, we discovered several other journals from different domains also contributing to this, such as from the fields of innovation, business research, and computing, as well as for particular topics, such as accounting or tourism.

3) Narrative Synthesis: Next, we look directly at the contents of the shortlisted papers in order to extract common themes and insights. This approach is independent of the network analysis of keyword cooccurrence used for our bibliographic analysis. It allows us to study the issues relating to IS during COVID-19 from another perspective, offering a complementary insight. To this end, we do not rely on automatic extraction of themes but on manual extraction done via in-depth reading of the papers.

We begin by splitting the papers into two naturally different groups. The first group is composed of papers that discuss the immediate effects of COVID-19. These effects became apparent quickly into the pandemic and had to be dealt with immediately (e.g., slowing down infection rates). The second group of papers deals with the implications of the pandemic on business, education, and technology in the postpandemic world. We further split each of these two groups into several subthemes to easily identify the common thread of discussion. This structure overlaps with the organization of the above-identified clusters, albeit not perfectly. This overlap is discussed in more detail later in the article.

First theme: COVID-19 (direct) Outputs: COVID-19 Apps, IT Platforms, and Infodemics

A common theme in this group is timing insofar as the papers deal with the pandemic as it is happening. They discuss a range of IT-related technologies and services designed to contain COVID-19, potential adjustments to the health system for pandemic situations, and seek to inform the public about the pandemic reality. We further arrange this theme into four subthemes, namely COVID-19 apps, IT platforms, new IT, and infodemic, as follows.

a) COVID-19 apps (for contact tracing): The common thread in the first subtheme revolves around (typically mobile) applications (apps) for tracking the movements of people in diverse ways. Papers highlight their relevance in slowing the spread of infection but are also critical of the ethical repercussions of such technology in the context of unwarranted surveillance. Topics largely overlap with Cluster 3 as identified in the keywords cooccurrence network. The first paper [40] looks at the benefits and drawbacks of such surveillance during a pandemic crisis. The authors, examining several countries in Asia, Europe, and the US, acknowledge the merit of voluntary and mandatory contact-tracing apps in reducing the spread of COVID-19 and also discuss several ethical implications of their usage, including privacy issues. In relation to this, the second paper [41] illustrates how Big Data improved personal accountability in South Korea during COVID-19. The authors noted that in pandemic conditions, the authorities seek to contain and control the disease while citizens want to maintain their health. These interests are somewhat opposing but can be reconciled via adequate policies. The next paper [42] focuses more on mobile apps, their features, and their potential for future development and also points out the unrealized potentials of such apps. The last two papers in this subtheme are more critical of COVID-19 apps. One of them [43] acknowledges that track and trace functionality has proven beneficial in fighting epidemics but claims that the government's approach failed because most stakeholders were alienated from the pandemic reality. By examining the surrounding political and scientific discourse of the French Stop-COVID-19 app, the authors conclude that its poor take-up was due to a lack of interdisciplinary cooperation. Finally, Leclercq-Vandelannoitte and Aroles [44] explore how, through a logic of "the end justifies the means," governments introduced a "new normal" of surveillance and control camouflaged as ways to curb the pandemic and pointed to the limitations, in terms of the public's resistance, to these policies and means.

b) COVID-19 IT platforms (for advancing e-health solutions): The second subtheme consists of papers that propose, examine, and/or criticize diverse IT platforms and other information solutions for tracking, containing, and/or stopping the pandemic. This resonates again with Cluster 3 from the keywords cooccurrence network, and Cluster 2, to a smaller

extent. Most papers deal with advancing e-health solutions for COVID-19 and possible future pandemics, focusing also on better management of medical resources. The first paper [45] deals with the development and implementation of the mask-supply information transitional platform in Taiwan. The authors pointed out that for such solutions to be adopted, the health behavior model and IT model for examining the factors affecting intention must be taken in conjunction. The next paper [46] acknowledges that many e-health systems were successfully introduced and that the feedback of end-users was extremely positive. The authors introduced a new goal-oriented requirements extraction approach: an elicitation approach. This approach points to another element in the development of such health platforms; specifically, the healthcare business goals to identify the ideal requirements for the development of an e-health system. The last two papers in this subtheme examine the IT platforms designed for the distribution and administration of vaccines. In [47], the authors started by explaining that the platforms for the COVID-19 vaccine distribution had to be developed swiftly and in a rapidly changing environment (agile development). Next, they adopted a clinical research methodology and agile software development approach to design such a time-critical system. The authors then concluded by highlighting the mistakes made or lessons learned as a first step to understanding the best practice requirements in developing platforms. The authors of the next paper [48] acknowledged that COVID-19 vaccine distribution faced challenges associated with the lack of production capacity, security, and miscommunication between actors. They suggested resolving these issues by virtue of blockchain technology. The authors then identified the distribution chain challenges via literature reviews and primary interviews, which allowed them to devise a blockchain framework for the vaccine distribution chain and evaluate the feasibility of its application. The authors ultimately claimed that their framework helps to minimize the circulation of counterfeit vaccines and vaccination records, improves communication between involved stakeholders, increases security, and simplifies the vaccine inventory and handling. In the last paper analyzed, the authors [49] reminded us that another way of gathering useful information is by crowdsourcing and citizen science, namely, voluntary laypeople engagement, which enables healthcare institutions to collect data about the preferences, expectations, and health needs of citizens. In fact, citizen science is often praised for fostering the transition toward personalized medicine. The authors argued that this facilitates the development of a lively healthcare ecosystem, whereby citizen scientists play various roles, ranging from data collectors to data analysts. They concluded by critically examining issues related to education and empowerment of the public, including their active involvement in service coproduction and value cocreation.

c) New (information) technologies for COVID-19: This subtheme involves papers that examine or discuss technologies developed specifically for COVID-19 (and intended for any future pandemics). These are primarily IT related but their scope is larger than that of the platforms covered in the previous subtheme. This subtheme mainly resonates with Cluster 2 (and somewhat less with Cluster 5) from the keywords cooccurrence network. The first paper [50] asks to what extent can Big Data processing, via Apache Hadoop, be of assistance in the COVID-19 era. The authors provided an overview of the management of Big Data in pandemic conditions and showed the challenges that users of Big Data were facing. This included both real-time emergency applications in health monitoring and global strategic issues. The authors also identified specific advantages of Hadoop solutions in the utilization of Big Data, and finally, proposed a framework of strategic data processing conditions. The next paper [51] continues along similar lines and looks at how 5G and Internet-of-Things (IoT) technologies can be efficiently utilized against COVID-19. The authors discussed many instances of how these technologies can operate both during and after the pandemic. On the other hand, the authors were also careful to emphasize technical requirements and challenges. In the next paper, the authors [52] examined the utilization and effectiveness of various IT solutions with respect to the microlevel and macrolevel health challenges that appeared during the pandemic. By studying and synthesizing several case studies, they proposed a framework for classifying the effectiveness of IT solutions. The next paper [53] is an opinion paper that reviews the emerging technologies used to mitigate COVID-19 and relevant challenges related to technology design, development, and utilization. The paper points out the urgent need for a greater understanding of the roles information research can play. The authors urged the scientific IT community to contribute knowledge and insights to help fight the pandemic, claiming that scholars are in an excellent position to leverage their experience to help society become more digitally resilient. The last paper in this subtheme [54] focuses on health management and offers a framework for health management informatics. The authors noted that digital health technologies can offer significant opportunities for pharmaceutical trials, medical studies, public health programs, and other aspects of pandemic response. However, they also warned that medical industry digitalization comes with many challenges, including data accuracy, data security, and privacy issues.

d) Dealing with COVID-19 infodemic: A diverse range of experts argue that, in the midst of a pandemic, we are faced with another (and potentially bigger) threat: the infodemic. Not surprisingly, our sample includes several papers related to the diverse aspects of the COVID-19 infodemic, which offers guidelines for tackling it and restoring trust in the medical authorities. This subtheme matches Clusters 4, 5, and 1 from the keywords cooccurrence network. The first paper [55] opens by establishing that the pandemic triggered a surge of fake news circulating on the Internet and also notes that the propensity for fake news varies hugely from country to country. To grasp the factors contributing to the spread of fake news in each nation, the authors then examined the relationships of "mobile connectivity" and (economic, political, and media) "freedom" in examining fake news in a sample of 72 countries. Interestingly, the authors find that while "mobile connectivity" and "political freedom" contribute to the propensity of fake news, "economic freedom" and "media freedom" inhibit it. Similarly, in the next paper in this subgroup, Reveilhac and Blanchard [56] looked at the diffusion of discussions about health technologies on Twitter by 4000 identified actors and found that the geographical distribution of important actors correlates with citizens' reliance on social

media to seek health information. Interestingly, conversations in the United States focus more on risk management and private funding, whereas European conversations focus more on health literacy, practitioners, and start-ups. In conclusion, the authors argued that institutions focus more on indirect, global, and strategic problems, whereas specialists are more concerned with direct and concrete problems. The next paper [57] concerns the Dark Web (or Darknet or Anonymous Web) as a source of COVID-19-related information. The authors investigated the role of not just COVID-19 skepticism but also quarantine loneliness as the motivation for using the Dark Web as an information source. The authors found that the unregulated nature of the Dark Web makes it a risky alternative for COVID-19 information, attracting individuals who are suspicious about the pandemic and excessively active online. Stieglitz et al. [58] first acknowledged that we increasingly use social media alongside traditional news as sources of information, which is exacerbated by the pandemic. However, overloading the public with (often conflicting) information easily leads to rumors and mis- and disinformation. This leaves the individual to navigate on its own devices in the mixture of information and misinformation. The authors contemplate a possible solution and develop design principles such as Conversational Agents, which have the potential to amplify and distribute trustworthy, reliable, and up-to-date information to the general public in times of uncertainty.

Second theme: Indirect consequences of COVID-19

While the first group of papers dealt with the immediate reality of the pandemic due to its unprecedented nature, the pandemic actually changed many (if not most) aspects of our routine lives. This includes not just our health but the way we work, study and learn, interact and socialize, or use the Internet. The pandemic triggered the emergence of new services and technologies and modified many of the existing industries. This second group of papers, arranged into five subthemes, examines these indirect repercussions of the COVID-19 pandemic.

Health and well-being: Healthcare is among the first of our institutions that is irreversibly changed by the pandemic. These changes were already discussed within the first group of the papers. We now add two more, which best align with Clusters 3, 4, and 2 from the keywords cooccurrence network. The first [59] discusses the factors that will affect the choices of adopting or nonadoption of new public health technologies developed during the pandemic. Focusing on Italy as the prime example of a country impacted by the crisis, the authors investigate the behavioral intentions and underlying attitudes of pharmacists related to telemedicine. They argue that the psychological mechanisms linked to the implementation of emerging technology are complex but may have major management effects. The second paper [60] studies the effects of extended reliance on virtual teams during the pandemic and asks what implications this will have on our psychological well-being, and whether the trend is likely to remain after the pandemic. The authors highlighted that remote working in virtual teams became the new normal, despite the ongoing debates about its effectiveness and its consequences, and specifically its impact on workers' psychological well-being. Since this trend is likely to remain, the paper concludes with a warning that organizations need to design interventions to help remote-working employees, and that (much) more research is needed on this matter.

Education: One of the areas that is irrevocably altered by COVID-19 is education, in line with Clusters 3 and 1 in the keywords cooccurrence network. Much of the teaching during the pandemic was carried out online. This concept was recognized as beneficial by many stakeholders since it precluded a need for classrooms and commuting, etc., and it is a practice likely to take root in the postpandemic world. The concept is recognized by the first paper in this subgroup [61], which uses the case of Taiwan to examine e-learning after the pandemic. The authors realized that there are several challenges, and asked how we can optimize online learning to benefit the education systems in the long term. They suggested that policymakers and educators should: 1) develop adequate training for instructors and students; 2) build a comprehensive technical environment for e-learning; and 3) customize the system according to students' perceptions and attitudes toward e-learning. The next paper [33] looks at the impact of the pandemic on research in the field of information management. Examining and integrating the views expressed by 12 experts, the authors extracted the relevant perspectives on online learning, digital strategy, artificial intelligence (AI), information management, social interaction, cybersecurity, Big Data, blockchain, privacy, and mobile technology. The authors concluded by setting out key recommendations for postpandemic, such as defining new roles for IS in business strategies. The author of an opinion paper [62] reminds us that the pandemic has one important serendipitous effect: it offers a rare and unique research opportunity. While this is probably true for most sciences (especially medical ones), the author examines it in the case of information management and IS. Indeed, the pandemic made us retreat into the digital arena, which will shape the way we think and work in the postpandemic world. This offers a sharper lens to study deep-rooted issues that otherwise would not have surfaced (a good example being the philosophical underpinnings of "social distancing"). The author closes by calling on the research community to seize this rare opportunity.

Digitalization: It is not surprising that the economy is among the most COVID-19-affected domains of our life. This refers not just to where and how we work or do business but also to wider topics such as manufacturing, digitization, and sustainability. Some of these trends are captured by papers in this subgroup, which sits with Cluster 5 (and Cluster 2 to a lesser extent) from the keywords co-occurrence network. The first paper [63] explores the conditions that characterize the adoption of complex information infrastructures in small and medium enterprises (SMEs). Organizations have used IT and digital technologies as a shield against the disruptive effects of the pandemic. However, this sudden digitization requires a suitable infrastructure. The authors investigated how the pandemic boosted the intentions of SMEs to adopt such infrastructures. Using a sample of 147 SMEs in Italy, the authors found that the pandemic has indeed sped up this process. In contrast, the authors of the next paper [64] asked whether the pandemic has accelerated digital transformation not in the developed world but in the developing economies. Focusing on the example of Ukraine,

authors found that digital transformation is quickly becoming a priority for many sectors of that country's economy, particularly in relation to using digital technologies to remake public services and ensure successful business operations during (and post) COVID-19. The authors also found that the main problems of digitalization in the Ukraine are legal complexity and insufficient funding on one hand; and lack of digital literacy/skills among the active population on the other hand. Finally, in this subgroup is the opinion paper [65], which looks at the interplay between the pandemic, sustainable development, and digitalization. The authors started by highlighting that this moment of accepting the "new normal" offers a great opportunity to reflect on what we have learned from the pandemic, revisit our assumptions, and think about how this can contribute to building a sustainable world. Highlighting six relevant themes in this context, the authors argued that human solidarity could turn this crisis into an impetus to finally achieve the United Nations Sustainable Development Goals. The paper concluded with a critical call for more research on developing the concept and practice of digital sustainability.

Technology: Almost all strategies for reducing the impact of the pandemic involved minimizing or preventing physical contact between individuals. However, this led to difficulties within many workplaces where the simultaneous presence of more people is necessary, ultimately putting pressure on businesses to innovate. This subgroup of papers examines some of those innovations which, by and large, stem from AI technology. These innovations nicely overlap with Clusters 1, 2, and 5 from the keywords cooccurrence network. The first paper [66] asks whether the pandemic will catalyze the usage of AI to automate the increasing number of workplaces. Termed intelligent automation (IA), its emergence has sparked multiple debates, which the author systematically reviewed in this opinion piece. Core arguments in favor of IA include changes in consumer preferences and increased business confidence in IA. The authors also critically examined the counterarguments, which include the limitations of Big Data availability and reliability and the fact that there are a range of tasks that still require human input. The next paper [67] looks at the challenges of implementing the Industrial IoT within Indian SMEs and examines to what extent challenges can be mitigated by Blockchain technologies. The authors concluded that adequate integration of these innovations can assist in improving production scheduling, boost smart manufacturing, and achieve more on-time deliveries. They identify ten such challenges, including the need for secure and efficient data management systems, and make the case that surmounting them means making manufacturing processes more conciliatory, effective, and traceable in real time. The authors conclude that blockchain-enabled IoT will be highly beneficial for Indian SMEs, both strategically and practically. Finally, Munjal et al. [68] discussed to what degree AI has helped organizations overcome the challenges of COVID-19. The authors cited that the pandemic encouraged businesses to place AI innovations on the forefront and the paper examines how innovation can be a rescuer for some companies and an opportunity for others. Specifically, the authors mapped out the journey of several global corporations and showed a progression from "striving to thriving" during the pandemic. They concluded that this paints a global picture of business areas where AI is increasing.

Industry: While the pandemic had an impact on all industries, in some cases that impact was for the better (e.g., online shopping); however, in most cases, the impact was detrimental. This is particularly true for industries whose routine operations involve physical proximity between people. A clear example is transit and transportation, such as commercial air traffic, which all but grounded to a halt in the first months of the pandemic. This subtheme includes three papers, whose topics overlap in Clusters 1, 2, 4, and 5 from the keywords cooccurrence network. In the first of these, Floetgen et al. [69] studied how the ecosystem of mobility platforms adapted to the new normal faster than their nonplatform competitors and became resilient to the pandemic conditions. Building on a case survey approach, the authors claimed that they found five archetypes of how providers leverage their platform-based nature to develop resilience. Their results emphasize the importance of platform dimension in these ecosystems, arguing that practitioners and policy planners should adjust to the new normal and stop looking for ways to resume existing practices. The next paper [70] deals with tourism, and in particular, it examines how the cruise industry reacted to the pandemic, which highlighted the need for touchless digital interactions, as well as real-time information and smart technologies. The authors discussed the impact of digital innovations from a business perspective and synthesized smart technologies in the cruise industry into a Smart Cruise Ecosystem framework. This includes all key elements of this endeavor from ship operations and crew management to guest experience and safety guidelines. The authors make the final argument that object detection, IoT, satellite communications, Big Data, automation, robotics, AI, cloud computing, augmented reality, and virtual reality are the key technologies that enable the SCE framework. The last paper [71] explores the COVID-19 lessons for the agricultural industry, which is perhaps most distant from IT but, nevertheless, is fundamental to our lives. Considering 150 countries and territories, the author revealed that the pandemic has not discriminated between agriculturally developed and developing nations. This, however, is not to say that the impact across all countries has been identical. The paper claims that countries that had modern IT solutions for tracing and planning agricultural activities in place before the pandemic allowed them to be less dependent on the physical proximity of the involved personnel. This minimized the consequences of the pandemic.

C . Relationship Between Cluster Structure (Cooccurrence Analysis) and Group Structure (Narrative Synthesis)

In this paragraph, we clarify the relationship between the cluster structure found via cooccurrence network analysis and the group structure constructed through narrative synthesis. Clusters were constructed by looking at cooccurrence of frequent keywords in papers and obtained from analyzing this mapped-out network. Counting how many times a given keyword occurs from paper to paper reveals what keywords are often found together. This naturally leads to clustering of the keywords, but

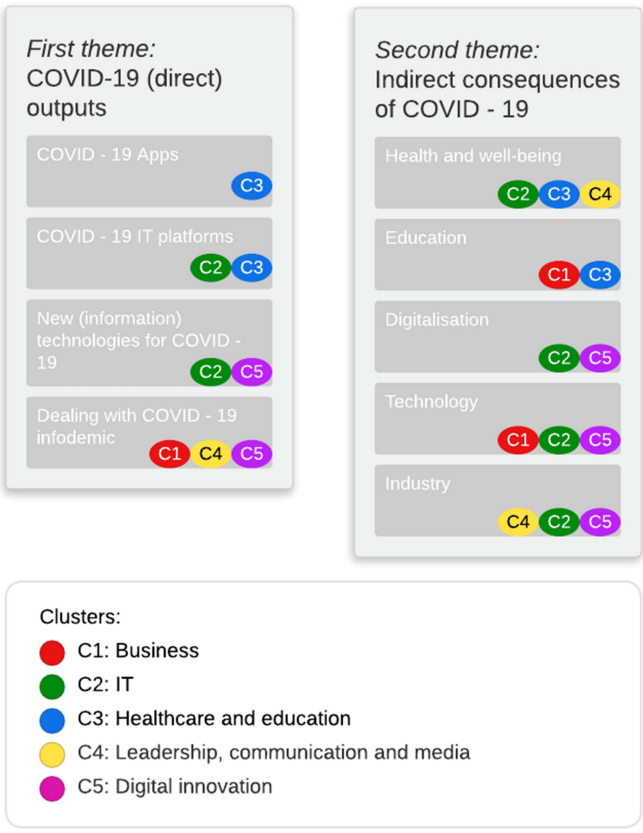


Fig. 6. Synthesis of bibliometric analysis and narrative review.

not of papers. In contrast, narrative synthesis is based on an in-depth reading of each paper's content and on manual (not automatic) extraction of common themes and messages. This qualitative approach is independent of the keyword approach and offers a complementary insight. It is by considering the results from both analyses that provides a more holistic picture.

That being said, there is an alignment between the clusters and the groups. For example, the COVID-19 app subtheme largely overlaps with Cluster 3 (Healthcare and education) as identified in the keywords cooccurrence network, whereas the COVID-19 IT platforms resonate again with Cluster 3 from the keywords cooccurrence network and Cluster 2 (IT) to a smaller extent. So, while these two arrangements are produced by independent methods, their results are—as one would expect—neither entirely different nor identically the same. We show this overlap more systematically in Fig. 6. A clear example of this is in consideration of the keyword "blockchain." It is found in Cluster 5 along with other keywords related to Digital Innovation. In contrast, narrative synthesis reveals the context in which the papers actually mention blockchain. These include proposals for vaccine distribution systems and for the industrial IoT.

V. Discussion and Conclusion

Our cooccurrence analysis showed that all papers retrieved from the search strategy revolved around five clusters which are interconnected and show how different areas of research converge and influence each other. In addition, the analysis provides a useful framework for exploring many different dimensions of digital transformation and innovation. Although the conceptual mapping of shortlisted papers reflected some broader insights into this research area, their bibliographic and in-depth content analysis provided additional clarity and a deeper understanding of this literature. This enabled us to tease out the critical aspects and limitations addressed in the literature to a higher degree. By combining these analyses, the reliability and validity of our findings were increased [72].

We show that domain journals are susceptible to critical debates and controversies in regard to the role of IS during the pandemic and endemic. IS scholars can thus indeed provide useful insights that can help solve challenges related to the pandemics and endemics [11], and they can do so while keeping a critical stance toward the potential role of IS. Furthermore, most critical debates are instigated by authors from Europe and Asia, whereas North America is somewhat of a laggard. An interesting feature is also a relatively high number of opinion papers in our sample; however, this is a consequence of the goal of this systematic review, i.e., focusing on more critical views. Opinion-based evidence is drawn from expert opinions, consensus, or comments that appear in journals, whereby the validity is higher if it is a synthesis of the opinion of a group of experts [73] and if a more rigorous protocol is used [33]. For investigating critical views and controversies, such papers proved to be a valuable source.

A. Common Themes

The narrative synthesis allowed us to understand where IS researchers have identified particularly salient points which helped elucidate some of the criticisms and limitations. In terms of contact tracing COVID-19 apps, the ethical and privacy implications were often at the forefront [40] and conflicting interests between the government and the public stilted the introduction of the apps [41], [44]. The alienation of the public was a major barrier [43]. On the other hand, some authors draw attention to the unused potential of such apps [42]. In general, this is one of the fields where a critical lens was applied to the research topic. In terms of the criticisms and limitations of COVID-19 platforms, especially in relation to their introduction, stem from the lack of integration of IT models with health-behavior models [45] and with healthcare goals [46]. Furthermore, the power of blockchain is seen as an answer to several issues relating to security and miscommunication. Finally, if we want COVID-19 platforms to harness the power of crowdsourcing and citizen science, Ciasullo et al. [49] argued that the limitations lie in the lack of education and empowerment of the public, which prevents them from actively engaging in service coproduction and value cocreation.

In terms of newly developed (information) technologies for COVID-19, our narrative synthesis shows that papers discuss issues related to real-time emergency applications [50], challenges related to technical requirements [51], and how different solutions could be classified in light of their effectiveness [52]. Also, wider issues are seen as critical from the challenges related to the digitalization of the medical industry in particular, such as data accuracy and security, to privacy issues [54], to global strategic issues [50]. The criticism also remains in regard to the lack of proper understanding of the role of information

research and the IT science community [53]. Finally, in terms of infodemics, the authors stress the problems of our fledgling understanding of both the propensity for fake news [55] and citizens' reliance on social media for (health) information [56]. These should be investigated in more detail keeping in mind the geographical embeddedness of the investigated phenomena and potential differences stemming from it.

The papers related to indirect consequences of COVID-19 highlight other issues. Among them are the limitations that stem from psychological factors and attitudes in adopting various solutions, ranging from healthcare [59] to education [61], to broader factors [63]. One venue of investigation needs to be how novel technologies affect the well-being of individuals [60] and consideration of the potential positive effects on organizations' intentions to adopt innovations [63]. In this line, the lack of research was pointed out in terms of the effects of designed interventions related to remote work [60]. For e-learning, we need more research not only into building adequate environments for education but also into constructing adequate training for different groups of stakeholders [61]. Included in the digitalization subtheme are not only issues pertaining to digital literacy [64] but also those warning about the potential lack of focus on the so-called digital sustainability [65]. The technology subtheme papers, on the other hand, point toward investigating the technology-individuals redundancy problem, as well as again bringing to the forefront the issues of IS systems in terms of their need for democratization of data and global equity [66]. A variety of technologies are otherwise pointed out [67] in terms of supporting companies' progression from "striving to thriving" during the pandemic [68]. Finally, in the industry subtheme, we see a gentle reminder of remaining issues related to industries that were typically at the forefront of COVID-19, such as the IT sector [69] and tourism [70], but also sectors such as agriculture [71]. Floetgen et al. [69] argued the need for both transition and transformation to digital in pandemic and postpandemic times. This serves as the starting point for organizations to stop looking (only) for ways to resume old practices. All of these are ideal future research opportunities.

The above findings are also witnessed in practice. The COVID-19 pandemic acted as a catalyst, accelerating digital transformation efforts by several years and pushing organizations to embrace technology-driven solutions [74] to ensure business continuity and resilience [33], [34], [75]. While IS supported remote working and rapid decision making, organizations were also left exposed to the need for cybersecurity enhancement [35] and the need to explore the impact of the new reality on employee well-being and engagement [34]. According to the IBV Trending Insights report [76], digital transformation is more than just technology and the human element (customers and employees) is the key to a company's success. At the same time, the report identified the two biggest challenges organizations are facing post-COVID-19 dealing with organizational complexity and managing (recognizing) employee burnout.

B. *Toward a Future Research Agenda*

We turn next to the identification of research gaps, also encompassing some of the above issues already mentioned. Literature reviews serve as the grounds for future research and theory [77]. Following Corvellec et al. [7] and Paré et al. [9], in terms of the benefits of analyzing papers addressing criticisms and limitations, we identified interesting gaps and potential research questions that are related to either providing new contributions to hidden assumptions, incoherence, incompleteness or weakness, and/or not-thought-out consequences or controversies. In this line, we also point out the gaps and potential research paths arising within these three areas.

TABLE II
HIDDEN ASSUMPTIONS, INCOMPLETENESS, AND NOT-THOUGHT-OUT CONSEQUENCES

Hidden assumptions	Incompleteness, incoherence, weakness	Not-thought-out consequences, controversies
Interests and lack of alignment with goals	Crowdsourcing and citizen science	Effects on well-being
Lack of integration with psychological preconditions	Missed potential of apps	Solutions in healthcare
Privacy and ethical considerations	Delving deeper into incoherencies	Digital sustainability
Diverse contexts and multilevel aspects	Technological dependence	
Individual redundancy problem and other general trends		
Conceptual unclarity and boundary conditions		

One of the hidden assumptions (see Table II) during the introduction of IS solutions during COVID seems to have been the alignment of interests between different actors; however, IS literature unveils that the ingrained conflict of interest between various groups results in limited IS solutions acceptance, as well as limiting their effectiveness later on. Furthermore, these new solutions have not been introduced into an empty space but rather within and to organizations that have already structured and committed to certain (organizational) goals (e.g., Alotaibi and Subahi [46]). It seems the IS community was somewhat remiss in pointing this out, as well as providing ideas ensuring that goals being reached with new IS solutions were aligned with the pre-existing goals of organizations (as well as individuals). How different relationships between different interests or goals can modify the adaption dynamics might be interesting future research. Furthermore, our research unveils an overall lack of focus on psychological preconditions, albeit some limited issues are covered (e.g., in [59], [61], and [63]).

The IS literature could therefore potentially benefit from either stakeholder theory, public policy, or institutional theory literature to better understand how the interplay of norms and values are affected by diverse forms and intensities of institutional pressures, thus influencing the potential alignment of interests and the adaptation of new IS solutions, especially since they have been rapidly introduced. Furthermore, from the public policy theory toolbox, collaborative governance theory can provide a good basis to explore conflicting interests between stakeholders and increase collaboration, since collaborative governance attempts to bring public and private stakeholders together in collective forums with public agencies to engage in building consensus. With insights from IS solutions being introduced rapidly in turbulent times, we would also encourage

advancing general technology adoption models (both innovation and organization-centered models as well as intention models from social psychology) to better understand the extent to which these contexts matter.

Next, different geographical and social contexts and their potential diversity should be explored further to better understand, especially the socio-cultural influences that can be important silent underpinnings to (especially rapid) adoption of IS solutions as well as their longevity. This is also related to privacy and ethical considerations that have already received attention within the COVID-related literature, but we know less if their effect will diminish or stay the same as we move away from pandemics, where these topics received renewed intense scholarly and public scrutiny. Focusing on different levels and especially how they interconnect—from individual to team and organizational or regional—can also uncover both the nuances as well as enrich the understanding from other levels. For example, effective (transformational) leadership was unveiled to be one of the key issues/topics in our cooccurrence analysis, with most focus on teams for now [47], [60]; however, the topic is important for all levels, as we know little how leaders on different levels interact during COVID-19 related IS solutions and decisions on their continued use also in the endemics phases. Furthermore, exploring distinct settings can also illuminate potential inconsistencies, and point toward some factors that remain hidden for now. Besides these, scale and time matter as well.

In terms of unveiled incompleteness, we are still unable to completely disentangle the axis of the power of crowdsourcing and citizen science (as shown in the example by Ciasullo et al. [49] within the field of health) and the need for citizens to be interested, empowered, and skilled. Since IS solutions in the pandemic encompassed various fields and areas (far beyond medicine), similar questions related to the content and the extent of skills arise, especially when rapid uptake and participation are needed. On the other hand, there are several unknowns related to unused potentials of already developed apps. These need to be also taken in conjunction with the potential technological dependence. Evidence related to adverse effects on, e.g., productivity or creativity in the short terms of the solutions developed and introduced relatively fast, remains incomplete, as well as these questions remain poorly addressed in terms of more long-term consequences. The issues are also connected with gaps in our understanding of the challenges connected to issues such as data accuracy or data security (as, e.g., indicated by Condry and Quan [54] in the area of health management informatics). Questions related to how to ensure data accuracy and security remain open. Furthermore, inconsistencies between the influence of various factors also need to be further explored, such as indicated by the work of Shirish et al. [55], which shows the opposite effects of political freedom on one hand, and economic and media freedom on the other.

Long-term effects, effectiveness, and sustainability come to the forefront. The questions have risen both in terms of conceptualization of desirable end effects and their hierarchy. The questions related to how solutions contribute to well-being remain open. Selected works highlight potential psychological and emotional detrimental effects (e.g., Chai and Park [60]) even when IS solutions have been at least prima facie considered effective. While models and frameworks for the holistic understanding of the effects and effectiveness of IS solutions still remain unexplored, these can affect whether or not the solutions will be sustainable, i.e., have long-lasting use and effect. The question remains as to which strategies can, for example, be borrowed from public policy to evaluate the long-term impact and value generation of IS solutions. Several research opportunities thus arise from longitudinal research designs.

It is significant that all of the solutions are developed within general trends and megatrends in society [78]—also that of individuals' redundancy issues—which need to properly be accounted for. Cluster 1 highlights that there is some work related to the issues of sustainable development, yet the coverage remains low, whereas, for digital transformation, this topic has received somewhat more attention. However, issues such as the digital divide and its effect on the participation of individuals in IS solutions developed during COVID, and used during and post-COVID, also require further exploration—with a potential theoretical basis from both the digital divide theories and social inclusion theories.

Not in the least, we believe that providing sounder theoretical underpinnings as well as exploring the (theoretical) boundary conditions is of importance. Boundary conditions are—and should be—a subject of extensive discussion. We follow the ideas by Busse et al. [79] that the exploration of the boundary conditions "fosters theory development, strengthens research validity, and mitigates the research-practice gap"—and in particular helps understand the generalizability of a theory [80]. Furthermore, boundary conditions can help clarify the scope and limits of the concepts under investigation, providing a clearer understanding of what is included and excluded from the concepts' definition. However, our analysis only included two conceptual papers, which gives an indication that there is still a relatively large potential to do so, from investigating the specific role of levels of uncertainty.

C. *Limitations*

Although we invested extensive efforts in both the design and in the implementation of our systematic review, we still may fail to capture all relevant papers and issues on this topic. Those can arise, first, from the choice of keywords, although they were designed with caution and in consideration of both existing keyword libraries, as well as other research efforts dedicated to identifying existing gaps and criticisms. Second, we use two databases, where conceivably the introduction of further sources could potentially better our results. Third, in line with the most systematic reviews in high-impact journals, we limit the choice of papers' language to English. We note that the second highest number of authors is from Asia; hence, our limitation to the English language might inadvertently introduce bias. Finally, we acknowledge our subjectivity in the analysis and classification of the sample studies. Because of the focus on the studies that introduced a more critical view of the role of IS in relation to the pandemic, other dimensions that combine the focus on IS and COVID-19 might be less represented. Nonetheless, since the aim of the research is to also focus on the critical views and exposed controversies, we believe this to be of lesser importance.

Naturally, our presented samples of papers in the narrative synthesis are only the tip of the iceberg in a vast sea of literature on all mentioned issues (subgroups). It is well known that the pandemic intensified publication production practically in all scientific fields, directly or indirectly related to the pandemic or its consequences. We also acknowledge that we left out a range of other scientific fields, such as epidemiology and other medical sciences. Those fields are out of scope for us but, without a doubt, represent an important (and expanding) volume of literature. While our sample is by no means exhaustive, it represents an excellent starting point for a more comprehensive literature review of any of the covered themes and topics.

Furthermore, there are also limitations in our methodology related to the inclusion and exclusion criteria used in constructing our sample of papers (shortlist). Modifying these criteria could lead to a different sample. However, the actual research topics we found in our sample are broad and comprehensive, and we believe it is unlikely we left out any important topics. In retrospect, this confirms our methodology of selecting the papers as adequate, meaning that even somewhat modified inclusion/exclusion criteria would not lead to a very different sample. We invite colleagues to use our sample of papers as a starting point for a further systematic literature review, possibly discovering new relevant controversies and issues.

APPENDIX 1

A. Scopus Database

((TITLE-ABS-KEY ("disease outbreak*") OR TITLE-ABS-KEY (epidemic) OR TITLE-ABS-KEY (pandemic) OR TITLE-ABS-KEY (covid*) OR TITLE-ABS-KEY (coronavirus) OR TITLE-ABS-KEY ("corona virus*") OR TITLE-ABS-KEY ("pandemic preparedness")) AND (TITLE-ABS-KEY (failure*) OR TITLE-ABS-KEY (factor) OR TITLE-ABS-KEY (criticism) OR TITLE-ABS-KEY (fad) OR TITLE-ABS-KEY (limitation) OR TITLE-ABS-KEY (challenge*) OR TITLE-ABS-KEY (disadvantage) OR TITLE-ABS-KEY (issue) OR TITLE-ABS-KEY ("negative experience") OR TITLE-ABS-KEY (inefficien*)) AND (TITLE-ABS-KEY (information AND system) OR TITLE-ABS-KEY (information AND technolog*) OR TITLE-ABS-KEY (ict))) AND PUBYEAR > 2019 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA, "BUSI")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (SRCTYPE, "j"))

B. Web of Science Database

(TS = ("disease outbreak*") OR TS = (epidemic) OR TS = (pandemic) OR TS = (covid*) OR TS = (coronavirus) OR TS = ("corona virus*") OR TS = ("pandemic preparedness")) AND (TS = (failure) OR TS = (factor*) OR TS = (criticism) OR TS = (fad) OR TS = (limitation) OR TS = (challenge) OR TS = (disadvantage) OR TS = (issue) OR TS = ("negative experience") OR TS = (inefficien*)) AND (TS = ("information system*") OR TS = ("information technolog*") OR TS = (ICT))

(PUBYEAR > 2020) AND (DOCTYPE (ar)) AND (LANGUAGE (english))

APPENDIX 2

TABLE III
CLUSTER 1 (RED): BUSINESS

Keywords	Links	Total link strength	Occurrences
Agility	14	34	6
Big Data	32	116	26
Business	29	97	21
Collaboration	20	49	9
Data Analytics	19	31	6
Logistics	20	48	8
Management	**35**	**142**	**31**
Performance	**36**	**205**	**46**
Resilience	31	143	30
Risk Management	25	63	17
Supply Chain	32	**154**	**37**
Sustainable Development	26	69	19

Numbers in bold represent numbers with the highest frequencies in the columns.

Links reflect the number of links of an item with other items; the stronger the link, the thicker the line in the visualization map. *Total link strength* represents the total strength of the links of an item with other items, *Occurrences* attribute indicates the number of documents in which a keyword occurs, i.e., the total number of occurrences of a keyword in all documents.

TABLE IV
CLUSTER 2 (GREEN): DIGITAL ECONOMY

Keywords	Link	Total link strength	Occurrences
Digital Marketing	10	27	6
Drivers, barriers, impact	**44**	**625**	**168**
E-commerce	22	90	23
Economic growth	16	34	8
Industry	18	40	7
Innovation	**40**	**209**	**51**
Knowledge Management	22	68	21
Networks	16	29	6
SMEs	26	91	22
Technology adoption	**34**	**245**	**59**
Tourism	12	20	9

Numbers in bold represent numbers with the highest frequencies in the columns.

TABLE V
CLUSTER 3 (BLUE): HEALTHCARE AND EDUCATION

Keywords	Link	Total link strength	Occurrences
Country	22	58	16
COVID-19 Pandemic	**45**	**798**	**308**
Customer satisfaction	17	48	10
E-learning	23	111	42
Health care	25	127	45
Human behaviour	33	264	69
ICT	**43**	**578**	**150**
Optimization	6	9	6
Technology acceptance	24	117	27
Theory and models	**42**	**567**	**146**

Numbers in bold represent numbers with the highest frequencies in the columns.

TABLE VI
CLUSTER 4 (YELLOW): LEADERSHIP, COMMUNICATION, AND MEDIA

Keywords	Link	Total link strength	Occurrences
Communication	22	52	13
Crisis management	**23**	55	21
HR	10	15	6
Leadership	19	41	11
Remote working	19	**62**	**24**
Social media	**26**	**66**	**23**
Technology transfer	**40**	**179**	**39**

Numbers in bold represent numbers with the highest frequencies in the columns.

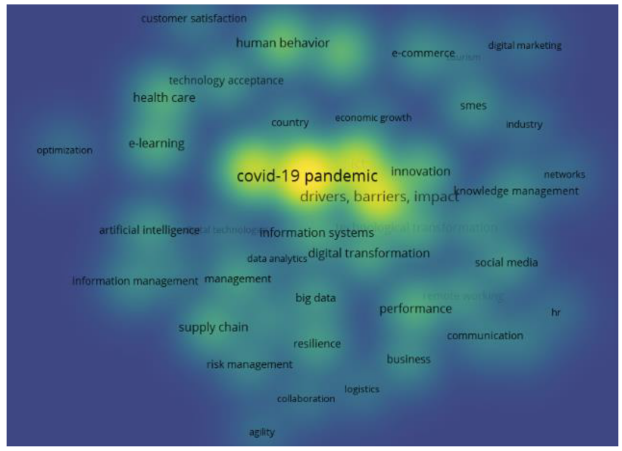
APPENDIX 3
DENSITY VISUALIZATION OF KEYWORD REOCCURANCE

The retrieved publication data are shown as labels and thermographic patches where the color of the patches depends on the number of times a particular keyword is used in the publications. The recurrent keywords are presented in warmer patches of colors; in our case, the COVID-19 pandemic or pandemic in general, IT, theory and models, technology adoption and acceptance, and digital transformation. Conversely, the smaller number of occurrences is denoted by colder color patches, as shown in the density view figure.

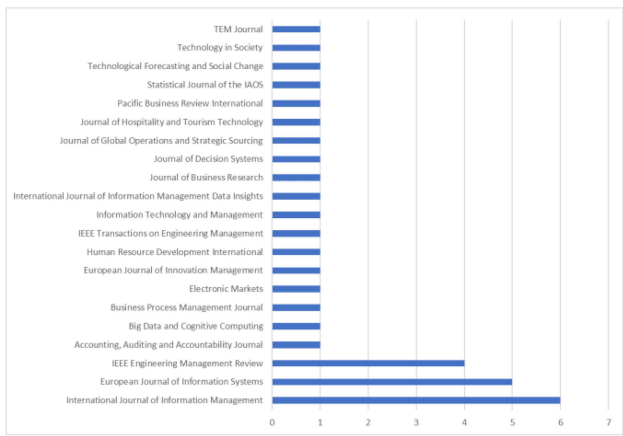
TABLE VII
CLUSTER 5 (PURPLE): DIGITAL INNOVATION

Keywords	Link	Total link strength	Occurrences
Artificial Intelligence	26	87	25
Blockchain	20	42	11
Digital technologies	23	40	9
Digital transformation	**32**	**124**	**37**
Information management	20	53	18
Information systems	**31**	**130**	**40**

Numbers in bold represent numbers with the highest frequencies in the columns.



APPENDIX 4
COMPLETE LIST OF INCLUDED JOURNALS WITH RESPECTIVE NUMBERS OF THE SHORTLISTED PAPERS



References

[1] L. H. M. Wong, L. Hurbean, R. M. Davison, C. X. J. Ou, and M. Muntean, "Working around inadequate information systems in the workplace: An empirical study in Romania," *Int. J. Inf. Manage.*, vol. 64, Jan. 2022, Art. no. 102471.

[2] N. L. Ngesimani, E. Ruhode, and P.-A. Harpur, "Data governance in healthcare information systems: A systematic literature review," *South Afr. J. Inf. Manage.*, vol. 24, pp. 1–8, 2022.

[3] M. Alkhaffaf, "The role of information systems in decision making: The case of Jordan Bank," *Comput. Eng. Intell. Syst.*, vol. 3, no. 10, pp. 19–27, 2012.

[4] S. Bhattacharya and N. Damij, "Value co-creation in a high-performance computing (HPC) service ecosystem: Opportunities for European SMEs," *Digit. Policy, Regulation Governance*, vol. 14, 2023, Art. no. 497.

[5] A. Rossi, "Foucault, critique, subjectivity," *J. Cultural Res.*, vol. 21, no. 4, pp. 337–350, 2017.

[6] M. Foucault, "is it really important to think? An interview translated by Thomas Keenan," *Philosophy Social Criticism*, vol. 9, no. 1, pp. 30–40, 1982.

[7] H. Corvellec, A. F. Stowell, and N. Johansson, "Critiques of the circular economy," *J. Ind. Ecol.*, vol. 26, no. 2, pp. 421–432, 2022.

[8] M. B. Low and I. C. MacMillan, "Entrepreneurship: Past research and future challenges," *J. Manage.*, vol. 14, no. 2, pp. 139–161, 1988.

[9] G. Paré, M.-C. Trudel, M. Jaana, and S. Kitsiou, "Synthesizing information systems knowledge: A typology of literature reviews," *Inf. Manage.*, vol. 52, no. 2, pp. 183–199, 2015.

[10] R. W. Palmatier, M. B. Houston, and J. Hulland, "Review articles: Purpose, process, and structure," *J. Acad. Marketing Sci.*, vol. 46, no. 1, pp. 1–5, Jan. 2018.

[11] P. J. Ågerfalk, K. Conboy, and M. D. Myers, "Information systems in the age of pandemics: COVID-19 and beyond," *Eur. J. Inf. Syst.*, vol. 29, pp. 203–207, 2020.

[12] C. M. Parra, M. Gupta, and P. Mikalef, "Information and communication technologies (ICT)-enabled severe moral communities and how the (COVID19) pandemic might bring new ones," *Int. J. Inf. Manage.*, vol. 57, Jan. 2021, Art. no. 102271.

[13] R. Hirschheim and H. K. Klein, "A glorious and not-so-short history of the information systems field," *J. Assoc. Inf. Syst.*, vol. 13, no. 4, 2012, Art. no. 5.

[14] J. Koivisto and J. Hamari, "The rise of motivational information systems: A review of gamification research," *Int. J. Inf. Manage.*, vol. 45, pp. 191–210, Jan. 2019.

[15] A. Madapusi and D. D'Souza, "The influence of ERP system implementation on the operational performance of an organization," *Int. J. Inf. Manage.*, vol. 32, no. 1, pp. 24–34, Jan. 2012.

[16] N. Röder, M. Wiesche, M. Schermann, and H. Krcmar, "The role of information systems in tolerating workarounds: A managerial perspective," in *Proc. 13th Workshop Inf. Syst. Serv. Sci.*, 2014, Paper 33.

[17] S. Laumer and A. Eckhardt, "Why do people reject technologies: A review of user resistance theories," in *Information Systems Theory: Explaining and Predicting Our Digital Society*, vol. 1, Y. K. Dwivedi, M. R. Wade, and S. L. Schneberger Eds. New York, NY, USA: Springer, 2012, pp. 63–86.

[18] M. Tarafdar, E. B. Pullins, and T. S. Ragu-Nathan, "Technostress: Negative effect on performance and possible mitigations," *Inf. Syst. J.*, vol. 25, no. 2, pp. 103–132, Jan. 2015.

[19] J. Choudrie and E. D. Zamani, "Understanding individual user resistance and workarounds of enterprise social networks: The case of service ltd," *J. Inf. Technol.*, vol. 31, no. 2, pp. 130–151, 2016, doi: 10.1057/jit.2016.9.

[20] R. M. Davison, L. H. Wong, S. Alter, and C. Ou, "Adopted globally but unusable locally: What workarounds reveal about adoption, resistance, compliance and non-compliance," in *Proc. 27th Eur. Conf. Inf. Syst.*, 2019, Paper 17.

[21] R. M. Davison, L. H. Wong, C. X. Ou, and S. Alter, "The coordination of workarounds: Insights from responses to misfits between local realities and a mandated global enterprise system," *Inf. Manage.*, vol. 58, no. 8, 2021, Art. no. 103530.

[22] R. Doyle and K. Conboy, "The role of IS in the COVID-19 pandemic: A liquid-modern perspective," *Int. J. Inf. Manage.*, vol. 55, 2020, Art. no. 102184.

[23] S. H. Bhatti, A. Ahmed, A. Ferraris, W. M. Hirwani Wan Hussain, and S. F. Wamba, "Big data analytics capabilities and MSME innovation and performance: A double mediation model of digital platform and network capabilities," *Ann. Oper. Res.*, vol. 31, Oct. 2022, Art. no. 20125, doi: 10.1007/s10479-022-05002-w.

[24] J. A. Cunningham, N. Damij, and D. Modic, "An exploratory study of high-performance computing technology adoption over the stages of entrepreneurship," *Int. J. Entrepreneurial Venturing*, vol. 14, no. 4/5, pp. 497–526, 2022, doi: 10.1504/ijev.2022.127444.

[25] J. A. Cunningham, N. Damij, D. Modic, and F. Olan, "MSME technology adoption, entrepreneurial mindset and value creation: A configurational approach," *J. Technol. Transfer*, vol. 48, pp. 1574–1598, Aug. 2023.

[26] S. L. Pan, L. Carter, Y. Tim, and M. S. Sandeep, "Digital sustainability, climate change, and information systems solutions: Opportunities for future research," *Int. J. Inf. Manage.*, vol. 63, Apr. 2022, Art. no. 102444.

[27] R. B. Llamzon, F. Ter Chian Tan, and L. Carter, "Toward an information systems alignment framework in the wake of exogenous shocks: Insights from a literature review," *Int. J. Inf. Manage.*, vol. 63, Apr. 2022, Art. no. 102450.

[28] K. Burnard, R. Bhamra, and C. Tsinopoulos, "Building organizational resilience: Four configurations," *IEEE Trans. Eng. Manage.*, vol. 65, no. 3, pp. 351–362, Aug. 2018.

[29] D. Ivanov, "Digital supply chain management and technology to enhance resilience by building and using end-to-end visibility during the COVID-19 pandemic," *IEEE Trans. Eng. Manage.*, 2021, doi: 10.1109/TEM.2021.3095193.

[30] F. Ye, K. Liu, L. Li, K.-H. Lai, Y. Zhan, and A. Kumar, "Digital supply chain management in the COVID-19 crisis: An asset orchestration perspective," *Int. J. Prod. Econ.*, vol. 245, Mar. 2022, Art. no. 108396.

[31] R. Watson, B. Ives, and G. Piccoli, "Guest editoial: Practice-oriented research contributions in the COVID-19 forged new normal," *MIS Quart. Executive*, vol. 19, no. 2, 2020, Art. no. 2.

[32] F. Olan, E. Ogiemwonyi Arakpogun, J. Suklan, F. Nakpodia, N. Damij, and U. Jayawickrama, "Artificial intelligence and knowledge sharing: Contributing factors to organizational performance," *J. Bus. Res.*, vol. 145, pp. 605–615, 2022.

[33] Y. K. Dwivedi et al., "Impact of COVID-19 pandemic on information management research and practice: Transforming education, work and life," *Int. J. Inf. Manage.*, vol. 55, 2020, Art. no. 102211.

[34] S. J. Barnes, "Information management research and practice in the post-COVID-19 world," *Int. J. Inf. Manage.*, vol. 55, Dec. 2020, Art. no. 102175.

[35] R. Cameron, "Post-pandemic information management best practices," *RTInsights.com*, 2022. [Online]. Available: https://www.rtinsights.com/post-pandemic-information-management-best-practices/

[36] B. Kitchenham and S. Charters, "Guidelines for performing systematic literature reviews in software engineering," Tech. Rep. EBSE-2207-01, ver.2.3, Keele Univ., Keele, U.K., 2007.

[37] M. J. Grant and A. Booth, "A typology of reviews: An analysis of 14 review types and associated methodologies," *Health Inf. Lib. J.*, vol. 26, no. 2, pp. 91–108, Jun. 2009.

[38] J. Peterson, P. F. Pearce, L. A. Ferguson, and C. A. Langford, "Understanding scoping reviews: Definition, purpose, and process," *J. Amer. Assoc. Nurse Practitioners*, vol. 29, no. 1, pp. 12–16, Jan. 2017.

[39] H. Arksey and L. O'Malley, "Scoping studies: Towards a methodological framework," *Int. J. Social Res. Methodol.*, vol. 8, no. 1, pp. 19–32, Feb. 2005.

[40] A. Urbaczewski and Y. J. Lee, "Information Technology and the pandemic: A preliminary multinational analysis of the impact of mobile tracking technology on the COVID-19 contagion control," *Eur. J. Inf. Syst.*, vol. 29, no. 4, pp. 405–414, Jul. 2020.

[41] P. D. Ahn and D. Wickramasinghe, "Pushing the limits of accountability: Big Data analytics containing and controlling COVID-19 in South Korea," *Accounting, Auditing Accountability J.*, vol. 34, no. 6, pp. 1320–1331, 2021.

[42] A. Čolaković et al., "Mobile applications for COVID-19: Benefits, technologies and future research opportunities," *TEM J.*, vol. 10, no. 3, 2021, Art. no. 1461.

[43] F. Rowe, O. Ngwenyama, and J.-L. Richet, "Contact-tracing apps and alienation in the age of COVID-19," *Eur. J. Inf. Syst.*, vol. 29, no. 5, pp. 545–562, Sep. 2020.

[44] A. Leclercq-Vandelannoitte and J. Aroles, "Does the end justify the means? Information systems and control society in the age of pandemics," *Eur. J. Inf. Syst.*, vol. 29, no. 6, pp. 746–761, 2020.

[45] C.-K. Huang, S.-H. Chen, C.-C. Hu, and M.-C. Lee, "Understanding the adoption of the mask-supply information platforms during the COVID-19," *Electron. Markets*, vol. 32, no. 4, pp. 2405–2427, 2022.

[46] Y. Alotaibi and A. F. Subahi, "New goal-oriented requirements extraction framework for e-health services: A case study of diagnostic testing during the COVID-19 outbreak," *Bus. Process Manage. J.*, vol. 28, no. 1, pp. 273–292, 2022.

[47] S. Nazir, B. Price, N. C. Surendra, and K. Kopp, "Adapting agile development practices for hyper-agile environments: Lessons learned from a COVID-19 emergency response research project," *Inf. Technol. Manage.*, vol. 23, no. 3, pp. 193–211, Sep. 2022.
[48] Y. Kamenivskyy, A. Palisetti, L. Hamze, and S. Saberi, "A blockchain-based solution for COVID-19 vaccine distribution," *IEEE Eng. Manage. Rev.*, vol. 50, no. 1, pp. 43–53, Jan./Mar. 2022.
[49] M. V. Ciasullo, M. Carli, W. M. Lim, and R. Palumbo, "An open innovation approach to co-produce scientific knowledge: An examination of citizen science in the healthcare ecosystem," *Eur. J. Innov. Manage.*, vol. 25, no. 6, pp. 365–392, 2022.
[50] O. Azeroual and R. Fabre, "Processing Big Data with Apache Hadoop in the current challenging era of COVID-19," *Big Data Cogn. Comput.*, vol. 5, no. 1, 2021, Art. no. 12.
[51] Y. Siriwardhana, C. De Alwis, G. Gür, M. Ylianttila, and M. Liyanage, "The fight against the COVID-19 pandemic with 5G technologies," *IEEE Eng. Manage. Rev.*, vol. 48, no. 3, pp. 72–84, Jul./Sep. 2020.
[52] D. S. Soper, H. Demirkan, and J. Schlicher, "Analytics and IT in the response to COVID-19: A research framework and lessons for the future," *J. Decis. Syst.*, vol. 31, no. 1/2, pp. 7–18, 2022.
[53] W. He, Z. Zhang, and W. Li, "Information technology solutions, challenges, and suggestions for tackling the COVID-19 pandemic," *Int. J. Inf. Manage.*, vol. 57, 2021, Art. no. 102287.
[54] M. W. Condry and X. I. Quan, "Digital health innovation, informatics opportunity, and challenges," *IEEE Eng. Manage. Rev.*, vol. 49, no. 2, pp. 81–88, Apr./Jun. 2021.
[55] A. Shirish, S. C. Srivastava, and S. Chandra, "Impact of mobile connectivity and freedom on fake news propensity during the COVID-19 pandemic: A cross-country empirical examination," *Eur. J. Inf. Syst.*, vol. 30, no. 3, pp. 322–341, May 2021.
[56] M. Reveilhac and A. Blanchard, "The framing of health technologies on social media by major actors: Prominent health issues and COVID-related public concerns," *Int. J. Inf. Manage. Data Insights*, vol. 2, no. 1, Apr. 2022, Art. no. 100068.
[57] A. Sirola, J. Nuckols, J. Nyrhinen, and T.-A. Wilska, "The use of the dark web as a COVID-19 information source: A three-country study," *Technol. Soc.*, vol. 70, Aug. 2022, Art. no. 102012.
[58] S. Stieglitz, L. Hofeditz, F. Brünker, C. Ehnis, M. Mirbabaie, and B. Ross, "Design principles for conversational agents to support emergency management agencies," *Int. J. Inf. Manage.*, vol. 63, 2022, Art. no. 102469.
[59] N. Cobelli, F. Cassia, and R. Burro, "Factors affecting the choices of adoption/non-adoption of future technologies during coronavirus pandemic," *Technol. Forecasting Social Change*, vol. 169, 2021, Art. no. 120814.
[60] D. S. Chai and S. Park, "The increased use of virtual teams during the Covid-19 pandemic: Implications for psychological well-being," *Hum. Resource Develop. Int.*, vol. 25, no. 2, pp. 199–218, 2022.
[61] H. Lee, R. S. Guo, and C. Chen, "E-learning in the postpandemic era: A case study in Taiwan," *IEEE Trans. Eng. Manage.*, vol. 70, no. 10, pp. 3526–3538, Oct. 2023.
[62] M. K. Sein, "The serendipitous impact of COVID-19 pandemic: A rare opportunity for research and practice," *Int. J. Inf. Manage.*, vol. 55, Dec. 2020, Art. no. 102164.
[63] P. Roffia and L. Mola, "Is COVID-19 enough? Which underestimated conditions characterise the adoption of complex information infrastructures in small and medium-sized enterprises," *J. Bus. Res.*, vol. 144, pp. 1249–1255, May 2022.
[64] Y. Safonov, V. Borshch, I. Shulzhenko, I. Zahrebelna, and I. Bolshakova, "Digital transformation in developing economies under the COVID-19 pandemic," *IEEE Eng. Manage. Rev.*, vol. 50, no. 3, pp. 46–57, Jul./Sep. 2022.
[65] S. L. Pan and S. Zhang, "From fighting COVID-19 pandemic to tackling sustainable development goals: An opportunity for responsible information systems research," *Int. J. Inf. Manage.*, vol. 55, Dec. 2020, Art. no. 102196.
[66] C. Coombs, "Will COVID-19 be the tipping point for the intelligent automation of work? A review of the debate and implications for research," *Int. J. Inf. Manage.*, vol. 55, 2020, Art. no. 102182.
[67] R. Kumar, R. Sindhwani, and P. L. Singh, "IIoT implementation challenges: Analysis and mitigation by blockchain," *J. Glob. Oper. Strategic Sourcing*, vol. 15, no. 3, pp. 363–379, 2022.
[68] A. Munjal, M. Shukla, and P. Pujari, "An exploratory study on digital learning innovations (MOOCS): The future of higher education," *J. Inf. Optim. Sci.*, vol. 43, no. 7, pp. 1665–1678, Oct. 2022.
[69] R. J. Floetgen et al., "Introducing platform ecosystem resilience: Leveraging mobility platforms and their ecosystems for the new normal during COVID-19," *Eur. J. Inf. Syst.*, vol. 30, no. 3, pp. 304–321, 2021.
[70] D. Buhalis, A. Papathanassis, and M. Vafeidou, "Smart cruising: Smart technology applications and their diffusion in cruise tourism," *J. Hospitality Tourism Technol.*, vol. 13, no. 4, pp. 626–649, 2022, doi: 10.1108/JHTT-05-2021-0155.
[71] J. Castano, "Censuses of agriculture and COVID-19: Global situation and lessons," *Stat. J. IAOS*, vol. 36, pp. 861–865, 2020.
[72] T. Orrensalo, C. Brush, and S. Nikou, "Entrepreneurs' information-seeking behaviors in the digital age–A systematic literature review," *J. Small Bus. Manage.*, vol. 31, pp. 1–46, 2022.
[73] A. McArthur, J. Klugárová, H. Yan, and S. Florescu, "Innovations in the systematic review of text and opinion," *JBI Evidence Implementation*, vol. 13, no. 3, pp. 188–195, 2015.
[74] Mckinsey.com, "How COVID-19 has pushed companies over the technology tipping point—And transformed business forever," 2020. [Online]. Available: https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever#/
[75] H. Hashemi, R. Rajabi, and T. G. Brashear-Alejandro, "COVID-19 research in management: An updated bibliometric analysis," *J. Bus. Res.*, vol. 149, pp. 795–810, Oct. 2022.
[76] I. IBM Inst. Business Value, "Trending insights report," 2022.
[77] H. Snyder, "Literature review as a research methodology: An overview and guidelines," *J. Bus. Res.*, vol. 104, pp. 333–339, Nov. 2019.
[78] J. Naisbitt, *Megatrends: Ten New Directions Transforming Our Lives*. New York, NY, USA: Warner Books, 1982.
[79] C. Busse, A. P. Kach, and S. M. Wagner, "Boundary conditions: What they are, how to explore them, why we need them, and when to consider them," *Org. Res. Methods*, vol. 20, no. 4, pp. 574–609, 2017, doi: 10.1177/1094428116641191.
[80] D. A. Whetten, "What constitutes a theoretical contribution?," *Acad. Manage. Rev.*, vol. 14, no. 4, pp. 490–495, 1989.

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