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COVID 19 and Information Technology: A Systematic Review

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ABSTRACT

The COVID pandemic has driven innovations that have made information technology all-pervasive in the lives of most individuals. This systematic review seeks to determine the key themes that reflect these advances. The demographics of the publications reviewed were also examined. A total of 84 peer-reviewed and conference proceedings publications were selected from the years 2020-2022. NVivo 12 Plus was used to construct word relationship trees and a word frequency cloud. It was found that there are four main themes: information management; public health management; technological advances; and services. The word cloud revealed that data, health, learning, and social were the most frequently associated words with information technology and COVID. Most affiliations were based in the United States, with 79 authors, followed by China with 27 and India with 21 authors. The average number of authors on a publication was 3.59. Future research into the ethical impacts of online monitoring and real-world surveillance is needed. As data management systems are increasingly being used by corporations and governments to combat and restrict the spread of misinformation, who decides the truth needs to be clearly transparent?

*Keywords***:** information management, NVivo, privacy, public health management, services**,** technological advances.

INTRODUCTION

The global COVID pandemic has driven innovation in the integration of information technology (IT) that has redefined the individual's experiences with the cyber and digital world. Technological advances in the internet of things, cloud computing, machine learning and social networking have enabled the addressing of risks of encountering the disease while managing holistically the impacts on all aspects of an individual's life (Mehraeen et al., 2020; Hau et al., 2021). While information technology is critical to maintaining the lead in an operational and competitive environment, during the pandemic it has also led to fostering of a collaborative spirit (Mehraeen et al., 2020). Notwithstanding, the benefits of increased technological advancements, there have also been costs, perceived loss of privacy, over-regulation and disruption to supply chains and service provision (Ansari & Singh, 2021; Cherrington et al., 2021; Laxton et al., 2022).

The COVID pandemic has led to increased and regular global flows of information (Afzal, 2020). The rise of social media, coupled with an increased politically charged environment has had an exponential effect on the rise of misinformation (Afzal, 2020; Kulai et al., 2021; Wang et al., 2021). Emotionally charged messages tend to travel faster, carrying either positive or negative news, as individuals seek to be informed on the latest information (Lee et al., 2021; Zheng, 2022). Anti-quarantine comments and other disestablishmentarist content is able to be transmitted effectively by disruptors using social media (Karmi & Anderson, 2020) Furthermore, the rise and flood of misinformation and unrelated data can impede the flow of information on critical events (Afzal, 2020). The flood of mixed messages in the social media sphere has impacted social collective behaviour as individuals seek to protect their own health (Sutton et al., 2020).

The rise in the forced adoption of new technology requires effective change management practices if implementation is to be successful (McKeeby et al., 2021). An important consequence of the pandemic as a disruptor event is that it has driven increased innovation and acceptance of IT supported services, both at a government and individual level. Governments have introduced polices that has been at the forefront of driving innovation with support, both financially and through reductions in regulations, to fast-track innovations (Patrucco et al., 2021; Liu et al., 2021). Furthermore, researchers have turned to novel funding methods to gain the funds to drive research, such as crowdfunding (Ramadi & Nguyen, 2021).

There have been many innovations in the provision of government services as a consequence of restrictions in face-to-face contact due to COVID. The rise in e-government is not without risks, with a decline in corporate social responsibility and a rise in corruptive practices in jurisdictions with limited monitoring of governance practices in place (Avotra et al., 2021; Boban & Klarić, 2021). Governments have also sought to monitor social media to track societal attitudes (Sujiwo et al., 2021). Furthermore, as governments have sought to control human interactions to mitigate the spread of the pandemic greater surveillance has come at a cost to privacy and anonymity online, in the home and community, the loss of which may never be reclaimed (Indulkar et al., 2021).

Teaching and learning have undergone monumental changes during COVID in the way information is presented and classrooms are constructed (Sweidan et al., 2021; Chu, 2022). However, these pedagogical shifts in the design of curriculum due to the need for online learning have imposed unrealistic expectations on teachers and students (Hu & Lu, 2020). Another consequence that accompanied the rapid rise of online learning is that it has exposed children to the risks posed by the virtual world and a need for increased vigilance to maintain their well-being (Matkovic et al., 2021; Zhang et al., 2021). Similarly, there are risks to the integrity of the education system with identifying falsification and other malfeasance, as well as countermeasures (Barbosa et al., 2022; Weinberger & Bouhnik, 2021).

This review seeks to explore the current literature to investigate the key themes related to COVID and IT. These themes enable insights into the current research trends surrounding these topics through word associations. The key demographics of the literature will also be explored.

METHODOLOGY

A systematic review of the literature using the meta-engine "One Search". A total of 147 articles were identified using the terms "information technology + COVID" found in the title. Note that the search engine also incorporates the full reference to the article automatically to the search parameters. The only limiting qualification that was placed on the search was aimed at ensuring maximum currency, with only literature published in the years 2020- 2022. These dates represent the period of maximum impact globally of the COVID pandemic. A total of 63 articles were rejected: 3 books; 2 book reviews; 43 articles considered grey literature, this included trade magazines and newspaper articles; 4 articles that were only available in a language other than English; 4 articles were repeats of ones that had been included; 1 article had been retracted; and 6 were found to be unrelated – a historical comparative study (1), articles relating to metadata study methods (3), and those related to medical procedures (2). The remaining 84 articles were used in the review (Figure 1).

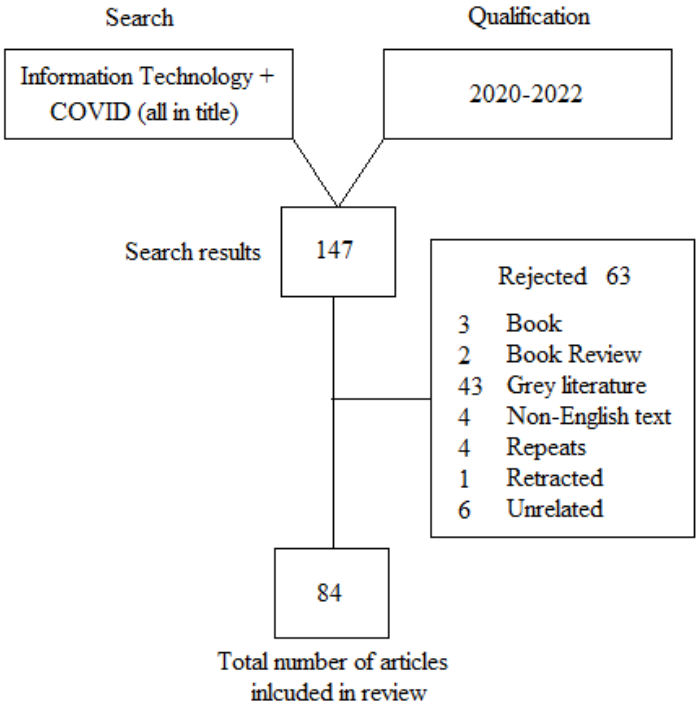

Figure 1: The process involved in the capture of the articles for this review using "One Search".

Articles were loaded into NVivo 12 Plus. As well as the default omission of words in NVivo, such as articles, pronouns, prepositions and irregular verbs, this study also removed non-informative terms such as "DOI", numbers and dates. The search terms "information" + "technology" + "COVID" were removed, these were contained in all papers and underpin all the relationships, thus dominating the word frequency word cloud. The NVivo thematic analysis was used with the 50 most frequent terms to identify any emerging themes, and the 50 most frequently used terms were shown in the generated word cloud in relative size to other words, words with higher usage are larger than those whose use is infrequent.

RESULTS AND DISCUSSION

Publication Demographics

There were an average of 3.59 authors per publication with the maximum number being 17 (Figure 2). Most papers included were written in 2021 with 45, 30 from journals and 15 conference proceedings (Figure 2). In 2022 a total of 7 papers were included, 5 from journals and 2 conference papers (Figure 2). A total of 32 papers were used from 2020, and 29 of these were conference proceedings with only 3 coming from journals (Figure 2). A total of 28 countries were listed as author affiliations, the United States having the largest representation with 79 authors, followed by China with 27 and India 21.

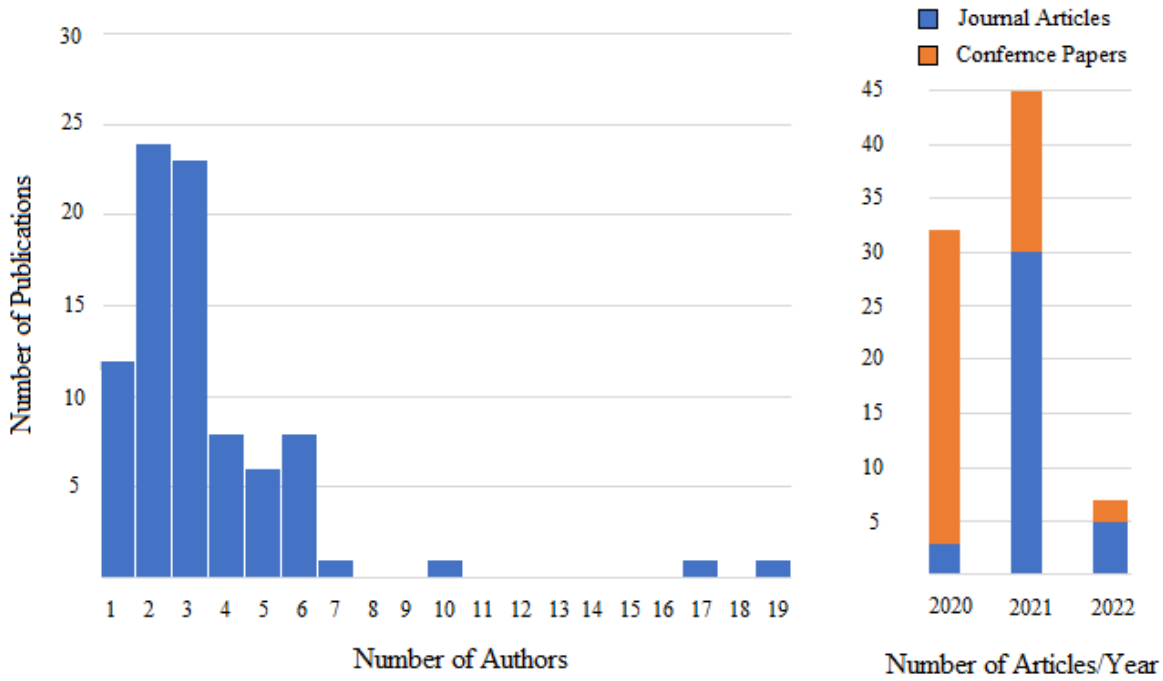

Figure 2: The number of articles used in the review showing the number of authors on each paper and the years and type of publication.

Thematic and Key Word Identification

Information technological innovations resulting from COVID disruptions can be classified into four thematic groups grounded in word clusters identified in NVivo: 1) the need to manage information; 2) management of public health; 3) technological advances, and 4) services (Figure 3).

The word cloud indicated that the most frequently used terms in connection with COVID and IT were “data”, “learning”, “social”, “health”, “research” and “pandemic” (Figure 4). These and less frequent words such as “students”, “public” and “model” are used to inform on the nature of the key identified themes.

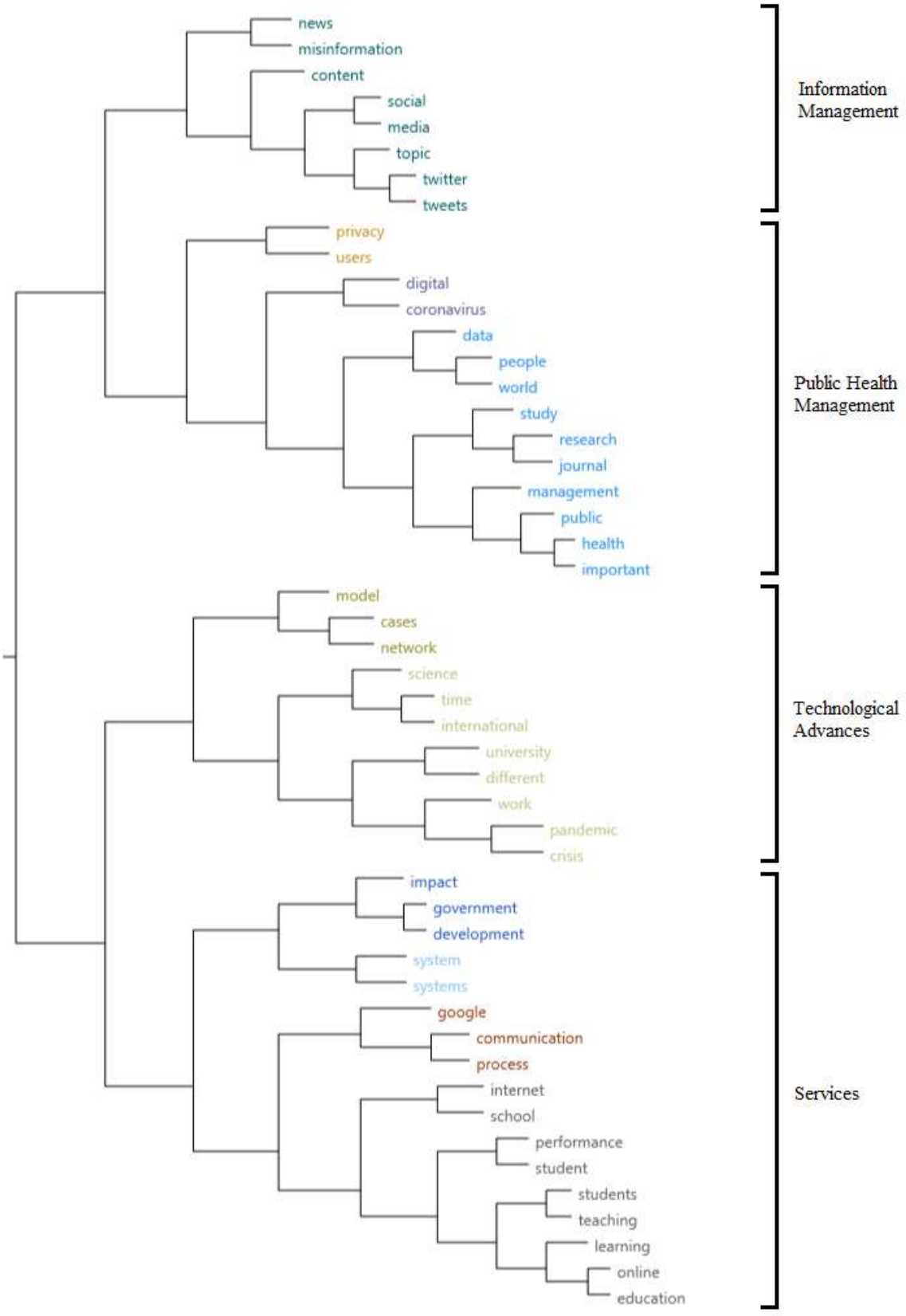

Figure 3: Word relationships identified with NVivo showing the four main clusters which reflect the themes in the literature.

Figure 4: The NVivo word cloud in connection with the keyword search "information technology" and "COVID" shows the relational frequency of word use by size, larger meaning more mentioned in articles.

Information Management

Information management was a key theme identified. Word groups indicated that the rise of the infodemia was reflected with "misinformation", "news" and "content", while the importance of social media in the transmission of information is reflected in the words "Twitter", tweet", "social", "media" (Figure 3). The most used term in the information management cluster was "social" (Figure 4).

The rise of infomediary, the excessive amount of information that exacerbates or complicates a solution to a problem, is a significant problem for IT specialists, particularly during a pandemic (Chang et al., 2020; Chong, 2020; Sathish et al., 2020; Bushuyev et al., 2021). As COVID has taken hold there has been a rapid uptake of social media platforms as users seek information from different sources to enable them to make informed decisions (Dinh & Parulian, 2020; Lloyd & Hicks, 2020; Lozić et al., 2021; Wu et al., 2021). The use of social media can impact the health attitudes of individuals to effect behavioural and attitudinal change affecting the effectiveness of government initiatives to manage the pandemic (Fan et al., 2020; Sathish et al., 2020; Tan et al., 2020; Reveilhac & Blanchard, 2022). How individuals engage with search engines has also been used to determine their attitudes at various stages of the pandemic (Ye et al., 2020; Zheng et al., 2020). Misinformation can cause major disruptions in providing effective care and management of the pandemic and can lead to information disorders, where individuals doubt the information that is supplied to them regardless of the source (Southwell et al., 2019; Sohrabi et.al., 2020; Chong et al., 2021; Padra & Pandey, 2021; Wang et al., 2021). Different social media platforms affect individual behaviour to the pandemic: YouTube and TikTok drive emotion, Twitter is driven by fact-seeking, Instagram and WhatsApp are more awareness generators, while Facebook is dominated by misinformation (Sathish et al. 2020; Kulai et al., 2021). However, these major social media provide the main modality for information sharing for netizens, leaving uses as determinants of that information is to be shared regardless basis in fact or opinion (Sohrabi et.al., 2020; Hu, 2021; Padra & Pandey, 2021; Tan & Chua, 2021)

Public Health Management

The identified theme of public health management can be divided into three main word clusters: the first deals with "privacy", "users" and the closely related "digital"; the second deals with "data", "people", and "management", "public", "research' and "health" (Figure 3). The word cloud highlighted "data" as the main topic and "health" and "research" similarly prominent, and this associated highlighting the role of IT during COVID and the research derived from large data sets to inform health initiatives (Figure 4).

While this information can be used to inform on where individuals are practising social distancing, IT application in terms of punitive or corrosive action has serious privacy and ethical concerns (Tang et al., 2020; Anari & Singh, 2021). This increase in surveillance will have long-term implications for civil liberties and the individual right to privacy (Yang et al., 2020; Mandal et al., 2021; Wang et al., 2022). Companies have developed software capable of detecting distance and masks, such as YOLO V4, and after the pandemic, it is highly unlikely this technology will be shelved (Indulkar et al., 2021). The use of activity on social media platforms has also been used to detect the level of social interactions during lockdowns (Anderson et al., 2020).

Fundamentally, there needs to be faith that the information collected is being used appropriately, and this relies on a level of trustworthiness in privacy by the society which is being monitored (Burdon & Wang, 2021; Wang et al., 2021).

Large global corporate actors, such as Apple and Google, have cooperated and developed applications that use Bluetooth on mobile devices to track proximity between individuals (Mandal et al., 2021). The use of tracing applications on mobile devices enables pandemic managers to quickly identify potential points of the transmission through contact tracing (Stahl, 2021; Tang et al., 2020). The use of deep learning-based human detection techniques enables data from surveillance cameras to use used to monitor social distancing practices has led to increased privacy concerns (Anari & Singh, 2021). Management of the disease was aided with the use of modelling infection growth estimation tools making IT critical in the decision-making process (Nazir et al., 2022).

Technological Advances

Technological medical innovations can be classified into two thematic streams: first, the use of big data to effectively trace and track the spread of disease, reflected in the subgrouping of "model", "cases" and "network"; and second, those that assist in the development of innovative medicines and understanding of the way in which the virus evolves underpinned by global cooperation which is dominated by research and the university sector, with the words "science", "time", "university", "international" and "different" (Figure 3). While technological advances in IT were important, and these assisted in the development of models and the role that globally connected universities play in that process, the word cloud indicates that they were not a major term used in the literature (Figure 4).

The use of IT in modelling the spread of the pandemic involves multidimensional data handling to provide statistical data to enable effective decision-making (Rogers, 2020). The pandemic has led to significant advances in artificial intelligence systems that have machine learning techniques (Xiao, 2021). Most of these models are machine deep learning inductive-based algorithms, such as the Group Method of Data Handling (GMDH); however, the quality of the models varies (Cheng & Ludäscher, 2020; Acosta & Garcia-Zapirain, 2020; Moroz & Stepashko, 2022).

COVID also impacted many aspects of supply chain networks, a disruptor event that drove technological innovation (Cherrington et al. 2021; O'Connor et al., 2021; Prasetyo et al., 2021; Voumick et al., 2021). It saw firms pivot and remap into new expanded, enhanced, and more sustainable, competitiveness business models (Hamilton, 2020). In particular, food supply chain management was significantly impacted by COVID, particularly as many sections of that industry had historically entrenched transaction practices and were resistant to IT-driven transformational change (O'Connell et al., 2021). COVID revolutionised the farming sector, with increased uptake of information sharing, logistical planning, and resource exchange. Primary producers and distribution networks had to develop novel ways to transact, find new markets and novel ways of selling such as online ordering, creating websites, and increasing social media usage (O'Connell et al., 2021). Similarly, the use of cashless payments and other transactional technologies developed as part of the new wave of the internet of things reduced the contact between individuals and was seen as a means of reducing human physical interaction (Dookeeram et al., 2020). In addition, road traffic management systems have been upgraded to monitor flows of traffic to areas of potential high-risk gatherings (Ferreira et al., 2022).

Information technology aided through the provision of artificial intelligence and cloud services assisted in understanding and combatting the pandemic by rapidly processing large data sets and enabling the sharing of this information to a wide audience of transnational stakeholders (Laxton et al., 2021). This was achieved by facilitating rapid data preparation for decision-makers and clinicians (Nazir et al., 2022). This led to the formation of the COVIDCV system, an application that enables parties to upload their qualifications, this facilitates rapid identification of key personnel on a global scale (Raja et al., 2021).

In terms of identification of COVID cases, artificial intelligence programs, such as Segmentation Identification and Logarithmic Transformation of Local Binary Patterns, enable rapid detection of the disease (Islam & Matin, 2021; Lakshmi et al., 2022; Nazir et al., 2022). Information technology also assisted in understanding how the disease changes through classification through residual dense neural networking (Nazir et al., 2022). The use of computer tomography has improved clinical workflows enabling improved treatment times (Islam & Matin, 2021). IT innovations and modelling have enabled the investigation of comorbidities with COVID (Podder et al., 2021). Similarly, the ability to assess larger data sets, data mining, has enabled the assessment of vaccine side effects (You et al., 2021).

Information technological innovations were major tools used to combat COVID in a clinical setting through the rollout of telemedicine, service robots, wearable devices and 3D printing of medical supplies (Dey et al., 2021; Dookeeram et al., 2020; Mandal et al., 2021; Hau et al., 2021; Liu et al., 2021). COVID led to an international shortfall in essential personal protective equipment, and it was the use of high-quality 3D printers that were able to mitigate this shortage, and more importantly enable the rapid customisation to suit individual client specifications (Prasetyo et al., 2021). Another innovation was the rise of telemedicine and its role as a means of measuring social distancing while retaining standards in healthcare (Dey, 2021; Dey et al., 2021). There have been advances in automated information retrieval systems which allow individuals to access information regarding specific topics using verbal queries (Cuenca & Morocho-Yunga, 2021).

Services

The impact on innovation in service provision is reflected in two thematic ways: first, the government provision of services, highlighted by the word clustering of "impact", "government" and "development", which was closely tied to "system" and "systems"; and second, more broadly the move to online learning in education and the word clustering of "school", "internet", "teaching", "online", "performance", "learning" and "student" (Figure 3). The term "learning" and "online" were prominent in the word cloud, highlighting the importance given to the research of online learning and teaching and its impact on student performance (Figure 4).

The use of IT systems allows secure and effective information sharing too many operational units within the government in real time (Popescu et al., 2021). However, it is important to recognise that not all members of the community are IT literate, and this lack of knowledge is particularly prevalent in the elderly and disadvantaged, further limiting their access to government services (Feldberg et al., 2021). Data literacy should be therefore seen as a social responsibility where data literacy is seen as a right, and to enable this, those people are often charged with the information provided to be trained effectively (Rubenstein et al., 2021; Radinsky & Tabak, 2022).

Information technology in the delivery of educational services to those in lockdown situations was critical to maintaining a functional educational system faced with the provision of a curriculum based on remote learning to a culturally diverse audience often using different platforms (Januar et al., 2020; Laxton et al., 2022; Williams et al., 2021; Wiyono et al., 2021; Desyanty et al., 2022). Student and teacher competency in the use of IT educational platforms is not uniform, and the level of computer literacy can have significant impacts on the learning outcomes for those who lack the competency or required tools such as Zoom (Barona & Ramirez, 2021; Delgado et al., 2021; Friedenthal, 2021; Sharma & Alvi, 2021; Pinto et al., 2022). Furthermore, students who study from home can feel isolated and emotionally venerable; this affects their academic performance, and the role of IT systems through the provision of virtual classrooms and interactive learning platforms and mediates this isolation (Laxton et al., 2020; Gopal et al., 2021; Karsen et al., 2021; Lim & Lee 2021; Poole & Zhang, 2021). The use of online applications, such as "Google Meet" and "Google Classroom", have achieved effective learning outcomes even in the teaching of physical activities (Tănasă & Vizitiu, 2020; Ceci et al., 2021; Sharda & Bajpai, 2021). However, the emotional intelligence of the teacher can significantly impact on the effectiveness of online teaching regardless of the tools at hand (Leonardo, 2020; Kunda and Bei, 2021).

LIMITATIONS

However, there needs to be a caveat in respect of the research that has been utilised in this review, with much of the infrastructure and finances needed to implement many of the IT innovations highlighting the disjunct in financial and technological capabilities between the developed and developing world economies (Dookeeram et al., 2020).

FUTURE RESEARCH

There is an ongoing need to explore how social media is used by governments to mediate their policies based on information gleaned from online discussions and posts. This involves a level of monitoring of these sites by governments and has implications for privacy. Much is now being written about combatting misinformation, but little is known about who makes the decisions on what is the truth, and what exactly is being censored. This lack of transparency has significant implications for the restriction of information management and sharing on a global scale.

Furthermore, research into the impact on long-term privacy of individual citizens is under threat through the increase in surveillance that monitors behaviour, often accompanied by recognition systems, many of which were purported to be temporary health management actions by the government. Studies on the ethical role of information technology developers, and their corporate responsibility to the citizens of the state also need to be explored. The literature is heavily focused on the rapid development of control and monitoring systems, without full consideration of the implications for their use of them by authoritarian governments. Understanding the increased disadvantage of those who lack computer literacy or the tools to access services is a growing area of research. This is particularly the case as there is a move towards e-government.

CONCLUSION

This systematic review found four key themes in the field of information technology and its relationship to COVID. First, information management and the need to manage large data derived from social media were key research foci, on how to deal with misinformation, however, little consideration was given to the fundamental right of free speech. Second, public health management in terms of monitoring the disease rates in the community was also linked to the monitoring of citizen behaviour in terms of compliance with government mandates. Third, technological advances in cloud-based research, intelligence systems for disease recognition, information sharing, and logistic support, coupled with practical innovations such as telemedicine and 3D printing of essential supplies were areas of rapid innovation during the pandemic. Finally, there was a move toward increased e-government and service provision, including a move towards online learning, both of which caused significant shifts in cultural and social practices. Therefore, while the pandemic has come at considerable costs to society, it has given rise to the rapid development of new and innovative technologies that will shape the lives of citizens globally well into the future.

REFERENCES

Acosta, M.F.J., & Garcia-Zapirain, B. (2020). Machine Learning Algorithms for Forecasting COVID 19 Confirmed Cases in America. *2020 IEEE International Symposium On Signal Processing and Information Technology* 1–6. https://doi.org/10.1109/ISSPIT51521.2020.9408742

Afzal, W. (2020). What we can learn from information flows about COVID-19: Implications for research and practice. *Proceedings of the ASIST Annual Meeting*, *57*(1), e245. https://doi.org/10.1002/pra2.245

Anderson, M., Karami, A. & Bozorgi, P. (2020). Social media and COVID-19: Can social distancing be quantified without measuring human movements? *Proceedings of the ASIST Annual Meeting*, *57*(1): e378. https://doi.org/10.1002/pra2.378

Ansari, M.A. & Singh, D.K. (2021). Monitoring social distancing through human detection for preventing/reducing COVID spread. *BVICAM's International Journal of Information Technology*, *13*(3), 1255-1264. https://doi.org/10.1007/s41870-021-00658-2

Avotra, A.A.R.N., Chengang, Y., Marcelline, T.R.S., Asad, A. & Yingfei, Y. (2021). Examining the Impact of E-Government on Corporate Social Responsibility Performance: The Mediating Effect of Mandatory Corporate Social Responsibility Policy, Corruption, and Information and Communication Technologies Development During the COVID era. Frontiers in *Psychology*, *12*, 737100-737100. https://doi.org/10.3389/fpsyg.2021.737100

Barbosa, E., Melges, A. & Gil, H. (2022). Senior and access to the COVID Digital Certificate: : Application of an Iconographic Tutorial in the elderly in Castelo Branco, Portugal. *2022 17th Iberian Conference on Information Systems and Technologies (CISTI)*, 1-5. https://doi.org/10.23919/CISTI54924.2022.9819981

Barona, C.B. & Ramirez, M.R. (2021). Effects of COVID 19 lockdown on the use of LMS platforms for virtual education. *2021 16th Iberian Conference on Information Systems and Technologies (CISTI)*, 1-6. https://doi.org/10.23919/CISTI52073.2021.9476645

Boban, M. & Klaric, M. (2021). Impact of Covid 19 Pandemic on Digital Transformation of Public Administration in European Union. *2021 44th International Convention on Information, Communication and Electronic Technology (MIPRO)*, 1312-1317. https://doi.org/10.23919/MIPRO52101.2021.9596678

Burdon, M. & Wang, B. (2021). Implementing COVID safe: The role of trustworthiness and information privacy law. *Law, Technology and Humans*, *3*(1), 35-50. https://doi.org/10.3316/informit.950076589645151

Bushuyev, S., Babayev, I., Bushuieva, V., Bushuyeva, N., Babayev & J., Bushuiev, D. (2021). Managing Project Success with "Infodemic" vs "Pandemic" Environment on the COVID - 19 Pandemic Case. *2021 IEEE International Conference on Smart Information Systems and Technologies (SIST)*, 1-7. https://doi.org/10.1109/SIST50301.2021.9465939

Ceci, F., Lazoi, M., Lezzi, M., Mohammad, H. (2021). Fostering knowledge sharing in the innovation process: Information and communication technology-based versus face-to-face relationships. *Knowledge and Process Management*, *28*(3),302-316. https://doi.org/10.1002/kpm.1668

Chang, S., McKay, D., Caidi, N., Mendoza, A., Gomes, C. & Dedeoglu, C.E. (2020). From way across the sea: Information overload and international students during the COVID-19 pandemic. *Proceedings of the ASIST Annual Meeting*, *57*(1), e289. https://doi.org/10.1002/pra2.289

Chavez, N., Penarreta, M. & Armas, R. (2022). Eva in the Time of Covid in Ecuadorian Communication and Information Companies. *2022 17th Iberian Conference on Information Systems and Technologies (CISTI)*, 1-5. https://doi.org/10.23919/CISTI54924.2022.9820536

Cheng, Y.-Y. & Ludäscher, B. (2020). Through the magnifying glass: Exploring aggregations of COVID-19 datasets by county, state, and taxonomies of U.S. regions. *Proceedings of the ASIST Annual Meeting*, *57*(1), e355. https://doi.org/10.1002/pra2.355

Cherrington, M., Airehrour, D., Madanian, S., Lu, J., Xu, Q. & Artiushkina, P. (2021). Remuneration Review: Risk, Planning, and Modelling beyond the Covid Crisis. *2021 IEEE 12th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON)*, 412-419. https://doi.org/10.1109/IEMCON53756.2021.9623069

Chong, M. (2020). Network typology, information sources, and messages of the infodemic twitter network under COVID-19. *Proceedings of the ASIST Annual Meeting*, *57*(1), e363. https://doi.org/10.1002/pra2.363

Chong, M., Froehlich, T.J. & Shu, K. (2021). Racial Attacks during the COVID-19 Pandemic: Politicizing an Epidemic Crisis on Longstanding Racism and Misinformation, Disinformation, and Misconception. *Proceedings of the ASIST Annual Meeting*, *58*(1), 573-576. https://doi.org/10.1002/pra2.501

Chu, Y.B. (2022). A mobile augmented reality system to conduct electrical machines laboratory for undergraduate engineering students during the COVID pandemic. *Education and Information Technologies*, 27(6), 8519-8532. https://doi.org/10.1007/s10639-022-10987-9

Cuenca, P. & Morocho-Yunga, J.C. (2020). Prototype for consultation of COVID information through a voice assistant. *2020 XV Conferencia Latinoamericana de Tecnologias de Aprendizaje (LACLO)*, 1-8. https://doi.org/10.1109/laclo50806.2020.9381162

Delgado, E., Ore, M., Roca, K., Navarro, B. & Carlos, H. (2021). Retrospective Analysis of the Performance of Students from a Public University in Pre-COVID Time due to the Use of Information and Communication Technologies. *2021 9th International Conference on Information And Education Technology (ICIET 2021)*, 340-345. https://doi.org/10.1109/ICIET51873.2021.9419646

Desyanty, E.S., Astuti, W., Tirtaningsih, M.T., Kusumaningrum, D.E., Hikmah, R.K.A. & Zahra, T.F. (2022). Learner Facilitation to Develop Conscientizacao During the COVID Pandemic. *2022 2nd International Conference on Information Technology and Education (ICIT&E)*, 358-362. https://doi.org/10.1109/ICITE54466.2022.9759892

Dey, J. (2021). Pivotal "New Normal" Telemedicine: secured psychiatric homeopathy medicine transmission in Post-COVID. *BVICAM's International Journal of Information Technology*, *13*(3), 951-957. https://doi.org/10.1007/s41870-021-00675-1

Dey, J., Sarkar, A. & Karforma, S. (2021). Newer post-COVID perspective: Teledental encryption by de-multiplexed perceptrons. *BVICAM's International Journal of Information Technology*, *13*(2), 593-601. https://doi.org/10.1007/s41870-020-00562-1

Dinh, L. & Parulian, N. (2020). COVID-19 pandemic and information diffusion analysis on Twitter. *Proceedings of the ASIST Annual Meeting*, *57*(1), e252. https://doi.org/10.1002/pra2.252

Dookeeram, D., Sammy, I. &Ali, K. (2020). Views on information technology during COVID 19. *Caribbean Medical Journal*, 1-3. https://doi.org/10.48107/CMJ.2020.12.006

Fan, L., Yu, H. & Yin, Z. (2020). Stigmatization in social media: Documenting and analyzing hate speech for COVID-19 on Twitter. *Proceedings of the ASIST Annual Meeting*, *57*(1), e313. https://doi.org/10.1002/pra2.313

Feldberg, C., Crivelli, L., Tartaglini, M.F., Martin, M.E., Garcia, L.M., Hermida, P.D., Natalia, I., Somale, M.V., Sevlever, G. & Allegri, R.F. (2021). Impact of an intergenerational training program in the use of information and communication technologies for older adults who receive cognitive intervention in the context of a Covid-19 pandemic: Preliminary results. *Alzheimer's & Dementia*, *17*(S7), e050594. https://doi.org/10.1002/alz.050594

Ferreira, J., Braz, F., Baldo, F. & Goncalves, P. (2022). Analyzing the impact of the covid epidemic on beach access traffic. *2022 17th Iberian Conference on Information Systems and Technologies (CISTI)*, 1-7. https://doi.org/10.23919/CISTI54924.2022.9820252

Friedenthal, M. (2021). How COVID Affected our Python Class at the Worcester Public Library. *Information Technology and Libraries*, *40*(4), 1-4. https://doi.org/10.6017/ITAL.V40I4.14041

Gopal, R., Singh, V. &, A. (2021). Impact of online classes on the satisfaction and performance of students during the pandemic period of COVID 19. *Education and Information Technologies*, *26*(6), 6923-6947. https://doi.org/10.1007/s10639-021-10523-1

Hamilton, J.R. (2020). The Strategic Change Matrix and Business Sustainability across COVID 19. *Sustainability*, *12*(15), 6026, (1-19). https://doi.org/10.3390/su12156026

Hau, Y.S. & Chang, M.C. (2021). Healthcare information technology convergence to effectively cope with the COVID-19 crisis. *Health Policy and Technology*, *10*(1), 27-28. https://doi.org/10.1016/j.hlpt.2020.10.010

Hu, J. (2021). What Does Channel Say? Understanding How Social Media Social Capital Facilitates COVID-19-Related Information-Seeking and Opinion-Expression on Two Types of Platforms: User-oriented versus Content-oriented. *Proceedings of the ASIST Annual Meeting*, *58*(1),737-739. https://doi.org/10.1002/pra2.546

Hu, Z. & Lu, W. (2020). PreKindergarten and kindergarten virtual school programs under COVID-19: A two-case comparative study. *Proceedings of the ASIST Annual Meeting*, *57*(1), e338. https://doi.org/10.1002/pra2.338

Indulkar, Y. (2021). Alleviation of COVID by means of Social Distancing & Face Mask Detection Using YOLO V4. *2021 International Conference on Communication Information and Computing Technology (ICCICT)*, 1-8. https://doi.org/10.1109/ICCICT50803.2021.9510168

Islam, M.R. & Matin, A. (2020). Detection of COVID 19 from CT Image by The Novel LeNet-5 CNN Architecture. *2020 23rd International Conference on Computer and Information Technology (ICCIT 2020)*, 1-5. https://doi.org/10.1109/ICCIT51783.2020.9392723

Januar, Rahmi, A., Andryadi, Hadini & Yudelnilastia (2021). Utilization of Information Technology Media and Communication in Distance Learning During the Covid 19 Pandemic. *Journal of Physics: Conference Series*, *1779*(1), 12043. https://doi.org/10.1088/1742-6596/1779/1/012043

Karami, A. & Anderson, M. (2020). Social media and COVID-19: Characterizing anti-quarantine comments on Twitter. *Proceedings of the ASIST Annual Meeting*, *57*(1), e349. https://doi.org/10.1002/pra2.349

Karsen, M., Kristin, D.M. & Pangestu, H. (2021). Evaluation on Student Engagement of Online Case-Based Learning and Flipped Learning During Covid 19 Pandemic (a case study approach). *2021 International Conference on Information Management and Technology (ICIMTech)*, *1*,271-276. https://doi.org/10.1109/ICIMTech53080.2021.9534949

Kulai, A., Sankhe, M., Anglekar, S., Halbe, A. (2021). Emotion Analysis of Covid Tweets using FastText Supervised Classifier model. *2021 International Conference on Communication Information and Computing Technology (ICCICT)*, 1-6. https://doi.org/10.1109/ICCICT50803.2021.9510156

Kundu, A. & Bej, T. (2021). COVID 19 response: An analysis of teachers' perception on pedagogical successes and challenges of digital teaching practice during new normal. *Education and Information Technologies*, *26*(6), 6879-6879. https://doi.org/10.1007/s10639-021-10503-5

Lakshmi, P., Sivagami, M. & Balaji, V. (2021). A novel LT-LBP based prediction model for COVID-CT images with Machine Learning. *2021 International Conference on Information Systems and Advanced Technologies (ICISAT)*, 1-5. https://doi.org/10.1109/ICISAT54145.2021.9678196

Laxton, D., Cooper, L. & Younie, S. (2021). Translational research in action: The use of technology to disseminate information to parents during the COVID-19 pandemic. *British Journal of Educational Technology*, *52*(4), 1538-1553. https://doi.org/10.1111/bjet.13100

Lee, C.S., Goh, D.H., Tan, H.W., Zheng, H. & Theng, Y.L. (2021). Understanding the Temporal Effects on Tweetcussion of COVID-19 Vaccine. *Proceedings of the ASIST Annual Meeting*, *58*(1), 768-770. https://doi.org/10.1002/pra2.556

Leonardo, Z.V. (2020). Uso de la Tecnologia de la Informacion y Comunicacion en educacion virtual y su correlacion con la Inteligencia Emocional de docentes en el Ecuador en contexto COVID-19/Use of Information and Communication

Technology in virtual education and its correlation with the Emotional Intelligence of Teachers in Ecuador in a COVID -19 context. *RISTI : Revista Ibérica de Sistemas e Tecnologias de Informaçã*, *40*(40), 31-44. https://doi.org/10.17013/risti.40.31-44

Lim, K.K. & Lee, C.S. (2021). Investigating Learner's Online Learning Behavioural Changes during the COVID-19 Pandemic. *Proceedings of the ASIST Annual Meeting*, *58*(1), 777-779. https://doi.org/10.1002/pra2.559

Liu, M., Bu, Y., Chen, C., Xu, J., Li, D., Leng, Y., Freeman, R.B., Meyer, E.T., Yoon, W., Sung, M., Jeong, M., Lee, J., Kang, J., Min, C., Song, M., Zhai, Y. & Ding, Y. (2022). Pandemics are catalysts of scientific novelty: Evidence from COVID-19. *Journal of the American Society for Information Science and Technology*, *73*(8), 1065-1078. https://doi.org/10.1002/asi.24612

Lloyd, A. & Hicks, A. (2020). Risk and resilience in radically redefined information environments; information practices during the COVID-19 pandemic. *Proceedings of the ASIST Annual Meeting*, *57*(1), e336. https://doi.org/10.1002/pra2.336

Lozić, J., Vojković, G. & Lozić, I. (2021). Analysis of the Financial Results of the Twitter Platform at the Beginning of Covid 19. *2021 44th International Convention on Information, Communication and Electronic Technology (MIPRO)*, 1420-1424. https://doi.org/10.23919/MIPRO52101.2021.9597016

Mandal, R., D'Souza, R.M.C., Sharma, Z., Raj, L.A., Soman, B. & Mashusudana, K. (2021). A Contrasting of the Pernicious and the Salubrious: An Assessment of the Global Impact of the Covid 19 Pandemic on Technology and Information. *Annals of R.S.C.B.*, *25*(2), 3513-352.

Markovic, R., Vejmelka, L. & Kljucevic, Z. (2021). Impact of COVID 19 on the Use of Social Networks Security Settings of Elementary and High School Students in the Split-Dalmatia County. *2021 44th International Convention on Information, Communication and Electronic Technology (MIPRO)*, 1476-1482. https://doi.org/10.23919/MIPRO52101.2021.9597179

McKeeby, J.W., Siwy, C.M., Revoir, J., Carlson, S.D., Joyce, M.D., Bailin, H., Frank, K.M., Krumlauf, M., Matlock, A.M., Lee, L.M., Sparks, M., Barnes, T., Liu, Y., Row, C.-H., Schmitt, J.M., Smith, D., Zelazny, A.M., Lonnerdal, D. & Coffey, P.S. (2021). Unveiling the silent threat among us: leveraging health information technology in the search for asymptomatic COVID 19 healthcare workers. *Journal of the American Medical Informatics Association :JAMIA*, 28(2), 377-383.https://doi.org/10.1093/jamia/ocaa237

Mehraeen, M., Dadkhah, M. & Mehraeen, A. (2020). Investigating the capabilities of information technologies to support policymaking in COVID-19 crisis management; a systematic review and expert opinions. *European Journal of Clinical Investigation*, *50*(11), e13391. https://doi.org/10.1111/eci.13391

Moroz, O. & Stepashko, V. (2020). Case Study of the Ukraine Covid Epidemy Process Using Combinatorial-Genetic Method. *2020 IEEE 15th International Conference on Computer Sciences and Information Technologies (CSIT)*, *2*, 17-20. https://doi.org/10.1109/CSIT49958.2020.9322000

Nazir, T., Nawaz, M., Javed, A., Malik, K.M., Saudagar, A.K.J., Khan, M.B., Abul Hasanat, M.H., Al Tameem, A. & Al Kathami, M. (2022). COVID-DAI: A novel framework for COVID-19 detection and infection growth estimation using computed tomography images. *Microscopy Research and Technique*, *85*(6), 2313-2330. https://doi.org/10.1002/jemt.24088

O'Connell, C., Gay, R., McDonald, N. & Tayal, S. (2021). COVID Connections: Lessons from Adaptations to COVID-19 as Strategies for Building Food System Resilience. *Culture, Agriculture, Food and Environment*, *43*(2), 123-136. https://doi.org/10.1111/cuag.12276

Patra, R.K. & Pandey, N. (2021). Disinformation on novel coronavirus (Covid-19): A content analysis of news published on fact-checking sites in India. *DESIDOC Journal of Library & Information Technology*, *41*(4), 275-283. https://doi.org/10.14429/DJLIT.41.4.16556

Patrucco, A.S., Trabucchi, D., Frattini, F. & Lynch, J. (2021). The impact of Covid-19 on innovation policies promoting open innovation. *R&D Management*, *52*(2), 273-293. https://doi.org/10.1111/radm.12495

Pinto, M., Caballero Mariscal, D. & Segura, A. (2022). Experiences of information literacy and mobile technologies amongst undergraduates in times of COVID. A qualitative approach. *ASLIB Journal of Information Management*, *74*(2), 181-201. https://doi.org/10.1108/AJIM-10-2020-0333

Podder, N.K., Shill, P.C., Rana, H.K., Omit, S.B.S., Al Shahriar, M.M.H. & Azam, M.S. (2021), Genetic Effects of Covid 19 on the Development of Neurodegenerative Diseases. *2021 5th International Conference on Electrical Information and Communication Technology (EICT)*, 1-6. https://doi.org/10.1109/EICT54103.2021.9733698

Poole, A.H. & Zhang, J. (2021). "It makes me sad": Archival Pedagogy in a Time of Covid-19. *Proceedings of the ASIST Annual Meeting*, *58*(1), 315-326. https://doi.org/10.1002/pra2.459

Popescu, V.F., Dragomir, F., Petre, R. & Bucata, G. (2021). Contribution to national security system, by creating an integrated open source portal with access to geo-information and telemedicine technologies for public health management (COVID 19 pandemic). *Romanian Journal of Information Technology and Automatic Control*, *31*(4), 21-32. https://doi.org/10.33436/v31i4y202102

Prasetyo, A., Abdillah, H., Wawan, W., Nurtanto, M., Kholifah, N. & Suyitno, S. (2021). How to the Need for Personal Protective Equipment (PPE) during the current Covid 19 Pandemic: Smart Products Solution. *2021 3rd East Indonesia Conference on Computer and Information Technology (EIConCIT)*, 309-313. https://doi.org/10.1109/EIConCIT50028.2021.9431851

Radinsky, J. & Tabak, I. (2022). Data practices during COVID: Everyday sensemaking in a high-stakes information ecology. *British Journal of Educational Technology*, *53*(5),1221-1243. https://doi.org/10.1111/bjet.13252

Raja, U., Chowdhury, N.S., Raje, R.R., Wheeler, R., Williams, J. & Ganci, A. (2021). COVID CV: A System for Creating Holistic Academic CVs during a Global Pandemic. *2021 IEEE International Conference on Electro Information Technology (EIT)*, 146-150. https://doi.org/10.1109/EIT51626.2021.9491917

Ramadi, K.B. & Nguyen, F.T. (2021). Rapid crowdsourced innovation for COVID-19 response and economic growth. *Digital Medicine*, *4*(1), 1-5.

Reveilhac, M. & Blanchard, A. (2022). The framing of health technologies on social media by major actors: Prominent health issues and COVID-related public concerns. *International Journal of Information Management Data Insights*, *2*(1), 100068. https://doi.org/10.1016/j.jjimei.2022.100068

Rogers, M. (2020). A case report: Challenges in COVID-19 modeling at a public health department. *Proceedings of the ASIST Annual Meeting*, *57*(1), e426. https://doi.org/10.1002/pra2.426

Rubenstein, E.L., Burke, S.K., D'Arpa, C., Lenstra, N. (2021). Health Equity and Small and Rural Public Libraries During COVID-19. *Proceedings of the ASIST Annual Meeting*, *58*(1), 827-829. https://doi.org/10.1002/pra2.577

Sathish, R., Manikandan, R.M., Priscila, S.S., Sara, B.V.J. & Mahaveerakannan, R. (2020). Report on the Impact of Information Technology and Social Media on Covid–19. *Proceedings of the Third International Conference on Intelligent Sustainable Systems*, 224-230. https://doi.org/10.1109/ICISS49785.2020.9316046

Sharda, P. & Bajpai, M.K. (2021). Online Learning and Teaching using Google Classroom during the COVID-19 Pandemic. *DESIDOC Journal of Library & Information Technology*, *41*(5),352-357. https://doi.org/10.14429/djlit.41.5.16205

Sharma, A. & Alvi, I. (2021). Evaluating pre and post COVID 19 learning: An empirical study of learners' perception in higher education. *Education and Information Technologies*, *26*(6), 7015-7032. https://doi.org/10.1007/s10639-021-10521-3

Sohrabi, C., Alsafi, Z., O'Neill, N., Khan, M., Kerwan, A., Al-Jabir, A., Iosifidis, C. & Agha, R. (2020). World Health Organization declares global emergency: A review of the 2019 Novel Coronavirus (COVID-19). *International Journal of Surgery*, 71-76. https://doi.org/10.1016/j.ijsu.2020.02.034

Southwell, B.G., Niederdeppe, J., Cappella, J.N., Gaysynsky, A., Kelley, D.E., Oh, A., Peterson, E.B. & Chou, W.-Y.S. (2019). Misinformation as a misunderstood challenge to public health. *American Journal of Preventative Medicine*, *57*(2), 282-285. https://10.1016/j.amepre.2019.03.009

Stahl, B.C. (2021). Emerging technologies as the next pandemic?: Possible consequences of the Covid crisis for the future of responsible research and innovation. *Ethics and Information Technology*, *23*(Suppl 1), 135-137.https://doi.org/10.1007/s10676-020-09551-1

Sujiwo, B., Wibowo, A. & Saputro, D.R.S. (2021). Sentiment Analysis of Indonesian Government Policies In Handling Covid 19 Through Twitter Data. *2021 4th International Seminar on Research of Information Technology and Intelligent Systems (ISRITI)*, 453-457.https://doi.org/10.1109/ISRITI54043.2021.9702784

Sutton, J., Renshaw, S.L. & Butts, C.T. (2020). COVID-19: Retransmission of official communications in an emerging pandemic. *PLoS One*, *15*(9), e0238491. doi:https://doi.org/10.1371/journal.pone.0238491idan, S.Z., Abu Laban, S.S., Alnaimat, N.A. & Darabkh, K.A. (2021). SEG-COVID: A Student Electronic Guide within Covid-19 Pandemic. *2021 9th International Conference on Information and Education Technology (ICIET 2021)*, 139-144.https://doi.org/10.1109/ICIET51873.2021.9419656

Tan, M. & Chua, A.Y.K. (2021). Students' Motivations for Not Sharing Rumours during the COVID-19 Pandemic in Singapore. *Proceedings of the ASIST Annual Meeting*, *58*(1), 842-844.https://doi.org/10.1002/pra2.582

Tan, T., Huang, T., Wang, X. & Zuo, Z. (2020). A preliminary investigation of COVID-19 transmission in the United States by incorporating social media sentiments. *Proceedings of the ASIST Annual Meeting*, *57*(1), e370. https://doi.org/10.1002/pra2.370

Tănasă, B.I. & Vizitiu, E. (2020). Study on the technique of the game of badminton by using information technology during the pandemic covid -19 in students aged 10-12 years. *Annals of the "Ştefan Cel Mare" University*: *Physical Education and Sport Section - The Science and Art of Movement*, *13*(2), 112-120. https://doi.org/10.4316/SAM.2020.0215

Tang, R., Erdelez, S., May, E. & Zhang, Y. (2020). The state of practice of COVID-19 tracking systems: An inventory study. *Proceedings of the ASIST Annual Meeting*, 57(1), e397. https://doi.org/10.1002/pra2.397

Voumick, D., Mim, I.J., Deb, P., Sutradhar, S., Salim, S.A., Sutradhar, K. & Khan, M.M. (2021). Development of A Web Based Covid Portal and Marketplace. *2021 IEEE 12th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON)*, 406-411.https://doi.org/10.1109/IEMCON53756.2021.9623065

Wang, T., Guo, L. & Bashir, M. (2021). COVID-19 Apps and Privacy Protections from Users' Perspective. *Proceedings of the ASIST Annual Meeting*, *58*(1), 357-365. https://doi.org/10.1002/pra2.463

Wang, X., Zhang, M., Fan, W. & Zhao, K. (2022). Understanding the spread of COVID-19 misinformation on social media: The effects of topics and a political leader's nudge. *Journal of the American Society for Information Science and Technology*, *73*(5), 726-737.https://doi.org/10.1002/asi.24576

Weinberger, M. & Bouhnik, D, (2021). Factors for Online Identity Falsification among Israeli Students in the Era of COVID-19. *Proceedings of the ASIST Annual Meeting*, 58(1), 860-862.https://doi.org/10.1002/pra2.589

Williams, H., Haynes, M. & Kim, J. (2021). Dual Teaching: Simultaneous Remote and In-Person Learning during COVID. *SIGITE 2021 - Proceedings of the 22nd Annual Conference on Information Technology Education*, 111-116. https://doi.org/10.1145/3450329.3476867

Williams, H., Haynes, M. & Kim, J. (2021). Dual Teaching: Simultaneous Remote and In-Person Learning During COVID. In *Proceedings of the 22nd Annual Conference on Information Technology Education USB Stick (SIGITE '21),* October 6–9, 2021, SnowBird, UT, USA. ACM, New York, NY, USA, 6 pp. https://doi.org/10.1145/3450329.3476867

Wiyono, B.B., Indreswari, H. & Prestiadi, D. (2021). The Use of Technology-Based Communication Media in The Teaching-Learning Interaction of Educational Study Programs in The Pandemic of Covid 19. *2021 IEEE 11th International Conference on Electronics Information and Emergency Communication (ICEIEC)*, 1-5. https://doi.org/10.1109/ICEIEC51955.2021.9463846

Wu, S. (2021). Understanding New Yorkers' Everyday Life Information Seeking Behavior in the Context of Coping with COVID-19. *Proceedings of the ASIST Annual Meeting*, *58*(1), 866-868. https://doi.org/10.1002/pra2.591

Xiao, Z. (2021). COVID 19 Mortality Rate Prediction based on Machine Learning Methods. *2021 IEEE International Conference on Computer Science, Electronic Information Engineering and Intelligent Control Technology (CEI)*, 169-177. https://doi.org/10.1109/CEI52496.2021.9

Yang, S., Fichman, P., Zhu, X., Sanfilippo, M., Li, S. & Fleischmann, K.R. (2020). *The use of ICT during COVID-19. Proceedings of the ASIST Annual Meeting*, 57(1), e297. https://doi.org/10.1002/pra2.297

Ye, Z., Mao, J., Liu, Y., Zhang, M. & Ma, S. (2020). Investigating COVID-19-Related query logs of Chinese search engine users. *Proceedings of the ASIST Annual Meeting*, *57*(1), e424. https://doi.org/10.1002/pra2.424

You, J., Shaik, N. & Chen, H. (2021). Data Mining on COVID-19 Vaccines: Side Effects. *Proceedings of the ASIST Annual Meeting*, *58*(1), 869-871. https://doi.org/10.1002/pra2.592

Zhang, Y., Tang, J. & Zhang, P. (2021). An Exploratory Study on Chinese Preteens' Internet Use and Parental Mediation during the COVID-19 Pandemic. *Proceedings of the ASIST Annual Meeting*, *58*(1), 875-877. https://doi.org/10.1002/pra2.594

Zheng, H., Goh, D.H., Lee, E.W.J., Lee, C.S. & Theng, Y. (2022). Understanding the effects of message cues on COVID-19 information sharing on Twitter. *Journal of the American Society for Information Science and Technology*, *73*(6), 847-862. https://doi.org/10.1002/asi.24587