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## **Impact of COVID-19 pandemic on information management research and practice: Transforming education, work and life**

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# Impact of COVID-19 Pandemic on Information Management Research and Practice: Transforming education, work and life

(An Opinion Paper)

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## **Abstract**

The COVID-19 pandemic has forced many organisations undergo significant transformation, rethinking key elements of their business processes and use of technology to maintain operations whilst adhering to a changing landscape of guidelines and new procedures. This study offers a collective insight to many of the key issues and underlying complexities affecting organisations and society from COVID-19, through an information systems and technological perspective. The views of 12 invited subject experts are collated and analysed where each articulate their individual perspectives relating to: online learning, digital strategy, artificial intelligence, information management, social interaction, cyber security, big data, blockchain, privacy, mobile technology and strategy through the lens of the current crisis and impact on these specific areas. The expert perspectives offer timely insight to the range of topics identifying key issues and recommendations for theory and practice.

**Keywords:** COVID-19; Digital transformation; Information Management; Information Systems; Information Technology; Pandemic; Practice; Research; Strategy

## **1. Introduction**

The July 2020 World Health Organisation (WHO) situational report - 175, highlights the stark reality of a new total of 12.7 million cases and 566,654 deaths globally from COVID-19 (WHO 2020a). Currently the USA, Brazil and India are experiencing the highest number of reported daily cases, whilst the rest of the world emerges from lockdown and attempts to slowly transition society to what can be described as - close to normal daily life. The grim reality of the virus trajectory and speed of transmission is that many tens of thousands of people may still be infected, and a significant number of people may still die from the virus.

The pandemic has devastated many aspects of daily life where governments across the world have needed to subject their citizens to prolonged periods of lockdown, necessitating the cessation of

almost all forms of human in person contact outside the immediate family. This has had an unprecedented impact on people's personal lives within a mental health context (Tubadji, et al. 2020), but also within organisations as they attempt to maintain operations during the pandemic. The cultural and economic impact of the virus has created the reality of the *new normal* within the COVID era, has necessitated a radical transformation to the way that people interact and operate within the workplace that could potentially influence many facets of our daily life for the foreseeable future (Griffin & Denholm 2020). Whilst many companies have been forced to close down or severely reduce operations, those organisations that have continued to operate have needed to work within a changed landscape of new processes and practices influenced by social distancing requirements and altered work patterns (Leidner, 2020; Richter, 2020). Many organisations have been forced to adopt new ways of remote working using new digital systems for communication and to completely rethink their business models to adapt to the realities of the COVID-19 environment (Carroll & Conboy, 2020).

The increased availability and use of technology during the pandemic, has also enabled authorities to develop critical COVID tracking infrastructure, where smartphone apps and IS technologies have been developed to control the spread of the virus. Studies have highlighted that managed and effective contact tracing and case isolation can control new outbreaks of COVID-19 within a period of three months (Hellewell et al. 2020). Authorities within the UK, Australia, France, China, and India have launched their own versions of contact track and tracing applications each reliant on smartphone apps and associated infection containment processes. The use of smart tracing apps within South Korea has frequently been cited as a test case for extensive use of technology and mass testing for controlling the number of cases nationwide (Deutsche Welle 2020). However, the widespread use of these technologies throughout the population, presents a number of security and privacy implications that are as yet unresolved, constraining wider diffusion in some countries and effectively limiting infection tracing effectiveness (Fahey & Hino, 2020; Rowe 2020).

The widespread adoption of digital technologies not just in the workplace, but also within society in general, has enabled people to maintain communications as the infection rate has continued to spread across around the world. The terms: "Zoom" and "Teams" have been incorporated into everyday lexicon as these platforms have seen widespread personal and organisational use to effect meetings, education, and training, as well as maintaining links with family and friends. This transformation has been enabled by the rapid diffusion of Information Systems (IS) technology and cloud based infrastructure that has allowed people to maintain interaction, whilst adhering to the new norms of social distance and self-isolation (Kodama 2020).

The long term economic and cultural impact of the rapid migration to digital stemming from the pandemic, is unknown. Researchers have offered extensive analysis on many aspects of the transformation implications on COVID-19 from a cultural and societal viewpoint, as well as a technological perspective. Many IS related themes have emerged within the COVID-19 literature where studies have analysed the implications from perspectives relating to: privacy, digital inequalities, communication, automation, societal disruption, use of social media and digital education implications (Carroll & Conboy; Chen et al. 2020; Venkatesh 2020). Studies are already assessing the potential of COVID-19 to permanently normalise the use of digital technologies for education, maintaining friendships, healthcare diagnosis, business operations, religion and interaction with government, effectively shaping human endeavour for the foreseeable future (Barnes 2020; Fernandes 2020; Griffin & Denholm 2020). This potential change in the IS landscape has attracted widespread comment and perspectives amongst academics where studies have posited the effects of the pandemic from specific viewpoints, highlighting the many and varied transformational implications. However, the literature has yet to offer a consolidated view on the IS related factors surrounding COVID-19 where the diverse range of perspectives and impacts can be assessed and analysed.

This study brings together the collective insights from several leading experts to discuss the impact of COVID-19 pandemic on IS related research and practice. The range of insights offered within this study cover a range of pertinent issues, reflecting the diverse perspectives from each of the invited experts. The research offers timely and relevant contribution to the extant literature presenting key insight and analysis to this key topic for researchers and practitioners alike.

The remaining sections of this article are organised as follows. Section 2 presents the experts' perspectives related to core themes surrounding IS and COVID-19. Section 3 presents an analysis of the key aspects from the perspectives and overview of the expert contributions in the context of the wider literature. Section 4 concludes the paper discussing implications for both research and practice.

## 2. Multiple perspectives from invited contributors

This section is organised by employing the approach set out in Dwivedi et al. (2015; 2019; 2020) and Kizgin et al. (2020) for presenting consolidating experts' contributions relating to the impact of the COVID-19 pandemic on IS related research and practice. The contributions compiled in this section are largely presented in an unedited form, expressed directly in the form written by the experts. Although, this approach can present an inherent unevenness within the logical flow, this method captures the distinctive orientations of the expert perspectives related to the chosen topic (Dwivedi et al., 2015; 2019; 2020; Kizgin et al., 2020). The list of contributions are provided in Table 1 and extended in further detail within this section.

**Table 1.** Invited contributions

<b>Contribution title</b>	<b>Author(s)</b>
COVID-19 and the Lessons of Pivoting Information Management Teaching Online	Crispin Coombs, Loughborough University, UK
The role of digitalization strategy at the time of COVID-19 crisis	Ioanna Constantiou, Copenhagen Business School, Denmark
Impact on AI Research and practice from a decision making perspective	Yanqing Duan, University of Bedfordshire, UK
Information Management impact of COVID-19: a personal view	John S. Edwards, Aston Business School, UK
Impact of the COVID-19 Pandemic on Information Management Research and Practice	Babita Gupta, California State University Monterey Bay, USA
Technology-enabled social interaction with colleagues during the COVID-19 pandemic: more hype than reality?	Banita Lal, University of Bedfordshire Business School, UK
COVID-19 and Information Systems	Santosh Misra, CEO, Tamil Nadu E-Governance Agency, Government of Tamil Nadu, India
Effects of COVID-19 on Information Technology Sector	<b>Prakhar Prashant</b>
Impact of COVID-19 on Cyber Security	Ramakrishnan Raman, Symbiosis Institute of Business Management, Pune & Symbiosis International (Deemed University), Pune, India
How mobile technology may help fight the COVID-19 pandemic? A viewpoint	Nripendra P. Rana, University of Bradford, UK
COVID-19, Big Data, Privacy, and Blockchain	Sujeet K. Sharma, Indian Institute of Management Tiruchirappalli, India
Post-Pandemic transformation in Information Systems Strategies	Nitin Upadhyay, Goa Institute of Management, Goa, India

## ***2.1 Contribution 1 - COVID-19 and the Lessons of Pivoting Information Management Teaching Online - Crispin Coombs<sup>1</sup>***

The COVID-19 pandemic has forced many organisations to make considerable changes to their normal business processes. One sector that has seen a substantial digital transformation has been the global higher education sector. The closing of university campuses, national lockdowns and social distancing requirements have meant that many Information Management (IM) academics across the world have needed to rapidly convert their existing teaching material to a format suitable for online delivery. This change has resulted in many IM academics learning new online teaching techniques, with little or no training, and minimal prior experience. The Information Management Group in the School of Business and Economics at Loughborough University, UK were no exception to this challenge. Over a few short weeks, IM colleagues had to convert existing and new teaching material to an online format for a variety of different cohorts including MBA, postgraduate and undergraduate students. An experience shared by many IM academics across the world.

For many institutions, attention is now turning to plan for the next academic year. At Loughborough, it is highly likely that some physical face-to-face teaching will be delivered. However, there is still the need to deliver some teaching online, especially for those students unable to return to campus. Although the first quarter of 2020 was an intensive and demanding time for IM colleagues, we gained considerable experience in online teaching methods. To share our experiences and distil key lessons, the IM group organised an internal webinar in June 2020. The remainder of this viewpoint discusses the main lessons that emerged from our discussion of rapidly converting to online delivery and the implications for future IM teaching delivery.

### **Setting Up the Home Environment for Online Teaching**

Many IM academics have moved to complete remote working at home. Therefore, when preparing for delivering online teaching, it is essential to think about how the home environment can be adjusted to create a professional screen appearance. Good lighting is vital for successful online delivery, and there is useful advice online that provides straightforward guidance on how to improve lighting. These adjustments need not be expensive. One IM colleague explained they were using a desk lamp with a daylight bulb pointed at the floor to ensure that they were well lit on screen.

A consideration of the best combination of microphone and sound was also essential to ensure that the academic's speech was captured clearly, and some colleagues had invested in new webcams and lapel microphones. Some IM colleagues found the use of headphones useful to focus on the session without distraction, while others found them onerous to wear during teaching sessions. Consideration also needs to be given to the academic's on-screen background, either by rearranging bookshelves and moving some objects out of shot or using a virtual background. Other areas to reflect on include: wearing professional attire, assessing the risk of external noises that may disrupt the session, and other household members adding concurrent demand on a home Internet connection. Addressing all these elements helped to create a professional on-screen appearance.

### **Establishing Rules of Engagement**

At the start of a teaching session, it was considered essential to explain how the session would be delivered and set expectations for students. For example, at the start of the teaching session, students could be asked to mute their microphones and post questions in the online chat. A colleague observed that many more established online educators would have a teaching assistant working alongside them to monitor the online chat while the academic was delivering the lecture. However, in the absence of additional support, it was recommended that the IM academic explained to students that they would

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review questions posted in the online chat after every session. During that review, the 'hand up' functionality, available in many video conferencing applications, could be used for students who wished to add a comment or ask a related question. This approach seemed to work well, especially for students that were not comfortable contributing in large groups or whose first language was not English.

### **Designing for Sociability**

A further theme that emerged from the discussion was providing time before the session for students to see each other and engage in small talk to create a sense of community and shared experience. This shared experience was achieved by asking all students to turn on their cameras before the start of the session for five to ten minutes of open discussion and chat.

Similarly, several colleagues observed that the students were keen for the IM academic leading the session to keep their camera on throughout the teaching session. This visual presence was necessary even when students were completing tasks on their own. For example, one IM colleague teaching Python programming would give a 15-minute overview of the programming exercise that the students were to complete. Following the overview, the students were given time to complete the exercise, and the academic would periodically check the online chat and respond to any queries. The academic kept their camera on, even when not actively contributing to the session. This constant visual presence seemed to help retain energy for completing the task among the students and provide a visual reminder that the academic was available to answer questions.

### **Teaching Content Burn is High**

A further observation from an IM colleague was that it took less time to deliver teaching content, compared to a physical face-to-face session. This change was attributed to students being far more efficient in their interactions during online discussions in a chat room compared to in-class discussions. Group activities tended to take 50 per cent less time which meant the academic had to be ready to return to content delivery more quickly than in a physical face-to-face session. The experience was compared to permanently cooking on high heat.

There was a consensus that lectures should be divided into short chunks, ideally being between 7 and 15 minutes with no lectures or recorded material longer than 20 minutes. One IM colleague had decided to divide each topic into a series of short lessons. After every two or three lessons, the colleague would pause to review the online chat for questions or ask the students to complete a short quiz to check their understanding and to maintain engagement.

Students enjoyed this style of online delivery, and in some cases, it seemed to be more effective than previous physical in-person teaching formats. For example, when teaching programming, the IM academic was able to share their screen to provide a live walkthrough demonstration that the students could follow on their computers, and ask students to share their screens to respond to problems the students encountered when attempting to complete coding exercises. This screen sharing approach may have allowed students to feel less exposed when asking for help compared to a physical group environment. The students may prefer the ability to ask for help in a more subtle way, such as posting a question in the online chat. This way of asking questions may allow the student to feel less self-conscious compared to putting up their hand in front of their peers in a computer lab. Similar recent experiences have been reported. For example, Davison, (2020) reports he was also able to encourage higher levels of student interaction through the use of online chat functionality.

### **A Model IM Course Would Look Very Different**

It was also generally agreed that if IM colleagues had been tasked to make a change to online delivery of teaching without the pressure of COVID-19, then the course would look quite different. There would be a strong focus on developing new online pedagogy that combined videos released at different points during the week with a regular group activity. For example, a course taught over ten weeks could have a format of three 20 minute videos released for each week, combined with a range of peer activities, live debates, and group activities, and only two or three large physical face-to-face set-piece lectures with questions.

## **The Future of IM Teaching**

This viewpoint has provided some lessons from IM academics on how they have rapidly pivoted their teaching delivery online to respond to COVID-19 constraints. However, there are several areas where further insights would be valuable.

For example, the campus experience is likely to remain an essential feature of the student experience at many institutions. Therefore, it will be interesting to see how IM academics combine physical face-to-face teaching with increasing online delivery capability. Some students may prefer to study some topics remotely, while other students may wish to study the same content in a physical classroom. The challenge for IM academics is to ensure that students in both situations get a high-quality learning experience, without one group feeling neglected, or the IM academic having to double their teaching load.

It will also be interesting to see how the student applicant market changes as a result of COVID-19. For example, will students still be keen to return to the campus, or will they be attracted to the possibilities of accessing higher education online courses from any university in the world, without having the cost and disruption of having to relocate. Student applicants may reassess their priorities when deciding where and how to continue their learning. IM academics need to be ready to respond to these changing market conditions.

Hopefully, COVID-19 will be the catalyst for IM academics to be provided with the resources and freedom to advance their IM teaching practices. A sophisticated combination of physical face-to-face and online teaching that is tailored to the needs of students could provide the opportunity to deliver an even better student learning experience. It may also help to ensure that IM learning opportunities are accessible to a broader and more diverse global student audience. In this way, we have the opportunity to ensure that the world is a better place after the pandemic.

## ***2.2 Contribution 2 - The role of digitalisation strategy at the time of COVID-19 crisis - Ioanna Constantiou***

The COVID-19 pandemic has intensified pressure in most industries where firms struggle to cope with a number of uncertainties with respect to both supply and demand. A number of political decisions in countries around the globe led to temporal lockdowns of and imposed forceful disruptions of everyday business activities. Depending on the industry at focus and the role of a firm in the value chain, this disruption had direct effects and indirect effects on the upstream and downstream transactions. For example, firms are not always able deliver the expected products to their business customers and consumers at the expected time. However, in this turbulent economic environment, some firms seem to cope better than others do. We acknowledge that this observation is a result of a number of internal, firm-related factors and external, socio-economic and political influences in the business environment.

We focus on how digitalisation influences the firm's ability of coping with COVID-19 consequences. Before COVID-19 crisis, a major focus of the firm's strategy involved the adoption of digital technologies and the introduction of digital platforms (Constantiou et al., 2017; Parker et al., 2016). We investigate how the different levels of digitalisation of firms and industries contribute to coping with the COVID-19 crisis. We are interested on the effects of social distancing which imposed restrictions on individuals' physical movements and thus influence their behavior as consumers and as employees. We argue that this crisis has a different impact on businesses depending on the degree of digitalisation of business activities and the contribution of digital technologies in value creation. In particular for:

- Online businesses such as social media platforms Twitter, Facebook, or digital platforms such as Google, where the majority of business activities are digital and value is created from digi-



tal services, the disruption from COVID-19 appears to have small negative effects on their sales<sup>2</sup> but could be challenged mainly from the sharp decrease of advertising revenues<sup>3</sup>.

- Businesses operating mainly through digital channels, such as retailers using ecommerce services indicate mixed results. The demand has increased for some products categories, e.g. food and beverages, home utilities etc. This increase has led to a number of bottlenecks in the supply chains, e.g., delays in delivery times<sup>4</sup>. Once these problems were overcome these businesses experience increase in their sales. A pronounced example in this case is Amazon<sup>5</sup>.
- Businesses in industries where digitalisation of the value chains both upstream and downstream is low are mostly challenged by the COVID-19 disruption of business activities. For example, car manufacturers experience challenges in the production process because of the reduced production of suppliers around the world and the inability of employees to go to work<sup>6</sup>.

The initial observations from the unexpected economic crisis from COVID-19 emphasises the importance of digitalisation both at firm and industry levels. In the current business environment, COVID-19 implications increase transaction costs and challenge established partnerships. The major reason is the transaction uncertainty, which is observed through unexpected fluctuations in production capacity, or the unexpected consumer behavior. Yet, industries shaped by digital platforms indicate higher resilience (Constantiou et al., 2017) in accommodating the numerous restrictions imposed by governments. Digital technologies emerge as flexible and adaptable strategic tools (Constantiou and Kallinikos, 2015), which enable rapid updating of business strategy and offer a protective shield to organisations experiencing sudden production or consumption disruptions because of external shocks. Since we are not in a position to foresee how COVID-19 pandemic will evolve in the future, but we can anticipate future similar challenges, businesses should reconsider their digitalisation strategy by focusing on exploiting the underlying opportunities in the near future.

### ***2.3 Contribution 3 - Impact on AI Research and practice from a decision making perspective*** ***- Yanqing Duan***

#### **Introduction**

As the ability for Artificial Intelligence (AI) to overcome some of the computationally intensive, intellectual and even creative limitations of humans, opens up new application domains (Dwivedi et al., 2019), AI has been hailed as a super power that is capable of performing tasks not only as good as humans, but also better than humans. It is argued that AI has great potential to significantly improve decision making (Duan, Edwards, & Dwivedi, 2019), to reach better decisions, to boost our analytic and decision-making abilities, and to heighten creativity (Wilson & Daugherty, 2018). While the world is suffering from the COVID -19 pandemic and witnessing the worsening situation each day, there are many opportunities for harnessing the benefit of AI. However, information on the role and impact of AI during the pandemic appears to be limited. Has AI failed the COVID -19 pandemic test? Where is AI when we need it most?

There is no doubt that one of the most critical challenges in dealing with the COVID -19 pandemic is making the right decisions at the right time for the right reasons. Decision makers in all sectors including government, public services, health care, social care, commercial companies, etc. appear to be struggling with making effective decisions quickly across all decision-making levels from strategic, tactical to operational. Many leaders and managers are constantly being criticised for mismanagement due to bad decisions that have led to unnecessary loss of human life and economic

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<sup>2</sup> <https://www.cnet.com/news/google-beats-sales-expectations-despite-economic-toll-of-coronavirus/>

<sup>3</sup> <https://techcrunch.com/2020/04/30/twitter-q1-sales-up-3-to-808m-as-it-swigs-to-a-loss-on-covid-19-mdaus-hit-record-166m/>

<sup>4</sup> <https://techcrunch.com/2020/05/29/the-best-investment-every-digital-brand-can-make-during-the-covid-19-pandemic/>

<sup>5</sup> <https://www.theguardian.com/technology/2020/apr/30/amazon-revenues-jeff-bezos-coronavirus-pandemic>

<sup>6</sup> <https://home.kpmg/dk/en/home/insights/2020/03/covid-19-impact-on-the-automotive-sector.html>

damage. The need for utilising technologies, especially AI, to assist decision makers in making the most effective and efficient decisions to deal with unprecedented crisis has becoming ever more imperative. This section aims to analyse and highlight the impact of the COVID-19 pandemic on AI research and practice for IM from a decision making perspective.

### **Critical challenges in decision making during the COVID -19 pandemic**

For many business leaders and managers, COVID-19 is the most disruptive, world-changing event in living memory. COVID-19 has emerged as the ultimate test for decision makers, ranging from political leaders, senior business managers, to health care operational level managers. It certainly poses the biggest challenge for testing their decision making performance. In dealing with the unprecedented situation of the COVID-19 pandemic, decision makers must make critical decisions swiftly. However, they all face many serious challenges in trying to make sense of a crisis that nobody has never experienced before and to take critical decisions to manage the pandemic effectively and efficiently. Among many challenges, the following are the most significant ones that are causing great difficulty in coping with the pandemic effectively.

**Imperfect information** – COVID-19 is the ultimate leadership and management challenge, but one of the biggest problems faced by leaders and managers is imperfect information that may be incomplete, imprecise, uncertain, unreliable, vague, or partially true. For example, leaders and managers are facing an inevitable task because they have to make critical decisions without enough data (Lodge & Boin, 2020; Marr, 2020). On the one hand, there is a serious lack of data because there are many unknowns due to the nature of the virus and the speed of the outbreak, but on the other hand, decision makers also have too much unreliable data and misinformation that requires filtering and judgement.

**Deep uncertainty** – Decision makers face many types of uncertainty because COVID-19 is unfamiliar territory. For example, there is uncertainty about the reliability of information flows (Lodge & Boin, 2020), unpredictable and uncharacteristic human behaviour, irrational reaction of financial markets, extreme volatility of economy, lack of data on measuring the lockdown impact, unknown outbreak patterns, etc.. Making decisions in a high-tempo, high-consequence environment where information is incomplete and there are no clear right answers is unprecedented in its degree of uncertainty. (Aon, 2020).

**High risk** – Decision makers at all levels face very high risks and extreme consequences if they make bad decisions, for example. Leaders and health care managers and professionals have to make life-or-death decisions under conditions of deep uncertainty (Lodge & Boin, 2020). Decision makers must assess the risks and take the right actions to mitigate the risks. The current pandemic provides an example of decision-making under deep uncertainty, where the potential harm is irreversible (in terms of death number and economic damage) (Lodge & Boin, 2020).

**Urgency** – Due to the nature of COVID -19 pandemic, fast decisions are required. Therefore, decision makers must make right critical decisions swiftly because any delays in taking action will cost lives and economic damage. Decision makers should also maintain constant vigilance to identify and assess tipping points and escalation triggers for next steps (Aon, 2020). However, making fast decisions can be a huge challenge when decision makers face deep uncertainty, high risks and huge pressure.

### **Implications for AI research and practice**

It is argued that a superhuman effort is needed to help ease the global pandemic and the deaths of so many people (Wakefield, 2020). There have been many debates regarding the use of AI in fighting pandemics and it appears there are more questions than answers. AI is argued to have raised to the challenge of finding a cure for this terrible disease (Wakefield, 2020). Can AI also rise to the challenge of empowering humans to become superhuman decision makers in fighting current and future pandemics? The challenges discussed above provide opportunities for future AI research and practice. It seems that there is very limited information on how AI is making a positive impact on managing the COVID-19 pandemic. A question has been raised: “has AI failed the pandemic test?”

(Grossman, 2020). Grossman (2020) argues that the results are mixed for “the first real test of AI in a crisis. While many individual applications are helping, the technology remains immature and unable to address complex public policy issues.” In terms of learning from COVID-19 for better decision making in the future, what is the impact for AI research? AI has transformed the way we live our lives (Junkermann, 2020). How can AI transform the way we make decisions, especially for crisis management during a pandemic?

One research implication for IM is to fully explore the role of AI in decision making for managing the pandemic. The decision making environment in the COVID-19 period is uncertain and defined by urgency and imperfect information. How can AI help human decision makers deal with uncertainty, urgency and imperfect information? Researchers have called for more studies regarding the role of AI in decision making (Duan et al., 2019) in general, but what is the specific role of AI during the pandemic in particular? Can we trust AI to lead the country in managing pandemics? AI can be used to support and help those making decisions, but powerful AI tools aren’t replacing human decision-making in the current pandemic (Junkermann, 2020). Would human decision makers take the risk of letting AI make decisions for them in the future when they are struggling to make critical decisions themselves during the pandemic? Do people trust AI to take the lead in managing pandemics?

Another important research question is how to empower human decision makers through AI augmentation. To unleash the power of human-machine teams for fighting the future pandemic with better decisions, IM and AI research should explore how future AI can be better designed and utilised to empower human decision makers with the following critical capabilities:

1. *Ability to deal with imperfect information* - AI is regarded as having so far not been very useful in tracking and predicting the spread of the disease (Naudé, 2020). It is not only due to a lack of historical training data but also problems with using “big data”, e.g., such as harvested from social media that contains huge amounts of noise needing to be filtered before meaningful trends can be discerned (Naudé, 2020). The limitation of AI models in addressing COVID-19 challenges, serves a wakeup call for the Machine Learning and Data Science community (Rowan, 2020). The uncharacteristic behaviour of human beings during the pandemic is interfering with existing AI models (Heaven, 2020). The pandemic has effectively shown where current AI can help, but also its limitations (Grossman, 2020). The key lesson learned is that any problem that is “novel” suffers from a lack of data, so unless there is a clear, pre-existing parallel, the contribution of data hungry AI technologies will be less than hoped (Grossman, 2020). How can future AI be designed better and made more resilient to dealing with imperfect information?
2. *Ability to assist human decision makers in making fast decisions* - AI can learn quickly and study the consequences adjusting decisions instantly where necessary. AI has great potential to assist human decision makers in speeding up the decision making process, especially in an emergency scenario where humans are under huge pressure. How can leaders deal with pressing uncertainty with the support of AI?
3. *Ability to assist decision makers in making the most effective decisions* – Decision makers must make the most effective decisions with imperfect data and deep uncertainty in a matter of urgency. Future AI empowered decision making must be able to assist human decision makers, e.g., in prioritising and balancing options effectively and allocating critical resources efficiently. It also needs to make ethical decision-making, e.g. in many instances, when making decisions, there is no “no harm” option available and the choice is whom to harm and how to minimise the harm. Taking sensible decisions in the presence of deep uncertainty requires more than decisiveness. It requires rational evaluation of the difficult choices to be made. If it is true that “*every single projection or prediction model for 2020, be it Finance, Sales, Anomaly, Traffic, and even Climate, has failed miserably at this point*” (Rowan, 2020), can future AI rise to the challenge of predicating unpredictable outcome?
4. *AI enabled collaborative decision making* – The COVID -19 virus has no boundaries and spreads quickly. To fight the pandemic effectively, it requires collaboration in all possible ways. There is no doubt that critical decisions should not be made in isolation. To this end, researchers should investigate how AI can be best designed and implemented to enable collaborative decision mak-

ing during the pandemic. For example, how can government and public services rapidly adopt AI enabled collaborative systems to deliver their new responsibilities more efficiently? There will be many opportunities for both AI researchers and practitioners in exploring the power of AI enabled collaborative decision making.

In summary, in terms of how AI can be better utilised in fighting the pandemic from a decision making perspective, there are many questions raised, lessons learned, and new opportunities emerged. The information management research must look beyond the current crisis and recognise the great potential of AI has for the future pandemic management and explore how we can leverage AI for better decision making and win the battle of this pandemic and the next one.

#### ***2.4 Contribution 4 - Information Management impact of COVID-19: a personal view - John S. Edwards***

I will look at this under three headings: What have we seen? What have we learnt? What do we need to do now?

*What have we seen?*

The National Health Service in the UK has performed wonders, though it is not clear if information management (IM) has played a major part. I do not know enough about healthcare provision in other countries to comment.

Many people and organisations have been able to work from home, either carrying on as normal, or in a way that offers equivalent services. IM, and especially the management of information technology, has been central to this. The internet has not collapsed under the strain, although there have been a few hiccups. Of course, it was originally designed to cope with major crises, albeit not a pandemic, so perhaps that is not a surprise. Cloud service providers say the cloud has been crucial – but then they would say that, wouldn't they? Microsoft Teams and Zoom have come into their own, though privacy reservations have been expressed about the latter.

Many organisations have also excelled in managing the provision of equipment and training to enable their people to work effectively from home.

However, there have been problems. In the UK, the major supermarkets responded much better than national and local government departments. Delivery services of all kinds have boomed. The UK government did introduce one major new online system successfully, but several others have virtually ground to a halt, either for lack of pieces of paper, from the sheer load on the system, and/or because the system cannot be changed rapidly. Similar issues have been reported in the US: one state apparently could not update its insurance system because it no longer had any COBOL programmers!

Fake news/information has been a problem. Not just on social media, but sometimes even from conventional news sources, though the UK has seen a considerable resurgence in audiences for live TV news.

*What have we learnt?*

In three words, agility is key. It is the only possible way to cope with “once in a hundred years” events.

And for those specifically fighting COVID-19, data is also key: accurate data, timely data and (this one may be less familiar to us in IM) comparable data. Sadly, we have also learnt - if we didn't already know – that data can be a political tool. Joined-up government in the UK is still a long way off, too.

Online shopping will surely not fall back to its pre-pandemic levels, which poses a problem for many types of bricks and mortar businesses.

We have also learnt that there is a tension between information privacy and security: not the security of the information (we knew that) but our personal security. Am I willing to allow my movements and contacts to be tracked by the government if it helps keep me healthy? If it helps keep me *alive*?

We have probably learnt nothing new about the fake news phenomenon (didn't we once call it propaganda?), but it really does seem that civilisation as we know it would now collapse without the internet.

*What do we need to do now?*

Beginning with practice, since there would be no point in IM research without it, IM practitioners need to work towards enabling the new normal, even though we do not yet know what that will be. How long will people and organisations who have established that they can work from home continue to do so? Permanently? It is important to accept that there will be an "interim normal" phase that is likely to last until around the end of 2021. As with any IM development, understanding what the users and their managers want is essential. Budgets will be tight during the interim phase, and probably in the new normal as well. IM executives should be well-placed to argue their case, but again politics (this time organisational) is likely to be a factor.

Government IM practitioners need to lobby for more integration. Lack of integration has literally cost lives during the pandemic.

IM researchers need to examine why some organisations did well and some did badly, though the latter are always harder to study. What were the real key factors? One especially interesting and important topic is to find out if there were any IM aspects involved in the supply chain problems around the provision of personal protective equipment to health care and other workers. Only after the political element of this crisis has died down will it be possible to get close to the real answers about that. Another aspect that has attracted very little attention so far during the crisis is the role of outsourcing: has it made things better, or worse, or is it just not terribly important compared to other factors?

Social media researchers need to continue their efforts to understand and help prevent the spread of fake news, though the wider context here is so vital that IM researchers will need to work in multi-disciplinary teams that include behavioural, sociological and even political researchers as well.

IM teachers in higher education, like those in most subjects, may have to make the biggest changes. Will lectures in large halls ever return? There has to be a possibility that the answer is no.

*And finally...*

One slightly tongue-in-cheek point to close with. Preparations for a crisis can sometimes prove beneficial even in a completely unconnected one, as those in the UK who had stockpiled food and supplies in case of a no-deal Brexit found!

## ***2.5 Contribution 5 - Impact of COVID-19 Pandemic on Information Management Research and Practice - Babita Gupta***

COVID-19 has been a disrupting event of unprecedented proportions unlike anything else in modern history. The reverberations of this black swan event will be discernible for years to come with significant implications in the post-COVID-19 world. Research from the post-2008 financial crisis analysis suggests that organisations that can leverage information technologies to transform their business models are likely to fare better in the new normal. Below I discuss my perspective organised around four themes:

### **Transformation in the supply chain industry**

COVID-19 has laid bare how vulnerable the old supply-chain model built on optimising cost can be. This was amply demonstrated in the agribusiness and dairy industry that typically relies on a centralised supply-chain model with very few, but very large capacity warehouses for distribution of food to the rest of the country. This model collapsed during the pandemic resulting in huge wastage of food at the supply points due to the inability to get the food to regions that needed it desperately. Breakdown in the supply chain exposed the problem that there is a disconnect demand and supply due to a disruption in the supply chain between the source, where the food is, and the places where there are food shortages. Therefore, a lot of the produce and dairy products were wasted resulting in huge

losses for farmers and dairy farmers while at the same time a lot of people were going hungry where the demand was.

One supply chain transformation that would mitigate the problems faced during COVID-19 would be to move from the current centralised, large warehouse infrastructure and using a cost optimisation model transition to a more decentralised supply chain model with more, but smaller, regional warehouses that are located nearer to demand locations. This requires a reversal from the optimisation focused strategies to strategies that promote a more sustainable, agile, and resilient supply chain modelling approach. The idea here, is that instead of focusing on how to optimise the profits or minimise the cost, now there is a need for building models which take these disrupting events and scenarios into account and build a more sustainable model.

### **Transformation in the role of government and companies**

During COVID-19 and the 2008 financial crisis, governments have needed to rescue several industries. This may not be sustainable for the future with tax-payers rightly demanding transparency and even questioning the practice, as this largely benefits the companies without the consumer reaping any long-term benefits. This may lead to citizens requiring their governments to implement stricter oversight of the bailout practices. This in turn could lead to an increase in the regulations and a requirement on part of the companies receiving government bailout to build in more redundancies in their operations and accounting for risks associated with such disrupting events.

Governments could also play a vital role in accelerating ICT infrastructure, especially in the developing nations that enable scaled up digital transformation of the companies including facilitating employees to work from home.

Data from COVID-19 suggest that disruptions disproportionately affect minorities and women. Governments and companies would have to address the equity issues that arise.

### **Acceleration of incorporation of the emerging IT into organisational processes**

New business models are emerging that facilitate organisational agility utilising emerging technologies. This requires the acceleration of the digital transformation of the businesses so that they are not as vulnerable for the next crisis. This transformation would enable the companies with the ability to respond to the internal and external environment changes while still creating value. This requires that an organisation has analytics capabilities built into the fabric of the organisation.

With the use of blockchain and AI, the organisation could automate the supply chain or the value chain, which minimises human intervention. This would allow a process to continue by providing a safe, secure, and trustworthy system without the need for human oversight at the critical juncture points. The use of blockchain could help organisations deal with scenarios where a person was typically needed to verify or validate a transaction creating bottlenecks.

COVID-19 has also enabled a change in consumer behaviour. An increasing number of consumers are more comfortable with digital platforms and digital commerce. Companies would also need to invest in data analytics technologies that can help them better understand the changing consumer sentiment to enable them to offer a variety of service channels with the levels of customer service demanded by the consumers.

The other thing that has emerged during the COVID-19 pandemic is the necessity to very quickly transition to the “work from home” (WFH) concept. It has become now accepted as a viable practice for most companies. In the post-COVID-19 world, companies will have to think about how to continue to have some or most employees work from home as it reduces the need for space and subsequent rent related costs. This has many other positive side effects including reducing congestion on the roads and subsequent lowering of pollution levels. However, there a need for more research to identify the best practices and technologies that allow employees to maintain a good work-life balance. Research is needed to study the psychological effects, organisational reward and evaluation structure, and the work-life balance during WFH using remote technologies. This also requires more

research into collaboration software that provides a secure network environment for the employees. Organisations need to ensure cyber-secure networks for collaboration.

### **Transformation of online education**

COVID-19 has had a huge impact on online education as almost overnight, schools and universities were required to shift to 100% online modality. For the IM field, this presents an opportunity to research best practices in pedagogies, technologies, and assessments of IS discipline to maintain the level of engagement, personal connection, and presence as would be expected within a face to face classroom environment. All of which are required whilst maintaining academic integrity. This is critical to maintain the supply of qualified professionals in the IS related field.

### ***2.6 Contribution 6 - Technology-enabled social interaction with colleagues during the COVID-19 pandemic: more hype than reality? Banita Lal***

The present situation with COVID-19 has resulted in various changes in the working lives of many individuals: the concept of 'going to work' has diminished. For many, the shift from working in a comfortable and dedicated office space to working in personal home spaces such as at the kitchen table has inevitably led to a radical change in their experiences and association with work. Thus, the meaning of 'organisation', 'teamworking' and 'colleagues' has changed as work-related activities become increasingly dependent upon technology. This can have numerous implications for individuals who are now homeworkers. As social distancing continues and individuals continue to work from home, the implications are becoming more apparent. One such implication is an increase in feelings of social isolation in the absence of face-to-face interaction with colleagues.

The subject of homeworking, where traditionally office-based workers now work from home by means of Information and Communications Technologies (ICTs), has increased since the 1990s owing to technological developments and organisations offering more flexible modes of working. Despite the growth in homeworking, there is limited research on how homeworkers manage aspects of their work lives - such as their social interactions with colleagues - via technology when working remotely. Given the current situation with COVID-19 where many organisations have stated that their employees will be working from home until the new year at the earliest – and in some cases, 'forever' – the importance of researching how homeworkers use technology to maintain social interactions with colleagues becomes highly pertinent.

The need to associate and identify with others through long-term, positive relationships is recognised as a fundamental motivation in all humans: our workplaces enable us to fulfil this need. It is understood that individuals must interact frequently with the same people, and that this interaction must occur in a relatively stable environment. When separated from their work environment, colleagues and social environment, individuals can increasingly feel disconnected from both their jobs and co-workers. This can result in: (i) a reduction in their commitment towards their job, (ii) feelings of anxiety and depression, (iii) feelings of being left out from decision-making processes, (iv) a decline in team synergy and trust and (v) their productivity. These impacts are exemplified given that during the COVID-19 pandemic individuals are not only separated from colleagues, but also their social circle outside of the workplace. The potential negative implications of loneliness on individuals are profound.

### **Technology-enabled social interaction: does it help?**

When face-to-face social interaction with colleagues is no longer possible, technology provides opportunity. Mobile technology in particular can change the relationship between the homeworker and their colleagues, allowing individuals to interact socially 'anytime, anywhere' (Lal and Dwivedi, 2010). Increasingly, new and varied applications on mobile devices enable individuals to have a greater feeling of being 'socially present' as they can potentially see and hear the person/people they are interacting with. By generating a feeling of greater social presence compared to other technological media, the mobile phone in particular can be considered to be one of the most effective means of synchronous and asynchronous communication for reducing homeworkers' feelings of solitude by enabling richer forms of communication.

We published a paper in 2009 on the topic of homeworkers' usage of mobile phones for social interaction with colleagues and how this interaction was managed across home-work boundaries (Lal and Dwivedi, 2009). Very few studies investigating this topic have been conducted since, as asserted by Hislop et al (2015). Our research identified that most homeworkers are happy to exchange their personal mobile phone details with a close network of colleagues for social interaction purposes. This network of colleagues becomes the homeworker's 'go to' people when they need information. Catch-ups with colleagues could be incorporated into their daily lives, e.g. whilst doing the washing. Some individuals liked being contactable 'anytime, anywhere' because it felt more like the spontaneous interaction that occurred in the traditional office; for example, when a colleague unexpectedly comes to your desk to tell you about their weekend.

During the present situation, many homeworkers will have a number of applications available for communication with colleagues, albeit via their own personal devices. How communication is 'done' does require some careful consideration. With unplanned social interaction, homeworkers have to think how best to communicate. For example, our study found that some homeworkers considered a SMS to be less intrusive than a phone call. Having to think about the mode of communication to be used also emphasises the difficulty in recreating the natural distractions and interactions that would have been inherent and more ad hoc in the workplace. Thus, as well as potentially being intrusive, homeworkers may actually make themselves more prone to interruptions during non-work time and space because such interruptions may actually be welcomed. On the contrary, despite the technological affordances that may be available, some homeworkers may prefer to have no social interaction with colleagues or may lose friendships with colleagues whilst working at a distant so therefore would have very limited to no social interaction with colleagues (Lal and Dwivedi, 2009).

Furthermore, when personal mobile devices are used for interaction with colleagues, individuals have to think about the blurring of home-work boundaries. While some of our participants were open to this, others tried to maintain these boundaries and subsequently introduced strategies for managing their technology use. In terms of how effective technology is in relation to social interaction with colleagues, there is not enough empirical evidence from which to draw firm conclusions. Subsequent and important questions that arise include: *how much social interaction with colleagues using technology is acceptable/manageable? What are the 'rules' in terms of when, what and how individuals communicate? At what point does communication become intrusive?* As decades of research has taught us, there is always the initial hype of technology followed by the reality. In the current pandemic, it is yet to be deduced whether maintaining social interactions with colleagues via technology is more hype than reality. In principle, 'yes'. In reality, we do not really know.

### **Important considerations for management**

There is clearly no substitute for face-to-face interaction, hence why many people are struggling whilst working from home during the pandemic. We acknowledge that technology can provide useful means of communication. However, from an organisational perspective, it is important for managers of any homeworkers to realise that although homeworkers are able to take responsive action to avoid feeling socially isolated, managers must ensure frequent online meetings and opportunities for interaction between homeworkers and colleagues for both formal and informal information sharing and development. It is important that organisations do not 'forget' their less visible workforce and perceive them purely as a means to an end. Further, support from management needs to be available so that homeworkers are not left to self-manage themselves and develop their own coping strategies, especially where individuals are new to the organisation and/or have not developed a network of close friends. We are all in challenging times and many things are learnt through trial and error. However, considering the technological affordances available today, management need to consider not just how the technology can be used to serve the organisation's purpose, but also how it can be used to enable their employees to enjoy healthy social interactions with one another in order to support their wellbeing. As research has repeatedly informed us in different guises, technology is merely a tool and the degree of success it has depends on how individuals respond to it. Thus, how successful technology is in enabling social interactions and social relationships amongst the workforce depends, to some degree, on how an organisation chooses to use it. Research in the Information Systems/Information Management area, too, must keep pace with the new opportunities and



challenges presented by the massive uptake of homeworking in the past few months.

## ***2.7 Contribution 7 - COVID-19 and Information Systems - Santosh Misra<sup>7</sup>***

The present coronavirus crisis has emerged as a major challenge to humanity. So far approximately 8 million people have been infected and about 435,000 lives have been lost world over.

Managing a crisis of this scale requires some of the most advanced tools of technology. All activities right from fever clinic management, sample collection, test result management, hospital bed management, supply chain management of drugs and essential medical equipment, quarantine monitoring, GIS support, infection heatmaps, containment zones, to data and trend analytics, all need technological solutions. One of the key requirements of a successful epidemic management is the ability to clearly and effectively communicate with people and make them aware of the infection and ways to prevent its spread. Broadly speaking technology has the following three roles in this crisis: Communication and awareness creation; Epidemic Management; and Policy and decision support system

### **Communication and Awareness Creation**

The COVID-19 epidemic is an unprecedented disaster. No country was prepared to handle something like this. The scale of the tragedy has overwhelmed health systems across the world. Hospitals are overflowing with patients; there is a shortage of necessary medical equipment; ventilators are in short supply; so far there is no medical treatment; elderly people and people with comorbidity conditions are highly susceptible and number of fatalities are rising around the world. Under these circumstances it becomes extremely important for Governments to communicate with people and make them aware of the threats posed by the virus. People also need to be told how the virus spreads and what they need to do to protect themselves and their communities from this deadly virus. From the epidemic management perspective, it becomes the responsibility of Governments to clearly communicate its action plan, restrictions and containment strategy to their citizens.

Another important aspect of communication during a epidemic such as this is to curtail rumour-mongering and spread of fake news. The anxiety and concerns of people need to be addressed through clear and accessible communication. This needs to be done in the vernacular language using a medium of exchange which is independent of the literacy level of the recipient.

Use of natural language processing (NLP) can help bridge the literacy and technology divide and help deliver the message in the local language of people. For example, in India the Government launched an “Aarogya setu” app. This app was meant to help with contact tracing and was also supposed to be a self-diagnostic tool for people. By answering a few simple questions, one could easily get reassured about his/her health. The app also nudged the users to seek medical help wherever needed. While this app was very popular and saw over 5 million downloads within first few days of launch (now it has reached 100 million plus downloads), it had its limitations. India has about 1.3 billion phones and only 374 million phones are smartphones. How do you reach almost 70% of the population who do not have access to the smartphones.

#### *‘Missed Call’ IVRS innovation*

An interesting ‘**missed call**’ innovation by Tamil Nadu Government was developed in collaboration with Indian Institute of Technology (IIT) Madras, Bharat Sanchar Nigam Limited (BSNL – a PSU) and Department of Telecommunication Government of India. This innovation relied upon use of interactive voice response system (IVRS). It worked by allowing the user to give a missed call (so that the user doesn't incur any charges) to a specified number and then the system would call back the user and ask a bunch of simple questions about his or her health. The answers to the questions could be given by pressing the number pad key on their mobile phones. The system collected their

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<sup>7</sup> The views expressed here are author's personal views and do not represent the views of Government of Tamil Nadu

responses and processed the data through a rule based classification system which categorised the callers in low risk, medium risk and high risk categories. For those in high-risk category the system forwarded their list to the health department of the local administration which in turn would make a follow up visit to the caller's home and provide necessary medical intervention. This simple innovation made the communication inclusive and accessible. During initial days of the crisis this system received about 1500 calls every day. The telecom companies also chipped in by converting their caller tunes to the corona prevention messages. This helped build mass awareness about the corona infection.

### **Epidemic Management**

An epidemic like this needs the public authorities to respond on multiple fronts. While patient care and saving of lives remains the paramount concern, the epidemic battle has to be fought at several levels. The public authorities need to manage the critical supply chain of medicines, personal protection equipment (PPE), sanitisers, oxygen, ventilators and its parts, and all other necessary equipment. The authorities also need to ensure that there are enough beds in the hospitals, sufficient ICU infrastructure and quarantine facilities.

Each one of these activities requires an end to end technology solution. Right from collecting the swab sample to its testing reporting and follow up intervention, all require a mature technology platform. Some of the key activities of epidemic management are as following:

- a) Sample collection testing and reporting
- b) Supply chain management of critical equipment and drugs
- c) Hospital bed and ICU availability tracking systems
- d) Quarantine monitoring system
- e) Patient monitoring system
- f) Vehicular movement regulation

While the first five activities are related to clinical management and patient recovery the last one is related to spread containment. For example in Tamil Nadu a new system for vehicle movement regulation was put in place which while facilitating emergency movement needs of people, restricted unnecessary vehicular movement. A system called TN-ePASS was designed to seamlessly share information about all vehicular movement to the concerned health and district administration authorities. Every time an e-PASS was issued it alerted the destination local authorities about the arrival of people from another region of the state. The local authorities then made appropriate sample collection and quarantining arrangements for the arrivals. It controlled the possible spread of infection by ensuring the health protocols are fully adhered to and Corona positive cases are quarantined and attended to. A total of 3.5 million requests have been handled for people and industrial worker movement on this platform (<https://tnepass.tnega.org>).

### **Policy and Decision Support System**

The entire technology effort becomes meaningful only if we can convert the data into policy intelligence and extract meaningful information to help the decision makers. Information such as geographical spread of infection, mortality rate, transmission rate, trend analysis etc, become critical tools for building a robust policy response to contain the crisis. Within Tamil Nadu, Karnataka and Kerala (3 states in the southern part of India), data analysis was extensively used in crafting a policy response to the covid-19 crisis. In particular following technology was used extensively:

- a) **GIS information system** - is extensively used for mapping the infection spread and generating heat maps for the policy makers to prepare the containment plan
- b) **Trend analysis** - to examine the infection trends and transmission rates to decide upon differential treatment of different districts

In Tamil Nadu when the Government wanted to provide relief to the stressed farm workers and daily wage earners, the GIS information system was used to decide which blocks are safer for opening up

the rural employment guarantee programme.

### ***2.8 Contribution 8 - Effects of COVID-19 on Information Technology - Prakhar Prashant***

The entire world is reeling through the effects of COVID-19 that has led to severe impact on almost every industry and business. The IS sector is one of the key industries that has delivered real change and positively impacted both industry and wider society during this crisis. Few industries can imagine operating remotely without the support of technology to continue operating to meet customer needs. The IS industry has managed to survive earlier recessions and global downturns over a number of decades. Organisations have managed the current situation by requesting employees to work from home to mitigate the spread of the virus and alleviate health concerns of the public. This change of working from home during the COVID-19 pandemic has resulted in a significant deviation from normal working practices via the use of IS technology and enabled whole swathes of society to continue to function.

One of the significant ripple impacts of the pandemic has been the widespread layoff of workers. This has been felt across all sectors in India, but the migrant workers specifically have been severely impacted as they travelled back to their villages mostly on foot for many hundreds of miles. Even the technology industry has not been immune to the crisis, as a number of IT/IS companies have announced staff cuts and India is one of the countries that has laid off significant numbers of staff during the pandemic.

The pandemic has seen a significant rise in the use of social media and remote working platforms. The transformation to accommodate home working and the change in consumer working practices has enabled key sectors of the IT/IS market to expand quickly to accommodate the surge in demand for key products such as Zoom, WebEx and Microsoft Teams. The products have enabled business continuity but have also connected people during isolation. It is likely that the huge demand for homeworking and the necessary change in network infrastructure to accommodate this during the COVID-19 crisis, will engender a lasting impact on peoples working habits, as employees may continue to seek to work remotely for the foreseeable future or adapt to a new blended working process.

Many aspects of the technology industry are heavily dependent on China for raw materials and hardware supplies especially 5G related products. The turmoil experienced by China during the pandemic has impacted the global supply chain of technology products forcing companies to seek alternative suppliers or to cease production during the pandemic. Now that China is on the tail end of the outbreak, manufacturing and exports have resumed ensuring that supplies can now be resumed to companies throughout the world. However, the political climate seems to have changed and specific countries such as the US and the UK seem to have changed their IS policy with respect to China and have effectively banned 5G products from China for the foreseeable future. How this plays out in the post-COVID era in terms of its impact on IM is yet to be decided.

Research organisations have turned to technology to seek solutions to containing the virus with track and trace systems and the use of technology to seek effective solutions for a vaccine via the use of AI and automated sequencing algorithms. The pandemic has devastated peoples lives across the world and impacted communities, cities and whole population groups, but without technology and the use of IS, it could be reasonably argued that the impact of the virus would likely to have been more widespread with deeper impacts to economies and society in general.

### ***2.9 Contribution 9 - Impact of COVID-19 on Cyber Security - Ramakrishnan Raman***

During the COVID19 crisis cyberthreats are also growing at a phenomenal rate and information managers have a vital role to play to ensure data availability and data access to all employees who work from home. While the access to information is important, giving safe and reliable access is also of equal if not paramount importance. Personal data continues to be a lucrative target to hackers during this pandemic. Malware and phishing schemes operating under the pretext of COVID prevention efforts have seen a steep rise since the covid19 outbreak. A malware named “coronavirus malware” is aimed at stealing bank account details, passwords, and other sensitive information from

users, highlighting the current threat to user data security. Although widespread system access has been given to employees, who work from home, information managers must ensure information security and safety of the data and the digital assets of the employee are safeguarded. Some critical aspects of the information infrastructure that information managers need to focus on include: scaling of VPN (Virtual Private Network) concentrators and portals as well as gateways, which help in handling the number of employees who will need to work remotely.

As the world is busy with the COVID-19 pandemic, cyber-attacks have increased. Even during the pre-pandemic period, cyber-attacks was a concern for several technology focussed organisations, but after the spread of the virus, it has become a concern for all organisations. Hackers have been exploiting various methods to steal valuable and sensitive corporate and personal information. While ransomware has been a great cause of concern, other threats including integrity violation with malicious code injection, brute force attacks, privilege abuse, Denial of Service (DoS) and variants, port scan, firmware downgrade attempts, Crypto mining and crypto-jacking attacks have also increased substantially.

It is a very difficult task for information managers to enforce security policies and controls on the remote devices used by the workforce. Many controls have limited scalability and also require a lot of time to deploy. Many organisations were prepared to allow their employees to work from home and hence have allowed their employees and partners to use their personal digital devices granting access to enterprise applications. This is highly risky, as allowing such users without stringent security mechanisms and controls is a significant threat and a vulnerable area for hacking. For several organisations, business continuation plans (BCP) and incident response plans (IRP) are non-existent. This makes employees a potential target for fraudsters who potentially access their digital devices. Cybercriminals are using the heightened digital footprint and traffic to find vulnerabilities and develop COVID-19-themed attacks in the form of phishing emails with malicious attachments that drop malware to steal data and credentials.

As many are looking for free resources and software that are available, and as software companies have offered their products during the COVID-19 period, hackers are creating look-a-like websites to host malicious code. They lure people to these sites and then drop malicious code on their digital devices. These look-a-like and fake websites have also been soliciting donations for those who in financial crisis and are duping donors. Apps which give information about COVID-19 patient count-status and links are laden with viruses and identity theft malware. Remote working tools such as videoconferencing systems have been hacked for vulnerabilities; recent examples on Zoom are alarming.

Under these circumstances, the role of information security leaders is highly critical. They have to safeguard their organisation and have to must ensure that their organisation's online services and digital platforms are resilient against cyberattacks. To safe-guard systems a two-fold approach must be adopted. First would be for the novice where organisations must make their remote workforce aware of scams and must make the aware of the general methods and techniques adopted by fraudsters and hackers, to ensure they don't fall prey to them.

Second would be deploying technologies and solutions that are easy to implement and quick to adopt. Cloud-based security and platform services reduce deployment time. They also enable organisations to increase dynamic scalability. Cloud-based data leakage prevention and threat-protection controls can also help safeguard organization's critical assets. Cloud-based managed detection and response services can be extended to remote workplaces.

Organisations that use secure remote access technology can give remote employees private access to enterprise applications and systems. This could be followed by those organisations which don't use the Virtual Private Network. Organisations can also use privileged access management services to allow special remote access to their application administrators. Multi-factor authentication services can also enable stringent risk-based access to internal applications of the organisation that are opened for remote access.

Finally, after the pandemic has passed and the new normal sets in, governments around the world will

issue new policies and regulations based on key lessons learned during the pandemic. Several companies will optimise costs and accelerate their digital transformations. Information managers will have to support these initiatives by leveraging digital technology and also transforming their service models which can help them to do more with less. The pandemic has ushered in a new era of cyber security. Information managers who protect their organisations' people, technology and data from the cybercriminals will be one among the several crucial players in the economic turnaround.

### ***2.10 Contribution 10 - How mobile technology may help fight COVID-19 pandemic? A viewpoint - Nripendra P. Rana***

The rapid outbreak of coronavirus (COVID-19) has brought an unprecedented global health crisis that will have immense concerns for our economic and social well-being (Baines and Elliott, 2020). The Director General of World Health Organisation (WHO) Tedros Adhanom Ghebreyesus has stated that "We're not just fighting an epidemic; we are fighting an infodemic" (WHO, 2020). Technology is a sector that could provide significant impact on an outbreak of COVID-19. Although use of technology cannot stop the spread of the pandemic, it can instruct, alert and enable us of the situation to significantly reduce its effect (van Beijma, 2015). The immediate need around the world is to suppress the virus, which is possible by detecting it and breaking the chain of transmission until the time vaccine is available to cure it. That means, the urgent requirement is to have widespread testing and thorough contact tracing in place to ensure that further spread of this disease is suppressed. During the spread of an epidemic, communication could be a vital tool that helps us not only to spot the virus but also to confine it by making the local population aware about it and the use of mobile technology can play a vital role in tracing the individuals' contracting the virus and allow others in taking corrective measures to stay away from potential areas of fear.

For example, In Singapore, the government is using 'Trace Together' app, which takes advantage of the Bluetooth functionality of the smartphones to detect and securely capture when two devices have been in close contact. When someone who has been using this app tests positive for COVID-19 is asked to share their data, which can in turn alert other people who may have come in contact with this individual in the near past (Yiu, 2020). This way the technology could be constructively used to spread awareness and other people who may have any suspicion could take necessary action to self-isolate themselves to stop the spread of this virus.

Similarly, Government of India has launched 'Aarogya Setu' app on 2<sup>nd</sup> April 2020, which is aimed to spread awareness relating to COVID-19 and to connect individuals to the essential health services relating to this pandemic. It is fundamentally a tracking app available in 11 different Indian languages, which uses the smartphone's GPS and Bluetooth features to track the coronavirus infection. The app is available to Android and iOS mobile operating systems. Using Bluetooth technology, this app tells how many COVID-19 positive cases are likely in a radius of 500m, 1km, 2km, 5km and 10km from the users, which very much helps people to understand the situation relating to the spread of virus in the surrounding area and take any further decision to travel. Similar to the app developed in Singapore, this app is also designed to keep track of other app users that a person came in contact with in the recent past. It then alerts app users if any of the contacts tests positive with COVID-19 (The Hindu, 2020).

The UK way of tracking this pandemic through the mobile technology app is different to other countries and it is very effective. The developed 'COVID-19 symptom study app' is a collaboration between King's College London, Twins UK, and health science start-up ZOE (Jacobs, 2020). This is the largest community empowered COVID-19 research project with over 3 million contributors across the UK, the USA and Sweden. This app does not use Bluetooth and neither connected to any tracker apps. The app allows users to report daily whether they are feeling healthy and they are asked to record if they have any symptoms related to COVID-19. The researchers analysed data collected from 2.5 million users in the UK who had been regularly reporting their health conditions and various symptoms linked with COVID-19. Out of which about 15,000 people were reported having had their test and it was found that 6,500 of them were found positive. By analysing the symptoms of people tested positive for COVID-19, this research extrapolated the findings to the rest of the population with similar more frequently emerging symptoms that were found in the users who were tested positive.

Logistic regression was used to estimate the most frequently found symptoms and it was detected that loss of taste and smell particularly emerged as key symptoms, with two thirds of users tested positive. The other more commonly witnessed symptoms found in COVID-19 tested positive patients, was a severe or persistent cough, fatigue and skipping meals (Agerholm, 2020; Chan and Spector, 2020). The mathematical model was created to predict with 80% accuracy, indicating if a person is likely to have the symptoms of COVID-19 based on four frequently occurring symptoms among those who tested positive for the virus. The findings of this research through mobile app technology, has a massive implication on those people who might have such symptoms and whether or not they would be likely to be contracting the virus. By using technology, we could experience how the new and emerging symptoms outperformed the classical and widely known symptoms such as cough and fever and how the trend of health related data obtained through the users routinely helped researchers to understand some of the early symptoms of COVID-19. This enabled the early warning of symptomatic users who exhibited some of the symptoms through the app in the past and suggested they self-isolate until they could undergo proper tests (Jacobs, 2020).

The UK government has announced its newly developed ‘trace and track’ app as a part of its latest move against the fight with Coronavirus pandemic. The purpose of this National Health Services (NHS) app is to alert those individuals who may have come in close contact with someone who has been tested positive for COVID-19. This app uses Bluetooth technology and works for iPhone and Android users’ phones. When two people meet, their phones will exchange an anonymous ID rather than any identifying information about the person. If and when one of those people is diagnosed with COVID-19, they would need to enter this information into the app. Then the app will ask the individual to upload the previous 14 days of Bluetooth anonymous ID to the cloud. These anonymous IDs stored in the individual’s phone are used to notify all other individuals who would have come in contact with the infected person in the last 14 days. As this app also asks users to specify the first half of their postcode, it would help government to trace the number of infected individuals in particular area and impose lockdown measures in areas where there are high number of cases (Chowdhury, Field and Murphy, 2020; Westbrook, 2020). The similar initiative has been taken by the two technology giants Google and Apple where users are asked to opt to a system that causes their phone to emit Bluetooth signals to other phones around them (Newton, 2020).

Likewise, Africans are using the mobile technical solution to help them optimise contracting the virus from each other in their own ways. For example, whereas a company in Nigeria has developed online COVID-19 ‘Triage Tool’ for Nigerian citizens to self-assess the coronavirus risks based on their symptoms and exposure history, South African government is using WhatsApp chat service to run an interactive chatbot, which answers common queries about COVID-19 myths, symptoms and treatment. Similarly, women market sellers in Uganda are using The Market Garden app to sell and deliver vegetables and fruit by promoting social distancing guidelines (Harrisberg, 2020). Similar mobile apps have been used in China and Korea to help stop the spread of the virus any further and alert people of possible threats in real time. Indonesia and Pakistan have also developed a scrutiny app similar to ‘trace and track’ recently developed in the UK to reinforce contact tracing and tracking (Fachriansyah and Syakriah, 2020; Khalid, 2020). The research also found the evidence of correlation between the roll-out of contact tracing apps and continuous suppression of COVID-19 infection through the data from China and Korea (Collins, 2020).

Although governments, charities, academic institutions, research organisations, start-ups, entrepreneurs etc, are developing and/or promoting various mobile technologies to tap local knowledge to spread awareness and alert users from the risk of virus, this is largely dependent on how individuals react to such initiatives. Moreover, this would also highlight that technology in itself is not a panacea and cannot replace other policy measures, but it plays a vital role within crisis management (Kritikos, 2020). Millions of people across the world are urged by their respective governments to start to use phone apps to help stop the spread of coronavirus. Despite its potential benefits in controlling and even preventing pandemics, UK researchers have found that this kind of digital tracing presents some serious social, legal and ethical issues. For example, people were asked to install the app when they would like to go out of their immediate neighbourhoods. The app tracked their movement and displayed a multi-colour coded warning to make individuals aware to enforce and

relax movements in a particular location. The related information with the app was also transmitted to a central database that captured a person's movement and coronavirus status in those specific areas. This posed serious concerns about data security and privacy of individual information (Collins, 2020). This is a serious issue that the developers, research institutions, technology giants and governments worldwide need to address to encourage and entrust people to start using such technology in the global fight to suppress this deadly virus.

The other challenge is to ensure that people have smartphone technology to use and gain benefit from it. The Office for National Statistics in the UK report that on average 79% of the UK adults aged 18 years or more owned a smartphone in 2019 – one of the largest percentage of population owning the smartphone in the world. However, further breakdown across the age categories reveals that only 40% of those aged 65 years or more have the access of smartphones (Boyle, 2020). This clearly indicates that a large majority of the older and more vulnerable population would be disadvantaged from not using the sophisticated apps where users can gain better awareness and safeguarding. This statistics is even worse in developing countries. For example, smartphone penetration within India was found to be at only 26% in 2018 and is predicted to reach 36% level by 2022 (Jaganmohan, 2019). However, in 2018, the smartphone penetration was found to be double in China with a figure of 54%. But these figures still indicate that there are a significant proportion of population, which is still deprived of having relevant resources to use such apps, which means it would be impossible to use such technology for controlling the spread of pandemic amongst the wider population.

Moreover, in India which is the second largest populated country in the world where the digital literacy rate is only 10%, implementing mobile apps for controlling a pandemic would be a massive challenge. The situation would not be different for the other developing countries (e.g. Pakistan, Nigeria, Bangladesh and Mexico), which are listed among the top 10 countries with the highest population numbers. In this context governments should not only increase awareness among their citizens but also plan to make available wearable Bluetooth enabled cheaper devices. This will improve the number of citizens that use them for better and accurate estimation of coronavirus infections, but also help government and health organisations to control the further spread of this disease (Kelion, 2020).

### ***2.11 Contribution 11 - COVID-19, Big Data, Privacy, and Blockchain - Sujeet K. Sharma***

Data is considered as the new oil in the twenty first century. In case of the COVID-19 pandemic, data have become even more critical as relevant information is becoming available in the digital world with the aid of the recent advancements in ICT. Individuals are willingly sharing personal data such as age, gender and location to battle COVID-19 on social media networks. In addition, Internet of Things (IoT) devices are providing platforms for generating, sharing and storing data within the current crisis. Individuals' personal data such as location and other demographics are providing insights to government and healthcare agencies for tracking infected persons and isolating them from other citizens. In India, COVID-19 contact tracing app, *Aarogya Setu* (bridge to health in the Sanskrit language) was downloaded by 100 million users within 6 weeks of its launch (Clarance, 2020). This app is helping in the collection of data that is generated by technologies such as Bluetooth and GPS using the user's mobile device to identify COVID-19 infected persons that could have been in close proximity of the infected user (Clarance, 2020) as well as creating hotspots to minimise the spread of the virus. Similarly, in other countries such as China and Singapore authorities have launched *Apps* to monitor the location of patients for facilitating better healthcare services to citizens. Big Data (structured and unstructured) generated by the aforementioned apps is in the control of governments and governments are also ensuring citizens that data will be used for controlling the disease only.

However, experts are claiming that there are security concerns with the *Aarogya Setu* App that puts privacy of millions of Indians at risk (Singh, 2020; Chandwani, Sharma & Singh, 2020). In the recent past, it has been noticed that scholars are debating the protection the personal data and concerns related to privacy (Kak, 2018). In fact, citizens are attempting to balance between their safety and concerns related to data. If citizens do not share their personal data, it might lead to more COVID-19 cases and hence more deaths of their near and dear ones. In this scenario, concerns related to privacy of data are relatively less important than sharing personal data with government and healthcare

agencies. Citizens are sharing their personal data to battle with COVID-19 as a single objective. Therefore, in this exceptional situation governments and other agencies must strictly follow General Data Protection Regulation (GDPR) guidelines (European Union, 2016) and citizens should be made aware about the protection of the privacy of their personal data. These challenges being faced by government agencies provide a room for researchers to come up with the data driven solutions in this era of Big Data. The following set of research questions are being proposed for researchers to ponder and provide data driven solutions.

#### *Research Question 1*

*How government agencies can use big data being collected in the national repositories as a means of causal inferences, predictive modelling and strategic planning for minimising the impact of the present as well as future pandemics?*

#### *Research Question 2*

*What is the impact of citizen's digital literacy (low/high) on the privacy concerns related to the protection of personal data in the post COVID-19 scenario?*

#### *Research Questions 3*

In the current as well as post COVID-19 scenario, role of emerging technologies such as Blockchain: a distributed ledger, Big Data, and analytics, is expected to be critical in ensuring transparency in the processes and data driven solutions (Ting, Carin, Dzau, & Wong, 2020; Hughes, Dwivedi, Misra, Rana, Raghavan, & Akella 2019). Various agencies are working hard on the development of a COVID-19 vaccine that will pass the relevant multi-stage trials.

*How Blockchain, Big Data & Analytics can be used effectively in the development stages and distribution of COVID-19 antidote?*

### **2.12 Contribution 12 - Post-Pandemic transformation in Information Systems Strategies - Nitin Upadhyay**

The pandemic has disrupted both business and home-life. Alongside the health and humanitarian crisis, business leaders and executives worldwide face unprecedented business challenges such as disruption of timely and necessary information, broken supply chains, delayed decision making, increased uncertainty, and the collapse of demand (Pedersen & Ritter 2020). Many organisations were not prepared for such disruption. Shiffman (2020) and Shiffman and Shawar (2020) indicated the importance of information systems during the Pandemic and its relevance in achieving strategic success. Information systems are critical to achieving business goals. Typically, the organisation's information system consists of IT infrastructure, data, and application systems and personnel that employ IT for its strategic functions and purpose (Davis, 2000). Information systems have also been utilised to deliver and disseminate information and communications services within an organisation. The study by Avgerou and McGrath (2007) argue that IS combine both technical and human activities with driving organisational goal and IS practices. The information system also focuses on managing enterprise-wide functionality, considering planning, designing, developing, implementing, and operating the systems and providing services (Davis, 2000; Parent, 2020).

As the world continues to see the surge in Pandemic waves, organisations must understand the role of IS strategy in driving business goals. The need for improved IS strategy has been emphasised in both empirical and prescriptive research studies (Shao, 2019). Organisations now have to lay down a roadmap for their recovery and future growth, and IS strategy play a vital role. Scholars have advised avoiding ad hoc IS strategies as they will not work and consume time, effort, and resources (Parent, 2020). Recognising the need better to understand the IS strategy from the context of pandemic, this article proposes a post-pandemic transformational IS strategy (PP-TISS) framework that can guide business leaders, practitioners, planners, scholars and strategists to transform IS strategy.

The following section provides a discussion where the description of achieving IS transformation is presented. Also, a post-pandemic transformational IS strategy (PP-TISS) framework is proposed that can guide business leaders, practitioners, planners, scholars, and strategists to transform IS strategy.



## Rationales for IS Strategy Transformation

IS practitioners consider understanding the strategic value of IS to achieve business success as one of the top goals (Pathaka, Ashok, & Tan 2020). Even many scholars have drawn themselves to investigate IS strategic value and advantage over the past two decades (Parent, 2020). Scholars have emphasised the need for IS strategies in empirical and prescriptive studies to achieve business success (Parent, 2020). The pandemic resulted in a shutdown of businesses across the world. Moreover, executives and leaders face severe challenges such as the uneven distribution of customer demand, interruption in supply chain line, poor execution and management of information flow, and lack of strategic decision making (Pedersen and Ritter, 2020). Businesses following the static IS strategic process gives very little or no space for them to play, experiment and tweak their processes, activities, workflows, interactions, and engagements (Neirotti & Paolucci, 2006; Parent, 2020). Salmela and Spil (2002) address the importance of dynamic and continuous IS strategic planning. Such IS strategic planning helps managers to relook, monitor, and manage critical aspects of IS planning periodically (Shao, 2019). However, situations such as a pandemic creates a tectonic shift in the operationalisation of business activities. Thus, organisation needs an adaptive and formal IS strategic process to deal in such a critical and untimely situation.

### A Proposed Framework

#### *Promoting transformation*

Pearlson & Saunders (2012) claim the need and importance of strategic leadership in promoting alignment between business and IS strategies. Shao (2019) observes that in practice where firms which are flexible, cohesive and innovative can leverage strategic leadership to drive IS strategy for its competitive advantage as compared to firms which emphasise control and efficacy (stability-oriented culture) (Chamorroremuzic & Sanger, 2016; Martins, Dias, & Khanna, 2016). Meanwhile, IS/business strategic alignment continues to be a significant concern of CIOs and other organisational executives.

This article adapts Mintzberg's strategy framework (Mintzberg, 1987) and Chen, Mocker, and Teubner (2010) constructs of IS strategy. Fig. 1 shows a post-pandemic transformational IS strategy (PP-TISS) framework that can guide business leaders, practitioners, planners, scholars, and strategists to transform IS strategy.

The elements, 6 P's and 3 IS strategy constructs, of the PP-TISS framework, are:

*Plan:* It is a conscious course of action or a guideline to deal with a situation and points toward a position that an organisation aims to attain (Mintzberg, 1987; Pedersen, & Ritter, 2020). Usually, it helps one to charter courses of action considering the present situation to achieving future objectives.

*Position:* It depicts the organisation's position in the environment (Pedersen & Ritter, 2020). Both internal and external factors, more specifically external factors to be considered to relook at the strategic position for the organisation (Mintzberg, 1987). For example, a detailed examination of the existing IS resources, infrastructures, and capabilities to be carried out to identify the gaps towards reaching a pre-defined position or it can be achieved through the pattern of behaviour.

*Perspective:* It depicts the organisational role of culture and identity towards the world and itself (Mintzberg, 1987; Pedersen, & Ritter, 2020). For example, some organisations excel in developing and exploiting new emerging technologies and markets while others perceive the world as stable and thus paly in established markets. Organisation members and stakeholders share perspective dimension through their behaviours and actions. Therefore, a considerable impact happens when organisational members and stakeholders locked in with particular IS technology, capabilities, resources, and infrastructures. A collective mind approach drives the organisational perspective, and a proper IS strategy plays a vital role in streamlining the perspective.

*Project:* IS-driven projects help the organisation achieve strategic goals (Pedersen, & Ritter, 2020). Thus, IS strategic planning and deployment of projects are crucial for an organisation to contribute to its strategic organisational value. Mirani & Lederer (1998) argue that organisations benefit from strategic, informational, and transactional benefits from IS projects.

*Platform*: depicts a firm's usage of the appropriate business model, for example, a platform to drive business goals (Sutherland & Jarrahi, 2018). Using the platform business model, firms have started leveraging network power through data and AI-enabled platforms to drive their business and strategic goals (Sutherland & Jarrahi, 2018; Duan, Edwards, & Dwivedi, 2019). In addition to connecting sellers and buyers (by matching supply and demand), these firms also develop and offer co-create space for others to contribute in terms of services and specific portfolios. Even blockchain-based platforms are providing opportunities to businesses for managing information systems effectively (Upadhyay, 2020)

*Preparedness*: depicts the organisational preparedness to manage, control, and execute projects and attain the prospective position in the business (Pedersen & Ritter, 2020; Parent, 2020). It needs to understand and examine its current and future needs to assess its preparedness. Some assessments could be done for identifying the gaps in terms of its resources, infrastructures, and capabilities.

### IS Strategy Constructs

*IS strategy to support business strategy*: depicts the role of IS strategy to assist the business strategy (Chen, Mocker, Preston, & Teubner 2010). For example, when a firm targets a development market strategy (Ansoff 1965), a suitable IS strategy that entails resources, capabilities, and infrastructures that help a firm reach a competitive position must be supported.



Figure 1 post-pandemic transformational IS strategy (PP-TISS) framework

*IS strategy to support IS function*: depicts the plan that aims to identify, utilise, and manage IS artifacts in an efficient way (Chen, Mocker, Preston, & Teubner 2010). It also helps the organisation to be prepared to execute relevant projects that would help it to achieve a competitive position. Firms must plan to (a) identify the required IS assets, including personnel, structure, financial resources, and technologies; and (b) allocate the existing IS assets most effectively and efficiently.

*IS strategy to support the shared view of IS role within the organisation:* deals with the organisational perspective in driving IS-related business decisions and activities (Chen, Mocker, Preston, & Teubner 2010). Such a perspective represents organisational members' collective mind approach to shape the business strategy of the organisation.

Based on the discussion above, the following definition of transformational IS strategy is developed:

*Transformational IS strategy is the organisational perspective and preparedness on the investment in, deployment, use, and management of information systems to plan for projects and platforms that help it [organisation] to reach a competitive position.*

The summary of the recommended set of questions that will guide the key stakeholders to drive their post-pandemic journey to transform IS strategies are presented in Table 2.

Table 2 summarise recommended set of questions for transforming IS strategy post-pandemic

P's	Plan	Position	Perspective	Project	Preparedness	Platform
IS strategy						
Supporting business strategy	<ul style="list-style-type: none"> <li>- Can existing plans be used for the future?</li> <li>- Are there any alternative plans?</li> <li>- Which plan will trigger fewer risks?</li> <li>- How often we need to change a plan?</li> <li>- How to monitor and manage the plan portfolio?</li> <li>- Where will the plan or will not work?</li> <li>- When existing or plans to be rolled out or changed?</li> <li>- Who will get impacted by the exiting or</li> </ul>	<ul style="list-style-type: none"> <li>- What is the current position and anticipated future position?</li> <li>- Are there any alternative future positions?</li> <li>- Which position will trigger fewer risks?</li> <li>- How often we need to change a position?</li> <li>- How to monitor and manage position portfolios to achieve dynamics of position?</li> </ul>	<ul style="list-style-type: none"> <li>- What is the current perspective?</li> <li>- Are there any alternative future perspectives?</li> <li>- Which perspective will trigger fewer risks?</li> <li>- How often we need to change a perspective?</li> <li>- How to monitor and manage a perspective portfolio to achieve dynamics of crisis?</li> <li>- How will members see organisation when crisis gets over?</li> <li>- Which perspective will prevail post-crisis?</li> </ul>	<ul style="list-style-type: none"> <li>- What are the current projects and anticipated future projects?</li> <li>- Are there any alternative future projects?</li> <li>- Which projects will trigger fewer risks?</li> <li>- How often we need to change the project?</li> <li>- How to monitor and manage the project portfolio to achieve dynamics of crisis?</li> </ul>	<ul style="list-style-type: none"> <li>- What is the current preparedness level and anticipated future preparedness level?</li> <li>- Are there any alternative future preparedness levels?</li> <li>- Which preparedness level will trigger fewer risks?</li> <li>- How often we need to change the preparedness level?</li> <li>- How to monitor and manage preparedness portfolio to achieve dynamics of crisis?</li> </ul>	<ul style="list-style-type: none"> <li>- What is the current business model and anticipated future business model?</li> <li>- Are there any alternative future business models?</li> <li>- Which business model will trigger fewer risks?</li> <li>- How often we need to change the business model?</li> <li>- How to monitor and manage a business model portfolio to achieve dynamics of</li> </ul>

	<p>plan?</p> <ul style="list-style-type: none"> <li>- How to minimise or mitigate plan risks?</li> </ul>					<p>crisis?</p> <ul style="list-style-type: none"> <li>- How to leverage the platform business model?</li> </ul>
Supporting IS function	<ul style="list-style-type: none"> <li>- Do the existing plan affects IS function?</li> <li>- How alternative plan affects IS functions?</li> <li>- Which plan will trigger fewer risks for IS function?</li> <li>- How often we need to change the IS function?</li> <li>- How to monitor and manage the IS function portfolio?</li> <li>- Where plan will or will not work for any specific IS function?</li> <li>- Who will get impacted by the change in IS function?</li> <li>- How to minimise or mitigate IS function risks?</li> </ul>	<ul style="list-style-type: none"> <li>- Do existing position affects IS function?</li> <li>- How alternative position affects IS functions?</li> <li>- Which position will trigger fewer risks for IS function?</li> <li>- How often we need to change IS function considering dynamics of position and crisis?</li> <li>- How to monitor and manage the IS function portfolio as per the current and anticipated position?</li> <li>- Where IS function will or will not work towards reaching to the position?</li> <li>- Who will get impacted by the change in IS function?</li> <li>- How to minimise or mitigate IS function risks considering position portfolio?</li> </ul>	<ul style="list-style-type: none"> <li>- Do existing perspective affects IS function?</li> <li>- How alternative future perspectives affect IS function?</li> <li>- Which perspective will trigger fewer risks for IS function?</li> <li>- How often we need to change IS function considering dynamics of perspective and crisis?</li> <li>- How to monitor and manage the IS function portfolio as per the current and anticipated perspective?</li> <li>- Where IS function will or will not work towards reaching to the perspective?</li> <li>- Who will get impacted by the change in IS function?</li> <li>- How to minimise or mitigate IS function risks considering perspective portfolio?</li> <li>- How will members see the organisation and IS functions when crisis gets over?</li> <li>- Which perspective will prevail and support IS function post-crisis?</li> </ul>	<ul style="list-style-type: none"> <li>- Do existing perspective affects IS function?</li> <li>- How alternative future projects affect IS function?</li> <li>- Which project will trigger fewer risks for IS function?</li> <li>- How often we need to change IS function considering the dynamics of projects and crises?</li> <li>- How to monitor and manage the IS function portfolio as per the current and anticipated projects?</li> <li>- Where IS function will or will not work towards reaching the project completion?</li> <li>- Who will get impacted by the change in IS function?</li> <li>- How to minimise or mitigate IS function risks considering the project portfolio?</li> <li>- How will members see projects and IS functions when crisis gets</li> </ul>	<ul style="list-style-type: none"> <li>- Do current preparedness level, and anticipated future preparedness level affect IS function?</li> <li>- Are there any alternative future preparedness levels that affect IS function?</li> <li>- Which preparedness level will trigger fewer risks for IS function?</li> <li>- How often we need to change preparedness level considering the dynamics of IS function?</li> <li>- How to minimise or mitigate IS function risks considering preparedness?</li> <li>- How to monitor and manage preparedness portfolios to achieve the dynamics of crisis and IS function?</li> <li>- Who will get impacted by the change in the preparedness level of IS function?</li> </ul>	<ul style="list-style-type: none"> <li>- DO current business model and anticipated future business model that effect IS function?</li> <li>- Are there any alternative future business models that affect IS function?</li> <li>- Which business model will trigger fewer risks for IS function?</li> <li>- How often we need to change the business model considering the dynamics of crisis and IS function?</li> <li>- How to monitor and manage a business model portfolio to achieve the dynamics of crisis and IS function?</li> <li>- How to leverage the platform business model considering IS functions?</li> </ul>

				over?  - Which projects will prevail, and support IS function post-crisis?		
Supporting the shared view of IS role within the organisation	<ul style="list-style-type: none"> <li>- Do existing plans work for future IS roles?</li> <li>- How alternative plans affect IS roles?</li> <li>- Which plan will trigger fewer risks to IS roles?</li> <li>- How often we need to change IS roles?</li> <li>- How to monitor and manage the IS role portfolio?</li> <li>- Where plan will or will not work for any specific IS role?</li> <li>- When existing or future plan affects IS roles?</li> <li>- Who will get impacted by the exiting or plan?</li> <li>- How to minimise or mitigate IS role risks?</li> </ul>	<ul style="list-style-type: none"> <li>- Do existing position affects IS role?</li> <li>- How alternative position affects IS role?</li> <li>- Which position will trigger fewer risks for IS roles?</li> <li>- How often we need to change IS role considering the dynamics of position and crisis?</li> <li>- How to monitor and manage the IS role portfolio as per the current and anticipated position?</li> <li>- Where IS role will or will not work towards reaching to the position?</li> <li>- Who will get impacted by the change in IS role?</li> <li>- Who will get impacted by the change in IS role?</li> <li>- How to minimise or mitigate IS role risks considering position portfolio?</li> </ul>	<ul style="list-style-type: none"> <li>- Do existing perspective affects IS role?</li> <li>- How alternative future perspectives affect IS role?</li> <li>- Which perspective will trigger fewer risks for the IS role?</li> <li>- How often we need to change IS role considering the dynamics of perspective and crisis?</li> <li>- How to monitor and manage the IS role portfolio as per the current and anticipated perspective?</li> <li>- Where IS role will or will not work towards reaching to the perspective?</li> <li>- Who will get impacted by the change in IS role?</li> <li>- How to minimise or mitigate IS role risks considering perspective portfolio?</li> <li>- How will members see the organisation and IS roles when crisis gets over?</li> <li>- Which perspective will prevail and support IS role post-crisis?</li> </ul>	<ul style="list-style-type: none"> <li>- Do existing perspective affects IS role?</li> <li>- How alternative future projects affect IS role?</li> <li>- Which project will trigger fewer risks for the IS role?</li> <li>- How often we need to change IS role considering the dynamics of projects and crises?</li> <li>- How to monitor and manage IS role portfolio as per the current and anticipated projects?</li> <li>- Where IS role will or will not work towards reaching the project completion?</li> <li>- Who will get impacted by the change in IS role?</li> <li>- How to minimise or mitigate IS role risks considering the project portfolio?</li> <li>- How will members see projects and IS role when crisis gets over?</li> <li>- Which projects will</li> </ul>	<ul style="list-style-type: none"> <li>- Do current preparedness level, and anticipated future preparedness level affect IS role?</li> <li>- Are there any alternative future preparedness levels that affect IS role?</li> <li>- Which preparedness level will trigger fewer risks for the IS role?</li> <li>- How often we need to change the preparedness level considering the dynamics of the IS role?</li> <li>- How to minimise or mitigate IS role risks considering preparedness?</li> <li>- How to monitor and manage preparedness portfolios to achieve the dynamics of crisis and IS role?</li> <li>- Who will get impacted by the change in the preparedness level of the IS role?</li> </ul>	<ul style="list-style-type: none"> <li>- DO current business model and anticipated future business model that affect IS role?</li> <li>- Are there any alternative future business models that affect IS role?</li> <li>- Which business model will trigger fewer risks for the IS role?</li> <li>- How often we need to change the business model considering the dynamics of crisis and IS role?</li> <li>- How to monitor and manage a business model portfolio to achieve the dynamics of crisis and IS role?</li> <li>- How to leverage the platform business model considering IS role?</li> </ul>

				prevail, and support IS role post-crisis?		
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## Implications

The Pandemic has severely affected businesses across the world and the full impact is yet to be felt. To avoid further disruption, organisations must strengthen and transform their IS strategy. This article proposes several implications for practice and research.

### *Implications for practice*

- Developing an IS strategic roadmap by considering the plan, position, perspective, project, preparedness, and platform dimensions.
- Focusing on the development of IS strategic constructs integrated with an IS strategic roadmap. Three critical constructs are: IS strategy to support business strategy, IS strategy to help IS function and IS strategy to support the shared view of IS role within the organisation.
- It can be expected that managers, leaders, and practitioners will leverage the PP-TISS framework to redefine and reformulate IS roles, IS functions, and business strategy to achieve business goals.
- It is assumed that post-pandemic change is expected in dimensions of plan, position, perspective, project, preparedness, and platform for the organisations. Thus, managers need to be ready and orient themselves to the PP-TISS framework.

### *Implications for research*

- It is expected that while deploying the PP-TISS framework to transform IS strategies, and it is imperative to understand the implications of change in IS roles, IS functions, and business strategy.
- Though the suggested and recommended set of questions for transforming IS strategy post-pandemic is positioned as helping stakeholders, it is critical to measure the change in organisational and individual (employee) perspective on adopting a particular IS strategy.
- A detail study to empirically validate the adoption benefits of the PP-TISS framework will help the community to be prepared for a crisis and accordingly (re)formulate IS strategy.
- As work from home and telecommuting will likely be the long term norm post-pandemic (Guyot & Sawhill, 2020), it will be interesting to examine the applicability of PP-TISS framework across the organisations to validate any deviation or impact.
- Organisations have just started to understand the impact in their operations and offerings, and it is necessary to assess and measure the current IS practices and thus look at the formulation of dynamic and adaptable IS strategic landscape.

## 3. A brief overview of full opinion articles included in this special sections

This section outlines an appraisal of the selected COVID-19 opinion articles presented within the IJIM special issue. Each study covers one or more themes related to the pandemic together with the views of the authors on the key specific IS themed topics.

The timely communication of key information on the spread of the COVID-19 virus and the dissemination of advice and guidance on how people can protect themselves and reduce the spread of the disease, has been critical since the initial outbreak. During the pandemic and subsequent lockdown within many parts of the world, people have relied on IS and online social media for support and information gathering on the virus spread as well as using social media platforms for maintaining

contact with friends and family. The study by Naby-Grover et al. (2020) discusses a number of these threads through a self-disclosure lens, highlighting the change in behaviour within social media communities as people assume new roles in providing health updates and offering advice and guidance on staying safe during the pandemic. The study posits the benefits in revisiting some of the commonly held assumptions relating to self-disclosure, its motivators and the underlying rationale on what people communicate during health emergencies to improve the reliability of data. The role of Twitter as the key platform for rapid communication during emergencies is widely documented (Kim et al. 2018), as users tend to use this specific platform as the medium for concise and targeted messaging to online communities. A total of 26,264 tweets over a five month period relating to COVID-19 were analysed by Rao et al. (2020), where the research focussed on the conversations relating to: virus contagion, prevention and the economy, acknowledging the contrasts in speed of broadcasting between alarming and reassuring content. The study posits the criticality of officials communicating clear and reassuring messages during crisis management scenarios and the monitoring of social media platforms to ensure that official messages are not used and retweeted to reinforce and alarmist narrative within social communities.

One of the significant observations from the pandemic, relates to the adaptability of humans to change their behaviour to deal with constraints in face to face communication and the inability to function within the workplace due to the constraints of the virus. This transformation in the context of the rise in usage of collaboration systems is assessed in Kodama (2020), where the research analyses the digital transformation of work styles through collaboration systems. The study highlights the step change in usage of cloud based collaboration and team working services is staggering with downloads of Zoom alone at levels of 14 times in the US, 14 times in the UK and 55 times in Italy when compared to pre-pandemic levels. The longer term business effects of COVID-19 are explored in the study, where the positive impact of the increased levels of digitisation and innovation can be leveraged for existing and new business models from the improved levels of collaboration and interaction. The strategic shift in digitisation achieved by many organisations during the pandemic is analysed in Seetharaman (2020), where the study asserts the adaptability to survive the change to business models is associated with their agility and ability to utilise opportunities. The increased levels of digitisation and impact on IS management from the pandemic is explored within a number of studies. The research by Richter (2020) and De et al. (2020) highlight the surge in use of digital technologies and some of the longer term implications relating to education, privacy, security, and governance in the context of changes to human interaction and working practices. The uptake in digitisation is further explored in Sein (2020) where the study looks through an affordance lens to seek to explain the underpinning mechanisms and facilitating conditions behind the widespread adoption of technology. The digital disruption and destruction stemming from the pandemic is explored in Bunker (2020) where the research calls for the critical analysis and evaluation how algorithms and data are being by various platforms during the pandemic. The exacerbation of misinformation on social media, resulting general confusion and crisis driven mental model alignment (and realignment) is discussed in the study, where constant attention, effort and resources are recommended to build trust in the data.

Alternative perspectives on the digital transformation stemming from COVID-19 and how people view and make sense of the new normal, are explored within a number of articles. The research presented within Carroll & Conboy (2020) and also Doyle & Conboy (2020) via the application of liquid-modern principles, explore the need for reflective practice on how people as well as organisations have adapted to the step change in working and socialising but also highlighting that fact that the human behavioural aspects of the pandemic, indicates that perhaps people are more conditioned to change than perhaps was initially realised. The articles by Papagiannidis et al. (2020) and also Papadopoulos et al (2020) discuss the potential for key lessons to be learned from this first significant pandemic within the digital age, and how organisations can be more prepared for future pandemics and learn from collaboration between diversified stakeholders to minimise risks to business continuity. What is clear from the COVID-19 related research is that organisations as well as people have needed to manage a step change in disruption during the enforced transformation to digital, as they have attempted to maintain business continuity and communication with stakeholders and family members respectively.

The digital divide and longer term consequences from the pandemic are explored in a number of studies. The study by Pan et al. (2020) focussed on the Chinese family perspective to illustrate many of the behavioural aspects and complexities faced by specific demographics in adapting to digital interaction. The article by Fletcher & Griffiths (2020) analyses the COVID-19 related digital divide through the lens of digital maturity and the inherent flexibility of digitally mature organisations to change to cope with the impact of the pandemic. The study posits the necessity for businesses across all sectors to reimagine their organisations to transform their digital capability in order to deal with any future crisis. The article by Davison (2020) looks through the academic lens on the many complexities of teaching online and the low levels of student interaction during remote lectures. The digital transformation within education from COVID-19, is empirically examined in Iivari et al. (2020), where the research assesses the impact on basic education in Finland and in India. The study highlights the inherent complexities stemming from the digital divide and the resilience, creativity, and perseverance from educators, as they have struggled to integrate the required digital tools within the learning environment. The impact of the pandemic induced digital divide is analysed in Barnes (2020) in the context of posing the question as to - how can technology be used more effectively to create equality and improve wellbeing? The study highlights the key aspects relating to how certain demographic groups are technologically disadvantaged and the role of research and practice in delivering inclusive benefits for any future global digital society.

The rapid adoption of digital solutions for the track and trace aspects of COVID-19 and the implications for privacy and security has been a core topic of conversation within the media and academic literature. The study by Rowe (2020) illustrates these points using case examples from Australia and France where the widespread download of contact tracing apps could have long term implications and a pertinent reminder of this potential extreme case of the privacy paradox where the government plays on the immediate benefits and downplays long-term concerns. These issues are further explored in Fahey & Hino (2020) where the study assesses the implications of the adoption of digital technology via mobile apps to trace their interactions with other people who could potentially be infected with the virus. The study highlights the privacy and data security implications of countries developing their own bespoke solutions effectively bypassing the solutions from Google and Apple, potentially increasing the risk of exposing personal data to nefarious use by authorities.

The rapid spread of the COVID-19 virus amongst the human population has increased the focus and momentum amongst decision makers on automation technologies and AI solutions. The research by Coombs (2020) illustrates these points highlighting the use of AI within COVID-19 transmission analysis, positing the increased likelihood of increased use of AI and automation solutions post pandemic. The study identifies - big data availability and reliability, task suitability, narrow capability and human worker availability as constraints on further adoption of AI and automation within organisations. The potential for AI during the pandemic is further explored by Sipiør (2020), where the study not only highlights the role of intelligent automation in the diagnosis, contact tracing, social distancing and workplace safety, but also the benefits in repurposing existing AI solutions for COVID-19 use, in shorter timescales than the development of an entirely new system.

Despite the efforts of global organisations such as the WHO, the response to the pandemic has been disjointed and uncoordinated as each country has adopted their own responses to the virus. Researchers are starting to document many of the lessons learned from an IS and systems perspective, and are actively identifying recommended new strands of research for the post COVID world. The study by Janssen & van der Voort (2020) explores these aspects from the Dutch perspective offering insight to the principles of agility and their potential conflicts in offering solutions positing the benefits in a greater understanding of these issues. The study by Pan & Zhang (2020) posits the merits of a timely post COVID-19 exploration of the many grand challenges facing the world and a re-examination of IS research and the achievement of the UN Sustainable Development Goals (SDGs). The research outlined in Venkatesh (2020) presents a technology focussed research agenda and direction related to the impact of COVID-19 to support the impact on people's jobs, home and social life and the benefits in cross-border collaboration between researchers within both developed and developing countries. The study by Luciano (2020) analysed the IS related elements of process effectiveness that hindered the impact of key elements of the distribution of emergency aid within



Brazil during the pandemic. The research highlighted the importance of joined up Government at a local and national level and criticality of effective IM.

#### 4. Concluding discussion

It is clear that underpinning the ability of governments, industry, and wider society to continue to operate and function within the COVID-19 pandemic, is a reliance on IS technology. Furthermore, technology has been pivotal in the efforts to develop a vaccine and has proved to be transformational in the efforts to track and trace COVID outbreaks in many countries throughout the world. The examination, reflection and academic analysis of the use and further adoption of IS during this crisis, is crucial for progress in the post COVID-19 era to ensure authorities can better understand how we got to this place and assign meaning to what has happened from a lesson learned perspective.

This concluding section discusses some of the key themes from the individual contributions highlighting some of the many issues and key insights from the pandemic through the lens of technology. This discussion outlines the many strands of recommended research agenda and outlines the pressing research topics stemming from the pandemic.

The themes relating to the increased levels of digitisation and management of IS have been discussed within a number of contributions that have explored these themes. The contribution from *Banita Lal* illustrates the role of technology in empowering homeworkers during the pandemic and the importance of maintaining social interaction with colleagues to mitigate the feelings of social isolation. The study highlights the criticality in considering technical affordances and for management to strike an appropriate balance between organisation goals and the wellbeing of employees. The transformative aspects relating to the supply chain industry, role of industry and government, emerging technology, and online education are discussed in the contribution from *Babita Gupta* where each of these topics are explored from the IS perspective. The article discusses the impact of the current events and how decision makers can develop new strategies and build on some of the key findings and lessons learned from the pandemic, where organisations promote more sustainable, inclusive and collaborative processes, best practice and strategic direction. The contribution from *Ioanna Constantiou* illustrates how an organisations digital maturity and technology aligned strategy affected their ability to operate effectively during the height of the pandemic, and how agility, flexibility and adaptability should form part of a firms business continuity strategy to mitigate negative impacts during any future crisis. The perspective from *John Edwards* reviews recent events from an IM perspective through a reflective lens to develop a practitioner and academic research agenda, raising a number of pertinent questions to be considered by decision makers. The key threads within this group of perspectives align with the observations in Papagiannidis et al. (2020) and Barnes (2020) on the ability of humans and organisations to change their behaviours and role of technology in making real change within a societal context.

The disruption and transformational implications of the pandemic have been discussed within a number of perspectives, where articles have addressed how organisations have needed to change their operations to survive during the crisis, and how these changes in in working practice have impacted workers and wider stakeholders. The strategic implications of the pandemic induced digital transformation are discussed in the contribution from *Nitin Upadhyay* where the article advocates the pivotal role of IS strategy and the criticality of organisations establishing a roadmap for their recovery and future growth. The transformation impact from the use of mobile technology during the pandemic is discussed in the contribution from *Nripendra Rana*. The article discusses the use of the track and trace mobile app in countries such as Singapore, UK, Nigeria, China, South Korea and India, highlighting the regional perspectives and limitations on widespread use. The study highlights the many considerations for future crises and realities on the ground in countries such as India where digital literacy is low, and the widespread use of technology to control a pandemic is a significant challenge. The contributions from *Prakhar Prashant* and *Santosh Misra* discuss the many disruptions from the pandemic and transformational implications for authorities and key decision makers. The *Santosh Misra* article illustrates many of the societal complexities and technical innovations from the Indian regional perspective, where key activities related to epidemic management are initiated via end

to end technology solutions. Education in all its forms has been severely disrupted across the world as access to in-person learning institutions, schools and universities has been curtailed during lock-down. The perspective from *Crispin Coombs* discusses these points from an IS viewpoint, where the article illustrates the many complexities and lived-in experiences from remote online teaching using the available digital tools. The study illustrates the many lessons learned from the experience of digital based IM related teaching and the potential of a blended offering to meet the needs of students whilst delivering a high quality learning experience. These perspectives outline many of the key issues and practical solutions to maintaining operations and everyday life during the pandemic via the use of technology. The young person's perspective on digital transformation during the pandemic is outlined in Iivari et al. (2020), acknowledging the criticality of addressing the digital divide and removing key barriers to basic education. For many people in developing countries the digital divide is most apparent due to social and cultural barriers reinforced by poverty and a lack of education amongst the population (Barnes 2020; De et al. 2020; Fahey et al. 2020). The post-COVID-19 era offers the chance to address many of these issues and use technology to deliver a more inclusive and sustainable world (Pan et al. 2020).

The topics of privacy and security are key underlying concerns for many citizens during the pandemic, as governments have rolled out track and trace apps for mobile phones to alert possible infection routes within the population. The perspectives from *Ramakrishnan Raman* and *Sujeet Sharma* highlight the privacy and security concerns from the increased levels of digitisation and reliance on new IS tools and mobile apps and requirement to reassess the cyber security landscape post pandemic. The perspective from *Sujeet Sharma* discusses the threats relating to the COVID-19 track and trace mobile apps, highlighting the case of the Aarogya Setu app that was downloaded by 100 million Indian users to help minimise the spread of the virus. The study poses a number of research questions relating to the use of big data, protection of personal data and use of analytics within the pandemic. These issues align with the concerns raised in Rowe (2020) and Fahey & Hino (2020) where decision makers have perhaps underestimated the concerns and subsequent reticence to use track and tracing apps where the safeguarding of personal data is deemed not to a priority.

The perspective from *Yanqing Duan* discusses the role of AI during the pandemic highlighting the following COVID-19 related challenges: imperfect information, deep uncertainty, high risk and urgency in the context of speed of decision making. The study explores these areas highlighting many of the instances where AI technology could engender better, more informed decision making during crisis management scenarios. The article posits the key challenge for AI in its role in empowering human decision making and recommends further research to ascertain how AI can help human decision makers deal with uncertainty, urgency and imperfect information during future pandemics. These aspects are supported in aspects of the literature where studies have posited the role of AI and its potential to enhance human abilities in a hybrid worker context, increase levels of automation and help shape society within a post-COVID era (Coombs 2020; Sipiior 2020).

This study presents an assessment of the key challenges and perspectives on the impact of COVID-19 through an IS and IM lens. The opinion articles each offer a distinct viewpoint on the core IS topics and how the use of technology has impacted organisations, people, and society during an era of rapid change. The pandemic has forced governments and decision makers to reassess how they use IS and to extend the use of technology to mitigate many of the societal impacts of the spreading virus. The key challenge looking forward, is how do these same decision makers harness the power of technology to learn the key lessons of the COVID-19 pandemic and ensure that the world is better prepared for future waves of the virus.

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