Post-Pandemic IT: Digital Transformation and Sustainability

Abstract: Decades-old research (by the authors and others) on global Information Technology (IT) trends demonstrate a steady increase in IT's role in organizational competitiveness. Digital transformation is bringing profound change to everything we do. Nowhere has this been more apparent than the recent changes demanded by the COVID-19 pandemic. However, the digital impact on every company began well before and will continue long after the pandemic. What has differentiate the pandemic conundrum is the ubiquity of the impact, a reality that demanded immediate changes to strategies and plans. This research analyzes IT issues and trends before and during the pandemic using data from global IT trends research and surveys to project how IT sustainability will be shaped post-pandemic. The paper examines the top significant management concerns and technology considerations to project the pandemic's lasting impact on IT and to answer the important question: Will IT revert back to where we were pre-pandemic? We conclude that the changes in IT, and specifically, digital transformation, are not just the result of an emergency-induced pivot, but a broad recognition that IT will sustain its fundamental role in driving/enabling significant economic value across every organization. The research concludes that IT in the post-pandemic era will continue to grow as an essential vehicle for competitive advantage and agility, while promoting sustainability through digital transformation.

Keywords: IT; Security; Digital Transformation; IT-Business Alignment; COVID-19.

1. Introduction

The impact of the COVID-19 global pandemic, triggered in December 2019, continues to influence public and private consciousness and decision-making. The commensurate economic impact on industry was both inevitable and inescapable. A worldwide recession was unavoidable [1]. The impact on organizations was swift, and many companies struggled to survive. The struggle ensues. Imposed lockdown measures meant that firms could no longer provide services or products from their physical infrastructure, forcing them to move operations online. Employees were either furloughed, terminated, or made to work remotely. Consequently, IT became a crucial and indispensable part of any organization that wished to survive the pandemic. Nevertheless, as the pandemic seemingly abates, most organizations continue to operate in a hybrid fashion whereby the traditional fulltime in-office paradigm is rare. That being said, the demand to leverage emerging information technologies for competitive advantage persists. Digitalization has become a global way of life.

There is a broad range of definitions of digital transformation. Generally, digital transformation relates to the conception of re-engineering businesses as a mechanism to capture information technologies' potential. It can also be defined as "the most profound and accelerating transformation for business activities, processes, competencies, and models to leverage the changes of digital technology and their impact in a strategic and prioritized way" ([2], p. 723). Digital transformation is considered a paradigm shift that has brought a new way of thinking about innovation within firms. It connects to digital innovation, where information technologies play a crucial role and involve stakeholders across the organization. Digital transformation is enabled/driven by technologies, such as artificial intelligence, cloud computing, mobile computing, big data, data science, business analytics, social computing, Internet of Things (IoT), cyber-physical systems, blockchain, and machine learning [3].

Examples of digital transformation go across every industry [4]. While there exist differences in levels of technological advancement, infrastructure support, and pace of digital innovation, "digital" organizations have demonstrated resiliency during the COVID-19 pandemic. We need look no further for examples of resiliency driven/enabled by digitalization during the pandemic than in education delivering courses online, see [5-7]. In the workplace, digital technologies prone to make processes/tasks, jobs and firms more resilient to unanticipated shocks. The COVID-19 pandemic has revealed that a workforce with digital skills can quickly adjust to new circumstances [8]. Studies show that organizations with higher digital resilience performed significantly better in general and that the ability to use digital technologies to implement successful remote work mattered ([9], [52}).

Furthermore, digital transformation is expected to have transformative effects not only on businesses, but also on society and the planet itself; referred to as "sustainability". Companies today employ digital transformation to pave the way for the creation of sustainable societies [10]. This includes the introduction, the production, the use and the disposal

of hardware (e.g., information technology equipment, data centers, networks) as well as software and applications – ranging from robotics, the Internet of Things (IoT), blockchain, artificial intelligence, etc. [11].   In this work, we examine digital transformation before and during the pandemic using various IT trends research, and make projections on how IT sustainability will be shaped post-pandemic as well as address the question whether there will be a new, post-pandemic IT normal.

2. Methodology

Since 1980, the Society for Information Management (SIM), in collaboration with a team of academicians (including the authors of this paper in various years), has conducted an annual survey of its members to identify and study the most important IT management issues. Over the decades, this trends study has evolved and expanded globally into an insightful and comprehensive investigation of information systems management issues, practices and leadership. More specifically, the trends study pursues insights regarding the key IT issues of the day. Today, the SIM IT issues and trends study is considered the hallmark of this type of study in the field. The study provides both practitioners and researchers with valuable trends analyses and a snapshot of the state of information systems management. In addition to the preceding research study, this opinion paper applies other surveys that examine key issues facing IT executives, issued by organizations, such as Gartner, UBS, Deloitte, and the International Data Group (IDG). One of strengths of these IT surveys is their ability to identify important trends by comparing survey data based on a similar sample from previous years. This enables organizations to effectively anticipate and prepare their organizational strategies and plans.

Two areas covered by this research are further explored here: global management concerns and the largest IT investments and technologies. The data from these surveys reveal insights on what many believe is the "new IT normal". Using the trends surveys, this paper analyzes the role IT played before and during the pandemic, while providing a prognosis of where IT is heading post-pandemic. One of the direct results of the pandemic is an exponential increase in IT dependency among organizations across all sectors.   Evaluating and understanding the current and future role of IT is thus a fundamental step in understanding and codifying the relationship between IT and business to promote sustainability.   These steps are critical to ensure that IT provides the essential services for business survival and competitiveness. They are also necessary to ensure that IT remains the primary mechanism to exploit emerging technologies to assist the organization in achieving sustainability.

3. Results: IT and the Pandemic

Technology has played a pivotal role throughout the COVID-19 pandemic; it affected a broad spectrum of activities, ranging from remote work to contact tracing. We have relied on technology for: (1) the scientific exploration of vaccines and their distribution; (2) ensuring sustainable flow of the supply chain; and (3) enabling companies to continue operations while simultaneously navigating this unprecedented upheaval [12]. The most current global IT issues and trends survey reveals that two management issues atop the concern list for IT and non-IT executives before, during, and as the pandemic started abating: *Security and Privacy* and *IT-business alignment* [13].

Security and Privacy remains a top concern for executives for over a decade. A global UBS Investor Survey ranked cybersecurity as one of the top three concerns for investors and business owners [14]. The IDG State of the CIO (Chief Information Officer) Survey reveals that although CIOs have previously thought that their security posture would dissipate, CIOs continue to focus their time and expertise on security management [15]. The UBS survey points out that cybersecurity incidents are on the rise and that security is no longer merely a concern of IT managers, but a key boardroom topic. Every business must recognize its strategic importance and continuously enhance their security infrastructure to prevent breaches. The pandemic amplified this concern because the global economic shutdown mandated isolation and thus remote work. This new reality required companies, academic institutions, and governments to move their operations entirely online [16]. The new, virtual workspace required supporting a myriad of technical platforms to ensure the continuity of employee efficiency and effectiveness. As organizational dependency on the Internet and Cloud Computing expanded, upgrading cybersecurity and clarifying privacy rights of the individual/corporate users moved from important to obligatory.

Furthermore, this reality creates an environment where *IT-business alignment* also remains a top management priority. The focus of IT-business alignment drives the activities that integrate IT and non-IT organizations. for sustainability and competitive advantage. Alignment of IT and the Business has persistently been ranked in the top three organizational concerns for decades. Studies have shown that IT-business alignment underscores the importance of a

close relationship between the business and the technical organizations and processes in a way that improves the value derived from digital transformation and helps promote long-term sustainability (see, e.g., [17] and [18]). Also, a high degree of IT and business integration correlated with organizational success (see, e.g., [19], [20], [52}). In the context of the pandemic, it now correlates with corporate survival.

Likewise, there is a significant interest in *Data Analytics and Data Management* (see, e.g., [21], [22]). Decision makers in the organization need to be able to obtain valuable insights from wide-ranging and rapidly changing data, spanning from process innovation to integration with core business processes and revenue generation. The former includes administrative tasks such as finance, accounting, and payroll. The latter constitutes how a firm will market and sell products or services and how it aligns the sales and marketing strategy to achieve revenue targets. The pandemic is driving organizational innovation as firms explore new digital business operations applications and continue to use emerging technologies to support and enhance current operations and exploit competitive advantage. The Gartner IT Survey reports, for example, that companies have been accelerating digital innovation and leveraging emerging technologies that support digitalization to come out stronger on the other side of the pandemic ([23], [24]).

Technology has also changed the workplace. Remote (or even hybrid) work, once the exception, has now become the norm. Before COVID-19, less than 10% of Americans reported working from home. Since the pandemic forced much of the workforce to remote work, it is expected that the "working from home" trend or some hybrid combination will continue. Gartner reports that about half of the workforce will likely work remotely (at least part of the time) in the years after COVID-19 [25]. For example, Microsoft formally announced that they would let more employees permanently work from home. Best Western Hotels is now partnered with Mursion to employ virtual reality in training and problem solving for front desk clerks. Anticipated to reduce human interaction, Home Depot built a mobile app that provides product information to new hires while at work [26]. These trends obviate the need for office space. The Gartner Report indicates that this will require organizations to pivot toward remote work operations; managers will re-evaluate the benefits of remote work by exploring the critical competencies of digital collaboration, and preparing to adjust employee experience strategies [27].

Furthermore, in recent years, digital technologies have also been deployed in the context of sustainability. Viability is one of the key consequences that stems from the implementation of digital technologies, as companies expand their visibility with increased added value by being sustainable [28]. Studies report that more and more companies are introducing new products and platforms based on digital technologies to ameliorate environmental sustainability [29]. For example, Goralski and Tan [30] highlighted AI-based technologies such as Smart Water Management Systems and PlantVillage for identifying waterborne diseases that have infested waters. [31] conducted a study on implementing digitalization for improving environmental sustainability. Digital technologies have also re-conceptualized supply chain processes and firms' overall operations. For example, food chain challenges are helping prevent food waste [32]. Recently, food supply chain disruptions occurred during the COVID-19 pandemic and the conflict between Russia and Ukraine [33, 34]. Jagtap et al. [34] proposed strategies to mitigate food supply chain impact through technological innovations to ensure food safety and quality. Yalina and Rozas [35] and Demartini et al. [36] suggested that digitalization can contribute to environmental sustainability; for example, by reducing carbon emission and minimizing other waste to the environment.

Digital transformation and technologies such as cloud computing, cyber-physical systems, and additive manufacturing are considered to be influencers of the sustainable business model [37]. For example, additive manufacturing addresses climate, energy, and environmental challenges [38]. In this context, going through a process of digital transformation, companies can promote various sustainable development programs. One such digital innovation is happening to healthcare services. Consumers are now able to connect virtually to health teams, global experts and health organizations with immediate access to a wide range of health services through internet-based technologies. The rapid shift toward virtual care delivery has resulted in heightened expectations among consumers to advance digital accessibility to healthcare services, support more equitable outcomes for populations and advance health system performance that promote a more sustainable society [39].

In addition, the pandemic has unmasked the indispensable roles that IT application tools play in maintaining and sustaining organizations during a period of unprecedented social and economic upheaval. The list of the largest three IT investments in the past 5 years ranked by the SIM IT study [13] - before, during, and as the pandemic started abating - is summarized in Figure 1. The list shows that the top three investments in IT have remained the same in recent years, even before the pandemic. Table 1 presents the most recent comparison of the largest IT investments as surveyed by IDG, Gartner and SIM. The comparison reveals that all three organizations designated cloud services, security/cybersecurity and analytics/big data as top 3 IT investments, but in a different order. We now provide further details on each top IT investment.

Figure 1: Largest IT investments Rankings, 2017-2021; data published in 2022 [13]
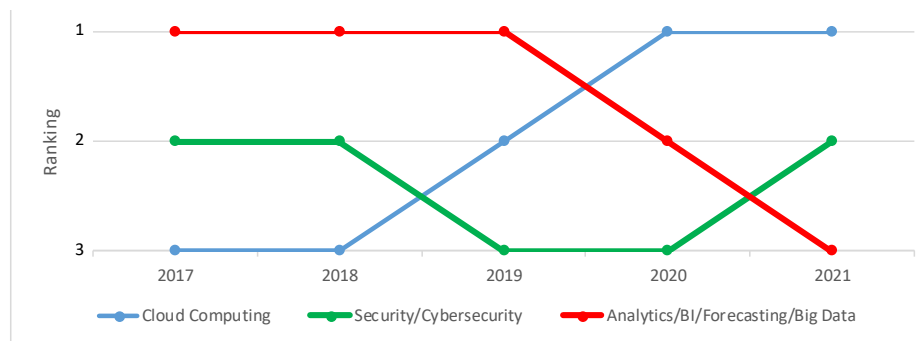
Big data analytics and forecasting tools have grown at a breakneck speed as organizations leverage information to achieve competitive advantage. These tools have been even more essential during the pandemic, ranked second on the IDG State of the CIO Survey, and the Gartner 2023 CIO Agenda, which is based on their CIO and Technology Executive Survey ([40]), and third on the SIM IT Issues and Trends Survey list of the largest IT investments. The Deloitte Tech Trends report [41] refers to these tools as enabling technologies that have proven their value. UBS also characterize them as key enabling technologies [14]. These tools have been used as emergency planning, adaptation, and contingency tools.

For example, governments at all levels have become big data devotees, employing analytics to determine pandemic-related health and economic policy strategies. Relative to health policy, big data provides modeling studies that enhance viral containment and thus mitigate spread; the use of analytics is also essential in deriving therapeutics and vaccines as government pharmaceutical and healthcare partners leverage their data. Thus, these tools have emerged as a crucial element in the policy making process [42]. Similarly, firms are increasingly reliant upon big data and analytic technologies to define and determine their digital strategies.

Furthermore, big data analytics can promote sustainability by changing how the impact on the environment is measured and mapped (see, e.g., [43]). This process can be used to design a method for the certification of goods in terms of their direct environmental performance, mainly measured by carbon footprint [44]. Blockchain is another example of a tool that can help businesses achieve sustainability by maximizing resource usage, and reducing carbon emissions [45, 46].

Cloud Computing topped the largest IT investments list in the SIM IT Issues and Trends Study and third on the Gartner IT Survey. It was ranked fifth in the IDG State of the CIO Survey. Similar to big data analytics and forecasting tools, both Deloitte and UBS refer to the cloud as an enabling technology that has proven its value and is the basis of numerous successful corporate strategies and new business models [14, 41]. The use of the cloud was intensified during the pandemic to ensure that data are both accessible and available to authorized employees using a diverse base of technologies. A survey conducted by Deloitte also reveals that accelerated by pandemic, cloud solutions continue to transform enterprise IT [47]. Deloitte concludes that the cloud's takeover of the enterprise is nearly complete, as 90% of organizations use cloud-based services. This results in accelerating digital transformation processes.

For example, the architectural and engineering design firm Borton-Lawson has increased its use of collecting data and conducting visualization remotely to streamline project execution. Moreover, the firm's oil and gas clients now rely on 3D laser scanning and drones to capture data from their sites and can access it remotely. Similar solutions also allow companies in the energy sector to monitor their installations without site visits. Zhang [48] discusses digital transformation of enterprises and how they can better adapt to the development of big data and cloud computing by innovating financial management methods. Artificial intelligence vendor Smartvid.io created a tool for computer vision paired

with artificial intelligence analyzing photos and video from job sites to spot safety hazards and identify possible construction errors. Smartvid.io recently augmented the tool to a social distancing monitoring feature [49].

Nevertheless, a new problem has emerged from the now ubiquitous home office: a sharp increase in spam email, malicious social media messaging and Distributed Denial of Services (DDoS) attacks. Malware and phishing websites have witnessed the highest increase compared to past cyber threats and attacks [50]. For example, despite rapid growth during the pandemic, the popular video conferencing app Zoom was deemed vulnerable. Consequently, organizations such as Google and NASA banned the use of Zoom.

As security tops the list of executives' concerns, security technologies were also ranked first in both the IDG State of the CIO Survey and the Gartner IT Survey and second on the SIM IT largest investments list. Security tools rose to the top according to the IDG State of the CIO Survey. Companies have invested heavily to ensure that systems and networks (as well as the online identity of employees) remain secure. There are various forms of IT security, including: (1) network and wireless security, which prevents unauthorized or malicious entities from accessing private networks; (2) endpoint security, which protects the network from endpoint devices that may try to install malicious code or software into the network; (3) internet security technologies, which protect from cyber-attacks; (4) cloud security, which secure user connections to the cloud; and (5) application security, which ensures that specific critical applications, for example, digital currency and digital payment technologies, are secure and less vulnerable to cyber-attacks. Every organization must therefore explore, develop and implement solutions to combat security threats intensified during the COVID-19 pandemic.

Table 1: Survey Comparison of Largest IT investments.

IDG State of the CIO Survey	Gartner CIO Agenda	SIM IT Issues and Trends Study
Security/risk management	Cyber/information security	Cloud Computing
Data/business analytics	Business intelligence and data analytics	Security/Cybersecurity
Cloud migration	Cloud services and solutions	Analytics/BI/ Forecasting/Big Data

An important outcome of these changes relates to the recruiting and retaining of IT talent. As with any period of big changes, concerns are raised over people losing their jobs when new technologies are introduced and implemented. Economists expect that between 10% and 15% of jobs will be lost as a result of technological changes [14]. Furthermore, the literature shows that finding and retaining IT talent is becoming a top worrisome concern for IT management [13]. These findings point to a highly competitive environment for technically skilled IT employees and confirm that IT leaders are justified in their concerns about talent acquisition and retention. Deloitte [41] projects that as traditional IT tasks and capabilities disappear, businesses will seek talent with new technical skill sets and soft skills. These skills, highly desired for the technologies dominating the digital transformation, are perceived by IT leaders as valuable but scarce, reflecting the overall concern with attracting and retaining high-quality talent [13].

4. Discussion: Is IT Going Back to Where It Was Pre-Pandemic?

These are uncertain times. While not something new, the pandemic, in concert with emerging technologies, global economic, social, political, and energy considerations, have compounded the challenges the world and every business is facing. This section makes projections and provides insights on whether the pre-pandemic global IT trends will return, or will there be a new IT normal.

One way to gain insights into this question is by using theoretical models or frameworks. Building upon the rapidly developing research on digital technologies, Kutzschenbach and Daub [51] outline an integrated framework linking different levels of "digitalness" with necessary changes in managerial practice to support organizational engagement

with sustainability challenges. Their research demonstrates that management needs to transform to leverage digital technologies for an on-going, learning-based engagement strategy. Another model that support digital transformation and sustainability is the Digital Transformation and Sustainability (DTS) Model proposed by Pappas et al. [10]. That model portraits how big data and business analytics ecosystems can pave the way towards digital transformation and sustainable societies. The model suggests that none of the actors in the society can be seen in isolation. Instead, we need to improve our understanding of their interactions and interrelations that lead to knowledge, innovation, and value creation. The model also helps gaining deeper insights on which capabilities need to be developed to harness the potential of big data analytics.

Here, we gain insights by examining the implications of IT issues and trends. One key trend that relates to digital transformation and supports sustainability is IT-Business Alignment. Alignment focuses on a collection of activities that IT managers and business managers carry out jointly to coordinate goals and operations across IT and other organizational functions (e.g., finance, marketing, HR). Organizations and their leadership - both IT and non-IT executives - need to recognize that it is not just how IT is aligned with the business; it is how IT and business are aligned with each other. For IT to transform the business, mature alignment is essential. Yet, there is an important caveat: it is not merely a question of alignment versus misalignment, but rather how to leverage opportunities, those that will cement the relationship between IT and business organizations, laying a foundation for success and sustainability. This also extends to relationships with external stakeholders, customers, clients, and partners.

COVID-19 rendered alignment more critical, where IT has fortified essential business processes; most important, it has kept firms solvent. Studies show that there are still challenges that need to be addressed. IT and business leaders need to work closely together and leverage existing tools and the lessons learned from their application to help the organization improve performance by applying IT and enable business change. Executives tend to look for the one silver bullet that will enhance this alignment. However, in reality, there is no one silver bullet and organizations need to address many strategic alignment maturity components [52]. Furthermore, the Deloitte 2020 Global Technology Leadership Study concludes that tech leaders have to wear the innovation hat. That means being forward thinking, helping the organization innovate, and focusing on disruption that's driven by technology. They also need to help the organization's other business leaders stay current on technology trends [53]. Overall, the pervasive/persistent IT-business alignment is driving the need for cohesive integrated IT-business strategies and is thus fundamental to succeed in the dynamic environment post-pandemic.

Additionally, organizations will continue to invest in IT communication and collaboration tools. This will lead to increased investment in bandwidth expansion and network equipment that leverages cloud services. IT Infrastructure will become more fundamental to IT leadership. IT infrastructure is the organizational keystone for deploying distinctive IT capabilities to exploit competitive advantage. Investments in IT infrastructure will increase to facilitate remote work among employees, customers, and partners, and the portion of the IT budget allocated for infrastructure will increase. It is notable that this investment must necessarily align with the overall firm operations and strategies. Before the pandemic, organizations had the luxury to explore digital initiatives over a time frame that they defined. The pandemic only accelerated the process in many organizations. We project that digital transformation processes will most likely continue in the context of sustainability initiatives. This wave of digitization is likely to make technologies such as Internet-of-Things (IoT), mobile, Blockchain, Artificial Intelligence, and Machine Learning even more essential to the organization. It is the integration and application of these technologies, along with the data, and architecture, and how the business changes to take advantage of these technologies, that will determine future leaders.

Since the trends presented and discussed above are not new trends, the post-pandemic era will likely be more "normal" than "new". That is, current IT digitization trends are likely to continue and even accelerate, but with some subtle changes and focus. Remote operations require communication and information security. More investment and regulation are thus warranted to ensure that business operations and secrets are protected. It is for this reason that we foresee *Security and Privacy* remaining atop the list of IT management concerns. Gartner estimated that worldwide security and risk management spending exceeded $188 billion in 2023 [54]. The global UBS Investor Survey also concludes that investment in cybersecurity will continue to be robust in the years ahead, growing by high single digits over the next few years. Investment in digital encryption and safety platforms will also increase. It is in the organization's interest to invest in this technology to ensure that the steady migration to remote work continues to generate positive outcomes. Laws and regulations must be amended to reflect the pivot to the sanctity of remote work and ensure its legitimacy.

Undoubtedly, IT is providing a more central role in the organization. This work demonstrates that the COVID-19 pandemic highlighted this phenomenon. Moreover, although the pandemic created an organizational dependency on IT, at the same time, the pandemic also provided IT leaders with an opportunity to shine, at least in part, thanks to their

attention over the past decade for overall business continuity, IT agility, and dedication to digital transformation. IT today is not viewed as a mere technical function, but as a function that covers a wide range of operational, organizational and strategic capabilities. IT has evolved as a partner to the organization's decision making processes. And while it seems that the pandemic made IT indispensable element of the organization, IT has been evolving and reshaping entire companies for a longer period of time.

Overall, this work provides an additional layer of understanding of continuing IT trends before, during and after the COVID-19 pandemic. The implications are clear; IT will continue to grow as an essential vehicle for competitive advantage and the creation of sustainable societies. Ironically, the pandemic is proof of IT's efficacy. The technological advances born of the pandemic are actually framing the future of labor itself. IT and non-IT leadership should not only focus on the software or hardware (which will keep on evolving). Instead, they need to work jointly to harness technology as a vehicle for achieving the organization's goals and leverage existing tools and the lessons learned from their application to help the organization improve performance and sustainability by applying IT tools and enable/drive business change. Both security and IT-business alignment will remain major management concerns and priorities.

Business executives need to recognize the essential role that IT plays in creating competitive advantage for the organization, streamlining operations, and promoting sustainability. This must include the recruitment and the retention of IT talent. During the transition period, as companies shift their demand toward new technical and soft skill sets, we are expect to experience a skills mismatch between those individuals who will be losing their "traditional" IT jobs and those new jobs that are being generated as a result of the digital transformation. IT skills shortages are thus expected for supporting emerging technologies or for maintaining strong cybersecurity for a hybrid or remote workforce. In many cases the skills gap will be sourced from service providers, assuming that they have the appropriate candidates.

Nevertheless, digital transformation and innovations will continue to dominate the economy and society at levels never seen before. As a result, the IT function is now facing growing business responsibilities. In addition to providing high quality and cost-effective services, which is the more traditional role of IT, it is also expected to enable and drive the business with revenue generation, optimizing various business processes, improving the client experience and co-adopt with customers. Consequently, IT is focused more on creating business value. Therefore, we are at a point in time when the organizational leadership needs to rethink the way it runs the business. To be successful in the post-pandemic era, IT leaders need to explore how to leverage digital transformation to support sustainability and competitive initiatives. Consequently, IT must work effectively and efficiently with their business partners. Beyond being technological gurus, they need to understand how the deployment of IT initiatives can enhance business performance while effectively communicating and working with their non-IT business partners. Technical skills and technology awareness are secondary to understanding how to apply IT for revenue generation, contingency planning, and survival initiatives. Unsurprisingly, non-IT executives should embrace the potential of IT and understand how to derive benefit from the leveraging of emerging technologies. More importantly, they ought to create an environment where the deployment of digitally-driven and enabled changes succeeds.

5. Conclusions

"*Are we going back to where we were pre-pandemic?*" NO. While we do not know the number of meetings or the percentage of employees that will eventually return to the traditional face-to-face settings, we do know this: IT is the enabler and driver of change in every aspect of every business in every sector, evidenced by an increasingly robust and flexible platform for remote virtual team environments. IT is a vital part of the 21st century organization's strategy. The digital transformation was quite real before COVID-19; it will endure after. The IT trends that have persisted for over a decade are not the result from an emergency-induced pivot; it is the far-reaching recognition that IT creates value to the organization. These IT trends will continue with changes in new technologies as they emerge.

Future work should look at the evolving role of IT in the organization and how the IT function and other business functions should mutually engage and enable activities that increase alignment and business value. Such work would allow scholars and practitioners to gain insights and develop prescriptive tools to leverage IT to provide demonstrable value to the business and promote sustainability.

In the post-pandemic era, IT will continue to grow as an essential vehicle for competitive advantage and agility, while promoting sustainability through digital transformation. The pandemic has presented new challenges and opportunities for IT and non-IT executives. Our prognosis for the near future is to proceed with vigilance. Changes are expected on the skills and talent required from IT, especially in a hybrid workplace that IT will have to support. Both the IT and non-IT functions and leaders must work in unison just as they should during times of growth. IT-business alignment is still a significant concern – some things never change, even in the COVID-19 age.

References

[1]   Erten, B. & Ocampo, J.A. (2021). The future of commodity prices and the pandemic-driven global recession: Evidence from 150 years of data. *World Development*, 137, 105164.

[2]   Hamidi, S. R., Aziz, A. A., Shuhidan, S. M., Aziz, A. A., and Mokhsin, M. (2018). SMEs Maturity Model Assessment of IR4. 0 Digital Transformation. *Proceedings of the 7th International Conference on Kansei Engineering and Emotion Research 2018 KEER*, 721–732. https://doi.org/10.1007/978-981-10-8612-0_75

[3]   Gomez-Trujillo, A.M. and Gonzalez-Perez, M.A., (2021). Digital transformation as a strategy to reach sustainability. *Smart and Sustainable Built Environment*, ahead-of-print. https://doi.org/10.1108/SASBE-01-2021-0011.

[4]   Mentsiev, A.U., Engel, M.V., Tsamaev, A.M., Abubakarov, M.V. & Yushaeva, R.S., 2020, The Concept of Digitalization and Its Impact on the Modern Economy. In *International Scientific Conference" Far East Con"(ISCFEC 2020)*, Atlantis Press, 2960-2964.

[5]   Alsoud, A.R. & Harasis, A.A., 2021. The impact of COVID-19 pandemic on student's e-learning experience in Jordan. *Journal of Theoretical and Applied Electronic Commerce Research*, 16(5), 1404-1414.

[6]   Dima, A.M., Point, S., Maassen, M.A. and Jansen, A., 2021, December. Academic leadership: agility in the digital revolution. In Proceedings of *the International Conference on Business Excellence,* 15(1), 518-529.

[7]   Eri, R., Gudimetla, P., Star, S., Rowlands, J., Girgla, A., To, L., Li, F., Sochea, N. & Bindal, U., 2021. Digital Resilience in Higher Education in Response to COVID-19 Pandemic: Student Perceptions from Asia and Australia. *Journal of University Teaching and Learning Practice*, 18(5), 7.

[8]   Piroșcă, G.I., Șerban-Oprescu, G.L., Badea, L., Stanef-Puică, M.R. & Valdebenito, C.R., 2021. Digitalization and labor market—A perspective within the framework of pandemic crisis. *Journal of Theoretical and Applied Electronic Commerce Research*, 16(7), 2843-2857.

[9]   Bai, J.J., Brynjolfsson, E., Jin, W., Steffen, S. & Wan, C., 2021. Digital resilience: How work-from-home feasibility affects firm performance (No. w28588). *National Bureau of Economic Research*.

[10]   Pappas, I. O., Mikalef, P., Giannakos, M. N., Krogstie, J., and Lekakos, G. (2018). Big data and business analytics ecosystems: paving the way towards digital transformation and sustainable societies. *Information Systems and E-Business Management*, 16(3), 479–491.

[11]   Liu, R., Gailhofer, P., Gensch, C.O., Köhler, A., Wolff, F., Monteforte, M., Urrutia, C., Cihlarova, P. and Williams, R., (2019). Impacts of the digital transformation on the environment and sustainability. Issue Paper under Task 3 from the *Service contract on future EU environment policy*.

[12]   Ågerfalk, P.J., Conboy, K. & Myers, M.D. (2020). Information systems in the age of pandemics: COVID-19 and beyond. *European Journal of Information Systems*, DOI: 10.1080/0960085X.2020.1771968.

[13]   Kappelman, L., Torres, R., McLean, E.R., Maurer, C., Johnson, V.L., Snyder, M. and Guerra, K., 2022. The 2021 SIM IT Issues and Trends Study. *MIS Quarterly Executive*, 21(1), pp.75-114.

[14]   UBS, (2021). *Future of the Tech Economy* https://www.ubs.com/content/dam/static/noindex/wealth-management/cio/future-of-the-tech-economy-20200610.pdf?campID=DDL-CIOFUTUREOFTECHONOMY-EMAIL-GLOBAL-20200617-PDF

[15]   IDG (2022). *State of the CIO*, https://www.idg.com/tools-for-marketers/2021-state-of-the-cio/#:~:text=Due%20to%20the%20impact%20of,for%20business%20growth%20and%20maintenance.

[16]   Dubey, A.D. & Tripathi, S. (2020). Analysing the sentiments towards work-from-home experience during covid-19 pandemic. *Journal of Innovation Management*, 8(1), 13-19.

[17]   Hustad, E. and Olsen, D.H., (2021) Creating a sustainable digital infrastructure: The role of service-oriented architecture. *Procedia Computer Science*, 181, 597-604.

[18]   Jonathan, G.M., Rusu, L. and Van Grembergen, W., (2021) Business-IT Alignment and Digital Transformation: Setting A Research Agenda. In *29th International Conference on Information Systems Development. Association for Information Systems (AIS)*.

[19]   Laya, A., Markendahl, J. & Lundberg, S. (2018). Network-centric business models for health, social care and wellbeing solutions in the internet of things. *Scandinavian Journal of management*, 34(2), 103-116.

[20]   Panda, S. (2021). Strategic IT-business alignment capability and organizational performance: roles of organizational agility and environmental factors. *Journal of Asia Business Studies*, 16(1), 25-52.

[21]   Peng, Q. & Ye, X. (2021). Research Trends in Social Media/Big Data with the Emphasis on Data Collection and Data Management: A Bibliometric Analysis. In: Nara, A., Tsou, MH. (eds) *Empowering Human Dynamics Research with Social Media and Geospatial Data Analytics*, 47-63. Springer, Cham. https://doi.org/10.1007/978-3-030-83010-6_4

[22]   Jayagopal, V. & Basser, K.K. (2022). Data management and big data analytics: Data management in digital economy. In Research Anthology on Big Data Analytics, Architectures, and Applications, Information Resources Management Association (IRMA), Chapter 78, 1614-1633. IGI Global.

[23]   Gartner (2021). *Gartner Survey of Nearly 2,000 CIOs Reveals Top Performing Enterprises are Prioritizing Digital Innovation During the Pandemic*, https://www.gartner.com/en/newsroom/press-releases/2020-10-20-gartner-survey-of-nearly-2000-cios-reveals-top-performing-enterprises-are-prioritizing-digital-innovation-during-the-pandemic

[24]   Kudyba, S. (2020). COVID-19 and the Acceleration of Digital Transformation and the Future of Work, *Information Systems Management*, 37(4), 284-287. https://doi.org/10.1080/10580530.2020.1818903

[25]   Gartner (2020). *9 Future of Work Trends Post-COVID-19*, https://www.gartner.com/smarterwithgartner/9-future-of-work-trends-post-covid-19/

[26] Meister, J. (2020). The Impact Of The Coronavirus On HR And The New Normal Of Work, *Forbes*, https://www.forbes.com/sites/jeannemeister/2020/03/31/the-impact-of-the-coronavirus-on-hr-and-the-new-normal-of-work/#6a3b4f792b60

[27] Saura, J.R., Ribeiro-Soriano, D. & Saldaña, P.Z., 2022. Exploring the challenges of remote work on Twitter users' sentiments: From digital technology development to a post-pandemic era. *Journal of Business Research*, 142, 242-254.

[28] Ordieres-Meré, J.; Remón, T.P.; Rubio, J. (2020) Digitalization: An Opportunity for Contributing to Sustainability from Knowledge Creation. *Sustainability*, 12(4), 1460. https://doi.org/10.3390/su12041460

[29] Feroz, A.K., Zo, H. and Chiravuri, A., (2021) Digital transformation and environmental sustainability: A review and research agenda. *Sustainability*, 13(3), 1530.

[30] Goralski, M.A.; Tan, T.K. (2020) Artificial intelligence and sustainable development. *The International Journal of Management Education*, 18(1), 100330.

[31] Balogun, A.L.; Marks, D.; Sharma, R.; Shekhar, H.; Balmes, C.; Maheng, D.; Arshad, A.; Salehi, P. (2020) Assessing the Potentials of Digitalization as a Tool for Climate Change Adaptation and Sustainable Development in Urban Centres. *Sustainable Cities and Society*, 53, 101888.

[32] Annosi, M.C., Brunetta, F., Bimbo, F. and Kostoula, M., (2021) Digitalization within food supply chains to prevent food waste. Drivers, barriers and collaboration practices. *Industrial Marketing Management*, 93, 208-220.

[33] Trollman, H., Jagtap, S., Garcia-Garcia, G., Harastani, R., Colwill, J., & Trollman, F. (2021). COVID-19 demand-induced scarcity effects on nutrition and environment: Investigating mitigation strategies for eggs and wheat flour in the United Kingdom. *Sustainable production and consumption*, 27, 1255-1272. https://doi.org/10.1016/j.spc.2021.03.001

[34] Jagtap, S., Trollman, H., Trollman, F., Garcia-Garcia, G., Parra-López, C., Duong, L., Martindale, W., Munekata, P.E.S., Lorenzo, J.M., Hdaifeh, A., Hassoun, A., Salonitis, K. & Afy-Shararah, M. (2022). The Russia-Ukraine conflict: Its implications for the global food supply chains. *Foods*, 11(14), 2098. https://doi.org/10.3390/foods11142098

[35] Yalina, N.; Rozas, I.S. (2020) Digital workplace: Digital transformation for environmental sustainability. *IOP Conference Series: Earth and Environmental Science*, 456, 012022.

[36] Demartini, M.; Evans, S.; Tonelli, F. (2019) Digitalization Technologies for Industrial Sustainability. *Procedia Manufacturing.*, 33, 264–271.

[37] Putthiwat, S.; Kamonchanok, S.; Pongsa, P. (2021) Factors Influencing Digital Transformation of Logistics Service Providers: A Case Study in Thailand. *The Journal of Asian Finance, Economics and Business*, 8(5), 241–251.

[38] Akyazi, T.; Alvarez, I.; Alberdi, E.; Oyarbide-Zubillaga, A.; Goti, A.; Bayon., F. (2020) Skills Needs of the Civil Engineering Sector in the European Union Countries: Current Situation and Future Trends. *Applied Science*, 10(20), 7226; https://doi.org/10.3390/app10207226

[39] Snowdon, A.W., 2022. Digital Health Ecosystems: A Strategy for Transformation of Health Systems in the Post-Pandemic Future. In *Nursing and Informatics for the 21st Century–Embracing a Digital World*, 3rd Edition, Book 1 (pp. 1-28). Productivity Press.

[40] Gartner (2022a). *The 2023 CIO Agenda*, https://www.gartner.com/en/information-technology/trends/cio-agenda-ebook-gb-pd?utm_source=google&utm_medium=cpc&utm_campaign=RM_NA_2020_ITTRND_CPC_LG1_H2-GTS-AOC&utm_ad-group=130141360451&utm_term=gartner%20cio%20survey&ad=628812147979&matchtype=p&gclid=EAIaIQobChMIzb_Ap-WD-wIVqjizAB3FlwCDEAAYASAAEgLF9fD_BwE

[41] Deloitte, (2020a). *Tech Trends 2020* https://www2.deloitte.com/content/dam/Deloitte/cz/Documents/technology/DI_TechTrends2020.pdf

[42] Ting, D.S.W., Carin, L., Dzau, V. & Wong, T.Y. (2020). Digital technology and COVID-19. Nature medicine, 26(4), 459-461.

[43] Marques, G., Miranda, N., Kumar Bhoi, A., Garcia-Zapirain, B., Hamrioui, S. and de la Torre Díez, I., (2020). Internet of things and enhanced living environments: measuring and mapping air quality using cyber-physical systems and mobile computing technologies. *Sensors*, 20(3), 720.

[44] Weersink, A., Fraser, E., Pannell, D., Duncan, E., & Rotz, S. (2018). Opportunities and challenges for big data in agricultural and environmental analysis. *Annual Review of Resource Economics*, 10(1), 19-37.

[45] Leng, J., Ruan, G., Jiang, P., Xu, K., Liu, Q., Zhou, X., & Liu, C. (2020). Blockchain-empowered sustainable manufacturing and product lifecycle management in industry 4.0: A survey. *Renewable and sustainable energy reviews*, 132, 110112.

[46] Esmaeilian, B., Sarkis, J., Lewis, K., & Behdad, S. (2020). Blockchain for the future of sustainable supply chain management in Industry 4.0. *Resources, Conservation and Recycling*, 163, 105064.

[47] Deloitte, (2021). *Everything-as-a-Service (XaaS) Study*. https://www2.deloitte.com/us/en/pages/about-deloitte/articles/press-releases/deloitte-survey-accelerated-by-pandemic-cloud-and-everything-as-a-service-xaas-solutions-continue-to-transform-enterprise-it.html

[48] Zhang, F., 2022. Digital Transformation of Enterprise Finance under Big Data and Cloud Computing. *Wireless Communications and Mobile Computing*, 2022, Article ID 1068467

[49] Rubenstone, J., Buckley, B., Yoders, J. & Rubin, D.K. (2020). *Industry Finds New Innovations to Stay Ahead of COVID-19*, Engineering News-Record.

[50] Khan, N.A., Brohi, S.N. & Zaman, N. (2020). *Ten Deadly Cyber Security Threats Amid COVID-19 Pandemic*. https://www.techrxiv.org/articles/preprint/Ten_Deadly_Cyber_Security_Threats_Amid_COVID-19_Pandemic/12278792/1

[51] Kutzschenbach, M. V., & Daub, C. H. (2021). Digital transformation for sustainability: a necessary technical and mental revolution. In *New trends in business information systems and technology* (179-192). Springer, Cham.

[52] Luftman, J., Lyytinen, K. & Ben-Zvi, T. (2017). Enhancing the measurement of information technology (IT) business alignment and its influence on company performance, *Journal of Information Technology*, 32(1), 26-46.

[53] Deloitte (2020b). *2020 Global Technology Leadership Study* https://www2.deloitte.com/us/en/insights/topics/leadership/global-technology-leadership-study.html

[54] Gartner (2022b). *Gartner Identifies Three Factors Influencing Growth in Security Spending*, Press Release, https://www.gartner.com/en/newsroom/press-releases/2022-10-13-gartner-identifies-three-factors-influencing-growth-i