

# Preface

## THE NEW TECHNOLOGY LANDSCAPE

In 2015, IBM observed that “cloud computing, mobility, social business, big data and analytics and IT security technologies are evolving very rapidly”, and that “as these technologies mature and converge, they are demanding a total re-examination of the underlying enterprise infrastructure” (IBM, 2015, p.2). Six years on, that prophesy is now coming true in organisations, big and small, across the globe. To the list cited by IBM, one could now add artificial intelligence (AI), the Internet of Things (IoT), blockchain, robotics, and the immersive technologies as constituting what are now considered the “digital technologies.” Many of these technologies work in combination and act as drivers for each other. For example, big data and analytics frequently utilise AI tools to provide another level of intelligent analysis. In parallel with the advent and take-up of digital technologies has been the advance of Industry 4.0, which is radically changing the way industries produce, develop, and sell their goods. This move to the “smart factory” relies heavily on the deployment of the digital technologies, or “enabling technologies” as they are sometimes termed in the manufacturing environment, which are being integrated into the existing network of industrial machines. Then, there is the inexorable growth in data, driven in the main by the expansion of IoT devices. Potnis (2020, January) notes that according to IDC, the overall number of “connected” IoT devices worldwide will increase to over 35.2 billion by 2023 and almost 42 billion by 2025.

This rapidly evolving technology landscape has brought with it a range of new concepts, terminologies, acronyms and abbreviations. As cloud computing has come to dominate as the delivery environment for computing and data storage, so the mass of IoT devices that collect this data have come to constitute what is often termed the “edge”, and the processing of data close to those devices as “edge computing.” Extreme Networks (2021) see edge computing as “an evolution of cloud computing”, which “brings application hosting from centralized data centers down to the network edge, closer to the enterprise and consumer, and the data generated by applications” (p. 2). Between the cloud and the edge, a new systems architecture of nodes is evolving that computes and reduces data from the edge before moving it to the cloud, this being termed “fog computing.” Then, the concepts of ecosystems and platforms, shared with other disciplines, are now being applied in a variety of contexts relating to digital technologies and digital transformation. Diana and Torrance (2020) define digital ecosystems as “a complex network of stakeholders that connect online and interact digitally in ways that create value for all” (para. 3). Others see the cloud, the fog, the edge and IoT devices as “the cloud ecosystem.” There are also different perspectives on what platforms are, but they are generally viewed as systems and interfaces that facilitate commercial interaction between businesses, customers and consumers.

Systems developers operating in a cloud environment have a range of new concepts, technologies and tools with which to work. Containers, for example, “let you work smarter by creating consistent development environments to rapidly develop and deliver cloud-native applications that can run anywhere” (Red Hat, 2019, May 29, p. 3). New entities have also emerged and become established as part of the technology supply network. Cloud service providers (CSPs) operate vast data centres that store petabytes and even exabytes of data arriving via the internet. Horison Information Strategies (n.d.) estimate that the installed global storage capacity for public cloud will reach 50% of all installed storage capacity by 2025. The term “hyperscalers” is also now used with reference to the large internet services companies who are dominating the cloud and are now expanding into other vertical markets – for example, Microsoft, Google, Amazon and Facebook. Birkinshaw (2019) terms some of these entities “ecosystem orchestrators”, and notes that companies like Google, Alibaba, and Uber, “create value through relationships and networks, not through physical goods or infrastructure” (para. 6).

The implications for industry and society at large are huge, and have parallels with the advent of the internet at the close of the 20<sup>th</sup> century. As Chatterjee (2020) notes, “the rapid pace of change in today’s digital economy has spurred the convergence of enterprises and even industries. With digital technologies, traditional barriers to entry are fast disappearing and a whole new set of non-traditional competitors have emerged, forcing decades-old industry leaders to evaluate their business strategies and competitive differentiators” (para. 1). This Handbook of Research examines the phenomenon of digital transformation through the lens of industry case studies where different combinations of these new technologies have been deployed. It covers a range of topics including cloud computing, internet of things, artificial intelligence, big data and analytics, immersive technologies, social media, chatbot implementation, project management, cybersecurity, sustainability and IT sourcing in various organisational settings. The book is aimed at IT professionals working in industry, public sector organisations, and consultancies, who are faced with similar challenges to those discussed here. It will also be of interest and value to the university community, providing 20 case studies of either industries, organisations or specific technologies - each with a detailed research methodology, objectives, findings and analysis - which can be used both for teaching and as a reference work for new research initiatives in this expanding field of study.

## **ORGANISATION OF THE BOOK**

This Handbook of Research comprises 20 main chapters from authors working in industry or higher education with first-hand experience of either using or researching digital technologies. A brief overview and introduction to the chapter content is provided here.

Cloud computing features in a number of chapters. As Kiran et al. (2020) note, “the cloud (public, private, and hybrid) is a key enabler of digital transformation in modern enterprises. Businesses now expect a cloud-like experience — better performance, more agility, operational simplicity, and greater responsiveness — in practically all facets of their operations” (p. 5). In Chapter 1, Maryam Rezaeian and Martin Wynn examine the growth in cloud computing in the university sector, and focus specifically on the impact this has had on the IT support function in a large international UK-based university. The research is based on six in-depth interviews with senior IT support managers, and reveals a range of issues that have required major change and adaptation of the support function. In Chapter 9, Christian Weber looks at how cloud computing has impacted multi-national industries, again using in-depth interviews with senior managers in six companies operating in different industry sectors. His research focuses on

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how cloud is affecting information systems (IS) strategy, and his conclusions suggest data management, IT skills and culture, and security issues are major change factors impacting IS strategy. This aligns with Fortinet (2019) who note that “83% of enterprise workloads will be in the cloud by 2020, and 63% of IT professionals see security as the most significant concern about this trend” (p. 5). In Chapter 17, Aydin Abadi, drawing on the extant literature and his own research, explains and illustrates his work on data availability checks in the cloud, and how blockchain technologies are enhancing proof of storage. As noted by Campagna (2017), “as more devices and critical data is moved to the cloud, the types of malicious attacks don’t necessarily change much, but how attacks are executed does.” Aydin’s chapter is a pertinent reminder of the intricacies of data security now necessary when operating in the cloud.

Artificial intelligence (AI), big data and analytics are themes that run through several of the chapters. As Dasgupta and Wendler (2019) note, “the transformative impact of AI comes from both its effect on intelligent decision making and predictions, as well as from its facilitation of greater automation” (p. 2), and both these aspects are evidenced in chapters in the book. In Chapter 4, for example, William Sayers examines the use of optimisation techniques in civil engineering, focusing on their potential for risk reduction. The author provides a review of optimisation techniques and related algorithms, and their application in the engineering field, and concludes that computer-driven and optimisation approaches will see increasing adoption. However, the author points out the need for multi-disciplinary teams, including experts in machine learning and data science, to work in an interdisciplinary nature, as the use of these techniques expands in corporate and scientific environments. In Chapter 12, Asif Basit examines how the interaction of process neurons can be used to analyse and understand business processes. To establish whether stigmergy - the spontaneous, indirect coordination between agents or actions - could be identified in a business environment, data was collected from a petrol station with a small shop and coffee bar. Informal interviews and observations aimed to identify the agents, signals and triggers, and how signals were strengthened or weakened. The research illustrates how business processes can be modelled as neural networks, opening up new possibilities in the design and control of processes, moving away from the deterministic top down paradigms of most business process management techniques, towards a decentralized self-organising paradigm. The implementation of chatbots is the subject of Chapter 15, in which Alexander Skuridin charts the origins and evolution of related technologies and assesses relevant models and frameworks. Based on an analysis of a case example from a global steel manufacturer, the author puts forward a four-stage model for chatbot projects that builds upon existing frameworks, and encompasses a set of critical success factors for such projects. The author concludes that chatbots will play a central role in the digital transformation of both industry and society at large, but points out that many obstacles will need to be successfully navigated in chatbot deployment and operation.

Chapter 6 investigates the use of advanced analytics in the procurement function of a major Tier-1 aircraft manufacturer. Adopting a qualitative, interview-based approach, Andrea Altundag establishes the current uptake of analytical tools and big data in this area of the company, and develops a maturity model for assessing the stage of analytics deployment in similar business contexts. This framework is unique in this industry sector, in that it examines several dimensions of change – not just technology deployment, but process change, structural evolution and people skills development. Simon Preis also focuses on analytics in Chapter 18, but in a different industry setting. The author examines the use of advanced analytics capabilities to support the development of predictive maintenance strategies and activities in the semiconductor industry. Based on a series of industry-based expert interviews at a case study company, the findings verify the importance of predictive analytics capabilities in the wafer fabrication process, and provide new insights into the integration of predictive maintenance technologies into

overall equipment maintenance operations. The study confirmed that predictive maintenance systems can deliver potential process improvements beyond the core maintenance tasks, but that the quality of predictions is variable, depending on the specific machine type.

Research on a number of the other mainstream digital technologies is reported in other chapters. The potential of the immersive technologies was highlighted recently by Genpact (2020) who note “what if manufacturers could digitally replicate entire value chains? Using machine learning and powerful VR and AR simulations to virtualize everything from individual components to processes, workflows, and consumption lifecycles” (p.37). Christine Baker examines the use and benefits of these technologies – augmented reality, virtual reality and extended reality – in Chapter 3. The author traces their origins and evolution over the past century, and their more recent application and benefits delivery in a wide range of industry sectors. She points out that the desired positive impact of immersive technologies rests heavily on the appropriateness and quality of the immersive content, and that the technology is only the delivery mechanism of the experience. She concludes, nevertheless, that immersive technologies are likely to make an increased impact in many aspects of our personal and professional lives, and that - subject to robust checks, controls and risk mitigation actions - the future of these technologies will enrich our lives. In Chapter 11, Andrew Nobbay examines how a work-oriented social media platform was used for innovation in a multi-national oil and gas company. The author uses the unified theory of acceptance and use of technology (UTAUT) framework (Venkatesh et al., 2003) to analyse how the Brightidea platform was used to promote crowdsourced innovation. The features that influenced use of the platform are identified and the potential for cross-functional innovation is explored. The chapter concludes that the social media-like features were positively viewed by users, and did indeed facilitate domain-crossing. It is a valuable example of how social media can be used productively within a corporate environment. Kiran Mysore and Martin Wynn discuss the Internet of Things in Chapter 8, a technology which, it seems, is all pervasive and a key component of digitalisation, producing vast amounts of structured, semi-structured and unstructured data. The chapter briefly reviews the IoT concept and its main technology components, and then reports on its varying uses in different industry sectors and the range of current and expected benefits. A number of emergent issues are examined, notably concerns around security and the need for a strategic approach to IoT deployment. The chapter concludes that the potential benefits will lead to a continued increase in the number of IoT devices, bringing about a major change in the supporting infrastructure, potentially entailing an industry-wide ecosystem providing global access to IoT device-generated data.

The relationship between digital transformation and sustainable development may not be immediately obvious, and Hilali et al. (2020) have observed that “empirical studies that have linked the factors of digital transformation and a more sustainable business are still scant” (p. 52), although work on the relationship between the two concepts is attracting increased attention within the academic literature. Indeed, Schneider (2019), amongst others, has looked to explore how companies can leverage digital technologies to innovate for sustainability. In Chapter 13, Peter Jones and Daphne Comfort review the concept of corporate digital responsibility and, more specifically, examine how the leading information technology companies publicly address their social and environmental digital responsibilities. Building upon an integrative literature review and an assessment of company web sources, the authors found the leading companies in this sector made significant commitments to addressing both environmental and social responsibilities, including, on the one hand, climate change, water management, and the circular economy, and volunteering and philanthropy on the other. Nevertheless, the authors set these findings within a wider perspective that encompasses the contradictory tensions between continuing economic

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growth and the transition to a more sustainable future, and concerns about whose interests are best served by corporate digital responsibility.

One of the main testing grounds for the development and implementation of digital transformation strategies in the recent past has undoubtedly been the automotive industry, which is undergoing radical change driven not only by digitalisation, but also by the advent of the so-called industry megatrends: “connected car, autonomous vehicle, sharing/subscription, and electrification” (Deloitte, 2021, para. 2). It is thus appropriate that several chapters here focus on different aspects of this industry wide change. In Chapter 2, Jose Irizar draws on his own industry knowledge of specific use cases and a set of in-depth interviews to examine the impact of several of the mainstream digital technologies (cloud, AI, analytics) in two multi-national companies operating in the automotive, and other, industry sectors. His findings highlight a range of issues, including the growing significance of the data-driven organisation, the need for a code of ethics to regulate AI operations, and the introduction of new management roles related to digital change at executive level. Then, in Chapter 14, Tina Wiegand and Christine Brautsch examine the recent evolution of project management practices in this rapidly evolving business environment. Through a combination of their personal involvement in the industry over the past ten years and a series of expert interviews, the authors detail the changes in project management techniques and methods now impacting IT projects. They conclude that agile technologies are now far more fit for purpose than the more traditional project management methodologies, and that a new approach will be required for IT project management to be effective in a turbulent industry environment. The authors put forward a new model that draws upon concepts and practices in project and sustainability management and digital technology deployment. Another key aspect of this industry transformation is examined and explored by Anatoli Quade in Chapter 10, in which the author reflects upon the growing significance of virtual projects in the automotive industry, driven by the changes noted above and the impacts of globalisation. From an analysis of existing literature, an outline model for virtual team leadership and operation is proposed, which is then further developed and validated by expert interviews in a global automotive supplier. The essential role of digital technologies in facilitating the operation of virtual teams is also explored. Then, in Chapter 20, Kerstin Felser focuses on the changes in IT sourcing strategy in the industry, driven by digitalisation and the megatrends. Using a combination of an online survey, a series of expert interviews and analysis of secondary sources, the author sets her findings within the overall context of the dynamic transitioning of the industry to new business models and relationships. She concludes that with digitalization, IT sourcing is becoming a strategic element of digital transformation manifested in multiple technology categories within the industry: digital processes and automation, Car-IT, and platforms and ecosystems; and that, as IT sourcing strategy evolves, new competencies, knowledge, skills, and a new digital mind set will become important assets for creating sustainable competitive advantage.

Whilst many of the chapters outlined above investigate digital technology deployment in large organisations, there are other chapters that focus on smaller scale operations. In Chapter 16, Phillip Turner examines the multiple aspects of recent change in a small-to-medium sized enterprise (SME) in the UK. The research approach is interpretivist, based on interviews with key personnel, and personal observation over a number of years as a range of digital technology projects have been implemented. The author relates technology deployment to value proposition and business model change management, and concludes that technology deployment - in this company at least - has not been related to any change in business model, and that technology in itself was not a primary factor in perceiving or managing disruption. The chapter provides an interesting counter balance to the large automotive companies, where widespread change is sweeping through the industry at pace. Olakunle Olayinka and Martin Wynn also focus on

small businesses in Chapter 19, this time in the context of Nigeria. Based on an initial survey of 47 small business enterprises (SBEs) and three follow-up case studies, critical influencing factors in the adoption of digital technologies are identified and a four-stage model to assess the level of adoption in such companies is put forward. The EDET model (Engage-Deploy-Exploit-Transform) allows assessment at individual process level and its application in the three case studies suggests a significant take-up of these technologies in most process areas in the companies studied. The developing world is also the setting for a case study on the development and use of a mobile application in rural India. As Yanes (2020) has noted “in poorer regions, mobile technologies have become an opportunity to boost economic, health, educational and technological development” (para. 2). Here, in Chapter 5, Martin Aruldoss and colleagues discuss the use of mobile apps to support the fishing communities of southern India, and more specifically describe how an app has been developed for the street selling fisherwomen in Tamil Nadu state. This app is now used by fifty fisherwomen to help them order fish from the markets and sell it on to customers. Although this project remains at pilot stage, the authors report a positive response from users, but further training and refinement of the app will be required. It will also facilitate a positive adjustment in the ways of working for the fisherwomen. As Staesser (2018) has observed “whether it is to increase food production, access health information, launch a start-up or improve education, a new reliance on mobile apps in developing countries transforms the way nations grow” (para. 8).

Cybersecurity is not normally seen as a digital technology in itself, but rather as a dimension of digital transformation that requires constant and vigilant management. Morgan (2020) recently reported that global cybercrime costs are estimated to grow by 15 percent per year over the next five years, reaching \$10.5 trillion annually by 2025, up from \$3 trillion in 2015. Morgan concluded “this represents the greatest transfer of economic wealth in history, risks the incentives for innovation and investment, is exponentially larger than the damage inflicted from natural disasters in a year, and will be more profitable than the global trade of all major illegal drugs combined” (para. 2). Here, in Chapter 7, Olakunle Olayinka and Thomas Win examine security and data privacy issues in two distinct and contrasting contexts: web-based small businesses and pandemic monitoring. In the former, they conclude that management of security issues was inconsistent and incomplete, and that such companies would benefit from adopting an established framework that provides a more thorough assessment on what is required to ensure an improved security profile. In the latter context, the authors put forward a privacy-preserving pandemic monitoring framework, consisting of three main components (multi-authority attribute-based encryption access control, blockchain-based record keeping, and a federated learning environment), to provide a robust and efficient means of performing privacy-preserving pandemic analytics. The chapter is an apt reminder of the new reality in which we live and work, crowded with new types of dynamic technologies and applications, that present a growing challenge to security leaders looking to effectively manage and reduce their cyber risk.

Finally, by way of conclusion, Martin Wynn reviews the different perspectives on digital transformation and IT strategy, and puts forward a framework for updating IT strategies in the digital era. In so doing, he draws upon the research and findings included the chapters of this book, and assesses the significance of digital technologies in the context of IT developments in the 21<sup>st</sup> century.

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