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The Smart Estate: Collaborative Working with Digital Information Management

Digital transformation is a fundamental reality for businesses today.

Warren Buffett, Chairman and CEO of Berkshire Hathaway

1.1 Introduction to the Book

With regard to Warren Buffett's quotation, organisations should realise that to postpone their digital transformation places them at risk of obsolescence. This is especially true in times of disruption. For instance, it has been reported that 97% of companies have advised that COVID-19 has sped up their digital transformation and 68% say the pandemic sped up their digital transformation significantly. Accordingly, it is up to a company's leadership team to commandeer this revolution while ensuring business continuity. With this in mind, the aim of this book is to explore how collaborative working and digital information management, including building information modelling (BIM) and digital twin technologies, can be aligned and integrated into modern estates management working practices. It responds to the increasing demand for practical, and industry-aligned, practice in estates and construction management. More specifically, the book addresses how digital information management can be pragmatically applied to current practice to increase collaborative working. To assist readers in this pursuit, case studies and example scenarios aligned to best practice methodologies are included. Practical advice is also provided to apply the theoretical principles of collaborative working and BIM and to introduce them within future estates management practices and projects.

The book explores the extent to which collaborative working in digital information management and BIM represents a viable tool in delivering improved estates management and construction outcomes and provides an important insight into the influence on the success of estates projects and programmes. In this regard, the book seeks to address the ongoing dilemma of improving collaborative working and act as a catalyst for improvements to professional and industry practices. It also encourages more organisations and individuals to embrace and embed collaboration and partnering within BIM digital platforms. This is a deliberate attempt to improve estates and construction practices in the UK, which have arguably not been delivering the impact and benefits that were intended in terms of successful outcomes.

The book focuses on:

- determining how collaborative working philosophies can be embedded and aligned in BIM technologies and practices to generate more successful project and estates management outcomes;
- developing a toolkit as a practical guide to assist companies in applying collaborative BIM strategies;
- identifying and detailing the steps required to enable digital information management, and specifically BIM, to benefit a building asset throughout its life cycle;
- building collaboration into FM delivery incorporating extended soft landings;
- case studies (featured in Chapters 8 and 9) detailing the successful and beneficial use of operational, maintenance, and facilities management software;
- the use, benefits, and value of digital twin technologies for collaborative information management;
- digital twin enablers for collaboration and the risks and barriers to adoption of digital twins; and
- Golden Thread initiatives and concepts around BIM.

The book is designed to assist students, academics, and practitioners in their awareness, understanding, and breadth of knowledge of the issues around collaboration philosophies and BIM digital platforms. These attributes will help to build trust and improved long-standing relationships between contracting parties on projects, with the overarching aim of delivering projects that are more successful. The overarching aim of this book is to create a practical guide for clients that can develop into a common client framework on how to initiate, procure, and manage collaborative BIM strategies. In this way it can offer clients turnkey solutions for defining, curating, coordinating, and maintaining the entire life cycle of digital building information.

The ‘value proposition’ of this book is that it will be read, understood, and accepted by readers as their main guidance and reference tool for improving best practices around the use of BIM and other digital portals. This is a book written for businesspeople by businesspeople based on sound theory (how to do it) and sound practice (lessons derived from case studies).

The book’s objectives are:

- to be the standard reference for asset owners’ understanding of the life cycle of their projects and therein reducing construction-based and operational-based risk;
- to identify a set of clear guidelines, national or international, to support the role of collaborative working in digital platforms such as BIM;
- to form the basis of a practical toolkit for guidance and teaching in the unique role that collaboration and BIM have for estates and project management practices;
- to look to future developments and identify the key role clients take in BIM, new developments in the RIBA Outline Plan Stage of Work, and other areas such as continuing project integration and collaborative working;
- to demonstrate the benefits of digital construction and information management in enabling a more efficient and effective estate; and
- to explore the role of digital twin technologies for the global built environment.

In previous studies into collaborative working, very little attention has been focused on the use of BIM technologies and methodologies for promoting improved estates outcomes. This book seeks to infill the literature and knowledge gaps through examination of mechanisms via the toolkit to encourage collaborative working within BIM strategies. It is also designed to address academic calls for greater insight into how collaboration can be created, mobilised, and developed using BIM as the catalyst.

Collaborative working is emerging as a ‘hot’ topic, considering the many cases over recent years when adversarial practices have emerged. Attempts by professional institutions to ‘turn the tide’ on this growing trend through codes of conduct have not always proved effective. Using BIM as a platform is hoped to address this growing concern. To address the deficiency of adversarial practices, this book is a practical ‘how to do it’ guide based on analysis of case studies and powerful practice examples for clients and professional practitioners to use in managing their estates and projects. Furthermore, the book does not just look at collaboration for project delivery, but it considers ongoing collaboration during the much lengthier operation and maintenance phase of a building. The book is a reflection on ‘before digital’ and ‘after digital’ and illustrates the benefits of the ‘art of the possible’ on an existing, complex university estate. It draws on case studies from the authors’ experiences and interviews, as well as other widely known recent publications. The book also incorporates a toolkit as a practical guide to introducing interventions to embed collaborative working into BIM strategies and therein improve practices and behaviours, which the research has found to be particularly beneficial for generating more successful project outcomes.

The book is mainly intended for construction management practitioners but could suit a wide target audience, including under- and postgraduate students and academics. The research findings are presented to prioritise use by professional practitioners and therein provide a practical guide for adherence to collaborative working philosophies and BIM technologies, and as a toolkit for improvements in estates and construction project management. The book is not designed as a holistic course textbook, albeit it could be a worthy inclusion in a recommended reading list for courses related to estates management and construction procurement. As such, it is not intended solely as a practitioner guide. Rather, the book aims to cross this divide and provide useful insight to both academics and practitioners in developing their understanding of the topic area.

Although the research was undertaken in the UK, and all findings are likely to therefore have best fit with the UK construction industry, the overall knowledge and understanding provided by this book will have international relevance. Other countries seeking to develop strategies for improved ethical practices using similar approaches to the UK will be able to utilise the book, with consideration of how the findings fit with their own understanding in practice.

1.2 Context and Background to Collaborative Working in Estates and Construction

Partnering and collaboration have long been championed and heralded as the future of the UK construction industry. Latham (1994) sought to ‘construct the team.’ He was heavily critical of traditional procurement and contractual routes, largely due to the

lack of coordination between construction and design. He suggested a change in culture and a move to partnering to increase fairness, encourage teamwork, and enhance performance through collaborative engagement of clients and design teams with contractors. This view was reinforced by Egan (1998) who saw early establishment of construction teams as an essential aspect of cooperative construction, with contractors able to contribute to management, buildability, health and safety, procurement, and supply chain management of projects. It was thought that such early collaboration reduced disputes and tender costs, and improved team working practices. More recently, the benefits of collaboration have been argued to include an increase in profits brought about by sharing expertise, knowledge, ideas, innovation, and best practice, and promoting efficiencies and improvements in decision-making (Hansen and Nohria, 2004). Collaborative working is also suggested to reduce the negative aspects of construction procurement by minimising conflicts and disputes through increased cooperation and developing relationships built on trust (Larson, 1997). Government support for partnering and collaborative thinking was championed by the Strategic Forum for Construction in the *Accelerating Change* report (Egan, 2002). Projects that had applied the principles of both Latham and Egan in the use of collaborative procurement methods were found to achieve significant improvements in client satisfaction, cost predictability, safety, and time predictability. Furthermore, there is an argument that when companies enter into highly complex, uncertain, and potentially risky projects as relative strangers, it is not surprising that frequent conflicts and disputes arise in traditional procurement systems (Chan *et al.*, 2004). Partnering and collaborative approaches seek to avoid conflicts and disputes by increasing levels of cooperation and developing organisational relationships built on trust (Larson 1997).

Notwithstanding the arguments in support of partnering and collaborative working, there is little evidence to suggest that such practices are becoming more widespread. Conversely, participation in these strategies is reducing in many cases. For instance, the RICS Contracts in Use Survey (RICS, 2012) found that partnering contracts during 2010 accounted for only 0.9% of all contracts by value, compared with 6.6% in 2004 and 15.6% in 2007. One possible explanation for this movement away from collaborative working could be reliance on the known and controllable which has previously been identified within the industry as a symptom of a 'negative culture' that is sceptical and suspicious of new initiatives. It has been argued that these old behavioural aspects, cultures, and attitudes are so deeply embedded in the construction sector that they are proving difficult to change (Thurairajah *et al.*, 2006). For collaborative working approaches to be more attractive to clients, they must seek to address problems of cultural indifference, old stereotypes, and the adversarial views of team members, alongside new ways of working being established (Liu *et al.*, 2004).

1.3 The Importance of Digital Information Management to Assist Collaborative Working

Estates strategies are embracing digital information systems for managing the life of buildings. This approach can create construction knowledge asset-based information platforms which can assist in developing more effective estates management practices

(Kiviniemi and Codinhoto, 2014). Notwithstanding this premise, there are sometimes many barriers and challenges to be overcome and these mainly revolve around cultural changes and interoperability issues. In the latter case, the ability of computer systems or software to exchange and make use of information has improved greatly in recent years. Technological advancements such as cloud-based applications have assisted in this regard and are continually being developed. Furthermore, governmental efforts to develop such initiatives as the building information modelling (BIM) development communities are about to be addressed in future years (Nica and Wodyński, 2016). Since 85% of life-cycle costs are spent in facilities management (FM) (Lewis *et al.*, 2010), the implementation of BIM in FM and maintenance, alongside the use of cloud-based applications, is seen to be essential. Wherever possible, such systems should avoid operational complexities and employ simplified user interfaces, allowing the systems to bridge more easily between existing FM workflows to model-based workflows. However, these transitions are significant and complex and help to explain why so few owners are adopting BIM (Cavka *et al.*, 2015).

The use of BIM can provide turnkey solutions for defining, curating, coordinating, and maintaining the entire life cycle of digital building information and should accordingly increase collaborative working in estates strategies. Furthermore, collaborative working has been associated with generating more beneficial outcomes for BIM technologies. This prognosis would suggest that there is a positive relationship between collaboration and BIM, with both supporting the development of the other. Later chapters of the book will explore how collaborative working and BIM can be aligned and integrated into modern working practices in construction and estates management.

The common data environment (CDE) has long been a mainstay of the topography of digital information management and BIM, but the evolving nature of the digital technologies, which may not be capable of addressing certain issues relating to FM, means that more comprehensive, user-friendly systems are required. Some software companies are already rising to this challenge with the development of their information management platforms (IMP). Such platforms are designed to support procuring, managing, and maintaining of interoperable data, to realise the full benefits of data management across an asset life cycle, from inception through to decommissioning.

1.4 Structure of the Book

The book has been structured into 13 chapters and covers the subject of the smart estate and specifically collaborative working aligned to digital information management. It approaches this subject from many different angles and perspectives but particularly in the context of the built environment. A brief outline of the themes of each chapter are detailed below.

Chapter 1: The Smart Estate: Collaborative Working with Digital Information Management

This chapter provides readers with an introduction to the book and the justification for choosing the subject area as its focus. There is an articulation and explanation of the aims

and objectives, and an identification of the potential readership of the book. This is followed by a brief description of the areas covered and the overall structure of the book.

Chapter 2: Introduction and Background to Collaborative Working and Partnering

An introduction to the concept of collaborative working and partnering is provided in this chapter, together with a description and explanation of what they are. An articulation of the different types and variations of collaborative working, as applied to the built environment, is also covered.

This chapter provides an overall context for collaborative working and partnering in terms of how they can be embedded into organisational cultures, policies, and procedures and the potential benefits they can generate for the built environment. Furthermore, it analyses how collaborative working and partnering can generate improved project outcomes.

The chapter starts by providing context for the discussions that follow around collaborative working and partnering. Accordingly, it provides background to the concepts of collaborative working and partnering. The choice of procurement strategies on projects is analysed with specific reference to the many different government reports which have been published. Thereafter, the overarching reasons for using collaborative working and partnering, as opposed to traditional procurement strategies, are discussed and the many benefits articulated. The different definitions of collaborative working and partnering are then presented to provide readers with a clear perspective of what they constitute. In addition, the different types of partnering are examined with reference to alliancing.

The chapter then covers the adversarial nature of the construction industry and some of the many problems that traditional forms of contracting procurement can create for projects and the built environment generally. Modern working practices are discussed in the context of collaborative working and partnering. A link is forged between collaboration, the use of building information modelling (BIM), and the introduction of innovative initiatives.

In summary the main areas covered in the chapter include the following:

- context of collaboration within the estates and construction sectors
- construction contracts that have embedded collaborative philosophies
- importance of trust within the context of collaboration
- trust as a collaborative necessity
- alternative definitions and meanings of trust
- different perspectives of collaboration and trust
- exemplar models of collaborative working around ‘perfection through partnering’ concepts
- philosophy and benefits of teamwork and integration of the whole supply chain
- different types of trust are identified alongside the ‘propensity to trust’ theory

Chapter 3: The Importance of Trust, Collaboration, and Partnering for the Built Environment

This chapter starts by articulating the problems around general traditional procurement in the built environment, as context for the discussion on partnering as a potential worthy

alternative to past practices. For this reason, it describes the traditional adversarial nature of the construction industry and past problems with the procurement processes for building projects. This description encapsulates discussions around some of these problems including the appointment of consultants, main contractors, subcontractors, and suppliers on the basis of lowest price tenders. The chapter concludes by discussing some of the implications around competing commercial interests associated with traditional procurement practices.

In summary the main areas covered in the chapter include the following:

- lack of trust leading to a reluctance to collaborate
- differing contexts to the problem of trust and collaboration
- in-depth analysis of why collaboration and partnering is important for estates management and the construction industry
- recent government reports (Construction 2025) focusing on the need to improve delivery by collaborative means and the introduction of NEC3 forms of contract to enable this
- explanation of the importance and benefits of collaborative working from a dependency and interdependency perspective

Chapter 4: Analysis for the Lack of Collaborative Working and Partnering in the Built Environment

This chapter of the book is largely based on the research study by Challender *et al.* (2014) which focused on collaborative construction procurement strategies. It concentrates on the lack of collaborative working and partnering in the built environment and specifically around the wide-ranging consensus that potential barriers in the construction industry could have hindered their success. For this reason, these barriers are examined and they include fear of the unknown, perceived loss of control, uncertainty, and the lack of understanding of how to change the way one works. The chapter then discusses the downward trend in the popularity and participation of collaborative working practices, once heralded as a breakthrough in construction management, but now making a return to traditional procurement based on lowest cost tenders. Following on from this it attempts to reconcile this downward trend by presenting evidence of low levels of client satisfaction, owing mostly to poor cost and time predictability, which have in turn been attributed to a low level of trust in practice. Furthermore, it examines reports that clients may be feeling the only way to assure themselves that they are not paying too much is to market test their projects in a highly competitive environment.

In summary, the main areas covered in the chapter include the following:

- risks associated with unethical practices under partnering arrangements
- abuse of power by clients towards main contractors, or main contractors towards their supply chains
- inequitable working arrangements – the disparity of power between clients and other organisations
- an examination of how partnering and collaborative working have been influenced in the past by austerity and economic uncertainty
- why collaborative procurement may be perceived as a risky alternative to traditional competitive tendering
- measures that could be introduced for partnering to succeed in the future, including BIM

Chapter 5: Potential Risks, Problems, and Barriers for Collaborative Working in Estates and the Built Environment

This chapter outlines some of the most common adversarial practices, relationships, and behaviours that exist in estates and construction as context to the challenges posed for these sectors. It explains the possible reasons for such predicaments by reference to the ‘one-off’ project nature of construction contracting and the resistance against changing old familiar traditional working practices. It then develops the discussions further by offering potential ways and means to address the risks, problems, and barriers brought about by these dilemmas, while contemplating the commercial, economic, and contractual pressures in the sector.

In summary the main areas covered in the chapter include the following:

- influence of legislative and governance measures alongside organisational barriers
- various incentives, problem-solving, and dispute resolution procedures as a means to address risks, problems, and barriers
- potential risks, problems, and barriers for collaborative working in estates and the built environment
- the fractious nature of the UK construction industry, based largely on ‘one-off’ projects
- potential barriers, systemic problems, and challenges to collaborative working and partnering
- propensity for contracting partners to trust one another in a commercially sensitive industry with large amounts of money at stake
- the short-term nature of construction projects and the imbalance and abuse of power between contracting parties
- partnering and collaborative working in times of economic uncertainty
- strategic partnering as a means to achieve greater opportunities for successful outcomes
- factors which could inhibit trust in partnering
- constructs, attributes, and factors which could influence trust in the context of partnering practices

Chapter 6: Collaborative Working with Digital Information Management in Estates and Construction

This chapter examines the emerging digital technology innovations in digital information management in engineering and construction. It covers the following areas:

- definition and scope of digital information management in construction
- the origin and development of digital information management
- aspects of digital information management and its requirements
- trends and innovations in digital information management

Chapter 7: Technologies for Collaborative Digital Information Management in Estates and Construction

Following on from the Chapter 6 covering emerging digital technology innovations in digital information management, this chapter considers those innovations which are

applicable in estates operations. It focuses on the wide-ranging variations in the way applications are implemented, owing to the peculiar nature of estates operations being different from other sectors in the built environment. Furthermore, it considers the nature of estates operations which adds some additional complexities and challenges regarding uptake and diffusion of innovations. For these reasons this chapter covers the intricacies in the digital transformation of estates by reference to the following sections:

- 7.2 Technologies Featuring in Digital Transformation of Estates
- 7.3 The Uptake of Digital Technologies in Estates
- 7.4 Factors Affecting Adoption of Digital Technology Applications in Estates

Chapter 8: Infrastructures for Collaborative Digital Information Management for Estates

In this chapter, the enabling infrastructures for digital transformation are examined focusing on key features characterising the pillars of socialism, mobility, analytics, and clouds driving progress. Further, key processes in the estates industry are delineated to expose specific areas of application. The discussions are covered under the following section headings:

- 8.2 Elements of Digital Transformation Infrastructure
- 8.3 Digital Transformation Processes in Estates
- 8.4 Aspects and Tools of Data Acquisition Aiding Digital Transformation
- 8.5 Digital Information Management Cases in Healthcare Facilities

Chapter 9: Actors in Digital Information Management for Estates

The role of actors in driving the information management process is covered in this chapter. The chapter establishes that while advances are made in the digital transformation journey, new roles emerge and training needs evolve. What these new roles are in the contemporary estates and associated markets are examined under the following headings:

- key actors in digital information management and transformation
- actors and professional institutions in estates digital information management
- emerging roles in estates digital information management

This chapter concludes with further case studies of digital technology application in estates.

Chapter 10: The Role of Digital Technology in Healthcare Facilities Management

The chapter is based on the MSc research of Ben Lyre, University of Bolton, and looks specifically at the role of digital technology in healthcare facilities management. Accordingly, while the chapter articulates and discusses the role of digital technology in the built environment, it is geared specifically to case studies around the healthcare sector. The use of digital twins for the built environment is just beginning, and yet to catch up with

healthcare, which was the motivation for choosing this sector as a model of good practice for the future.

The chapter starts by considering the importance of facilities management (FM) in the healthcare sector and examining the different digital technologies that can be used to streamline estates services. For this reason, it considers such digital technologies as the enablers to overcoming problems, creating efficiencies, and generating other benefits for managing large complex healthcare estates. It introduces the concept of artificial intelligence (AI) in estates management and the crucial role that this can play. In addition, it discusses the knowledge management technologies required to effectively manage healthcare facilities with an emphasis on achieving organisational objectives. In this sense, it articulates the benefits that knowledge management can provide identifying knowledge and skill gaps. It then explains build competencies for developing human resource professionals and establishing a knowledge-driven culture to facilitate the success of the innovation framework or process. Accordingly, this chapter investigates the knowledge management technologies required to effectively manage healthcare facilities with an emphasis on achieving organisational objectives. This is to provide an overview of the significant research efforts in digital technology that apply to improving the FM processes for the management of infrastructural assets and to present a road map for future research on digital FM applications.

In addition, the chapter explains the various digital technologies, systems, and software currently being used within healthcare FM. These include the following:

- geographic information systems (GIS)
- Internet of things (IoT)
- mobile-first
- machine learning and predictive analytics
- building information modelling (BIM)

Finally, the chapter provides some conclusions based around the future of digital technologies and a brief overview on the aspects covered.

Chapter 11: An Introduction to Smart Estates and Digital Information Management for Collaboration in the Built Environment Using Case Studies

This chapter of the book discusses the immense potential of digital twins for the urban built environment in solving some of the current urbanisation-led challenges. The research further recommends strategies on how best to derive the value of a digital twin to improve the future state of the urban built environment, such as target value design, knowledge sensitisation, continuous upskilling, collaboration, secure and safe data, infrastructure, and the need for standardisation.

The chapter uses case studies carried out in Singapore and the town of Herrenberg in Germany, which are two examples of where digital twins, albeit on different scales, have proved very influential in promoting such technology globally. It starts by giving context to the digital transformation in the built environment. In this regard it discusses how digital technologies have allowed the construction and engineering industries to develop what could not be created before, to construct new forms of building, and therein transform

cities. It then explains the work of the Centre for Digital Built Britain (CDBB) that provided the framework for information management to enable stable, resilient data sharing between digital twins. Furthermore, it refers to the work of the UK Government's Digital Framework Task Group (DFTG) which has devised a set of principles to promote the creation of a UK network of the digital twin.

The chapter then provides a background and context to digital twins and describe what they are, with alternative definitions given. It explains the three virtual models that make up digital twins and their key characteristics as a context for what they represent. An articulation is also made of the six recognisable elements that form part of the digital twins' maturity spectrum. The original concept, history, and evolution of digital twins are then discussed with reference to certain similar technologies dating back to the Apollo missions of 1968–1972. The chapter then proceeds to explain and discuss the importance of digital twins on the built environment and urbanisation on a global scale. The need for urban built environments to pave the way for continuous evolution, integrating emerging technologies for more effective global sustainability, is then discussed.

The ways and means by which digital twins have been regarded by many as a natural evolution of BIM is discussed and evaluated. Following on from this, the challenges around the built environment, particularly focused on fragmentation and low, underachieving productivity levels, are covered. To address these challenges, the use of digital twins in the built environment as a collaborative tool for creating smart cities in terms of urban modelling and planning is analysed. In this sense, the chapter explains how digital twins allow a high-degree simulation of urban plans, real-time monitoring and control of urban transport infrastructure, future mobility, and improved sustainability, with reference to the Singapore case study. Finally, the other benefits to digital twin technologies is described relating to efficiency and streamlined information workflows in capital delivery, health and well-being, security, building automation, and predictive maintenance.

Chapter 12: The Benefits and Value of Digital Twin Technologies for Collaborative Information Management

The chapter will discuss the full value and benefits of digital twins especially linked to collaboration and information management, using Singapore and Herrenberg, Germany as case studies. With reference to these case studies, the chapter articulates how Herrenberg established an 'Integrated Mobility Plan' and formed a digital twin pilot to reduce its high levels of traffic, while improving its environmental sustainability through reduced carbon and noise emissions. Conversely, it explains how Singapore, developed 'Virtual Singapore', a city-state digital twin and collaborative data platform designed to allow users from government and different industries to create and test new technologies, applications, and services.

The chapter discusses collaborative insights for the built environment by enhancing live real-time capabilities and data capture. It then explains how digital twin-related technologies are maturing to deliver intelligent solutions for urban planning and city science. Virtual technologies to help us manage demands on transport infrastructure, emissions, increasing energy use, and other challenges in urban areas more effectively are discussed. In addition, the chapter explores the means to address the ever-growing challenges around

environmental sustainability through digital technologies. It then assesses the ability for digital twins to monitor and control real-time asset outputs and how this technology can boost any number of adaptable services. The chapter then covers scenario planning and risk assessments and the notion of ‘digital siblings’ to understand the ‘what if’ scenarios, where things go wrong, and systems and assets fail. Predictive analytics and scheduling are discussed and also how a digital twin can act as a validation model framework with data from the real world. It then examines how this technology can provide a more effective and informed support system for decision-making, with the aim of transforming decision-making and investment.

Better synergies in intra- and inter-team collaboration are then explored. From this angle the chapter explains how digital twins allow information and data flow to enhance collaboration across the supply chain, reduce silos, and increase the understanding of existing built asset projects. This is followed by an insight into the optimisation of asset performance and sustainability. This covers the measures to improve the performance of future buildings through sensor networks linked to building elements and components. A case study in this context is discussed – namely the Energy House research by the University of Salford in the UK.

In addition to the above, greater efficiency in safety from digital technologies is examined, whereby individuals can get real-time monitoring and warnings, including updates of dangers and guidance for responding to emergencies. Finally, the ecosystem of connected networks, portfolios, and sectors is discussed. This includes examples whereby sensors, using IoT technologies linked to physical assets, can be utilised to evaluate their performance, condition, and status in real time.

Chapter 13: Digital Twin Enablers for Collaboration and the Risks and Barriers to Adoption of Digital Twins

This chapter of the book looks at enabling technologies for urban digital twins. It explains the role and importance of the following aspects:

- building information modelling (BIM)
- Internet of things (IoT)
- big data
- cloud computing and data analytics
- 3D and 5G modelling and high definition simulations
- artificial intelligence (AI)
- digital twin ecosystems
- smart buildings
- smart cities

In addition to the above, the chapter covers the current state of adoption and development of digital twins across the world. The digital twin market and uptake outlook and the importance of this to global economies are then analysed. Also, some emerging market case studies are used to demonstrate the successful outcomes that these have generated, and the challenging plans for future expansion and development. Following on from this, the digital twin information framework is discussed, including the Digital Twin Hub

launched by the Centre for Digital Built Britain (CDBB) as a platform for organisations and researchers who wish to improve governance around digital technology for the built environment.

The chapter then introduces the various issues that need to be considered for the adoption of digital twins, with reference to the complexity of the technology that is involved in their composition. In this regard, the technological challenges associated with addressing some of these issues are articulated including the following:

- spatial–temporal sensor data resolution
- connectivity latency
- broad data volumes
- high data generation rate
- wide data variety
- high data veracity
- fast archival retrieval and online data processing

Following this, the chapter then looks at the specific risks and barriers to development and implementation including:

- insufficient business case and evidence-based case studies
- complexity in data
- slow industry uptake in BIM
- multidimension fragmentation
- incompatibility in data language
- incompatibility in modelling social, economic, and environmental data sets
- data ownership, privacy, and security

Finally, conclusions and recommendations are identified and discussed, which includes the best ways to introduce digital twins for the urban built environment. These cover the potential of smart cities, which could herald the adoption of city-scale digital twins to solve current global urbanisation challenges.

Chapter 14: Reflections, Overview, and Implications for Future Practice and Closing Remarks

This final chapter summarises each chapter of the book and extrapolate the key findings and issues raised. Following on from what has been articulated and discussed, it presents some reflections and recommendations for the future of collaborative working and digital information management in the built environment, taking account of the inherent dilemmas and challenges that are faced.

1.5 Summary

There are many different aspects and themes relating to smart estates, especially within the context of collaborative working with digital information management. For this reason, the book's focus has become an increasingly 'hot topic' over recent years, predominantly to

address some of the challenges in the sector on a national and international level. Such challenges have revolved around not only the lack of collaborative working and partnering but also the quality and availability of useful digitally enhanced information and technologies. Accordingly, *The Smart Estate: Collaborative Working with Digital Information Management* is concerned with how we make improvements and positively contribute to the estates and facilities, construction, and engineering sectors and adopt different innovative initiatives and measures in addressing some of these challenges. For this reason, the book covers collaboration and partnering philosophies working alongside digital technologies, such as building information modelling (BIM) and digital twins, for procuring more successful project outcomes. In recent years, companies have realised that they need to focus on non-financial strategies linked to these aspects alongside their economic goals. This involves investing jointly in their staff and their systems which can bolster their reputations and in turn increase their success in the marketplace. In addition, commitment to collaborative partnering and investments in digital technologies can have a positive relationship with the job satisfaction and career success of employees and provide a safe and caring environment for them to prosper. As a result, companies that have embraced these areas have found that this raised the motivation levels of employees and increased the productivity and retention of the workforce. Accordingly, the evidence would therefore suggest that collaborative working linked to investment in digital technological advancements could have far-reaching positive effects on organisational success. Notwithstanding this assertion, such positive measures are not always easy to integrate into the built environment, which is predominantly associated with fragmented, complex, and potentially confrontational practices. This can create a dilemma for the sector and is evidenced in reported case studies referenced throughout the book. The book responds to this dilemma and addresses how standards can be pragmatically applied to professional practice and provides case studies and example scenarios aligned to modern-day requirements.

The book's toolkit includes the use of case studies to look at how successes, failures and key risks can be influenced by collaboration policies working with digital technologies. Other sections identify how policies and strategies, that can support smart estates, including BIM and digital twins, that can assist businesses in the built environment achieve more successful outcomes. These tools are intended to assist academics, construction-related practitioners, and clients in their awareness, breadth of knowledge, and comprehension of the issues around collaborative working with digital information management. This can then be linked to development of their smart estates with the overarching aim of delivering more successful project outcomes.

Although the research was mostly undertaken in the UK, the book utilises international case studies including those from Germany and Singapore. Accordingly, the findings are likely to have best fit with the UK construction industry, albeit the overall knowledge and understanding provided by this book will have international relevance.

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