g insight

About

Digitalization is leading to the transformation of the construction industry with the opportunities it offers to transform and optimize every stage and process of the asset life cycle. The magazine ***g insight*** provides influential knowledge and thinking on key digitalization trends inside the built environment, such as digital building, BIM, digital twins, sustainability, asset lifecycle management, etc. With our expertise and contribution of professionals, the magazine will show you a clear and feasible digitalization route through a global lens in both theoretical and practical ways, to make every project a success.

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Glodon Company Limited

SPOTLIGHT

Understand Current Status of Digital Twins in Construction Sector

Developing and Using Digital Twins from Design to Handover

Roles of Project Professionals in Creating Digital Twins during Design and Construction

OPINION

Thinking about Digital Twins for Smart Built Environment

AUGUST 2022

Digital Twins for Built Environment

Transforming Asset Lifecycle From Design to Handover

The construction industry, although one of the least digitized, has witnessed a significant acceleration in technology adoption in recent years. It holds the potential for higher productivity, more efficient processes, new business models and sustainable value chains.

Digitalization can be beneficial but disruptive. Meanwhile, the sector confronts major challenges amid pandemic and geopolitical risks. Besides, workplace safety, data security, and sustainability issues have mounted more pressure on the industry. Construction activity has already seen a contraction in some major markets.

Advances in the digital twin technology present an opportunity to integrate the physical world into the digital world and transform the construction industry, responding to some of today's challenges. The construction professionals should be more prepared and comfortable with using digital twin systems through the project lifecycle to deliver built assets that are economically viable and socially and environmentally positive for current and future generations.

Hope you can find valuable news, market intelligence, and technology insights in this groundbreaking issue that will make your digital twin journey easier.

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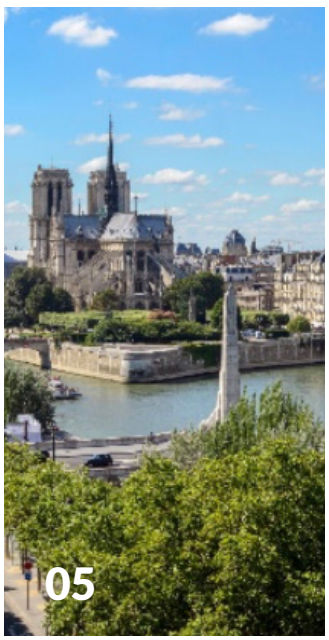


Voice of Glodon: The Key to Digital Transformation in Construction Industry

(By James Liu, Senior Vice President of Glodon)

Over the past century, the development of digital applications in the construction industry has fallen behind other industries. According to McKinsey Global Institute's Industry Digitalization Index, the construction industry is ranked as the second least digitalized industry in the world.

As awareness of environmental protection has increased over recent years, developing regions have shifted the focus of their development in the construction industry toward high quality and efficiency. Developed regions are paying increased attention to asset operations, maintenance and management. The industry's need for digitalization is becoming increasingly evident. The new type of industrialization of the construction industry should be carried out through digital means. And the previous investment-intensive large-scale

growth model should be transformed into a new development model driven by value creation to green the entire value chain and orient industrial transformation and upgrading towards industry-level refinement.

Digital twins have become one of the best vehicles for all stakeholders' efforts throughout the entire project life cycle, to systematically integrate digital applications and optimize productivity and production relations. This involves comprehensive use of information technologies such as sensors, computing and modeling, for description, diagnosis and decision-making in physical space conducted via software definitions, thus ensuring interactive mapping between physical and virtual space.

BIM, a pivotal part of the digital twin application, permits the creation of digital replicas with two-way connectivity to physical entities or processes, facilitating the transfer and integration of asset data at various stages of the life cycle. This information integration through digital twins is made possible by in-depth applications and mature technologies, such as cloud technology, big data, IoT, communication technology and AI. Virtual design permits, for example, the simulated implementation of physical projects, allowing a transition from the virtual to the real, while modeling makes an opposite transition possible. The virtual model can then be linked to the physical using sensing devices and intelligent hardware, permitting a symbiotic, closed-loop mutual mapping of virtual and real interactions. Thus, the digital twin seems set to become a key technological application in the construction industry, one which will play a pivotal role in catalyzing a once-in-a-century leap forward in the industry.

NEWS

Glodon Initiates Digital Building Demonstration Project in South China

Glodon laid the foundation stones for its South China Headquarters in Guangzhou on May 20. Glodon is on track to develop pilot digital buildings that are people-centric and function-centred through digitalization, green and industrial construction and operation. The construction of the new Headquarters will focus on key steps of the digital construction from design to construction. After completion, the Headquarters will be the smart hardware research and development center and the industry big data center and become a platform for communication and cooperation on the digital building.

San Francisco Ranked the World's Most Expensive City for Construction

2022 International Construction Market Survey published by Turner & Townsend found that construction in San Francisco costs $4,728.50 per square meter due to a storm of inflation, supply chain issues and demand from tech companies. Last year's top city, Tokyo, fell to the No. 2 spot on the list, followed by Osaka. Hong Kong has moved from second to seventh position. In total, North America had four markets in the top 10. The big shift in positioning for North American markets was said to be driven primarily by the strengthening of the US dollar, higher building material costs driven by supply chain disruptions and the region's high labour costs.

Dubai Developer Launched Zero-Carbon Smart City Project in Riyadh

Dubai developer URB has masterminded a zero-carbon future city called ALNAMA in the Saudi Arabian capital. The city is planned to become a smart zero-carbon destination, promoting sustainable living in a 10-square-kilometre community with various hubs, including residential, educational, commercial, tourism and medical. CEO of URB, Baharash Bagherian, explains ALNAMA aims at "producing all the city's renewable energy needs, as well as the resident's caloric food intake on site. Biosaline agriculture, productive gardens, wadis and carbon-rich habitats are key features of the development's innovative and resilient landscape design."

Minister Emphasises Construction Workplace Safety in Singapore

The Singapore authority is reviewing current workplace safety and health (WSH) requirements, calling for raised safety officer requirements for worksites, Singapore Manpower Minister Tan See Leng said on June 23. There have been 27 workplace fatalities in 2022 in Singapore so far, among which 10 were in construction. The Ministry of Manpower has since taken stronger enforcement actions and introduced stiffer penalties against errant employers. These measures will target companies with poor workplace safety and health standards. This means that safer construction companies will have better business opportunities while unsafe firms will be disqualified from competing for government contracts or will have a tougher time getting foreign manpower because they have more demerit points.

Australian Construction Activity Shrinks in June

The Ai Group and HIA Australian Performance of Construction Index (Australian PCI) fell by 4.2 points to 46.2 in June, indicating a contraction in activity across the construction sector. Housing, apartments and commercial construction saw activity fall significantly from the previous month, reflecting the impact of material and labour shortages and rising interest rates and costs. Only engineering construction was positive and improved from May after three months of moderation but remained well below the peaks seen in late 2021.

LEXiCON Project Launches Standardized Approach to Construction Product Information Sharing

UK's Construction Innovation Hub (CIH) and Construction Products Association (CPA) have launched a methodology, part of the LEXiCON project, for standardized construction product information sharing. It covers the creation and ongoing management of human-readable and machine-interpretable product data templates to make it easier for people to upload, categorise and compare data between products. To meet UK's Construction Playbook targets and respond to the Building Safety Act, more steps will follow in the project's next phase.

Cyber Attack Guidance Launched for Construction Firms in UK

UK's GCHQ, the country's intelligence, security and cyber agency, have published cyber security guidance for the UK construction industry following a string of cyber-attacks targeting tier-one contractors over the past three years. The guidance is tailored for small and medium-sized firms that rely more on digital tools and ways of working. It offers practical advice for each stage of construction, from design to handover, and sets out the common cyber threats the industry faces, including spear phishing, ransomware and supply chain attacks.

Paris Unveils New Design of Notre-Dame de Paris Surroundings with Support of Autodesk

The City of Paris has chosen a design from a competition to reimagine the area surrounding the Notre-Dame de Paris. The competition is supported by Autodesk, whose Building Information Modelling (BIM) solutions were used to create a 3D model of the existing area surrounding the Notre-Dame cathedral that competing teams used to understand the constraints of the site. It also helps competing teams create photorealistic visualizations of design proposals. The visualization enables the city to foresee a reduction in errors and greater clarity and collaboration with the winning team. Construction is planned to begin in 2024 and be complete in 2028.

Pilot Digital Twin Project in Los Angeles Helps Decarbonize Building Sector

Cityzenith, a Chicago-based digital twin platform, announced in June that it is partnering with Los Angeles's Better Buildings Challenge, a community of building owners representing 150 million square feet of commercial real estate space committed to 'going green', to help construct a digital twin of a section of the city to help make its buildings more sustainable and reduce carbon emissions. The partnership will explore digital twin technology to enable owners of buildings of any size, anywhere, to simulate their optimum financial paths to net-zero emissions.

MagiCAD 2023 Released with New Intelligent Tools for MEP Design

MagiCAD has released MagiCAD 2023 for Revit and AutoCAD, which takes another step forward in the intelligent use of data for innovative MEP design functionalities that help improve the speed, efficiency and quality of design work. MagiCAD 2023 for Revit enables ventilation designers to perform calculations across multiple model files with a new connection node between models' function. MagiCAD 2023 for AutoCAD introduces new functionalities across all MEP disciplines for effective and high-quality design work.

INTELLIGENCE

Global Construction Industry Confronts Major Challenges Amid Pandemic and Geopolitical Risks

(Source: GlobalData)

Market Development Summary

The global construction industry is confronting major challenges as it emerges from the widespread disruption caused by restrictions imposed to contain the spread of COVID-19. With the Ukraine crisis set to persist in the coming quarters, the global economy will face severe headwinds amid high energy and commodity prices, supply chain bottlenecks, and worsening investor confidence. Amid rising inflation, central banks have been tightening monetary policy, but with inflation being driven by supply-side pressures, there is a growing risk that high interest rates will choke off the recovery from the pandemic. Global construction output is now projected to expand by 3.3% this year, a downward revision from 4.0% previously. This follows growth of 3.7% in 2021 and the contraction of 2.3% in 2020.

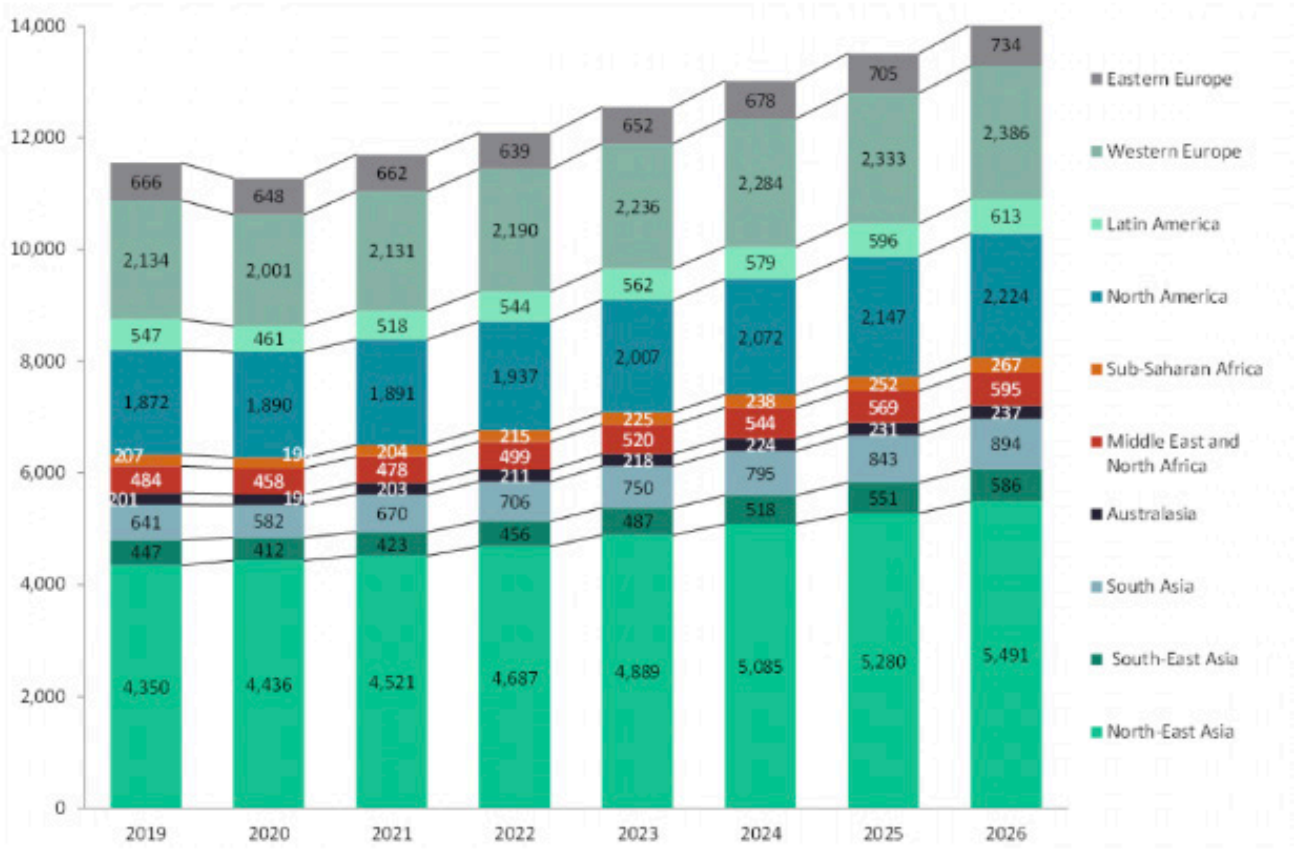


Figure 1: Global Construction Output Value (Real, 2017 US$ Billion), 2019–2026 (Image: GlobalData)

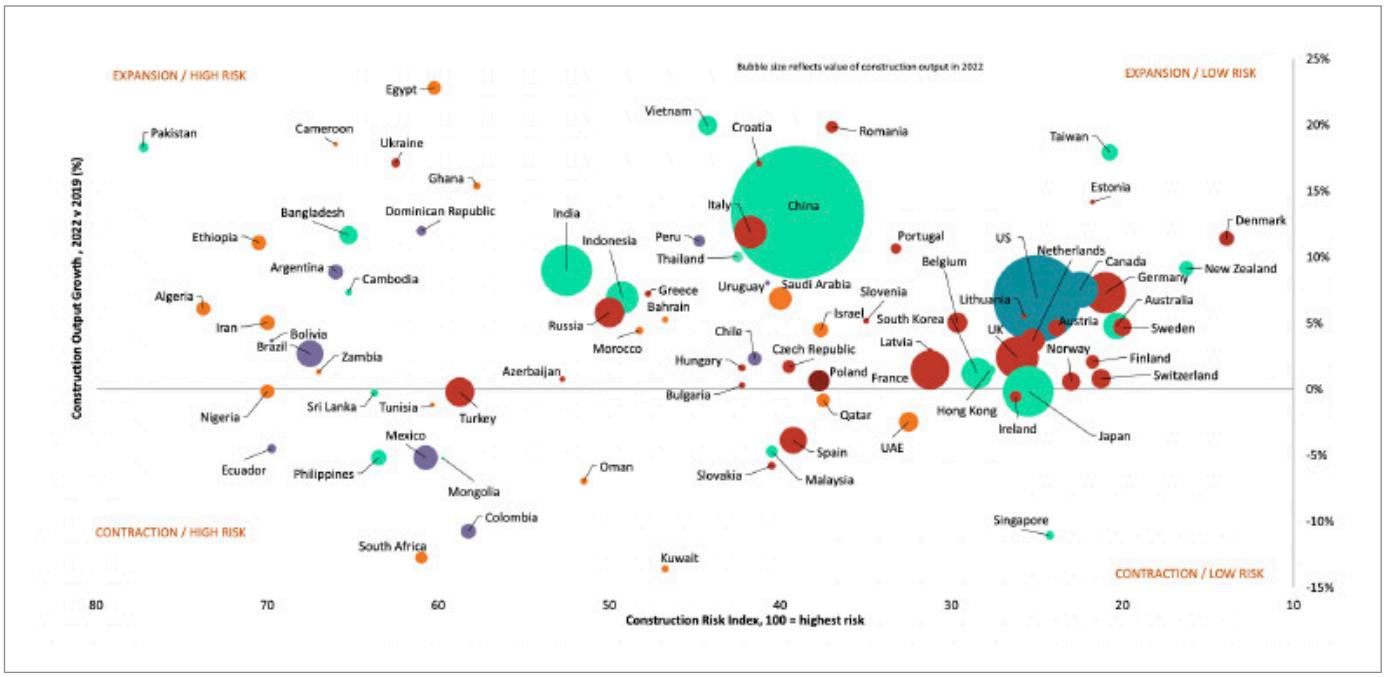


Figure 2: Construction growth versus risk in countries and regions, 2022 (Image: GlobalData)

Excluding China, the global construction industry posted growth of 4.5% in 2021, and is set to slow to 2.9% in 2022. Performances across countries and regions will vary greatly, but South Asia and North-East Asia will be the best performers when comparing output in 2022 to the pre-COVID-19 levels. India suffered a sharp contraction in 2020 but rebounded in 2021, and in 2022 output across South Asia will be 10.1% higher than in 2019 in real terms.

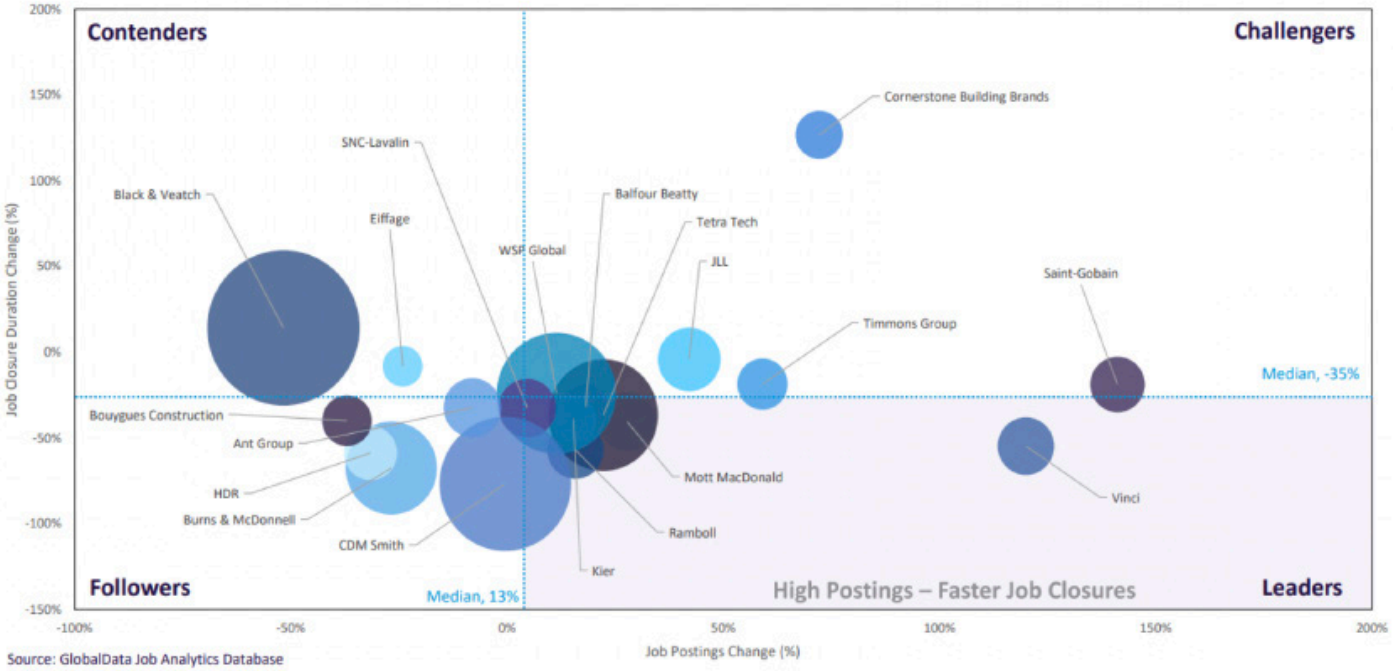
Opportunities and Risks

The key risks to project momentum remain significant, with geopolitical uncertainty stemming from the ongoing Ukraine crisis, in addition to rising inflation, tightening monetary policy and supply chain disruptions.

Supply chain disruption is the main road blocker. The global construction industry has been recovering from the severe disruption caused by the COVID-19 pandemic. However, it continues to confront major challenges. Shortages of key materials and associated rising prices for such materials have impacted the progress of construction projects, while logistical hold-ups along with supply chain disruptions are extending lead times. The combination of these factors means that contractors are finding it increasingly difficult to complete projects on time and on budget. Many of these challenges have been exacerbated by the Ukraine crisis, which has resulted in a further surge in energy costs as well as disruptions in the supply of vital materials, including steel.

Labour shortage has been a long and looming challenge. In addition to supply chain disruptions, the construction industry has also generally been struggling to recruit labour to meet requirements. The shutdown of the construction industry in many major markets in 2020 and also during periods in 2021 resulted in a sharp decline in construction employment, and there have been difficulties in recruiting talent as construction activity bounced back. Prior to the COVID-19 crisis, there had already been concerns about the ageing construction workforce and the looming challenge of ensuring that retiring skilled workers would be replaced. The reliance in many markets on immigrant labour has also been exposed in the wake of the COVID-19 crisis, with a proportion of this workforce not returning to their previous locations.

ESG is one of the most important themes of this decade. It's little wonder that pressure on the construction sector to further contribute to the clean environment and be more and more transparent as far as environmental, social and governance (ESG) are concerned. Calls for the construction sector to act are coming from many directions. Investors and consumers are voicing concerns about ESG issues, with legislation, regulation, and reporting requirements evolving quickly in many jurisdictions around the world. In the UK, all companies bidding for government contracts worth more than £5m a year must now commit to net zero by 2050, while new proposals in the EU call for the mandatory disclosure of the emissions potential of new buildings over their whole life cycle, effective from 2027 to 2030. Companies must perform well in all areas of ESG. Being a laggard in any one of the pillars of ESG framework will hurt their brand reputation and, ultimately, profits. In general, European construction companies respond more rapidly in terms of ESG hiring.



Source: GlobalData Job Analytics Database
Note: Size of bubble indicates ESG-related posted job count by company. High posting-faster job closure suggests growth in job postings and faster closures compared to the previous quarter
Data as on: June 9, 2022

Figure 3: ESG hiring of construction companies in Q1 2022 (Image: GlobalData)

SPOTLIGHT

As the world faces numerous challenges, a renewed approach to designing, constructing, and managing the built environment will be crucial. The construction sector should be prepared to use digital twin systems to deliver constructed assets that are economically viable and socially and environmentally positive for current and future generations.

This section is based on the RICS research paper in collaboration with Glodon, Digital Twins from Design to Handover of Constructed Assets, which examines the current state and future potential of digital twins across the built environment. To know more findings of the study, please visit glodon.com/en.

Understand Current Status of Digital Twins in Construction Sector

Most discussions about digital twins in the built environment sector focus on the operation and maintenance phase of assets. They have led to a view that digital twins primarily work to improve asset operation and maintenance, including the planning and procurement for operation and maintenance just before commissioning. Does this mean digital twins should only be developed and used after the asset handover or for existing assets? How are they relevant to the profession, especially the design and construction phases? What are the three things holding back the use of digital twins in the built environment sector?

It is clear that digital twins in the built environment sector are still developing. While they present several benefits, there remain numerous blockers to their use.

To better answer these questions, RICS, in collaboration with Glodon, conducted an online industry survey in September 2021 to collect insights on the current status and future potential of digital twins across the built environment.

By the time the survey was closed in early November 2021, there were 752 views, 366 starts, and 196 responses. Of these, 184 valid responses were used for further analysis. Of the respondents, 50.2% work in the broad areas of project management, construction and quantity surveying, and infrastructure, with 14.8% selecting design and engineering as their primary job roles. There was a good mix of organization sizes represented by the respondents. Micro and small organizations represent 24.3% of the responses, while 37.3% are from large organizations with over 1,000 employees.

From the survey, it is clear that digital twins in the built environment sector are still developing. While they present several benefits, there remain numerous blockers to their use. Key results of the survey are presented below.

Use of Digital Twins in Construction Sector is Still Low

Of the respondents, 16.9% stated that they are not familiar with digital twins, while 21.5% are using digital twins, and 42.4% are currently exploring the use of digital twins.

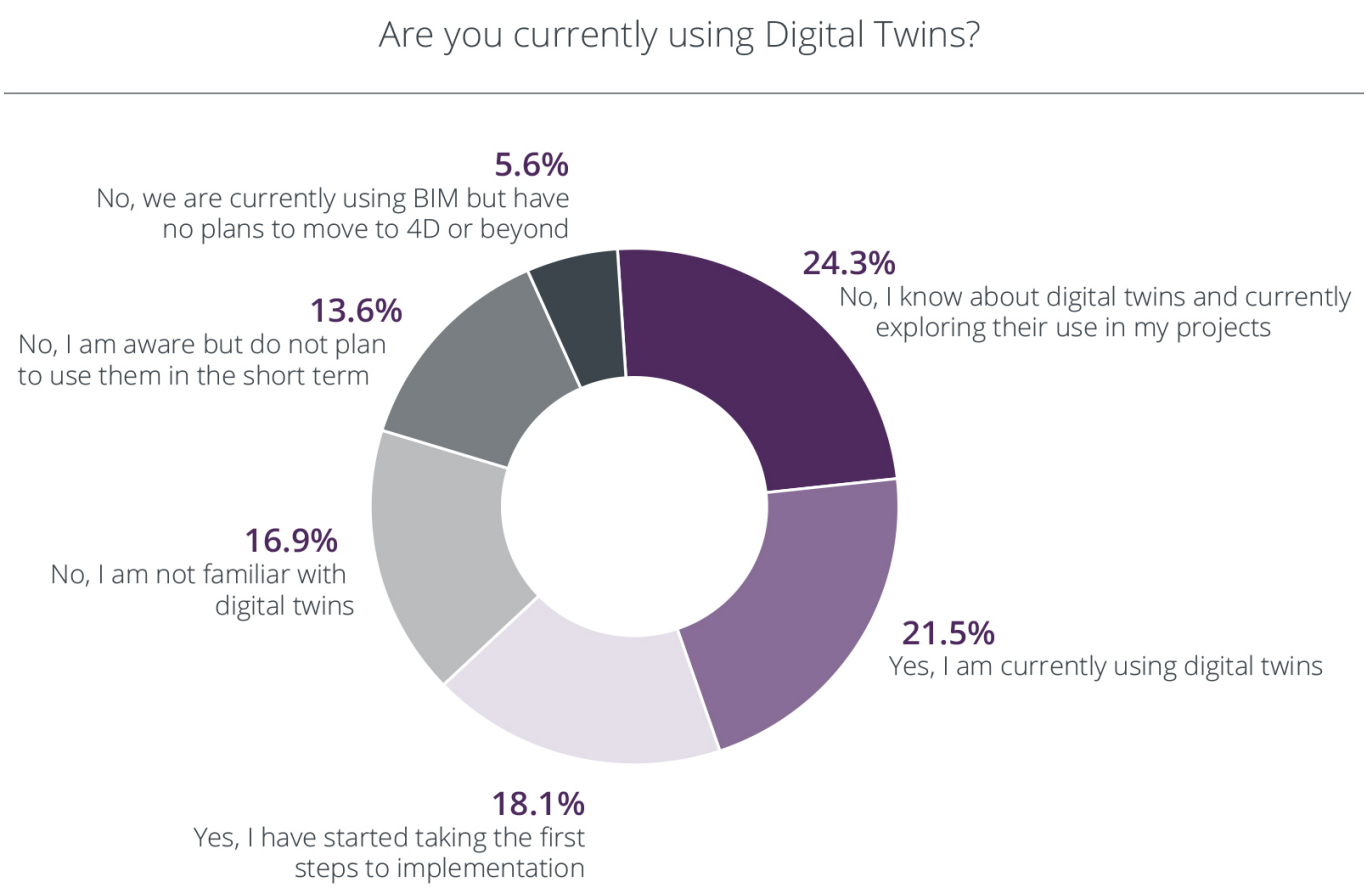


Figure 1: Current use of digital twins (Image: RICS)

Data are a Priority of Digital Twins Implementation during All Lifecycle Phases

When asked to select the top three current uses or possible uses of digital twins in the design and construction phase, 54.4% of the respondents selected "Facilitating data sharing to deliver performance efficiencies for all stakeholders" as their top choice. Other top choices included 53.7% selecting "Gathering real-time site data for decision making and collaboration" and 41.5% selecting "Progress monitoring and project controls". Surprisingly only 27.2% of respondents selected "Enhancing the handover process" in their top three choices, with a fifth overall ranking.

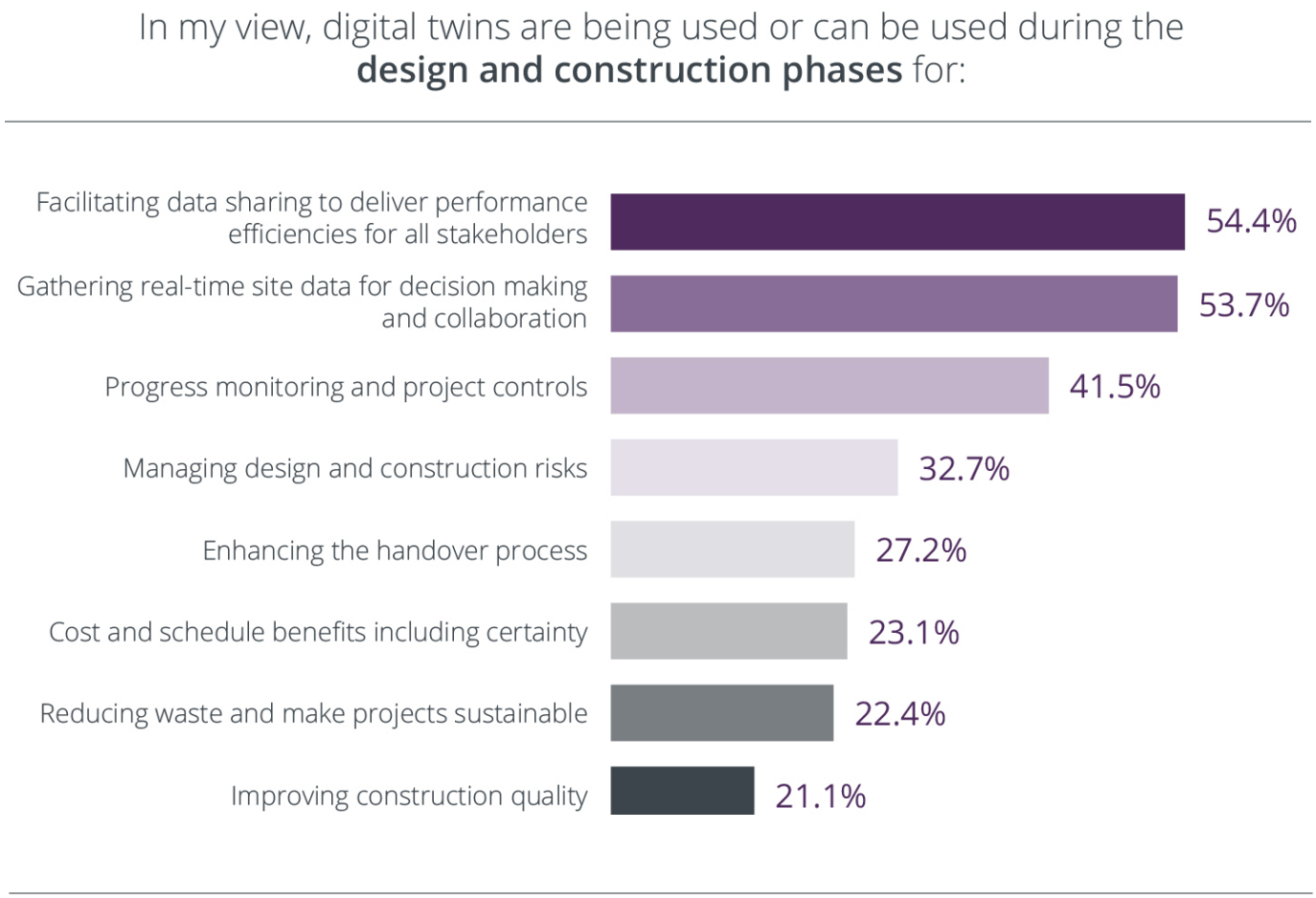


Figure 2: Choices of uses during design and construction (Image: RICS)

Regarding the uses during the operation phase, the top three selection are "Gathering real-time asset operation and maintenance data". "Making better operation, maintenance and renewable decisions" and "Imrpoving asset performance and onwer's bottom line", with 68%, 53.7% and 51.7% of respondents, respectively. 23.1% of respondents come to realize the role that digital twins play in "Meeting Environmental, Social and Governance (ESG) goals".

As-built BIM Models are the Top Deliverable Requested by Clients

In the top three choices of digital twin deliverables demanded by clients, respondents ranked "As-built BIM models" as first with 53.1%, "Dashboards showing connected real-time asset data" as second with 48.4%, and "Digital assets for various work processes" as third with 46.9% of respondents.

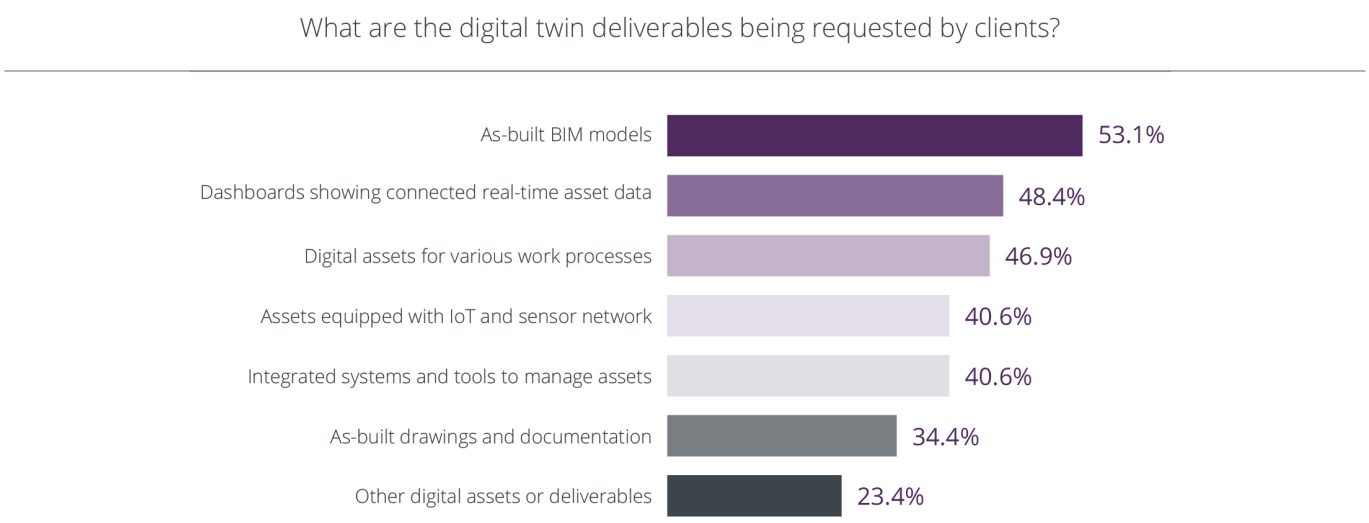


Figure 3: Deliverables requested by clients (Image: RICS)

Digital Twins for Asset Whole Lifecycle are Highly Recognized

When asked if they would deploy a digital twin on a project, 64% of the respondents saw the benefits of developing, deploying and using digital twins over the whole lifecycle of the asset.

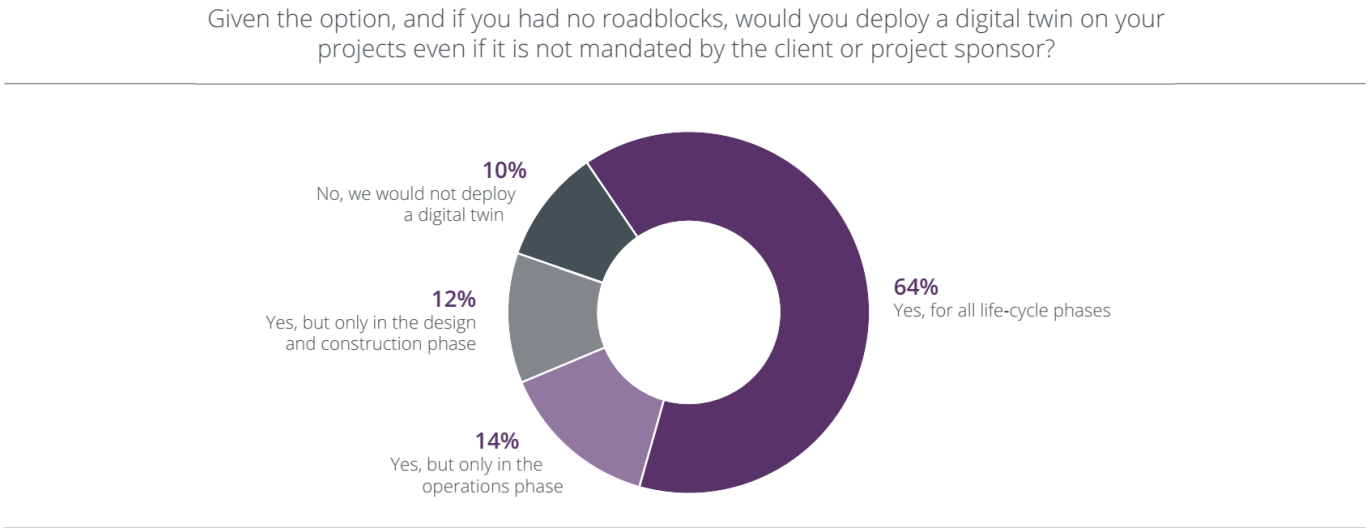


Figure 4: Life cycle uses of digital twins (Image: RICS)

High Cost is the Top Blocker that Hinders Adoption of Digital Twins

"High costs, including direct and hidden costs", "No demand or financial support from clients", and "Perceived complexity due to lack of information and training" were ranked as the top three blockers that hinder the use of digital twins during the design and construction phases.

When it comes to operation and maintenance phases, "High costs, including direct and hidden costs", "No demand or financial support from clients", and "Lack of standards" were ranked as the top three blockers that hinder the use of digital twins.

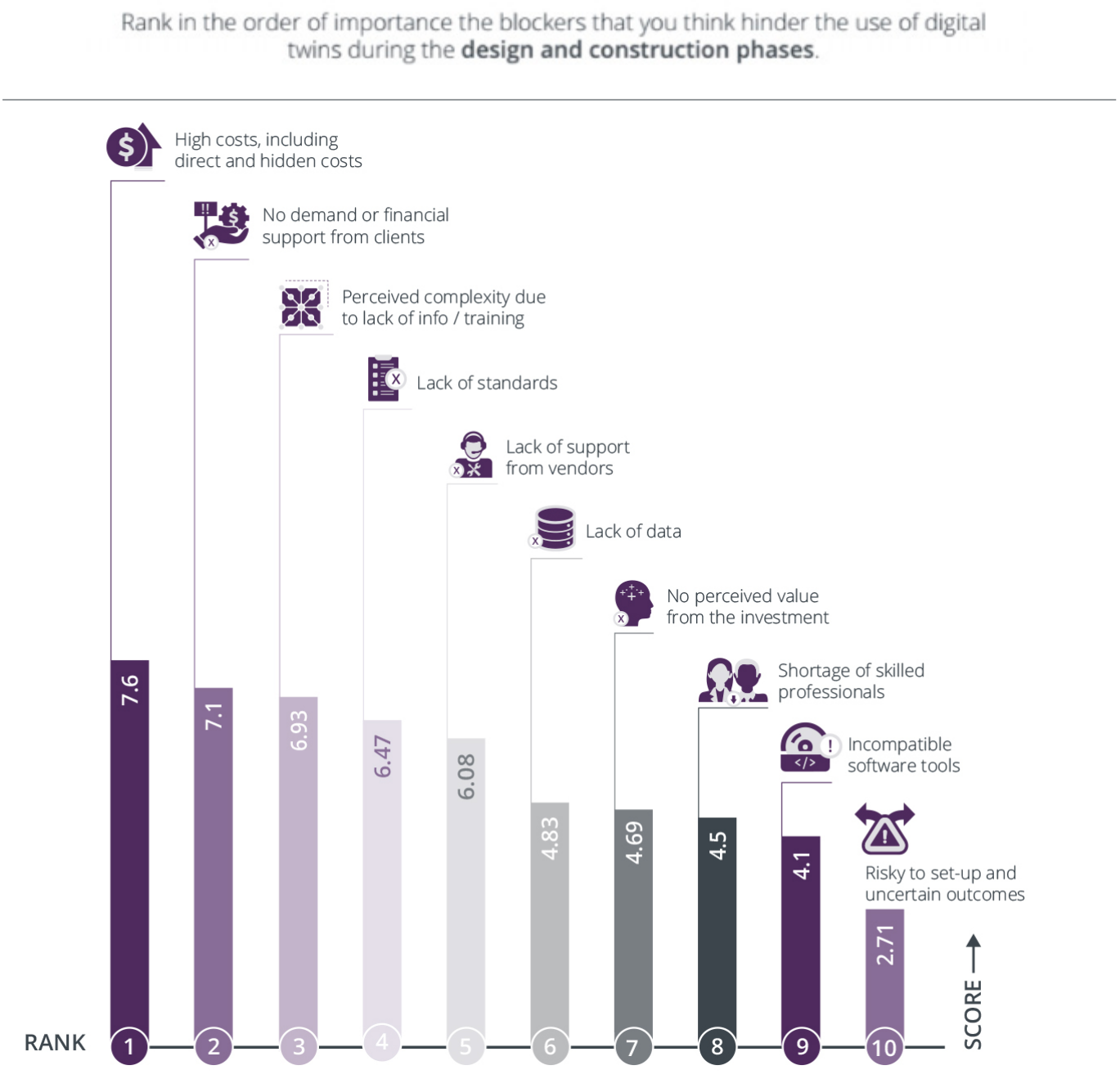


Figure 5: Blockers during the design and construction phases (Image: RICS)

Developing and Using Digital Twins from Design to Handover

A digital twin can be created at any project or asset life cycle stage. However, the creation of the digital twin, or detailed planning for its creation at an early stage of the life cycle and its use in the pre-project or project stage, is desirable.

Based on the type of asset and use case, actions needed during the design, construction and handover phase are different.

Life cycle stage → / Type of asset ↓	Design	Construction	Handover	Use
An existing asset with no planned intervention	No action needed	No action needed	No action needed	Digital assets are created from as-built information and point cloud data. Digital twin developed, deployed, used and continually updated for operation, maintenance and end-of-life
Existing asset undergoing renovation, refurbishment or retrofit	Design data and other digital assets produced for the renewal	Construction data and other digital assets produced while undertaking renewal	Digital twin with data, information, and models developed and handed over	Digital twin deployed and continually updated for operation, maintenance, and end-of-life
A new asset with no digital twin requirements during design and construction	No action needed	No action needed	The traditional handover process used	Digital assets are created from as-built information and reality capture. Digital twin developed, deployed, and used for operation, maintenance and end-of-life
A new asset with digital twin provisioning during design and construction, and deployed and used during the in-use phase of the asset	Design data and other digital assets produced and updated	Construction data and other digital assets produced and updated	Digital twin with data, information, and models developed and handed over	Digital twin deployed and continually used and updated for operation, maintenance, and end-of-life
A new asset with digital twin provisioning during design and construction, and deployed and used for the whole of life, including the project stage of the asset	Design data, other digital assets including a digital replica produced, and replica used for simulation and further what-if analysis	Construction data other digital assets produced and updated, including an updated digital replica produced along with the physical asset, and used during construction	Digital twin with data, information, and models developed and handed over	Digital twin continually deployed, used, and updated for operation, maintenance, and end-of-life

Figure 1: Typical scenarios of digital twin applications from the design phase to the handover phase (Image: RICS)

Digital Twins at Design Stage

During the design stage, the main contribution to developing a digital twin is producing and creating digital assets such as BIM, drawings, images, and other types of design data and information about the construction objects and the asset itself. Careful consideration of the consistent classification of elements, and definition of a data dictionary that is complete enough to fulfil the intended use cases, are foundational requirements. Verification and validation of data is essential.

The creation of the digital twin, or detailed planning for its creation at an early stage of the life cycle and its use in the pre-project or project stage, is desirable.

A virtual representation that acts as a representational (graphical) and computational model is developed. The delivery of digital assets during design is guided by the overall information management process adopted for the digital twin.

At the design stage, the careful planning of the sensing layer (e.g. sensors, IoT devices, and asset and facility management system) can also be conducted and integrated with the design of the physical asset. Design specialists, vendors, and suppliers may be involved in specifying the sensing layer at this stage.

The use of the digital twin can enhance the design process and the creation of digital assets. This happens in two ways:

Firstly, by using digital twins, the designers and engineers have an opportunity to model, simulate and conduct what-if scenarios to improve and optimise their design. In a connected environment, they can also see how their asset design fits with existing assets and the surrounding environment. This can be performed at an individual asset scale to a district or city level.

Secondly, the design can be informed by data, information, and evidence received from various sources in a connected ecosystem. This can ensure tight coupling between the design, construction, and operation of built environment assets. Digital twins can improve the built environment's operational efficiency by integrating and automating the historical data and information from downstream processes such as asset management and facility management to inform performance-led design. While not possible on all projects, early involvement of construction and asset and facility management experts, along with the use of digital twins, can enhance the detailed design process.

The opportunity during the design phase is to create simulations of how the asset will operate and how end-users will use it, from traffic flow analysis to occupancy to energy use. By starting with simulations that can be validated in the actual asset, design intent can be carried forward and iterated with actual data once the asset is operational.

Digital Twins at Construction Stage

The physical asset is stood-up during construction. Large volumes of data are generated, updated, used and stored during construction. This is the stage where as-designed, as-planned, and as-built data about the asset can be merged. Any changes (captured by images, videos, point clouds)

during construction can be merged into the virtual representation using the as-built data. The use of BIM and related processes such as 4D and 5D BIM helps streamline the management of data and information during this phase.

In the construction stage, the sensing layer is assembled and installed as part of the physical asset and marked on the virtual representation for handover. As part of the digitisation, further BIM integration into construction, growing site data from digital tools, real-time inventory tracking and prefabrication and industrialised construction are beginning to knit together to improve the information management process during construction.

Taken together, construction teams are now better positioned to create, deploy and use digital twins from the inflow of materials, products and prefabricated components, the models of the asset itself, and the analytics to make those flows of data into valuable insight. Digital twins, in turn, can be effectively deployed during construction. Many site-based processes can be enhanced by using digital twins. Production management, work performance, health, safety, and wellbeing of workers, materials, and equipment tracking, can all benefit from the use of digital twins.

Digital Twins at Handover Stage

The handover of an asset can be significantly improved when digital twins are used. The traditional handover is generally inefficient and uses a fragmented and siloed approach to passing on the necessary data and information to the asset manager or operator. This may lead to missing information, difficulty assessing critical information or tedious processes due to a lack of interoperability of systems. As-built BIM models have been used to partially overcome these issues, but regular updating of these models with performance data is still a challenge.

As the design and construction process progresses, large volumes of data are generated and updated in the form of models, images, videos, point clouds, etc. This data is only as valuable as the asset manager's ability to access and operate, which can be a huge issue. These as-built BIM models (or asset information models) are still document-centric, do not provide a virtual-physical-virtual loop, come together towards the end of the project, and do not use recommended information management processes and practices.

On the other hand, a digital twin will allow a knowledge graph of the real world entity to be composed based on a selected ontology that represents the various entities, their interrelationships and the information associated with them, integrated from many data sources, one of them being the as-built models (or asset information models).

The digital twin collates all the handover information into a cohesive information model that is easy to access, use, and update during the operation, maintenance, renewal and end-of-life stages. Applicable to both new and existing facilities, a digital twin promotes best information management practices, reduces risks, and captures performance data and knowledge. As the creation of the digital twin begins early, the design and construction teams can continuously stage and validate asset data to assure data quality and accelerate and enhance the handover process.

Roles of Project Professionals in Adopting Digital Twins during Design and Construction

When an asset owner seeks to develop the digital representation of the asset, it is essential to take into consideration the purpose that ultimately the digital twins will serve. This purpose will dictate what type of data is important and needs to be collected, its frequency, the system it will be required to be connected to, and the industry standards required to store the data. The sophistication and accuracy of the digital information created will ultimately impact the business outcome; therefore, it is essential to understand key stakeholders and customer needs and address them appropriately.

Project professionals, including construction managers, cost managers, and quantity surveyors, play a critical role for the creation and use of digital twins for both existing and new assets

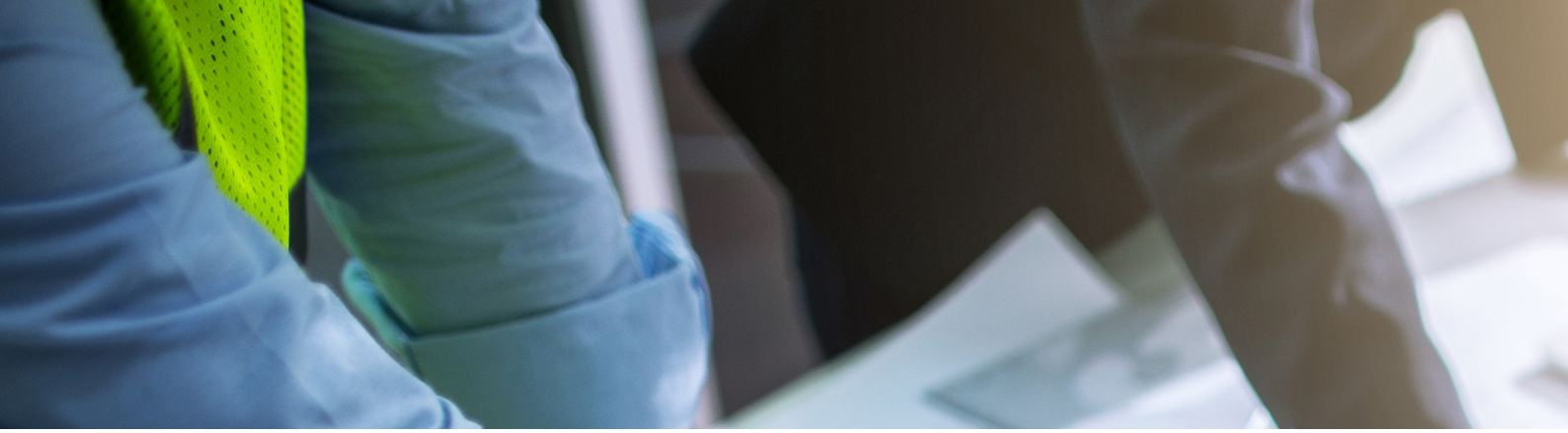
So, capturing the requirements and deliverables of a digital twin initiative are essential. Alongside this, it is also necessary to understand the legal and regulatory implications and how data and information security, privacy, and accuracy can be ensured.

Project professionals, including construction managers, cost managers, and quantity surveyors, play a critical role for the creation and use of digital twins for both existing and new assets, with the opportunity, and responsibility, to be the creator and steward of data and be at the foundation of their asset owners' digital twin journey.

Making a Business Case for Digital Twins

Digital twins require resources, effort, and investment in the pre-project, project and use phases. As such, adopting and implementing a digital twin on a project would require careful analysis and decision-making. Project teams can assist (and work with specialist consultants) in this analysis and decision-making process, carefully tying the analysis to the outcomes and benefits of the digital twin.

If a decision is made to proceed with the use of a digital twin, project team members can help build a detailed business case and a detailed implementation plan, including the procurement and delivery plan of the twin. Numerous resources are now available to conduct the analysis, make a go or no-go decision, and then take the remaining steps (e.g. the Digital Twin Toolkit by CDBB, Digital Twin Navigator for NHSScotland, IET Digital Twin report, DTC's maturity levels).



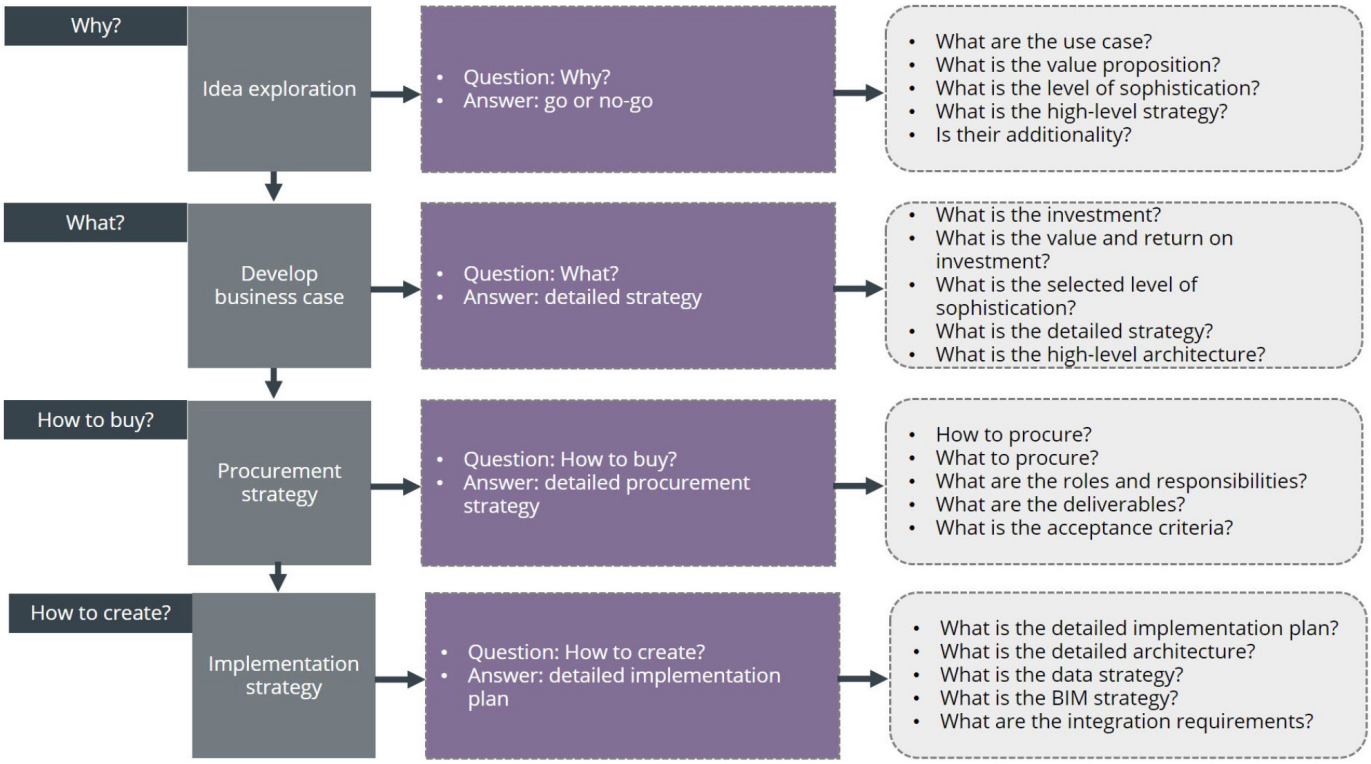


Figure 1: Need assessment of digital twins (Image: RICS)

Participating in the Information Management Process

Construction managers, cost managers and quantity surveyors can play a leading or supporting role in the information management process. Successful creation, deployment, use, and updating of a digital twin depend on a sound information management process. Numerous information management protocols are already in place as part of the BIM adoption and implementation journey. These can be used to establish data and information models, specific data and information flow, roles and responsibilities, collection and dissemination work practices, and related standards in conjunction with BIM and CDE. Project professionals can guide the project team in establishing information exchange processes, enabling information integration, and coordination and collaboration of the team for sharing, updating, and securing data and information in a digital twin.

Understanding the Legal and Regulatory Issues

Since digital twins act as a central repository of static and dynamic data and information, some legal and regulatory issues must be considered.

The data captured with a digital twin includes as-designed, as-planned, as-built and performance data. These data sets are dynamically merged. A golden thread connects and tracks this data and information over the life cycle of the object or asset.

Thus, a highly advanced form of digital twin can be seen as a live document held digitally with "fingerprints" (e.g. using blockchain technology for highly complex interconnected and inter-operable digital twins) of people recording their decisions about the asset's design, construction and use.

While, on the one hand, this provides an accurate and updated record of asset data, it does bring some unique legal and regulatory issues to the forefront. The legal environment for digital twins is impacted first and foremost by data ownership issues.

This will have to be addressed contractually, keeping in mind the extended period the data may stay live in a digital twin. The contracts will have to address confidential data and information issues and shared ownership in cases where a complex system within a digital twin combines data and information from individual objects provided by different team members.

As digital twins break down silos and enhance collaboration, the issue of data sharing and accuracy will also have to be contractually resolved. Given the complex nature of the digital twin, the whole area of disputes and liability will take on a new meaning and need a reassessment.

On the one hand, a digital twin, with the help of a golden thread, can determine when, how and which party decided regarding an issue under consideration; it may be very complex to ascertain causal linkages to the source of the problem.

Managing Security and Privacy

Digital twins also pose security and privacy challenges. With both static and dynamic data and information about the performance of an asset stored in one repository, it is vital to consider data privacy and security in a robust manner.

It is important to consider how to keep the data and information safe and private, and protect against breaches of the twin itself. This is a risk that the project team must holistically address. It is essential to protect the virtual representation, the physical asset, and the synchronisation mechanisms between the two. At the same time, data and information stored in a digital twin must also comply with privacy regulations and be protected against illegal access. Appropriate security and privacy arrangements must be addressed upfront as the digital twin is created.

SURVEY

Participate in Our Global Survey Now

RICS and Glodon are seeking input from quantity surveyors and cost managers globally to form valuable insight for an industry white paper to be published in December 2022.

We are conducting research to study the role of data and technology in quantity surveying and cost management practice. The research seeks to understand the current state of usage, benefits, improvements and blockers to gain insight into how data and technology assist the design and delivery of construction and infrastructure projects with superior environmental, economic and social outcomes.

The survey consists of 14 questions and no personal information is required. All answers will be anonymized and used for research purposes only. Expert focus groups will also be conducted to complement the findings of this survey.

Participate now at https://www.surveymonkey.com/r/NXBKBTR.

Participate Now

Digitalization of Construction Industry Brings Opportunities and Challenges

(Content based on Pierpaolo Franco's online interview with Andrew Beard)

The construction industry is undoubtedly one of the most critical industries in the world economy. However, it is significantly lagging in digitalization more than other sectors, even though it can benefit considerably. Faced with challenges around project efficiencies, safety concerns and labour shortage, as well as the volatile market environment and unpredictable interruptions, companies are now becoming more aware of the potential and plan to invest more in digital technologies.

In an interview, Glodon's Vice President ***Pierpaolo Franco*** and ***Andrew Beard***, then Arcadis' Global Head of Cost and Commercial Management at interview time, who is now the Cost and Commercial Practice Lead at Mace, exchanged their perspectives on the digitalization of the construction industry for international companies.

Opportunities Come with Challenges

"Digital transformation is a challenge brought to the construction industry," Pierpaolo said; especially when you push it to a global level, there are more issues that need to be taken care of when involving a digital process in the solution using it as an additional tool for business.

To cope with it, companies need not only to procure advanced technology but also make sure they understand how to really get the very best out of that technology, which needs good collaborations with partners, such as digital solution providers.

Innovation is also important in the digitalization journey, especially from an ideation perspective. It is about where ideas generate. By collecting a wide range of ideas from close work with people

inside and filtering down these ideas based on the assessment of value, companies can redevelop the digital solution that suits their business goals.

And then, it is really about change, changing behaviours and working practices. It is when scale becomes really apparent. According to Andrew, "what we then need to do is really make sure we are standardizing those things because the investment really goes further when it is able to reach the widespread and a whole of organizations. We had many ideas which have been possibly great ideas on face value, but it turns out not to be scalable, so they tend to be sort of one-off solutions which very hard to then invest in."

Motivations behind Digitalization

"Digitalization is a journey," said Andrew, and he sees different motivations for companies to set off.

For companies that aim to provide value, creativity and outcomes to customers, digitalization and technology are the key enablers. Another thing that can be improved with digitalization is the client experiences. With digitalization, the way clients consume and receive services and advice can be improved so they can ultimately relieve some of their pain points and make their life easier.

For some, it is about people. People come to work, and digitalization can help to make their life easier, and make them more efficient and more productive.

This is a journey and opportunity for people to learn new skills and build new capabilities, as well as remove some of those things that might have been manual in the past and quite tedious. It also helps companies meet standardization needs, so that their people can work in a standard and efficient, productive way wherever they are in the world.

> "Digitalization is not an easy journey, and the impact that digital transformation has on the business needs to be significant and make a change, not just because it has to be done"

Digitalization provides companies with a global outlook allowing people to be more mobile, and move work across the globe. This is a significant point with skills-gapping in the global industry and what we face moving forward.

Another point made is that digitalization provides leading opportunities. Digital front runners will have the chance to overcome the disruption brought by digitalization, further improve themselves and seize the opportunity to emerge as disruptors in the industry.

"Digitalization is not an easy journey, and the impact that digital transformation has on the business needs to be significant and make a change, not just because it has to be done," Pierpaolo emphasized.

Innovating to Sustainable Built Environment

Sustainability has nowadays become a big issue that every entity is talking about. Increasing government regulations, higher customer expectations and expanding employee awareness, have all driven up the need for transformation towards a sustainable way of development. As Andrew said, "it is a challenge for our generation." And Pierpaolo also believes digitalization needs to play a very important role in this aspect.

Digitalization can really help with the awareness, education and understanding of the industry. The ability to push the information out accurately, so it reaches more and more people is really vital.

In the construction industry, probably one of the biggest challenges is effective decision-

making. Where people are creating new assets, operating new assets, or disposing of assets, how do we do that in a sustainable and environmentally conscious way but also create values for future generations? How do we make the longevity of assets improved? How do we make a community more successful? These all must be considered as part of sustainability in its broadest form.

So digitalization ultimately can improve decision-making, providing insights on questions like should we demolish this building or should we repurpose it? What's the energy strategy of this building? Actually, should we be looking at this building in all the sets of buildings or assets in terms of whole life value or whole life cost perspective? And how might that inform decisions in the creation or planning phase?

Digitalization with data ultimately allows companies to do more in a more accurate way, where people can merge sets of data and optimize certain tension. With optimization tools, people can assess a series of options quickly. It also facilitates the presentation and visualization of information to key stakeholders and decision-makers to improve their assessment and, ultimately, what they choose to do moving forward.

Connectivity is another perspective. Especially digital twins and intelligence within the built environment can provide the much-needed connection. The intelligence-gathering and algorithms enable people to do more with data sets to make assets better connected and more intelligent. These are things that are probably very difficult for humans to do.

"This is gonna be really important. Those things touch upon a much broad assessment of sustainability. How do we get better-connected communities, and how do we build or create things which ultimately stand the test of time and enable people to be successful whether they are living, working or playing in a particular asset," said Andrew.

Moving Towards the Future

Moving forwards, with the topic of sustainability in mind, business objectives will become much broader. It will be a business objective that is about financial sustainability. The financial performance of an organization is really fundamental in business and economics, but it will also be much broader in terms of sustainability as well.

The ability to integrate much more complex sets of parameters and data and ultimately bring those together in a factual way and then optimize and improve relationships between those against a certain business objective is really a direction of travel.

Thinking about Digital Twins for Smart Built Environment

(Content based on discussions at Digital Built World Summit)

Digital Built World Summit (Image: FuturePlace)

Digital Built World Summit, held in Sydney on 23-24 May by FuturePlace, is the world's premier event for executives in the AEC, Smart City focused on improving digital business outcomes. It was themed on leveraging digital technology, including digital twins, to create a smart, responsive, sustainable and autonomous built world, which attracted over 300 attendees and presentations from over 75 leading global speakers. Various seminars took place during the summit, shedding light on developing digital twins.

Digital Twin beyond Technology

The digital twin is a kind of technology, but it goes beyond that for many attending the summit.

Simon Evans, Digital Twin Leader of Arup and Chair of the Gemini Call at the National Digital Twin Programme, argued the digital twin is a methodology, not a technology. "It's an approach of using data to get and derive better insights. It should be lots of different platforms that talk and deliver the insights that you need. ... And if there is a tech piece, it is about a constellation of technologies connected; it is never gonna be one giant digital twin platform."

He also noted digital twin transformation is a social-technical challenge that is a much wider, large-scale issue. "It is a journey, not a destination." Technology and use cases are maturing all the time, so what a digital twin looks like today will be very different from a digital twin in the future. "So we should appreciate the journey that provides value, not focus on that unicorn, that end of the journey. It's more about how can I get return investment now, the incremental approach," he added.

"The idea of digital twins as a journey is important because these systems are not static. They are dynamic"

It takes years to develop a qualified digital twin or digital twin system, and there's a journey to get people from today to there, said David McKee, CEO of Slingshot and Co-Chair of Digital Twin Consortium. "If you think about maturity of digital twins, you start with models of simulation to say this is what we gonna build. It's not a digital twin. ... as you then build that layer of data, and you start having those real-time data that respond to what you required, it started to graduate to become a digital twin."

"The idea of digital twins as a journey is important because these systems are not static. They are dynamic," elaborated Brett Dixon, Infrastructure Group Lead of Asia Pacific at Esri, "If you're implementing a citywide digital twin or a statewide digital twin, you'll never get to the end because the requirements from the users will just continue to emerge and evolve over time."

Digital twin systems need to evolve with new requirements coming along. Therefore, the frameworks and standards related need to be agile. Brett explained, "They need to encourage and continue innovation and continuous engagement with users ... Otherwise, they'll just become static and deliver no value."

Digital Twin Needs to be Purpose-driven

Speakers repeatedly mentioned that digital twin should be purpose-driven, in other words, case-driven. "Everyone is trying to just search for some meaning or for what the digital twin can do and how we can actually articulate its benefits," said Raj Thampuran, Managing Director of Surbana Jurong.

Paul Mullett, Group Director of Engineering and Technology at Robert Bird Group, also emphasised the point around purpose, "It sounds like a bit of a cliche. But actually, this all has to be purpose-driven, and the purpose isn't 'I want x/y/z sensors in my buildings so I can monitor these things. The purpose is 'are all of my buildings more energy efficient or all of my traffic flow more freely?' or whatever it might be. That's the purpose."

The purpose is crucial because it determines what you need from the digital twin and the functionality. This is one key lesson from the National Digital Twin Programme for the United Kingdom. "It determines things like the data refresh rate, because not all digital twins need to be with a kind of a real-time data refresh rate. It depends on the purpose," said Mark Enzer OBE, the Global CTO of Mott MacDonald and Head of the National Digital Twin Programme.

There is also a much broader-sensed purpose or vision. According to Mark, the built environment needs to have an explicit purpose which enables people and nature to flourish together for generations. "We reckon that connected digital twins can massively help in that, but it's kind of starting with that endpoint in mind."

Data Becomes More Valuable with People

"The industry captures a lot of data or static data. 96% of that data goes unused." For Bill Harris, Business Development Director for APAC at Asite, data is the new oil. "How do we start taking that static data and combining that with operational data to then start providing value to asset whole of life? That's the question that sits, I guess, in front of us now."

However, Nicolas Waern, CEO and Digital Twin Evangelist of WINNIIO, argued there is a huge difference between data and oil. He thought data could be turned into value and create a lot of impact through different means, like digital twinning, forever and over and over again, unlike oil that was dug out and used once.

And data itself do not provide much value. "The data needs to be turned into information, that information is then transferred into insights, that insight needs turning to action. And that action that we need to take has to lead to an impact. I think that's also a digital twin come in," Nicolas added.

Glodon Vice President Pierpaolo Franco echoed this view in his speech on the topic of Data in Digital Building Platform, saying accurate and real-time data play a crucial role in the building life cycle.

On the other hand, Paul Mullett placed importance on people. "People have always been more valuable than oil. People will remain more valuable than data. And actually, at the heart of all of this are people and their skills and no matter what you wanna do with your digital twins and what your aspirations are." He warned that one of the biggest challenges in the industry right now is developing people's skills.

Just as David McKee said, "data needs managed and do not collect data just for the sake of it, we need to harness that, and there is the value."

Step by Step, Litte by Little

But before cashing in the potential and opportunities, here are the challenges to creating and enabling digital twins.

"We are to move towards that type of future of multiple connected digital twins, then we're gonna need to have some form of framework, consistency of approach to allow that connection actually to take place," said Rory Brown, Director of Smart Places Programs at NSW Department of Planning and Environment.

Mark Enzer also mentioned that solving system-level problems and challenges relied on connecting single digital twins. And that connection is all about data sharing. "It's about the digital twin speaking the same language, it's about securely resilient information flow across organisational and sector boundaries." Equally important for him is the standards and guidance generated bottom-up by people learning by doing and then progressing by sharing.

Brett agreed that the main challenges confronting digital twin projects are people and organisational ones. He noted that the path to success must address the people issues, the organisational challenges, the technology and data integration. The focus on the technology will likely lead to failure. Organisations need to think about being dynamic to engage users, and a coalition of the willing should be formed to bring people in and motivate them to work towards a common vision which also needs strong leadership.

None of these can be done overnight. "It's not just digital twins, but all big IT projects are risky," Damien Cutcliffe, Director of Business Development and Growth, Digital at WSP, made another point, " If you try to make it perfect upfront, and you hold back on, a sort of exposing that, sometimes you lose advocacy and support. So it's trying not to overdo it at the beginning of things important."

This is agreed by CEO and Founder of BE-WISE Cristina Savian, who said implementation of digital twins at an early stage could easily fail because of trying to do too much, trying to tackle too many cases and trying everything too much at the same time.

A suggestion can be taken from Paul, "Don't be overwhelmed. Take a step at a time. Don't try digital twins on the whole planet. You don't need to. Focus on clear objectives where you want to get to, look at your people and collaborators, and take step by step."

PROJECT

PROJECT OVERVIEW

LOCATION
Xi'an, China

CONSTRUCTION PHASE
Construction

DESCRIPTION
R&D Building, frame shear wall structure, with 3 floors underground, and 12 floors above ground

DEVELOPER
Glodon Company Limited

GR. CONSTRUCTION AREA
66,278 m^2

START TIME
September 16, 2019

STRUCTURE COMPLETE TIME
May 25, 2021

GLODON SOFTWARE
BIM5D

"This is an excellent example of Glodon itself using Digital Twin and AI over the Digital Building Platform to construct an intelligent building, leading digital transformation in the AEC sector."

——Glodon Recommend

KEYWORDS

BIM5D

Digital Twin

Glodon R&D Building

Digital Building Platform

Virtual & Physical Building

Sustainable Glodon(Xi'an) R&D Building Adopts Digital Twin

Considering China's sustainability target Glodon decided its latest building investment to meet this target by utilizing the Digital Building Platform. Xi'an's R&D Building uses this approach through the lifecycle (from design to operation) with an integrated and innovative solution based on the Digital Twin paradigm. Consequently, besides meeting the green (COP26 and Sustainability) targets, the advanced use of Digital Twin (DT) with AI over the Digital Building Platform allowed the BoD to understand how to better manage the company's assets (now and future).

Challenges

Digital Twin (DT) is gaining more attention in the AEC industry due to its potential values and promising benefits. However, we need to keep in mind some challenges about DT. First of all, only a few software or solutions are available in the market. The above information indicates DT is not an option for everyone, especially for SMEs.

Secondly, data is the key to DT. Data disconnection of each stage during the entire life-cycle weakens DT's values. For example, the operation and maintenance stages are the value point of DT. Lack of accurate design and construction data requires modelers to rebuild models using technologies such as point cloud which is expensive and time-consuming.

In addition to that, DT was mapped to our business model. Therefore, we became more critical of how DT was applied. On this basis, it was essential to show the added value to both stakeholders and the company's shareholders, ensuring that they have a good and thorough understanding of how the building will be constructed and later operated. We learned that lack of evidence hinders both stakeholders and shareholders' understanding of the added value of DT towards better construction and asset management. So, standardizing the DT process as part of the project life-cycle helped to eliminate these challenges (risks) and understand the opportunities of DT application.

Project's Outcomes

Glodon (Xi'an) Digital Building R&D Mansion Tower: The building has a total construction area of 66,278 m^2, a frame shear wall structure, three floors underground, and 12 floors above ground. The project started on September 16, 2019, and its construction was completed on May 25th in 2021.

The digital building platform is also based on the digital twin, which drives the physical production line for synchronous operation and collaborative management. Based on the project control unit, the project team conducted real-time scheduling, production scheduling, logistics scheduling, and construction schedule between the factory and the site through this platform, forming integrated management.

With the help of BIM technology, integrated with the on-site IoT and AI technology, the team applied real-time twinning of the model data and real data. As the whole process was data-driven, the team initially designed on-site industrial construction to ensure the quality of process standardization. It also implemented the data-driven lean construction.

On the digital building platform, the smallest process management unit- five elements of lean management affect the project success: progress, cost, quality, safety, and environment. In the office, the team conducted digitization in process-level in-depth design, scheduling, resource procurement and supply, and other business so that design, scheduling, and procurement were in place. Digital building platform helps digitize the office, construction site, and working surface and enables them online. Driving the allocation of relevant resources through the business needs on the construction site ensures the supply of labor, material, and machine and the operation on the construction site in place.

The team applied timely payment of costs, quality guarantees, and accident prevention through the dynamic optimization of progress. At present, 80% of the process tasks have clear operating standards, and the building's quality standards have been upgraded.

The team dynamically optimized the whole schedule management process by planning and scheduling in detail and minimizing task execution process. In addition, they paid the labor team and suppliers on time according to actual progress (in contrast to traditional payment methods which are based on the contract progress measurement).

Relying on the data driving force of the digital building platform, the team innovatively applied AI learning, graphics technology, cloud computing, etc., to develop an increased intelligent bill of quantities (image 3). With the help of big data, it connected the designer, developer, contractor, and building materials suppliers to offer data services such as material selection and pricing throughout the whole life-cycle.

Through evaluation, it also built an industrial supply chain service-based platform to provide new ideas and models for the transformation and upgrade of supply chain finance. Moreover, Xi'an

Summary of Benefits

The team implemented the digital building concept based on cutting-edge science and technology to offer industrial quality and human-oriented healthy buildings and thus fully meet people's individual needs. The intelligent building can implement a comprehensive analysis through deep cognition, intelligent interaction, and self-evolution. The cloud, among other services, can also quickly compute based on the real data from various sensors in the building. Consequently, the building is becoming a "living body," analyzing the indoor environment such as temperature, humidity, wind speed, monitoring health status, and providing other humanized services.

Digital technologies are merging with the building industry, affecting its digital transformation significantly. The fully DT-supported paradigm using the digital building platform converts the building industry into a dynamic ecosystem that offers better cooperation, and thus a value chain supply is developed.

The traditional building industry must be upgraded involving all elements, processes, and stakeholders and reconstructed through digitalization, and online intelligent system, to create new design, construction, and O&M.

Building has been "built twice" using the digital building platform. Two "buildings" are delivered (virtual and physical buildings).

For the virtual building, digital models will be delivered through digital virtual construction such as collaborative design, virtual production, virtual construction, and virtual operation and maintenance. Then, the industrial intelligent lean construction that integrates both digital production line and physical production line will help deliver of high industrial quality of the physical building.