Building smart

How digital technology can help construction companies achieve more value

This document has been commissioned by Orange Business Services

April 2017

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Digital technology helps construction companies build asset value and improve project cashflows

Since the outlook for the construction sector in Asia is relatively muted, builders and developers are presented with an opportunity to harness digital technologies both to improve profitability as well as to build smarter buildings. Sector growth is forecast at approximately 4% per year until 2020 (compared to over 5.4% in recent years)[1], with infrastructure projects being the main focus in emerging countries and commercial buildings in mature markets such as Hong Kong, Singapore, Australia, Korea and Japan.

For builders and developers focused on commercial, office and residential buildings in mature markets, the operating environment today is tougher than ever. Besides having to manage "traditional" trade-offs between time, cost and quality in construction projects, companies also have to take into account a number of other emerging challenges and market trends:

Rise in operational complexities:

Since the beginning of the 2010s, construction companies have been growing in scale and expanding beyond their own markets in an effort to diversify their portfolio and tap growth in other markets. Companies now need to manage projects concurrently in different geographies, whilst having to optimise asset lifecycle management and manage projects more tightly in order to contain risk of delay.

Stronger project management is all the more important as companies expand, given the variety of contracting and project control methods that exist in different geographies. In such circumstances, project lifecycle decisions taken at the outset now have a greater bearing on final output quality and cost, building operating efficiencies, the need for facility management expertise and asset management capabilities.

Intensifying competition, particularly for commercial real estate:

Nearly 130 million square feet of office space is expected to enter the market in 2016 in the Asia Pacific region, creating conditions that will favour tenants in most markets despite strong demand for office space[2]. This puts pressure on owner-operators, who need to make their properties more attractive and better value-for-money for potential lessees.

Changing tenant expectations:

Tenants, especially large occupiers such as multinationals, expect high performance buildings which provide unprecedented level of comfort and convenience for occupants, as well as state-of-the-art security management capabilities. At the same time, they increasingly seek out sustainable and energy-efficient spaces, as a form of corporate social responsibility and to safeguard against rising energy prices which have increased operating costs[3]. Many multinationals now have global policies on workspace which carry mandatory provisions related to environmental and energy consumption requirements.

Increasing government focus on green building development:

Buildings account for 40% of energy use and approximately one third of greenhouse gas emissions globally[4]. As a result, they have become the focus of regulatory requirements and incentives, as part of governments' carbon emission reduction targets under the 2011 United Nations Framework Convention on Climate Change[5].

To overcome these challenges and remain competitive in the changing operating environment, companies are being forced to think about ways to increase efficiency and bring out the value in every stage of the project life cycle – from building design and performance assessment to quality control and facility management. New technologies in the digital age, such as the Internet of Things (IoT), can help achieve this.

Digital technology helps build new paradigms to achieve efficiency in the building process and quicken completion

Using advanced Building Information Modelling technologies

Advanced Building Information Modelling (BIM) presents new forms of digital planning and control technology today that can be used to anticipate, resolve and document any clashes and deviations during the different stages of the construction project, while taking into account potential workflow, economic and environmental impacts[6]. This enables increased efficiency and early risk identification, while cutting down on the time and cost related to re-work, especially on mechanical and electrical (M&E) systems.

While related concepts have been around for some time, their implementation has been primarily constrained by incompatible techniques and software across the multiple parties involved in the construction value chain. Advancements in BIM technology are now lowering this barrier to implementation.

BIM case study: Leadenhall Building in London[12]

- A logistically complex project which required the installation of large pre-fabricated components
- BIM technology was paired with radio frequency identification (RFID) sensors, such that individual pre-fabricated parts can be tracked throughout the supply chain so as to mitigate any downstream delays in construction
- The data was fed into the BIM once the parts were installed, allowing for real-time rendering of the building in progress, as well as the establishment of project controls and key performance indicators

BIM case study: Singapore Sports Hub[11]

- US$1 billion design and build project with a tight timeline which used BIM to enhance the mechanical, electrical and plumbing (MEP) aspects
- BIM was instrumental in enabling efficient and thorough communication between the MEP team, the architect and the structural engineers for the most complex areas, eg. the moving roof
- Many potentially costly reworks were addressed and resolved digitally
- BIM model was developed to a high level of detail such that the team was able to obtain accurate quantity take-offs and pre-fabrication drawings from the model
- In certain areas such as the Energy Centre and the chiller plant rooms, the MEP was entirely pre-fabricated leveraging BIM capabilities

This comes in the form of a movement towards a universal BIM language and standards (e.g. OpenBIM), as well as software solutions that enable easy and accurate data transfer to and from the specialised applications used by architects, civil and structural engineers, builders, as well as cost estimators[7].

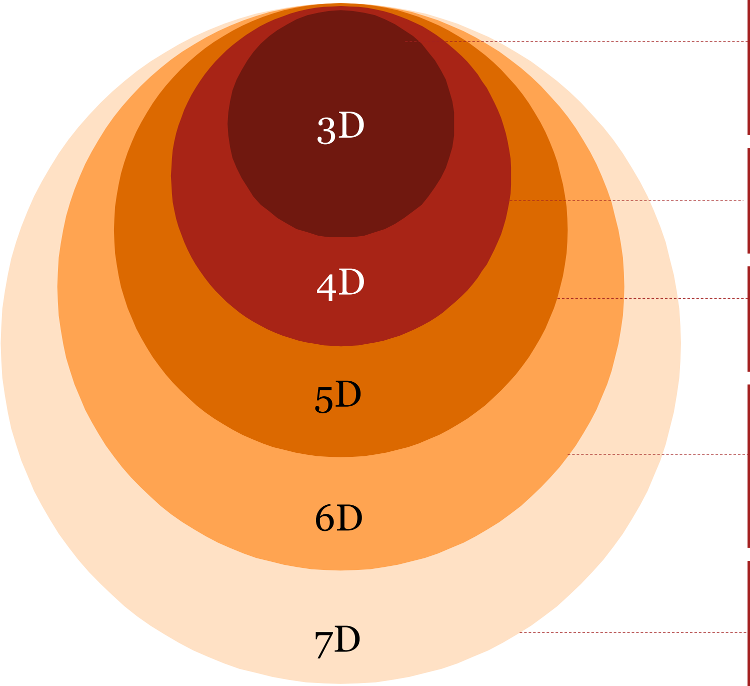
The technology allows the ‘on site manager’ to enter ‘real time’ progress and defects reporting to the master schedules for the projects; this greatly improves efficiency of reporting as well as the accuracy – which can only improve the overall quality of our buildings.
As both the software itself and users of the software become more sophisticated, the potential for open collaboration increases, and the full value of the information sitting in BIM is unlocked – justifying the costs involved in implementation.

Explaining BIM[8]

BIM has been adopted in many countries since the early 2000s for 3D modelling as well as collaborative architectural, structural and mechanical, electrical and plumbing (MEP) design. However, there is potential to leverage the spatial dimension data sitting in the 3D model, to bring about further efficiencies.

For instance, the data can be enriched with time information (i.e. a "4D" BIM) in order to model and optimise the actual delivery of construction projects. The 4D BIM data can be exported and shared across all actors involved in the construction process. This helps increase visibility in terms of the construction steps and timing. Adopters of 4D BIM have reported productivity improvements averaging more than 20% compared to the conventional methods of construction[9].

It is also possible to enrich 4D BIM data with further information, so as to better estimate costs, analyse energy usage and improve facility management ("5D", "6D" and "7D" BIM respectively).



Spatial dimensions
- Existing conditions modelling
- Animations and walkthroughs
- BIM-driven pre-fabrication
- What we want to be

3D + time information
- Project phasing simulations
- Lean scheduling

4D + cost information
- Real-time cost planning
- Detailed cost estimates

5D + sustainability
- Conceptual energy analysis
- Sustainable element tracking
- Leadership in Energy and Environmental Design (LEED) tracking

6D + facility management
- Life cycle BIM strategies
- BIM-embedded Operations and Maintenance (O&M) manuals
- BIM maintenance plans and technical support

A study on the benefits of BIM amongst users in Asia at various levels of adoption showed that 97% of contractors in Japan reported a positive return on investment. Companies are also reporting a positive impact, with 41% reduction in errors and omissions, 31% reduction in re-works, 21% more accurate project estimation, 19% faster project duration, and 23% better waste management[10].

In the future, BIM will become a fully integrated tool that can be used to model and optimise the entire lifetime of a building, from planning, procurement, construction, sequencing, testing and commissioning, to facilities management.

In general terms BIM has been adopted by most players in the construction industry in one form or another, but quite superficially and focused on the structural and architectural finishing aspects of the building process. There is a whole area of asset management and facility management that can greatly benefit from the data captured within any BIM system; particularly unique reference tags applied to all M&E equipment, which will provide an efficient and accurate lifecycle estimate for building owners/operators, as well as schedules of preventative maintenance, replacement schedules & records, and more efficient stock of spare parts and equipment.
In some countries, such as Singapore, public authorities require government tenders to be made in BIM format.

Using smart construction equipment

Another way to achieve efficiency in the building process is to harness Internet of Things (IoT) technologies at the construction site. Relatively inexpensive sensors are installed on construction equipment and, coupled with analytics, enables the tracking, analysis and optimisation of equipment performance and utilisation.

Smart construction equipment enables tangible benefits:

10%

Improvement in fuel utilisation[15]

43%

Reduction in fuel costs[16]

A multi-billion dollar construction firm deployed IoT and related analytics solutions to all its sites and across 16,500 pieces of equipment globally. This enabled it to collect and analyse data on equipment availability, health, status, location and maintenance costs, so as to pinpoint improvement opportunities. Using this data, the company managed to realise 11 percent more predictive maintenance versus corrective maintenance and to cut its operational expenditure per asset by US$ 1,100, achieving savings exceeding US$ 15 million per year[18].

By extension, the data also allows for the monitoring and troubleshooting of operator techniques and efficiency, so as to decrease equipment abuse, extend component life, improve occupational health and safety, as well as increase productivity.

The same technology can be used to monitor key indicators of potential maintenance issues, such as temperature fluctuations and excessive vibrations.

When abnormal patterns are detected, alerts can be triggered, so that maintenance workers can intervene before critical equipment fails. Performing proactive maintenance in this way can help prevent downtime and unnecessary delays in projects[13].

A variety of data points can be collected on a real-time basis, from engine hours and idle time to fuel usage, providing visibility on when materials are delivered, how much and where equipment is being stored and then where it is used. This enables companies to re-deploy un-used assets and tighten the schedule for equipment movements across sites.

Digital technology helps improve building management and maintenance

Technology embedded into buildings (a.k.a. “smart buildings”) can be used to optimise not just the construction process but also facility management.

The business case for smart building technologies is strengthening as the number of success stories increase around the region.
Regulatory demands also put more requirements on building safety and energy control and smart buildings enables building owners and operators to achieve energy efficiencies that are aligned to governments’ green agendas.

While they have long been seen as gadgets, smart buildings have now reached an age of maturity. There is no better time to consider the use of smart building solutions, be it early on in the design phase, or as a retrofit for older facilities.
Cost effective and viable smart initiatives enable better energy management over the life of the asset, along with better respect to the environment. This translates to cost savings for building owners, which means their building space stock can be more attractive and affordable to potential tenants.

Technological advancements such as device miniaturisation and "ruggedisation" for site environments have resulted in cost-effective and quick-to-install sensors and controls.
Improved database and network solutions have enabled analytics to be performed in real-time, as well as the storage of large volumes of data for analysis at a later date.
The emergence of machine learning and predictive analytics have allowed for a new level of building automation.

Further, smart building solutions are becoming increasingly affordable. Today, the overall cost to add IoT controls and monitoring to a building is estimated to be at USD $0.75 a square foot, which is five times less expensive than traditional approaches such as deploying a basic Building Management System[21].
With a small investment the following may be possible:

Energy savings

Smart sensors (e.g. z-wave, ZigBee, bi-directional people sensors) and related controls can be used to monitor and adjust a range of building conditions including ambient light, temperature, humidity and indoor air quality. This enables dynamic resource management and the matching of energy use to occupancy patterns, so as to achieve energy efficiencies and optimise returns on the lease.

What are smart buildings?[20]

According to Continental Automated Buildings Association (CABA), a leading international not-for-profit organisation that promotes advanced technologies in homes and buildings, smart building is defined as "a building that uses both technology and process to create a facility that is safe, healthy and comfortable and enables productivity and well-being for its occupants. An intelligent building provides timely, integrated system information for its owners so that they may make intelligent decisions regarding its operation and maintenance. An intelligent building has an implicit logic that effectively evolves with changing user requirements and technology, ensuring continued and improved intelligent operation, maintenance and optimisation. It exhibits key attributes of environmental sustainability to benefit present and future generations."

Sensors

Devices that measure values such as temperature, humidity, power consumption and occupancy levels

Dashboard or user interface

Applications humans use to interact with the system where data is reported

Gateways

Middle-tier components that collect, aggregate and securely transmit data from the sensors to a back-end infrastructuree

Output devices

These carry out the commands from the system (e.g. actuators that turn air conditioning and lighting on and off)

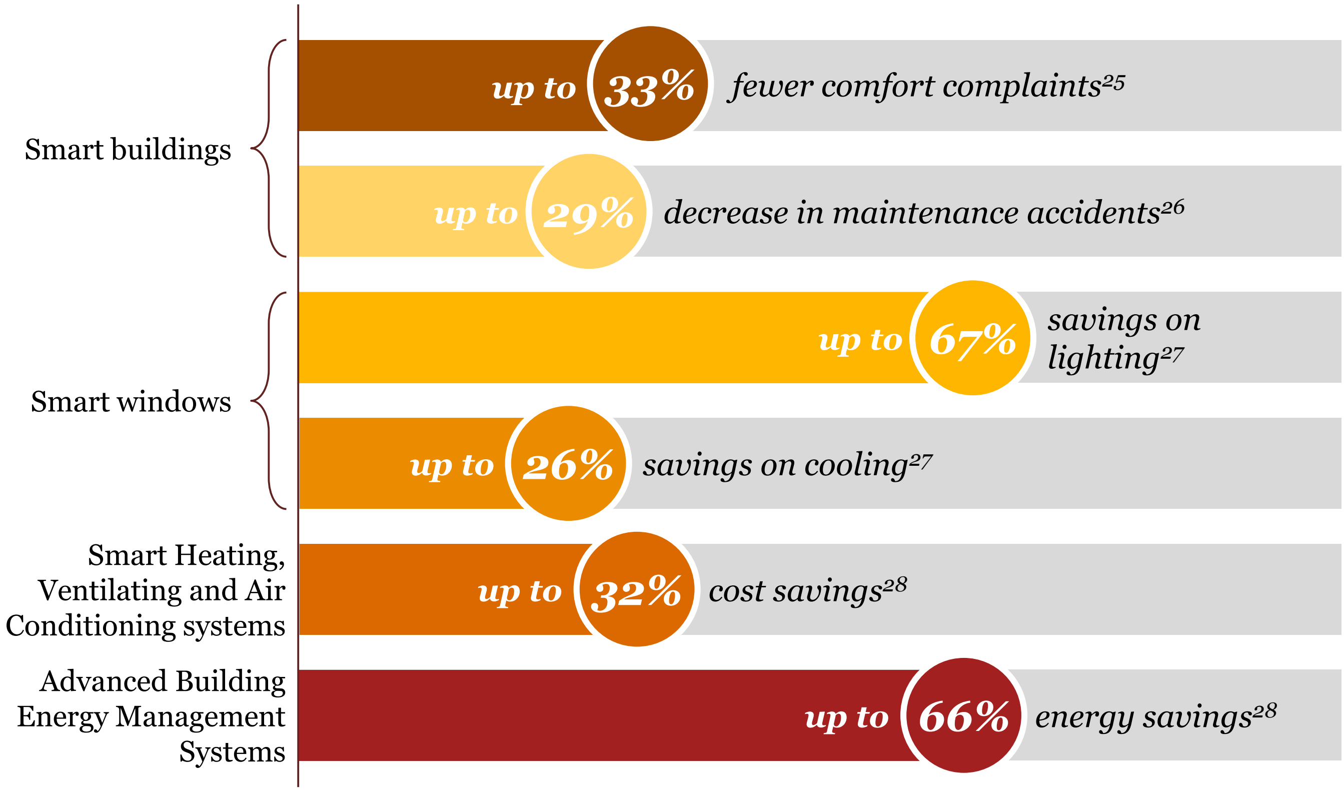
Back-end infrastructure

Repository for information transmitted; data enrichment and analysis. This enables scalable analytics abilities

These components in turn allow for central (and possibly remote) monitoring, control and wherever applicable, automation of building systems, including:

- *Lighting*
- *Energy management*
- *Heating, Ventilating and Air Conditioning (HVAC)*
- *Access control, security and video*
- *Communication (i.e. public address system)*
- *Fire safety*
- *Elevator*
- *Parking*

Benefits from smart buildings



Certain spaces may be filled to full capacity at one time of the day but empty during others, meaning money is being wasted when a HVAC system uniformly heats or cools a building that does not have uniform occupancy and usage[22]. As a result, flexibility in heating and cooling is required and may be achieved in many ways.

By using people counters and demand-controlled ventilation, space occupancy levels can be tracked vis-à-vis a building's designed occupancy, and outdoor air intake can automatically be dropped should the former fall below that of the latter[23].

Over time and as a result of big data and predictive analytic algorithms, Building Automation Systems may even be capable of learning occupant habits, and creating a program to meet energy needs in the most efficient way possible.

Improved comfort levels

According to Harvard Business Review, working in a green (and by extension smart) commercial building can boost employee productivity by 15%[24].

By matching energy use to occupancy patterns, smart sensors and related controls inherently help to ensure that tenants are enjoying the highest level of comfort coupled with the most optimal cost efficiencies. This in turn increases tenant appeal and retention, and is a selling point for owner/operators looking to make their properties more attractive to potential lessees.

Automated fault detection and diagnosis

Automated fault detection and diagnosis (AFDD) refers to software algorithms that can detect and diagnose unwanted operating conditions (i.e. “faults”) in equipment and systems in order to cut energy wastage and mechanical inefficiencies. They do this by connecting autonomously and in real-time to existing data sources (e.g. Building Management Systems, sensors, weather data, etc.) and applying deductive modelling and statistical techniques to acquired data, so as to detect suspected faults. Upon detection, AFDD tools can further provide expert and timely diagnosis of the underlying cause, helping maintenance staff determine and prioritise remedial actions. Predictive maintenance in this manner can help reduce downtime and O&M costs.

AFDD tools also enable automated ongoing commissioning, in which controls are automatically adjusted to compensate after a fault is detected. Studies have shown that continuous commissioning of building systems can yield savings of an average of over 20% of total energy cost[29].

Increase visibility and control

Dashboards and related backend solutions allow facilities professionals to easily monitor building performance via smartphones and tablets, remotely and 24/7[30]. Further, smart technology can be applied not just to a single property but also across portfolios. By doing so, owners gain the ability to benchmark performance across similar facilities. The data can also be combined with tenant information in order to make smarter leasing decisions.

Other applications

Smart technology can improve spatial management by providing valuable insight into how and to what extent space is being used. This helps facility managers optimise the facility’s layout based on current and future needs. Physical Security Information Management Systems also enable the seamless management of security (technology, manpower and processes) thus enhancing security, with efficiency. They have the ability to detect falling accidents and assist in emergency building evacuations. Access control can be enhanced by detecting events such as tailgating, and security can be further improved by detecting loitering in pre-defined zones.

In addition, smart technology can be deployed for specific use cases. For instance in retail, smart sensors can provide a precise understanding of shoppers’ activity, including traffic, paths, display attention and dwell time to improve retail optimisation. This also extends to other features, such as automatically prompting additional cashier support when customer queues elongate.

Case studies: smart buildings in Asia

One Island East: a commercial building in Hong Kong comprising 59 office floors with a typical floor plate of 2,300 square metres[31]. One Island East was awarded a “Platinum” rating by the Hong Kong Building Environment Assessment Method (BEAM) for environmental performance in 2009[32]

Air-conditioning, fire, security and other critical systems are monitored by a computerised Building Management System

Indirect office lighting with adjustable illumination levels reduces energy consumption by as much as 60%

Carbon dioxide sensors efficiently optimise the volume of fresh air supply received by tenants, avoiding unnecessary energy wastage

SK Chemicals Eco Lab: an office building in South Korea that was awarded a “Platinum” rating from the Leadership in Energy and Environmental Design (LEED)[33]

The building has in place a Building Energy and Water Management System as well as automated energy control technology

Lighting and temperature can be controlled by individual users

Overall, the building enabled 45% savings in energy and 63% lower water usage compared to existing facilities

4 Mort Street, Canberra: a retrofit of a 50-year-old building in Australia that enabled an improvement from 2 to 4.5 star NABERS Energy Rating[34]

Improved systems monitoring through the installation of a modern building management system (BMS), resulting in annual cost savings of US$ 100,000

Increase in asset value estimated to US$ 1.1 million, for an investment of US$ 750,000

The retrofit enabled 70% of reduction in annual greenhouse gas emissions equating to 786 tons CO_2***-equivalent***

The construction industry has traditionally been slow in adopting new technologies. This may in part be due to the involvement of many independent parties in each project thereby increasing the challenges involved in coordinating technology solutions. Another major inhibitor to technology adoption in the construction industry is the traditional procurement methodology of tendering under a “cheapest price wins” environment - technology investment is squeezed out in order to win projects. For this reason, alternative forms of tender evaluation as well as partnering approaches such as Public-Private Partnerships (PPP) tend to increase technology adoption.

Despite this, as technology advances, early adopters and digital leaders are emerging, enabling them to deliver value throughout the building lifecycle. All stakeholders need to upgrade their competencies, invest, as well as adopt new processes and behaviors, or risk losing out.

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