Driving Whole-of-life Efficiencies through BIM and Procurement

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Sustainable Built Environment National Research Centre

Final Industry Report, Project 2.34

Acknowledgement

This research has been developed with funding and support provided by Australia's Sustainable Built Environment National Research Centre (SBEnrc) and its partners.

Core members of SBEnrc include Aurecon, Curtin University, Government of Western Australia, Griffith University, John Holland, New South Wales Roads and Maritime Services, Queensland Government and Swinburne University of Technology. Construction Skills Queensland were welcomed as a project member for this project.

The SBEnrc research team also acknowledges the important contribution of interviewees and Project Steering Group members who were a central part of this project.

ISBN: 978-0-9925816-2-6

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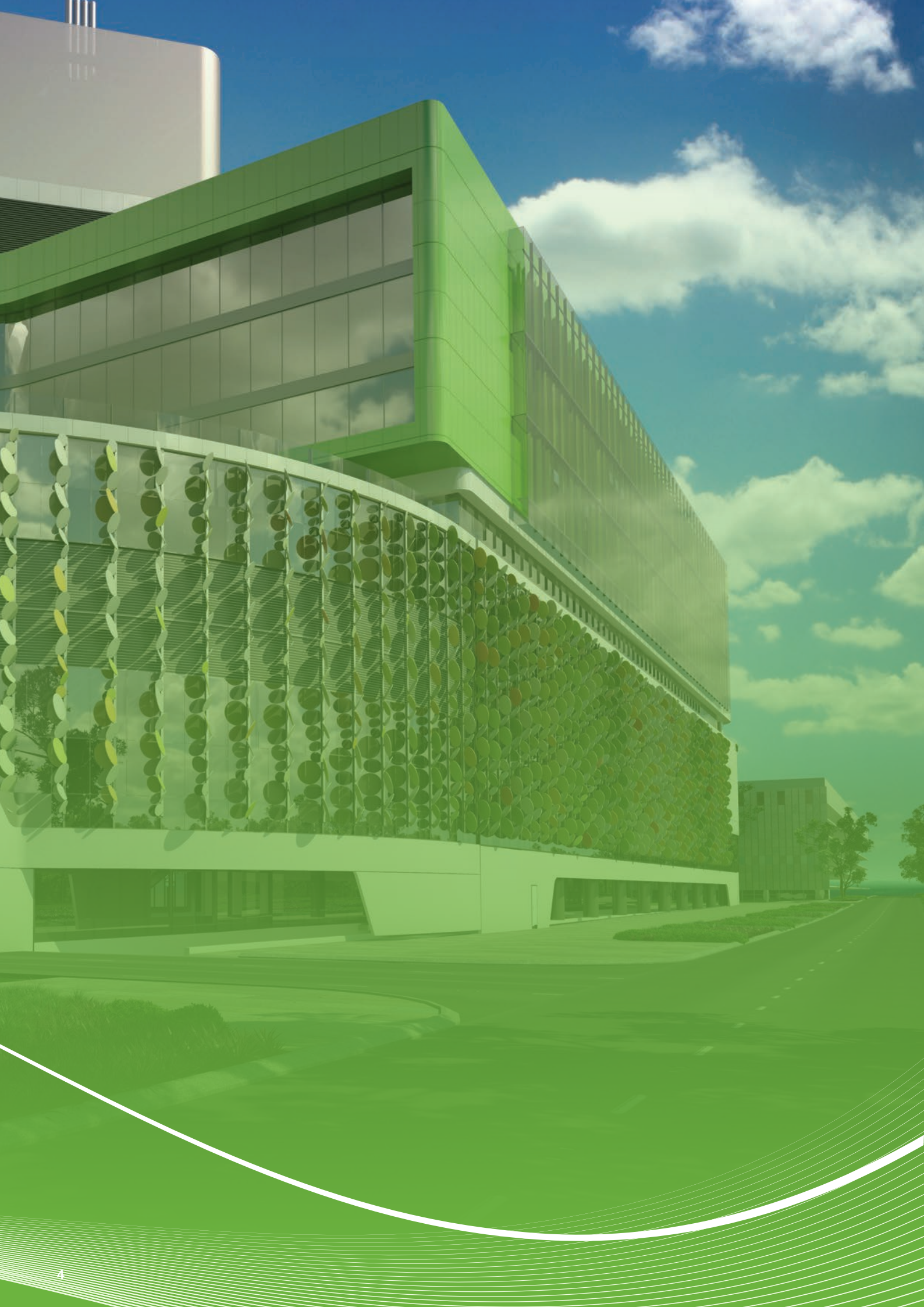
The SBEnrc is continuing to build an enduring value-adding national research and development centre in sustainable infrastructure and building, with significant support from public and private partners around Australia and internationally.

Benefits from SBEnrc activities are realised through national, industry and firm-level competitive advantages; market premiums through engagement in the collaborative research and development process; and early adoption of Centre outputs. The Centre integrates research across the environmental, social and economic sustainability areas in programs respectively titled Greening the Built Environment; People, Processes and Performance; and Driving Productivity through Innovation.

Among the SBEnrc's objectives is to collaborate across organisational, state and national boundaries to develop a strong and enduring network of built environment research stakeholders through collaborative industry research teams.

Essential to SBEnrc achieving its goals is this core project Driving Whole-of-life Efficiencies through BIM and Procurement.

Dr Keith D Hampson
Chief Executive Officer, Sustainable Built Environment National Research Centre



Introduction

Building Information Modelling (BIM) is a digital process *that encompasses all aspects, disciplines and systems of built assets within a single virtual model*. This allows stakeholders *to collaborate more accurately and efficiently than with traditional processes*.[i]

Industry challenge

In 2013, the Australian Department of Industry identified lifting productivity and economic growth as one of the most important challenges that Australia is facing. In 2014, the Australian Productivity Commission highlighted that a more widespread adoption of BIM could enhance productivity across the industry, and in turn have a positive impact on the cost structure of infrastructure projects. In order to understand the real impact of implementing BIM and improve the outcomes from these efforts, organisations need to develop and implement a strategy for monitoring and reviewing progress towards specific goals.

Although there have been significant benefits identified internationally from implementing BIM, there is little information on how to realise and monitor benefits from its implementation across the life-cycle of a built environment asset, either infrastructure or building. There are also no current comprehensive methodologies for BIM to develop a strategy to identify what benefits can be achieved, how they are to be achieved and how progress towards goals is to be monitored. This collaborative research engaging players across the supply chain aimed to cover these gaps.

Objectives

1. Define indicators to measure tangible and intangible benefits of BIM across a project's life-cycle in infrastructure and buildings.
2. Pilot test a whole-of-life BIM value realisation framework on leading infrastructure and building case studies and validate the NATSPEC National BIM Guide within this context.[1]

Key outcomes

- BIM Value Realisation Framework and BIM Value, an interactive online tool to develop a benefit realisation and monitoring strategy, in line with NATSPEC National BIM Guide.
- Three Australian exemplar case studies across design, construction and asset management showcasing benefits, tools and metrics for uptake of BIM.

[1]NATSPEC is an Australian not-for-profit organisation owned by the design, build, construct and property industry through professional associations and government property groups (http://www.natspec.com.au).

Opposite: New Perth Children's Hospital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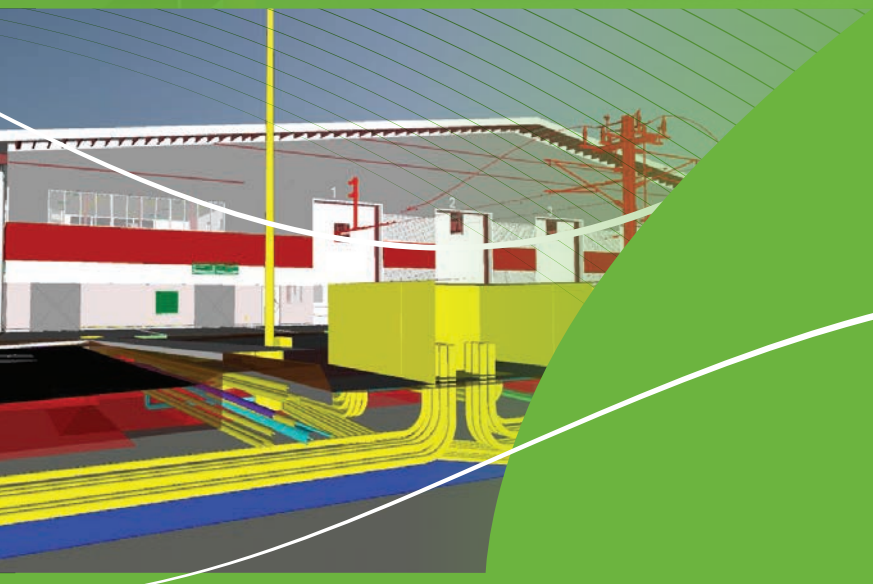


Case study 1

DESIGN

New Generation Rollingstock Maintenance Centre
Queensland

Context

The New Generation Rollingstock (NGR) project is a A$4.4 billion project that will increase South East Queensland's rail fleet by 30%. By the December 2018 expected commencement date for full operations, at least one of every two operational trains will be an NGR train. This case study is based on the purpose-built train maintenance centre being delivered at Wulkuraka near Ipswich, Queensland. The Queensland Department of Transport and Main Roads awarded the contract to a consortium comprising Bombardier Transportation, John Laing, ITOCHU Corporation and Uberior. Laing O'Rourke is the Design and Construct contractor for the train maintenance centre.

The project was procured through a combined model known as an Availability Payment Public-Private Partnership, which permits private sector funding of public infrastructure projects in addition to part-government funding for project delivery. Specific drivers for implementing BIM in the NGR project include: cost savings, improved risk sharing and more certainty to meet project schedule requirements. As a result, based on the unique contractual arrangement, payments to the consortium are tied to fulfilment of milestones.

This case study found 25 benefits from implementing 17 different BIM-related processes and tools across design and construction tasks. The project is using four metrics to measure the benefits of this implementation and the case study identified six other metrics that could be used in the future. There are also three unrealised benefits and four that were expected to be realised in the near future.

Challenges

The NGR delivery team faced a number of challenges that could have hindered maximising benefits from implementing BIM. Most of these challenges where linked to modelling tools, model requirements and actions by some stakeholders. Challenges experienced included: software functionalities, data requirements and interoperability limitations, sizeable initial effort in setting up the model, poor documentation and inadequate data management by some stakeholders, insufficient awareness of design and project implications, and ambiguous definition of performance indicators. This project also faced some unavoidable challenges due to project specific characteristics such as the need to use different metric systems and ensure effective procurement of associated services.

Lessons learned

Lessons learned for project and asset managers through this case study include:

- The use of federated models can provide significant benefits in terms of: having a controlled environment for information exchange; coordination of drawings and project scheduling; and improved learning curve and overall understanding of coordination processes.
- Ensuring buy-in from supply chain stakeholders should be among the implementation strategy priorities in order to maximise its effectiveness. Considerations that can help this process include: early involvement of team members in processes related to their role; active communication to keep stakeholders informed on progress; outcomes-based communication to client and related stakeholders; as well as encouraging the use of BIM by technical disciplines in their work, and as support tools for all stakeholders. Appointing BIM super-users, expert personnel to help with trouble-shooting and set-up of specific tools and processes, can also help improve communication across multi-disciplinary teams.

Case study 2

CONSTRUCTION

Perth Children's Hospital
Western Australia

Context

The Perth Children's Hospital (PCH) is a A$1.2 billion project carried out under a two-stage managing contract model between the Government of Western Australia and John Holland. The project used BIM for the design and construction of the hospital and has required a facilities management BIM model as a key deliverable. This hospital will become Western Australia's principal children's hospital providing best possible clinical care and outstanding paediatric research. This landmark project is a cornerstone of the Western Australian State Government strategy to deliver major social infrastructure for future generations.

This project established a series of BIM-related objectives ranging from identifying and resolving all major spatial and coordination issues between elements before construction began, to maintaining data integrity of all furniture, fixtures and equipment throughout the asset's life-cycle. This project is currently under construction, well into Stage Two, and due for completion in late 2015.

This case study identified 26 benefits achieved from implementing 20 different BIM-related processes and tools across design and construction phases. Although only one metric was found currently being used to monitor benefits from this implementation, the case study identified 20 potential metrics that could be used for this purpose. There were also six benefits that were expected but not realised and four that were expected to be achieved in the near future.

Challenges

Challenges faced by the PCH delivery team during the design and construction process included software and hardware limitations, lack of access to skilled personnel, buy-in from different stakeholders, short delivery timeframes, quality assurance issues, data security and access, interoperability between specialised software packages, high pace of technological progress, changes to brief, and lack of suitable industry standards.

The case study also highlighted the challenges brought by the different data requirements for each life-cycle phase, and most of all when transitioning into the operations phase. This will require eliminating information from construction and design that will not be useful for asset management and maintenance. Additionally, creating interfaces between the construction data in the BIM model and the asset management system was also seen as a future challenge.

Lessons learned

There were a number of lessons learned for project and asset managers. These included:

- Seemingly small technical details can be the source of a significant amount of rework if not addressed early in the project. Examples included software configuration that does not take into account future data uses thereby introducing errors into future data management.
- There are a number of considerations that strongly influence the achievement and maximisation of benefits from implementing BIM processes and tools. These include: embedding data and information quality assurance elements in all processes; consistent and well-defined data structures and standard formats (including object family classification); use of integrated libraries; clearly defining BIM requirements for different life-cycle phases and ultimate goals; and establishing model governance and interoperability protocols.
- Maintaining consistency can become a significant challenge across large multi-disciplinary teams. Establishing and enforcing protocols to ensure aspects such as consistent naming conventions across all consultants is paramount from early project stages.

Case study 3

ASSET MANAGEMENT

Sydney Opera House
New South Wales

Context

The Sydney Opera House (SOH) is an iconic Australian building that has been estimated to be worth A$4.6 billion and contributes A$775 million annually to the Australian economy[ii]. The SOH has a long-standing history of innovative information management. This history started with a challenging design and construction process, which prompted what could be the first field-to-finish system for surveyors in Australia, creating great efficiency gains. It now continues with the implementation of what is expected to be a fully integrated BIM asset management system.

The SOH BIM journey started in 2004 with the Sydney Opera House Exemplar Project carried out by the CRC for Construction Innovation[iii]. This project proposed and tested a partial digital facilities management model and made a number of recommendations in 2007 based on the CRC's collaborative research with the SOH. Since then, BIM practices have been used for construction and refurbishment works and their information management team has endeavoured to complete the BIM architectural model.

The new SOH facility management interface and BIM4FM had not been fully deployed at the time of carrying out this research. This case study therefore focused on the journey so far and expected benefits. The SOH expects to achieve significant advantages from implementing BIM. Specific drivers identified were: improving data management by having a single source of information for the complex precinct; improving staff safety and emergency management response; addressing specific performing arts requirements; achieving sustainability goals; and improving heritage management and monitoring systems.

Challenges

During the past ten years, the SOH has faced the following challenges in the development of their BIM for asset management system: software limitations/inadequacy; limited funds to gather data and develop the architectural model of a complex heritage building; defining an implementation strategy that would serve all their asset management needs; resistance to change across different functions; complying with public asset government requirements; Australia's geographic isolation implications for software and system support; and the uniqueness of the SOH building and information management requirements.

The SOH also expects to face challenges during the deployment of the new BIM4FM system, including: addressing new skills and training requirements, ensuring acceptance by end-users, and process requirements of integrating currently independent databases.

Lessons learned

Success factors identified for the development of a BIM for asset management strategy and BIM4FM interface include: internal inspiration and corporate culture; close external collaboration with industry and research stakeholders; client involvement as both owner and operations/asset manager; and the leadership and vision of specific individuals within management.

Becoming a well-informed client has allowed the SOH team to develop a highly tailored solution that could meet their particular needs. This process can also include non-price criteria in tender descriptions in order to increase innovation and include new skills. An active dialogue with industry and research collaborators can also help clients to become more informed and stay up-to-date with the fast pace of technological advancement.

Key industry issues

The three case studies highlight commonalities and differences in approaches and challenges for the development and implementation of a BIM strategy.

Client role

This refers to the role the clients had in the development and implementation of the BIM strategy across each project. It mainly relates to the drivers for and approach to achieving this implementation.

Informed/Expert client

The SOH team in New South Wales has invested in cultivating an informed and involved client approach to the development of their BIM guidelines and requirements. They have carried out extensive research into national and international practices, significant stakeholder engagement and collaboration, as well as maintaining close ties to industry and research groups. This role is widely recognised within the industry and acknowledged by commonly inviting SOH representatives to speak at conferences about BIM for asset management as well as by the New South Wales Government Architect who has shown a focus on implementing BIM.

Visionary client

Although the Western Australian Government did not have extensive experience in the use of BIM at the start of the PCH project, the delivery team has endeavoured to carry out extensive consultation to develop and implement their strategy. Here, the client aimed to set a leading example to other WA organisations to demand more of its partners by demonstrating the benefits that can be realised by embracing advanced digital technologies and associated organisational change. This was done out of the belief that clients are the ultimate long term beneficiaries and must remain involved in the development process in driving change until it becomes self-sustaining.

Performance driven

In the case of the Queensland NGR project, the BIM implementation strategy was initiated by the contractor in an effort to satisfy performance-driven objectives set by the client. These related to cost savings, risk sharing and project schedule requirements. Implementing BIM would also help documenting progress payments and meeting design obligations early enough so that full payments were made based on timely task achievements.

Role of collaboration

Collaboration was found to be a critical factor across all three case studies at two levels:

Collaboration across industry and research partners

Although the NGR and PCH case studies had limited collaboration arrangements with industry players outside of the project stakeholder group, the SOH case highlighted significant benefits from their interaction with industry and research organisations. Interaction with other parts of the industry through collaborative research projects has provided the SOH with the opportunity to learn more about global initiatives relevant to their own needs and to network with other organisations to stay up-to-date.

Collaboration across disciplines and stakeholders

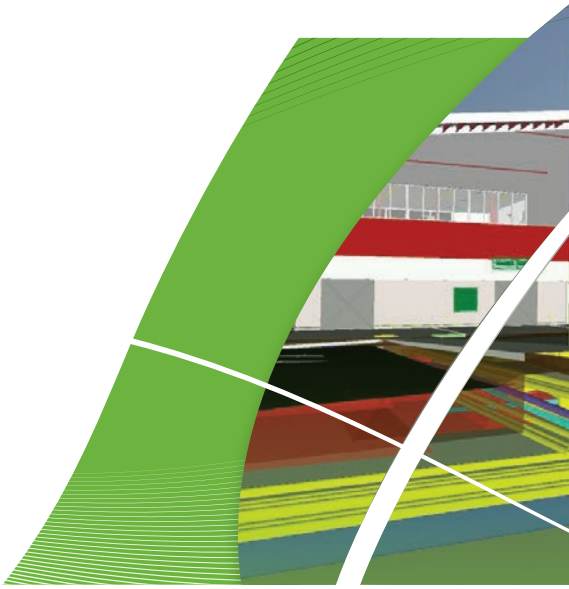
In all three case studies, collaboration across different stakeholder groups within the project was highlighted as an enabling process to maximise the effectiveness of the BIM implementation strategy. The PCH contract, for example, emphasised the need for close collaboration across project stakeholders in order to achieve the effective use of BIM to its highest level. The SOH has made stakeholder engagement and active dialogue a key element of its decision-making and learning processes. The NGR highlighted that collaboration and communication across stakeholder groups was greatly enhanced with the use of BIM, leading to significant time savings and benefits.

Software

The three case studies mentioned the number of software solutions required to cover all desired functionalities, difficulties to compare across software providers and the rapid change of versions as a common challenge. There is no single BIM software solution available in the market that covers all BIM uses and in many cases the project team required functionalities that were not covered by any of the commercial software developers.

Skills

All three case studies highlighted challenges in securing personnel with appropriate skills and capabilities. It was pointed out, for example in the PCH case study that, although there has been some improvement recently across certain disciplines, it is still an important industry factor limiting the realisation of benefits and creating industry-wide inefficiencies. Access to skilled personnel was seen as a regional and national challenge rather than just a project challenge.



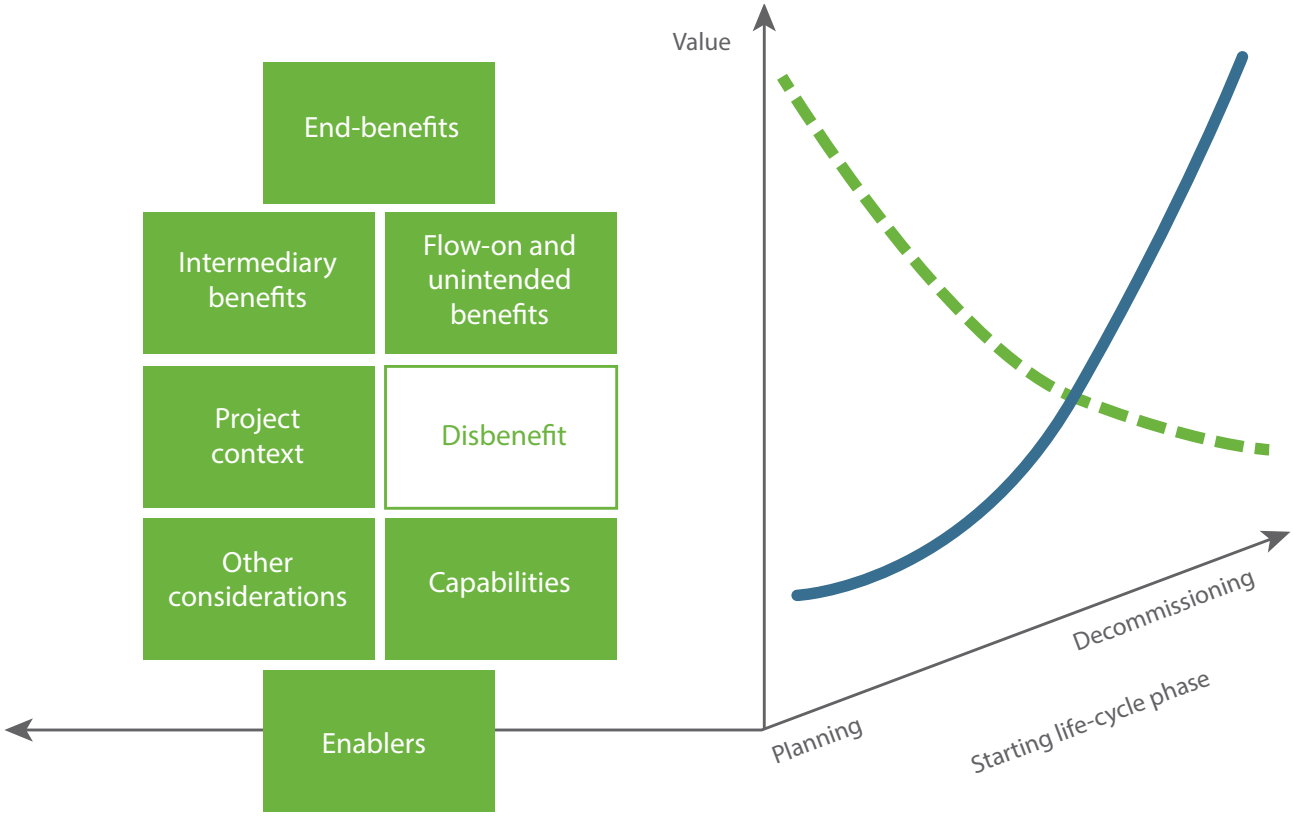
BIM value realisation

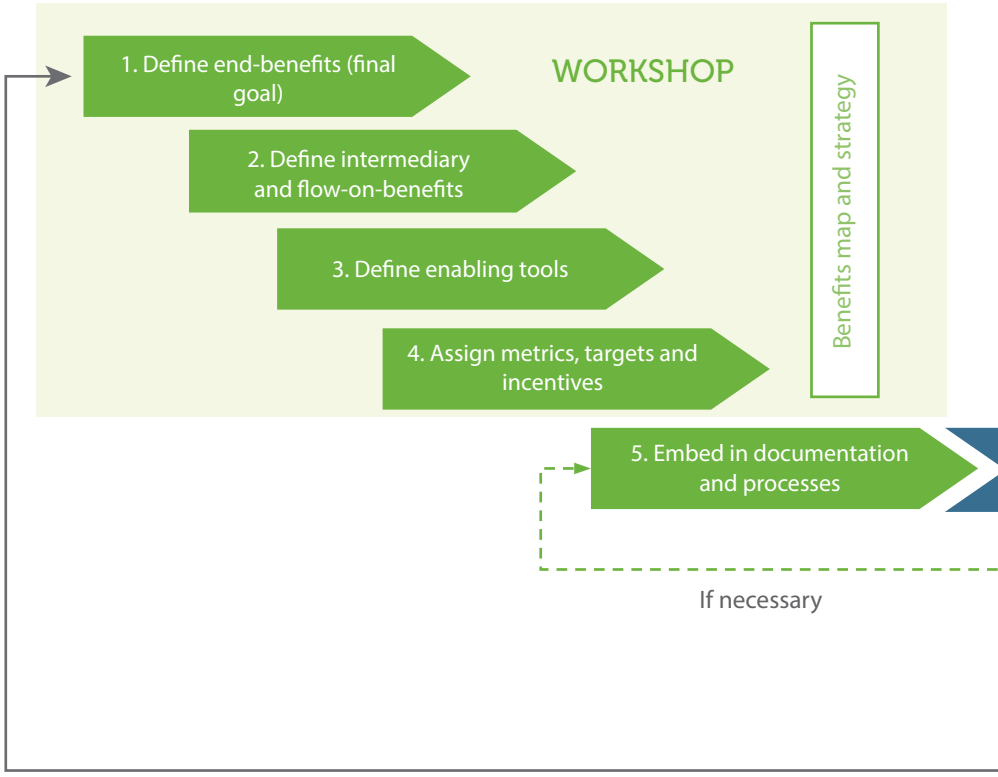
SBEnrc drew from international practice and literature as well as the three exemplar case studies across Australia to develop a BIM Value Realisation Framework. The framework can be readily applied to both infrastructure and building assets at different life-cycle phases. The framework is an adaptation of the Benefit Realisation Management (BRM) methodology, which has been adopted by a number of public and private organisations including the Government of New South Wales. This methodology was originally developed to understand the return on investment from information technologies and systems, and to overcome the limitations of traditional investment appraisal techniques.

The BIM Value Realisation Framework essentially follows the traditional BRM structure and principles but has been tailored to the construction industry supply chain and the implementation of advanced information technology systems such as BIM. One of the key aspects of the framework is to avoid the "I want BIM" blank statement and instead focus on specific benefits that will drive a BIM implementation strategy.

There is no single BIM software that covers all functionalities and processes. The value to each stakeholder is therefore delivered by identifying the specific benefits they aim to gain by implementing BIM tools and processes. This allows teams to have a clear understanding of the overall goals, select the path to these goals based on performance-driven objectives and to monitor progress towards these goals.

The framework also acknowledges that value is realised not only through specifically planned end-benefits but also through unintended and other flow-on benefits.


End-benefits
Intermediary benefits
Flow-on and unintended benefits
Project context
Disbenefit
Other considerations
Capabilities
Enablers
Value
Planning
Decommissioning
Starting life-cycle phase
Contributing factors to realising value
Ability to impact project life-cycle value
Accumulated value over project life-cycle



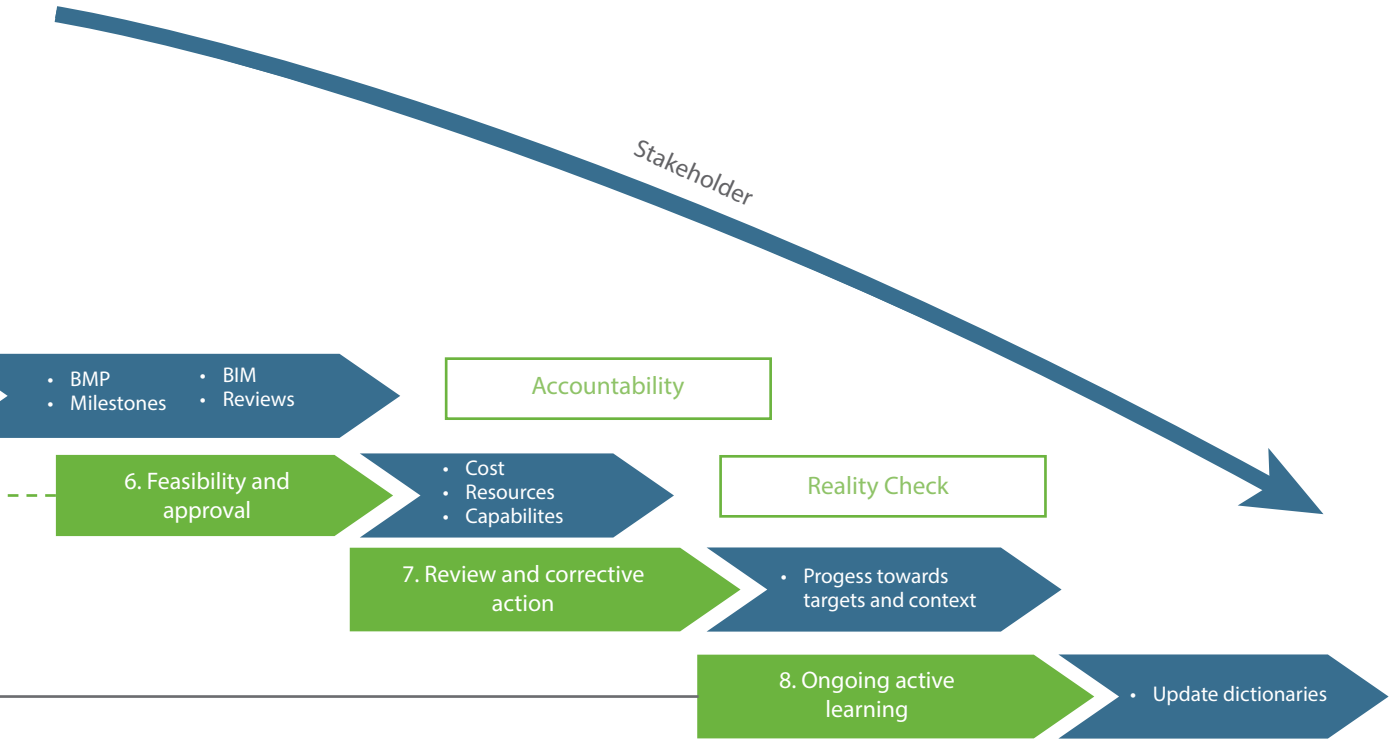
The framework was then translated into a practical eight-step guide for project teams to demystify BIM by understanding its potential benefits and implications.

Step 1 Define end-benefits: end-benefits are the ultimate objectives. They are the value the team wants to have realised from implementing BIM – such as lower cost, improved safety and competitive advantage gain. It is recommended end-benefits are defined via a workshop with key stakeholders.

Step 2 Define intermediary and flow-on benefits: these are the story behind each end-benefit and defined in the same workshop environment as the previous step. Intermediary benefits are those expected to occur between the implementation of early changes and the realisation of the end-benefits. Flow-on benefits are those that may be derived from achieving the end-benefit.

Step 3 Define enablers: enablers are processes and tools related to BIM uses and implementation. They help achieve the first intermediary benefit in the chain. A risk is associated with each enabler, and other considerations such as new skills requirements and cost need to be considered.

Step 4 Assign metrics, targets and incentives: assigning metrics to benefits is the basic requirement to provide effective accountability. It is important to choose as many as appropriate in order to have better insight into the success of the implementation strategy. Targets should be assigned to each metric and, if appropriate, financial incentives for exceeding targets.



Step 5 Embed metrics and targets into progress documentation and processes: this ensures accountability and provides a rich source of information which the group can use to make decisions and introduce changes in a timely manner to correct situations that may be hindering the achievement of goals set in previous steps. Metrics, targets and incentives should be embedded in the project documentation including the regular progress report as well as the BIM model itself. These should also include processes to record context information that may be used to understand different levels of success across different projects.

Step 6 Workshop follow-up/feasibility and approval: this step is a reality check to evaluate the specific software solutions that can be used as enablers to achieve the selected benefits most effectively. The associated cost, for example, will largely depend on the capabilities of the project team and previous experience with specific software packages as well as licences already purchased.

Step 7 Progress review and correction initiatives: realising value requires active monitoring of progress towards targets related to benefits. These should be reported on and reviewed during project progress meetings.

Step 8 Ongoing active learning: benefits are dynamic and will change as technology and organisational capabilities develop. Therefore, benefits, enablers and metrics dictionaries should be developed and regularly reviewed and updated.

Next steps: this should be recognised as only the beginning of the journey. There are a number of considerations that will have to be addressed such as standards, protocols, BIM management roles, risk apportioning, skill development plans, and system requirements.

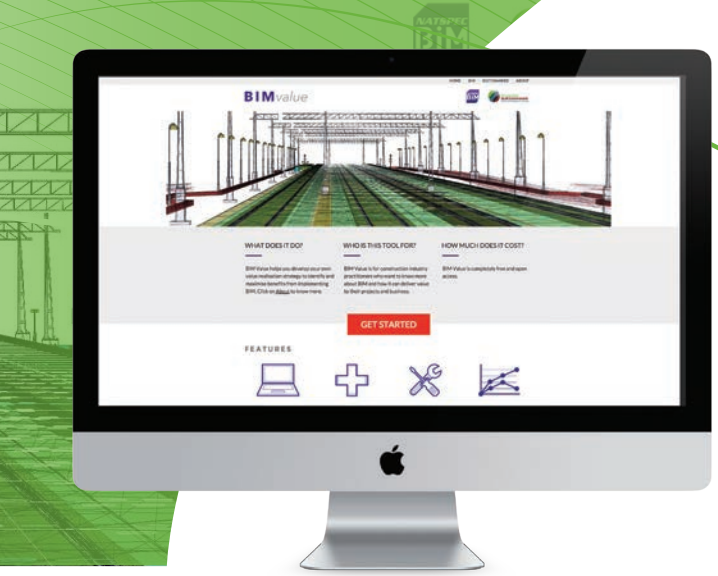
BIM Value

Developing the BIM Value Realisation Framework included the compilation of a series of extensive benefits, enablers and metrics dictionaries that have now been translated into an online interactive tool to step through the first four levels of the framework. This tool is BIM Value and provides the industry with a free, step-by-step guide to identify and realise benefits from implementing BIM. It provides an approach for industry practitioners seeking to implement BIM across the life-cycle of built environment assets and wanting to understand how BIM can deliver value to their projects and businesses. This BIM Value tool helps managers identify benefits that are most important to them, how to achieve them and how to measure progress towards those goals.

Additional features include:

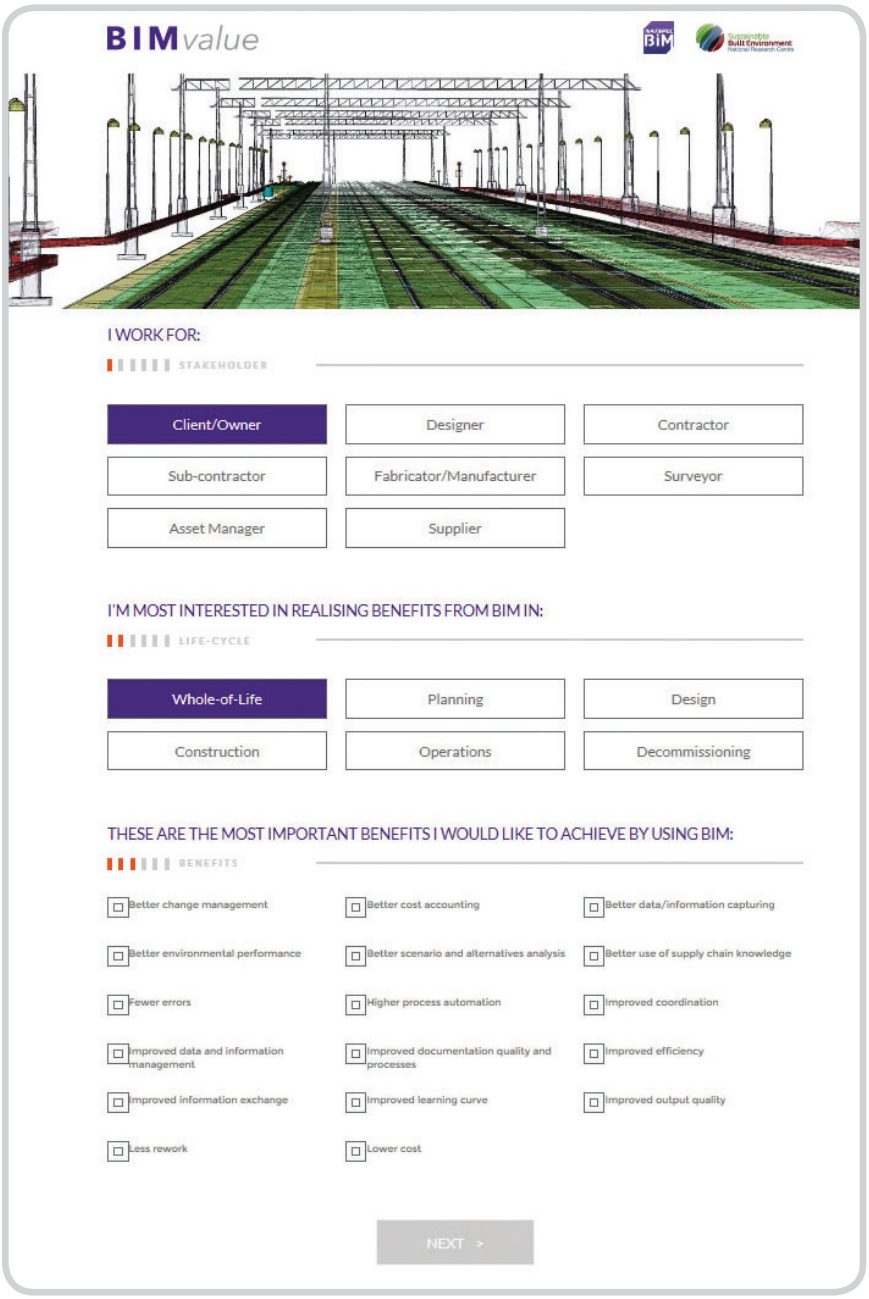
- general and introductory information about BIM, useful for first time BIM users or the BIM-curious
- dictionaries that illustrate how benefits can be achieved, what the benefit flows are and the enabling tools and processes required to achieve them
- a suite of indicators that can serve to monitor progress towards goals, with examples of how they have been used to measure benefits from BIM
- real-world examples illustrating how these benefits can be achieved.

The content is based on academic and industry reports and has been developed in close collaborative consultation with SBEnrc members and project affiliates, including industry, government and research organisations across Australia and internationally. This makes it relevant to a wide range of stakeholders and includes the combined knowledge of a large group of practitioners and experts. This tool is based on the upcoming book Delivering Value with BIM—A Whole-of-life Approach edited by Adriana Sanchez, Keith Hampson and Simon Vaux (Routledge, 2016).



Future value

BIM Value has been developed in partnership with NATSPEC, an Australian not-for-profit organisation aiming to improve the construction quality and productivity of the built environment through leadership of industry information. NATSPEC has positioned itself as a provider of information to help implement BIM in the construction industry. This partnership is likely to be extended to develop new modules of the tool that can increase its value to industry. One such module could for example form the basis for a world-first BIM Benefits Benchmarking System. This initiative will also aim to understand how meta-data created from using the tool can be used to benefit industry.



Conclusions

This project sought to provide the built environment industry with a framework to measure and maximise benefits from implementing BIM across the life-cycle phases of a built asset. To achieve this, Australia's SBEnrc team drew from international practice and literature as well as carried out three exemplar case studies across different Australian states and life-cycle phases. The team also worked in close collaboration internationally through the International Council for Research and Innovation in Building and Construction (CIB) Task Group 90: Information Integration in Construction (IICON). This group is working towards a more comprehensive view of the role of integrating information across the whole-of-life and supply chain of the built environment. Nationally, the team collaborated with SBEnrc's industry and government partners and a number of industry organisations. This collaborative research effort aimed to ensure that the outcomes of the research were relevant to all stakeholder groups as well as complementary to outputs of other organisations active in this space. Outcomes of this project will help achieve more informed performance assessments and continuous improvement processes for implementing BIM across assets and life-cycle phases.

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This research would not have been possible without the ongoing support of our industry, government and research partners:

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Project members

Project affiliates

These organisations have provided support for the research undertaken by the Sustainable Built Environment National Research Centre by providing feedback and advice regarding the research outcomes and final dissemination strategy.