Building Information Modelling for Work Health and Safety Management

2A
Guidelines to Procurement, Tendering and Supply Chain Monitoring

CONTENTS

LIST OF FIGURES

TABLE OF ACRONYMS AND TERMINOLOGIES

AIR	Asset Information Requirements
BEP	BIM Execution Plan
BIM	Building Information Modelling/Building Information Model Interchangeable with digital model/digital modelling/digital engineering/digital twin.
ECI	Early Contractor Involvement
EIR	Exchange Information Requirements
HSE	Health and Safety Executive
IDMF	Infrastructure Data Management Framework
ISO	International Organisation for Standardization
OIR	Organisation Information Requirements
PIR	Project Information requirements
WHS	Work Health and Safety

FOREWORD

Construction is one of the most dangerous industries in which to work and many safety incidents, injuries and fatalities could be prevented through improved design, planning and communication. Building Information Modelling (BIM) is an enabling technology for the generation and management of digital design and construction information from which Work Health and Safety (WHS) hazards and related risks can be identified and managed. There is an opportunity for BIM to support the elimination or mitigation of risks. WHS management requires controls to be in place over the entire asset lifecycle including project planning, design, construction, end use, maintenance, decommission and demolition. BIM as an enabler of data and information management provides the opportunity to improve health and safety through better analytics, modelling and simulation with the underlying assumption that this will provide for better insights, decisions and outcomes. Data as an asset to manage is core to this suite of guide notes in the BIM for WHS Management Decision Framework.

Skye Buatava,
Director, Centre for Work Health and Safety

Scientific research is vital to improving our way of life and work health and safety is an important part of our work lives. The research that created these guidelines has the capability to put Australia on the cutting edge of safety practices in our infrastructure projects and highlights the way businesses can use BIM to improve their WHS outcomes. I'd like to thank our research partners who led with project with the Centre and also acknowledge our national and international contributors for sharing your experiences so freely with us.

Claudelle Taylor,
Enterprise Solution Managers, CIMIC

Our industry needs tools to bring BIM and WHS management together and best practice examples are key to this. We are a very competitive sector and we are often looking over our shoulder to see new ways of managing BIM. The best practice examples in this Decision Framework across the six areas give us insights on what to do and also trigger other ways we can adapt to the digital world through WHS.

Prof Kerry London,
Pro Vice Chancellor Research, Torrens Global Education

The study is an excellent example of impactful research through involving end users of research. The Decision Framework is also informed from analysis of policies and practices in other countries coupled with international research on Building Information Modelling adoption over the last decade. Australian researchers at different times have led the way in construction IT research and are certainly a leader in construction safety research. I was delighted to lead this research project and chair the Industry Advisory Group. I am deeply grateful to all those who contributed from the advisory group, the researchers at Torrens University Australia, Western Sydney University and the Centre for Work Health and Safety.

ACKNOWLEDGEMENTS

AUTHORS

Professor Kerry London, Torrens University Australia (Editor and lead researcher)
Dr Zelinna Pablo, Torrens University Australia
Angelica Vårhammar, Centre for Work Health and Safety (Editor
Dr Payam Rahnamayiezekavat, Western Sydney University

RESEARCH TEAM

Professor Kerry London, Torrens University Australia (Lead)
Dr Zelinna Pablo, Torrens University Australia
Angelica Vårhammar, Centre for Work Health and Safety
Dr Payam Rahnamayiezekavat, Western Sydney University
Associate Professor Yingbin Feng, Western Sydney University
Dr Peng Zhang, Western Sydney University

CONTRIBUTORS

WESTERN SYDNEY UNIVERSITY

Associate Professor Swapan Saha
Adjunct Professor Gabrielle Wallace

CENTRE FOR WORK HEALTH AND SAFETY

Skye Buatava
Dr Gregory Zelic
Ron Keelty
Daniel Craig
Alison Taylor

INDUSTRY

Ross Trethewy, Lendlease
Ying Chan, Lendlease
Luke Belfield, Office of Projects Victorian State Government
Simon Marr, Men from Marrs Contracting
Cathy Hayes, CBP Contractors
Eric Bugeja, CIMIC
Medy Hassan, Haus Holdings
Annelise Cannon, Lendlease
Joe Amodeo, Richard Crookes
Mark Glading, Lendlease
Mark Holliday,
Matthew Kehoe, Office of Projects Victorian State Government
Oskar Casasayas, Office of Projects Victorian State Government
Vik Goundar, Benchmark Drafting Services
Alex Scotts, F&D Normoyle Engineering
Simon Vaux, DEOS Digital

EXTERNAL REVIEWERS

Claudelle Taylor, CIMIC (Industry)
Professor Ning Gu, University of South Australia (Academic)

INTRODUCTION

CLIENT RESPONSIBILITY

Clients who build, own and manage a significant portfolio of physical assets are more and more seeking better ways to maximise value from their asset portfolios. The planning, design, construction and operation of these assets results in the creation of data relating to the asset portfolio. This data and information are also an asset that needs to be effectively managed across the lifecycle of the assets.

The majority of the data in digital models (Building Information Models) is created by external organisations to the client organisation. However, ultimately the client is the organisation that has the most to gain from the model either through ensuring that high quality designs are communicated well and translated to effective construction methodologies, or models are updated during construction to support safe, efficient and sustainable construction activities or data is used in operational phases to inform asset maintenance and management. Importantly, data can contribute to ensuring safe work environments and safe construction sites are established.

Therefore, the client and asset owner have a responsibility to ensure that the manner in which they explain their data requirements is clear. Thus Procurement, Tendering and Supply Chain Monitoring are critical activities that help to guide the creation, use and management of information requirement expectations.

INTERNATIONAL BIM AND WHS STANDARDS AND GUIDANCE DOCUMENTS

The international standards ISO 19560 series establishes the requirements for all phases of building information modelling (BIM). The UK BIM Alliance has also developed a suite of Guidance documents to support the implementation of the standards. ISO Part E Guidance Note Tendering and Appointments provides useful information to the Appointing Party (the client), the Lead Appointed Party (contractor and consultants) and the Appointed Party (typically subcontractors).

The international standards ISO 45001 specifies requirements for an occupational health and safety (OH&S) management system to enable an organisation to proactively improve its OH&S performance in preventing workplace injury and ill-health. Safe Work Method Statements (SWMS) document processes for identifying and controlling health and safety hazards and risks. Under the Model Work Health and Safety Act 2011 and the Work Health and Safety Regulation 2011, a ``SWMS must be prepared before high-risk construction work begins. The ISO 45001 and SWMS provide useful information for establishing information requirements in relation to Work Health and Safety management.

DECISION FRAMEWORK BIM FOR WHS MANAGEMENT COMPANION GUIDE NOTES

Importantly within the context of the standard the client should develop the hierarchy of documents as outlined in the first Guide Note in this series Decision Framework 01 Information Requirements and the component 1a Guide to Developing Information Requirements and the Self- Assessment Matrix

INFORMATION PROTOCOL AT PROJECT LEVEL

The creation of the specific documents for tendering relies on ensuring quality information is developed at a project level through translating organisation information requirements.

In the ISO series it is envisaged that an Information Protocol is developed to be included in the project tender documents.

An Information Protocol should be established by the appointing party at a project level (ISO 19650-2) or an asset/portfolio management level (for ISO 19650-3). It should be included in invitation to tender information and then in appointment documentation for every third party (where the third party is a separate legal entity) that will manage or produce information as part of their activities within that appointment.

INTEGRATING INFORMATION REQUIREMENTS, KNOWLEDGE DOMAINS AND BIM LODS

INTEGRATING THE ELEMENTS

It can be a complex integration exercise to bring together the process for developing organisational information requirements, asset information requirements, project information requirements and then exchange information requirements. The following Figure 2 Integrating BIM and WHS Management Mapped to Information Requirements, Knowledge Domains and LODs provides a high level perspective within the context of key project phases.

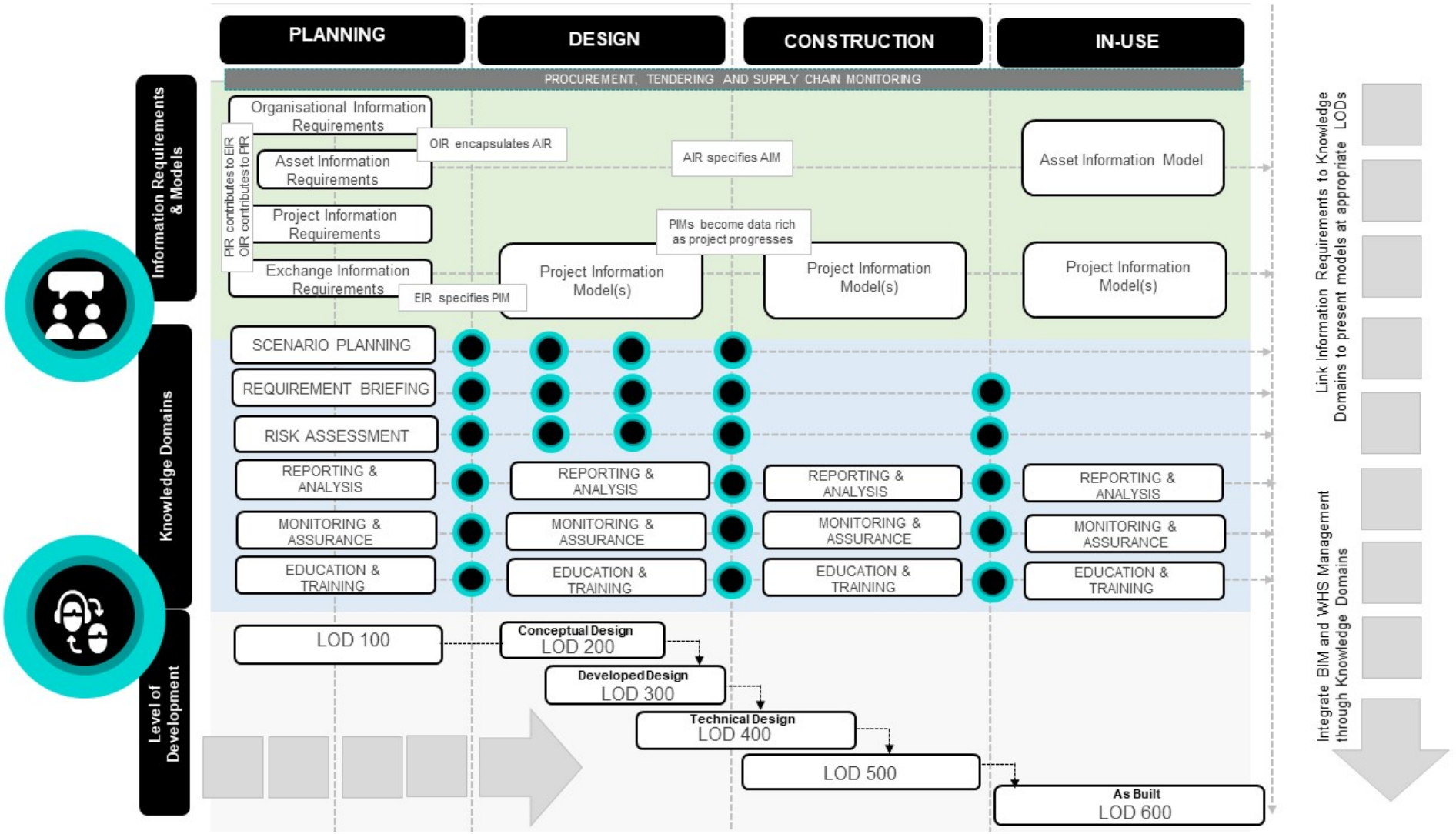

Figure 01 Integrating BIM and WHS Management Mapped to Information Requirements, Knowledge Domains and LODs

CASCADING FROM INFORMATION REQUIREMENTS

The concept of information requirements is critical to set the environment and inputs for the management of information within the entire built environment ecosystem. According to the ISO 19650 series, information should be created for a specific purpose for someone to make use of it. Information requirements specify the precise information someone needs so that when it is received they can action that purpose successfully. There are divided opinions regarding how much information should be requested and collected and we discuss this in more detail later in this Guide. Generally, it is accepted that the client should work collaboratively with their supply chain participants to create information with its use in mind.

The ISO 19650 series frames information requirement resources to include organizational information requirements (OIR), asset information requirements (AIR) and project information requirements (PIR). Collectively, they define the inputs for appointment level information requirements i.e. exchange Information requirements (EIR). The standard also describes the relationships between the OIR, AIR, PIR and EIR whether it is informing, specifying, encapsulating and/or contributing. Figure 2 maps key relationships.

The six Knowledge Domains would have varying provide a frame of reference for integrating WHS management with Building Information Modelling through major initiatives including; scenario planning, requirement briefing, risk assessment, reporting and analysis, monitoring and assurance and education and training. The first three could tend to be event based whereby they occur periodically at specific times; handover from one project phase to the next or targeted at the beginning of handover from one BIM Level of Development to the next (ie LOD 300 to LOD 400 etc.). The last three are initiatives could occur at regular intervals at project phase handover or alternatively be more all-encompassing and occur as a program of events underpinning project phases.

Finally, Level of Development is an extremely important element of the entire BIM process. Without LOD, it can become hard for everyone to work on the same page, creating inconsistencies that can hamper a project's prospects. With the help of LOD specifications, communication and collaboration can become easier and faster, making room for efficient deployment of resources at all levels of design and construction. It is safe to say that integrating LOD with WHS management has not been achieved in a consistent and coherent manner universally. However, in a similar manner to efforts to integrate environmental sustainability to BIM; it is possibly that BIM offers the opportunity to influence WHS management outcomes as well. The suite of documents within the BIM WHS Management Decision Framework provides the beginning of the journey to understand how to bring together at a strategic level key concepts (refer to Figure 3).

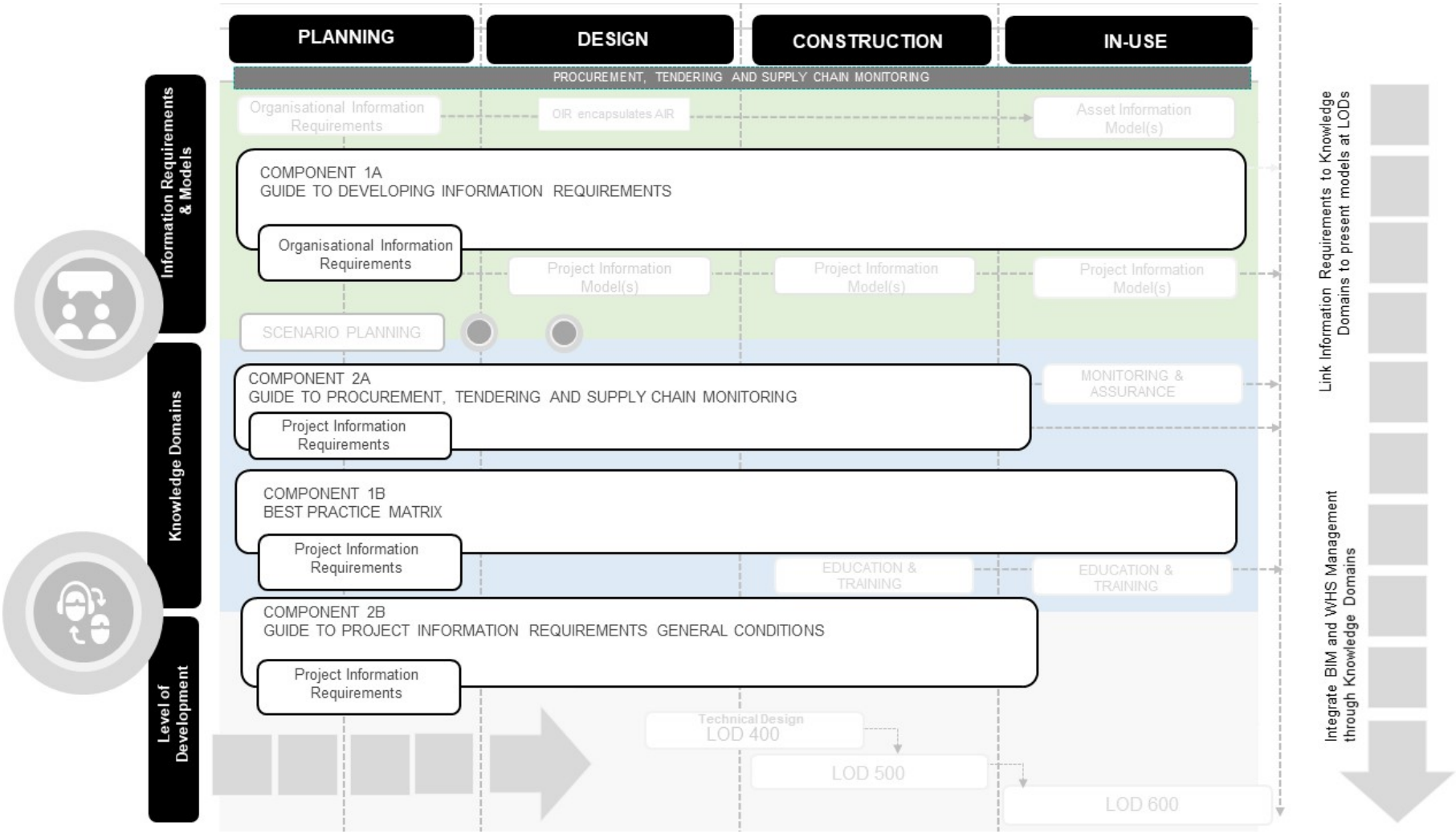

Figure 02 BIM WHS Management Decision Framework Components mapped to Information Requirements, Knowledge Domains, LOD and Project Phases

ISO 19650 TENDER AND APPOINTMENT

The ISO 19650 series only refers to the tender package for the lead appointed party. However, an information protocol will need to be included in any tender package so that every party invited to submit a tender is aware of their obligations should they be appointed. Similarly, the ISO 19650 series does not specifically consider the tender or appointment of sub-parties, but they too will need to enter into an information protocol where they are managing or producing information as part of their scope of works.

NSW INFRASTRUCTURE DATA MANAGEMENT FRAMEWORK

In New South Wales the Infrastructure Data Management Framework (IDMF) is a set of guidelines, procedures and standard approaches to support consistent management of infrastructure data across the NSW Government sector. This Guideline Decision Framework is aligned to the IDMF.

ABOUT THIS GUIDE NOTE

The Guide Note provides information derived from a research study sponsored by SafeWork NSW Centre for Work Health and Safety and completed by Torrens University Australia and Western Sydney University.

The Note supports the NSW implementation of the Infrastructure Data Management Framework and the ISO 19650 series. This guidance document (Guide Note 02a) sits within an overall guidance framework as shown in Figure 1.

The purpose of this Guide Note is to provide tips on principles and processes on BIM generally and specifically on BIM for WHS management:

1. Procurement strategies influence
2. Tendering at each stage of tender process
3. Supply Chain Monitoring

GUIDE NOTE DOCUMENT HIERARCHY

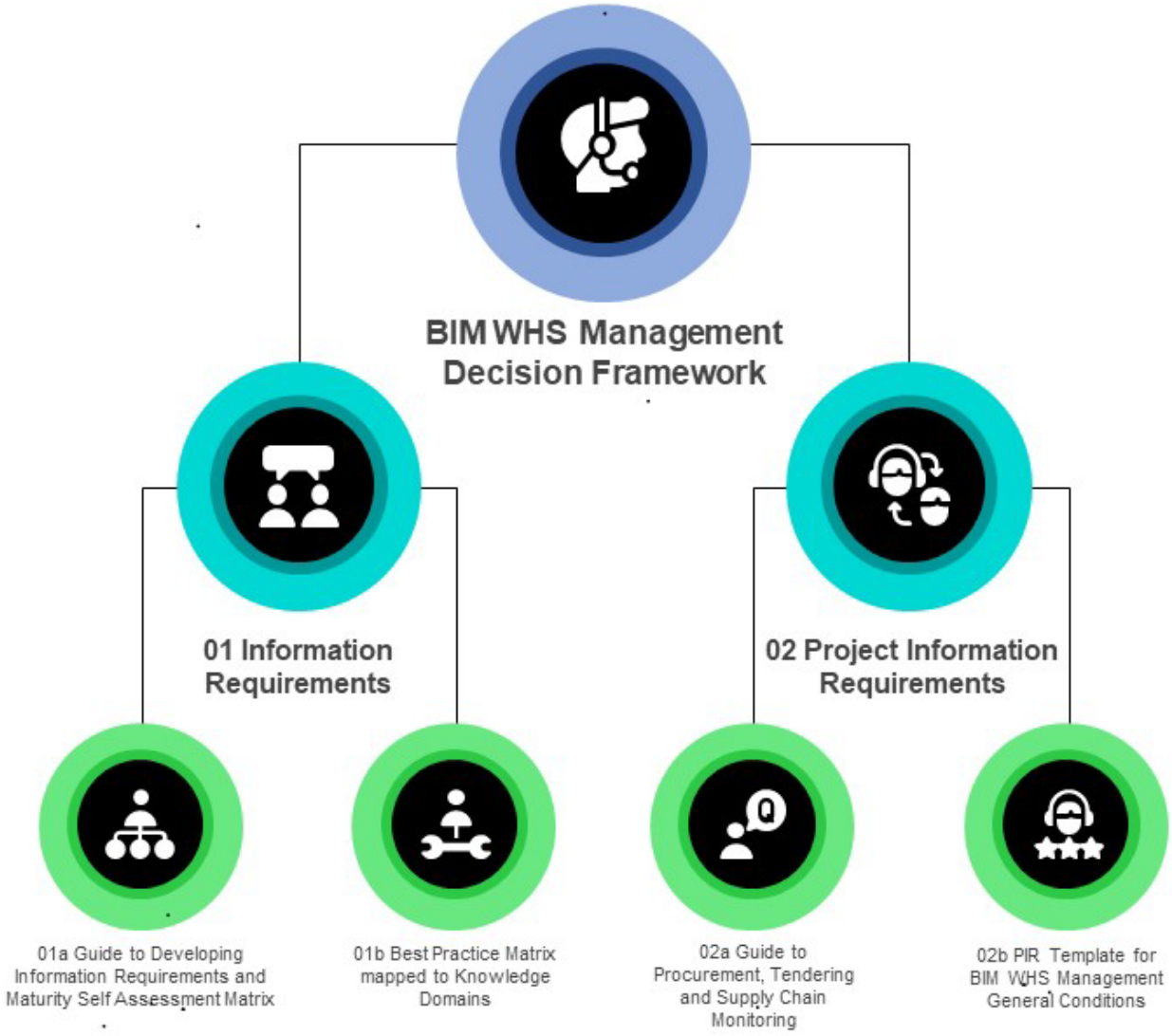

Figure 03 Guide Note Document Hierarchy

WHO IS THIS GUIDANCE WRITTEN FOR?

This Guide Note is for individuals and organisations involved in deciding on project procurement strategies, drafting tender requirements and managing contracts on behalf of the appointing party, lead appointed party and the appointed parties. The Note is for the leadership team including; clients, facility/asset managers, project directors, project managers, design consultants, contractors and key specialist subcontractors. It is specifically aimed at **senior executives** who make decisions regarding procurement strategies, **asset and project managers** those who work on projects and make strategic decisions at a project level on tendering and contract management.

WHO IS THIS GUIDANCE 'OF PARTICULAR INTEREST TO' AND WHY?

This Guide Note is of interest to parties involved throughout the asset delivery lifecycle, who seek to produce reliable information requirements that meet defined purposes, and enable effective delivery of information across the entire lifecycle. There are those in organisations that procure capital works, who do not work directly on projects, who have a stake in creating, using and/or managing quality information management. The overall objectives of an organisation also often rely upon quality information management that is well integrated to other portfolios' information systems; for example, finance, human resource management, equipment procurement and asset maintenance.

KEY TAKEAWAYS

PROCUREMENT STRATEGIES

CASE STUDY

TENDERING PHASES

SUPPLY CHAIN MONITORING

1. Procurement strategies can influence collaboration significantly.
2. Some procurement strategies are more aligned with collaboration than others.
3. Regardless of which procurement strategy is chosen, the key to project success with respect to BIM for WHS management is to develop and communicate clear requirements and expectations.
4. BIM and WHS management can be successfully integrated.
5. Logistics planning is critical to WHS and BIM and can be used to model scenarios for offsite construction.
6. BIM can be used to communicate at weekly safety meetings.
7. The size of a company does impact the ability to be innovative and implement the adoption of BIM for WHS management.
8. The tender documents do not need to be prescriptive as the appointed party can produce a BIM Execution Plan however an information protocol should accompany tender requests.
9. Consult key stakeholders for WHS, BIM and risk considerations
10. Broadening evaluation panels to ensure appropriate WHS and BIM expertise is integrated into assessments
11. If the Model is to be used as part of the contract documents legal advice should be sought for contract management
12. The capacity and capability to deliver needs to be well integrated along the entire supply chain
13. The use of BIM can eliminate or minimise construction site WHS risks by integrating safe work method statements and site safety plans into models that can be continually revised to reflect changes to the design and construction processes.
14. The development of an information creation, use and management culture that values accuracy and certainty can improve decision making through accurate WHS analysis, reporting and performance
15. Commitment to BIM for WHS management by the client requires the establishment of accountability at each tier of the supply chain through monitoring of information protocols
16. Clients can catalyse BIM for WHS management by acknowledging and ensuring accessible online platforms are available to all supply chain organisations as appropriate

PROCUREMENT STRATEGIES

ABOUT PROCUREMENT MODELS

INTRODUCTION

On construction projects, various procurement strategies are used. For the majority of projects, we typically see the procurement strategies that are referred to in Australia as 'Traditional', 'Design and Construct' and 'Management Contracting'. We see variations of Design and Construct, such as 'Novated Design and Construct' and 'Developed Design and Construct'.

In more recent times, we have also seen the emergence of 'Early Contractor Involvement', as an alternative procurement strategy, along with broader project organizational arrangements, such as Public-Private Partnerships and Alliance contracting.

DATA CREATION AND MANAGEMENT THROUGH PROCUREMENT

Different procurement and project organizational structures can influence how data is created, managed and shared across the supply chain. For most strategies, there is a clear distinction between the 'Appointing Party', often the client, and the 'Appointed Party'.

Parties play different roles in establishing information requirements, in creating information and in receiving and using information for decision-making.

For example, on a project using a Traditional procurement strategy, the client will typically work with an independent designer to define information requirements. A construction contractor accepts these requirements, creates information and then passes it on to the operator of the completed asset. If the transitions between design, construction and in-use phases are not well managed then the benefits of the collaborative nature of the building information modelling process can be lost.

The process is different under an Alliance. The Appointing and Appointed parties work together as a single unit in defining information requirements, starting with high-level requirements that can cut across several projects. For each project, parties jointly create and collaboratively share information, from concept definition to design to implementation, right up to the time the asset is handed over for operations and maintenance.

SELECTING PROCUREMENT STRATEGIES

Some procurement strategies appear to be more collaborative than others. The Traditional procurement strategy is considered less collaborative and integrative across phases as it compartmentalizes each stage to a particular contract. The use of BIM may be restricted to certain contractors and to specific project stages.

Procurement strategies that integrate across multiple phases can positively influence collaborative practice across design, construction and in-use phases. Such procurement strategies can create an environment that integrates supply chains and thus manage and monitor the use of BIM for WHS management more effectively. Research has suggested that the benefits of BIM are optimised under more collaborative arrangements, such as Public-Private Partnerships (PPPs) and Alliances.

"It comes down to the client's specification of it, not so much the type of contracts. You can ask for the highly detailed model on a design-only contract. You can ask for a highly-detailed and collaborative model that can be used by many other parties during design-only. You can ask for a recent blockwork thing on a PPP. It's more about what's specified in the contract. The designers, the contractors will do what is required in a contract and it's just about how do you specify it."

– Senior Manager, Transport for New South Wales, Australia

The environment for high-quality data management is created by the initial conditions set by the client. If the client organisation has a high level of maturity in developing information requirements and controls data creation, flow and management well, the type of procurement strategy used may be less influential. The key to developing information requirements begins with a client conducting a self- assessment of maturity in BIM adoption. This will clarify their capacity to identify the purpose for the information and how will it be used in all phases.

Clients can address the challenge of ensuring integration across more phases by appointing a BIM project manager and/or introducing Early Contractor Involvement. The challenge is to ensure consistent and coherent adoption of BIM for WHS management.

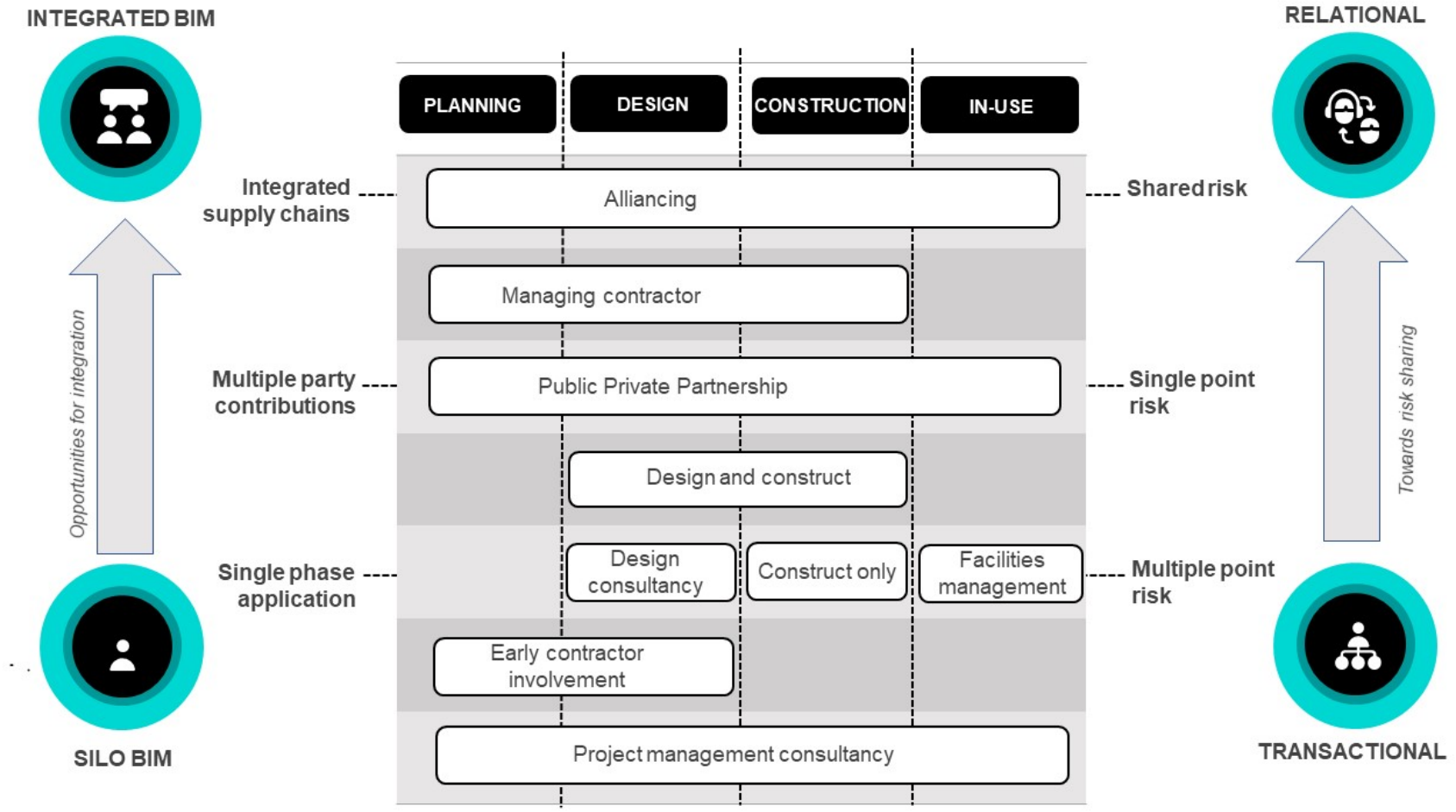

Figure 04 Alignment between BIM and Project Delivery strategies adapted from Holzer, R. H. (2015). BIM for procurement - procuring for BIM. In R. H. Crawford and A. Stephan (Eds.), Living and Learning: Research for a Better Built Environment: 49th International Conference of the Architectural Science Association (pp.237-246).

CASE STUDY: COMPLEX TIMBER FAÇADE

INTRODUCTION

A construction project, which we shall refer to “Project One”, located in Sydney, Australia, involved a six-story, circular, commercial building. The façade was wrapped in 20 kilometers of prefabricated, sustainably-sourced, timber strips.

This case study focusses on the façade and the façade subcontractor. Project One involved critical safety issues including cranage of façade elements and people working at heights, challenges that were intensified given that the structure was surrounded by three other towers, limiting the available space around the construction site.

Project One was led by a real-life client referred to here as the integrated global corporate real estate and investment group (hereafter “the integrated global corporate”), a multinational with expertise in infrastructure, design, construction, development, investments and management. The integrated global corporate was involved as developer, design manager and construction manager. An independent architectural consulting firm was tasked to develop the concept design.

MYTHBUSTER: BIM IS FOR THE BIG END OF TOWN

A key stakeholder in Project One was the façade subcontractor, due to the design involving timber strips wrapped around the structure.

The façade subcontractor is a small-sized company with employees from multiple disciplines including various professional, para-professionals and trades people.

The company employs project managers, estimators, drafts people, engineers, riggers, carpenters, electricians and factory supervisors. Their reputation is built upon providing solutions to complex construction engineering projects and BIM is a key to their problem solving. Apart from its nine factory-based and 12 site-based contractors, the company employs only a total of 13 people; thus, this case study indicates that small companies have the potential to drive the use of BIM for WHS management across entire supply chains.

An Environmental, Health and Safety Manager who was part of the team described Project One as “absolutely the most well planned, well defined, designed, coordinated project”.

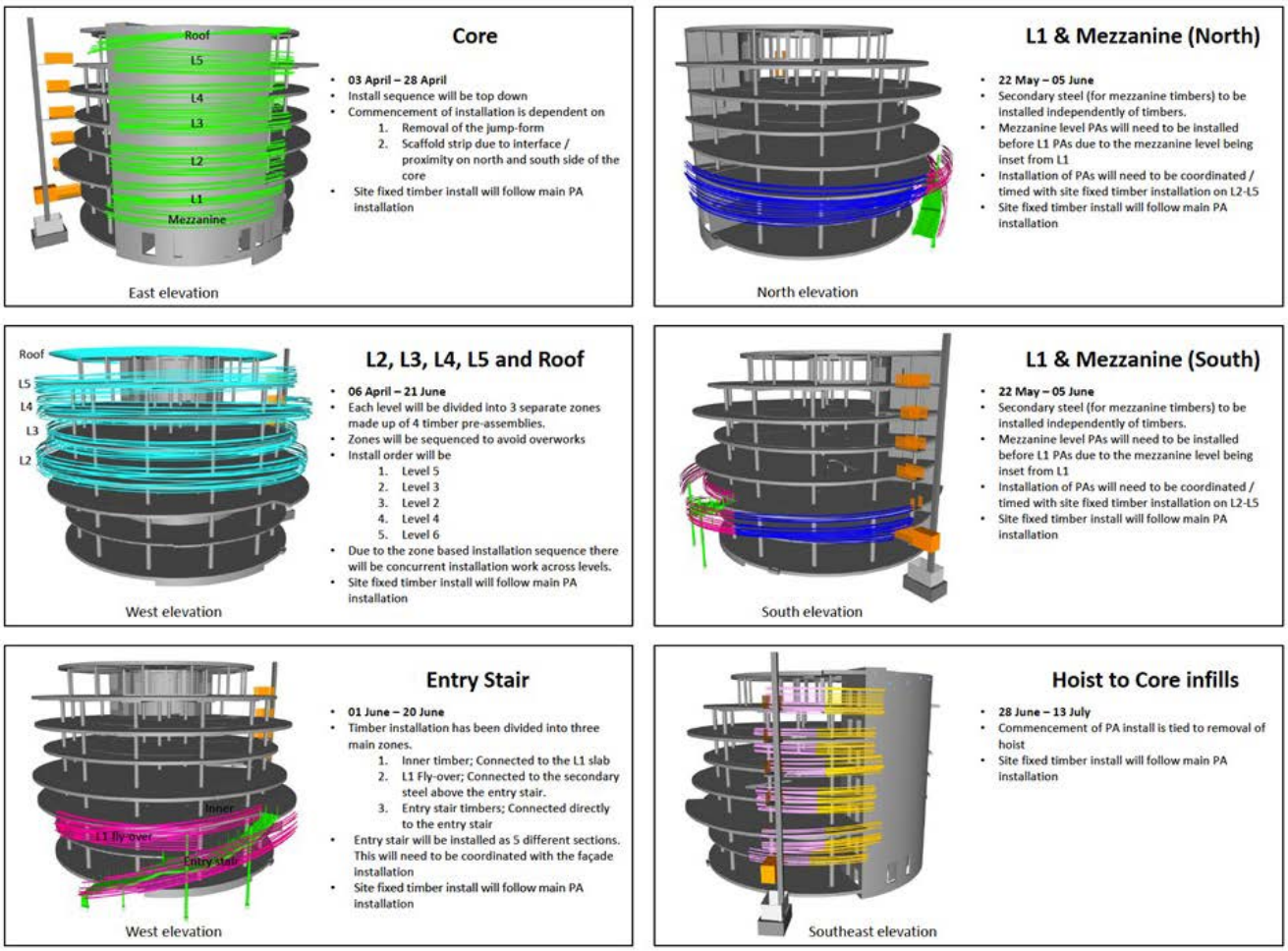

Figure 05 Model indicating site façade sequencing used for site communication at safety meetings.
Source: Images provided by Alex Scotts, F&D Normoyle Engineering Pty Limited.

"The] circular floor plans [are] not perfect circular but ... they all shift in different directions. So you've got areas of overhangs. You've got areas with terraces that are open to the sky...it's quite complex. So, we used the model, back then, very early on, to look and interrogate and all the sections."

- Architecture and Urban Design Manager, Project One Team

This project involved an implicit and explicit integration of BIM and WHS management, with 3D models being used in sophisticated ways to plan crane positions, identify dangerous work areas and communicate the sequence of activities so that the supply chain could anticipate potential hazards.

WHS is a high priority for the integrated global corporate who operate in more than 40 countries. Across these locations, the company upholds a set of 18 standard requirements that frame risk assessment across different stages of the project life cycle.

These requirements are operationalized across different business units and are implemented through WHS plans and sub-plans in every single project.

An organized site is a safe site. Communication is key to an organized site. BIM was instrumental in visualizing and explaining façade sequencing, to coordinate the timing of the works. The communication of the sequencing was articulated to the other trades on the project in weekly toolbox meetings where the team would be at any given time.

The integrated global corporate's WHS systems are comprehensive and clearly signal to its partners that "safety is always a big item." However, the systems have also been described as manual and onerous, primarily because they remain largely paper-based. While all of the integrated global corporate's projects are marked by high standards of WHS, few projects pursue WHS targets by systematically using digital tools. BIM and WHS are rarely combined in strategic, meaningful ways. Project One was an exception. Highlights of this successful project are now summarized.

INITIATING INNOVATIVE USE OF BIM

The integrated global corporate decided to use BIM extensively as a response to the complex design and construction.

Project One team used the BIM environment to model each of the 122 timber panels of the building façade.

The location of cranes and the elevated work platforms were also positioned in the model.

Simulation of cranes, work platforms and the workflow process established how safe access was to be achieved to install each specific panel.

The team pushed the use of BIM to higher levels of detail than usual.

"So, in some instances we were having to think about this building as six different buildings rather than one tower. Each level had its own unique circumstances, and the relationship that each level had with the other levels was also unique too… In a 2D world, this is pretty difficult to see. In a 3D world, it's a lot easier to understand where they should be."

– Digital Engineering Manager, Project One Team

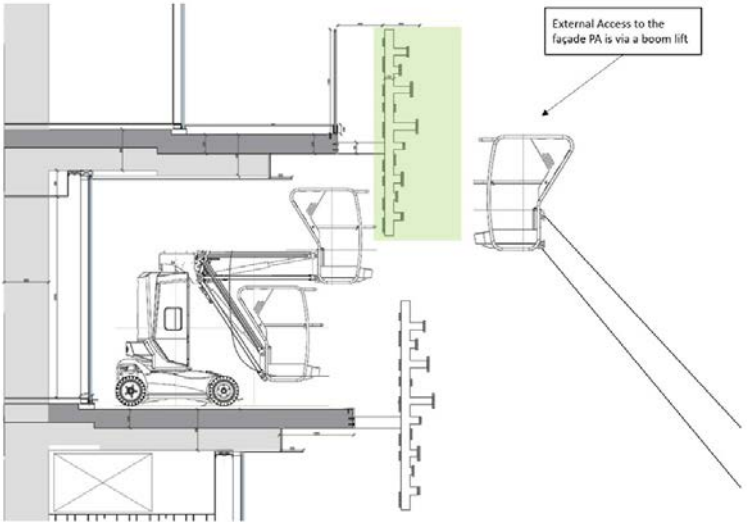

Figure 06 Façade Section view of working at heights using elevated work platforms information included in the Model. *Source: Images provided by Alex Scotts, F&D Normoyle Engineering Pty Ltd.*

DEFINING TENDER REQUIREMENTS

As a result of extensive BIM-supported planning, the integrated global corporate was ready, "*a year before a shovel hit the ground*", to bring together all stakeholders together to visualise the project using a 3D model.

The integrated global corporate acknowledged that 3D visualisation tools were pivotal to explaining their plans to subcontractors, as well as expanding their own knowledge.

The digital models created by the integrated global corporate during planning framed conversations with subcontractors about constructability, construction method and safety.

"In terms of the actual detailed scope…what we did imply through the tender documents was that we wanted them to design in 3D, and we wanted them to present their methodology back to us in 3D. Now, because we required that from them at the tender time, part of the swings was for them to show us…, make us satisfied, that they have understood the building and the nature of the building and they've understood the task at hand for when they go to install it."

– Construction Manager, Project One Team

During tendering, the integrated global corporate did not issue a blanket requirement for all contractors to use 3D models. However, the integrated global corporate did strongly imply that specific subcontractors, such as those responsible for formwork and façade, were expected to design and present their construction methodologies in 3D.

The tendering process involved a tender interview, where 3D models played a central role. The integrated global corporate used models to present the construction program to all subcontractors, including those in charge of activities such as painting, metalwork and final cleaning.

CONSTRUCTION PROGRAMMING, WORKFLOW AND SAFETY INTERACTION

The introduction of the 3D model during the tendering interview provided an early opportunity for the integrated global corporate to help subcontractors understand that their position was that "*because we were a team, you work with your subcontractor. We sit down, we have the architect's model open and we work with that subcontractor to understand how their elements of work come into play.*"

"In all our rooms we had a desk, a lot of paperwork and we also had a big screen and we'd walk through the model. We'd show them, 'look guys', our model is linked to our construction program. We'd say, 'this is how we are building the model, and how we're building the building' they'd look and go, 'oh, yeah, actually I didn't realise it was round'."

- Construction Manager, Project One Team

The integrated global corporate thus showed contractors in 3D "how they [were] going to potentially perform their works" and how the integrated global corporate could "bring them on the journey". BIM-supported exchanges became one basis for scoping work. For example, the formwork subcontractor was asked to model the scaffold and the edge protection in BIM, which allowed the integrated global corporate to understand how the building would be built from a structural point of view.

FACILITATING ROBUST TENDER RESPONSES

"So, we then developed very thorough methodologies that became part of our safe work method statements that the guys would then follow on a daily basis. And would be used as means of communicating to the other trades where we were going to be working at any given time which, sort of feeds information to the exclusion zone set ups so that trades on lower levels don't walk underneath something that's hanging off a crane."

– Project Manager, Façade Subcontractor, Project One Team

The strength of the relationship between the façade subcontractor and the integrated global corporate was that they believed in the value of BIM.

The integrated global corporate attempted to create a level playing field by ensuring that parties who incorporated the cost of BIM into their tenders were not "unfairly" compared with parties who were cheaper by not using BIM.

By the time they had developed the technical design, the façade subcontractor had completed "*mountains of work on methodologies and systems which allowed us to put together a very comprehensive set of documents about how it was going to be built*."

This information then informed detailed, daily programs, which the façade subcontractor integrated into safe work method statements and construction methodologies.

The Model was instrumental in integrating the WHS information and also as a tool to explain and communicate key safety instructions and practices. The following figure 5 indicates a typical example of graphic extracted from the Model and included in the safe work method statements.

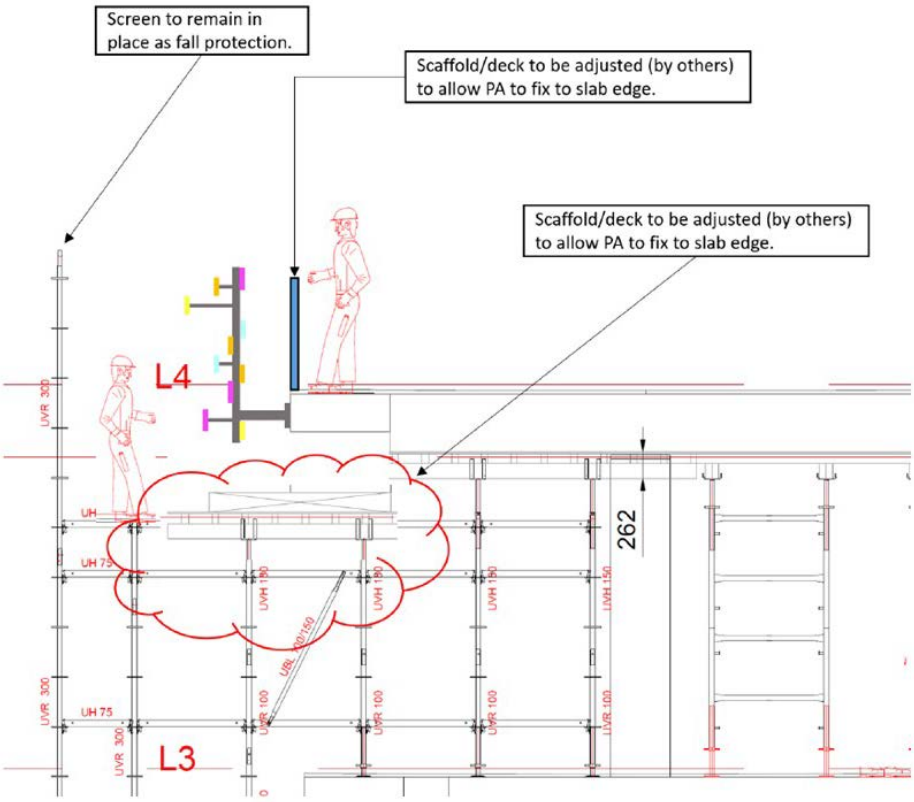

Figure 07 An example of a Safe work method statement
Source: Images provided by Alex Scotts, F&D Normoyle Engineering Pty Limited.

PRACTICING AND MONITORING

"We displayed the weeks program, but we also had snapshots of the model and then zoom around to the model as to where we were up to and a look ahead for the next month or three months as to what we were doing onsite. .. In some cases we highlighted exclusion zones for that day or for that week where we were installing the façade or where we were stripping scaffold. So, workers who were on their smoko or just walking to site, and are lining up to go through the turnstyle, they can have a quick squiz at the TV and understand what is going on, on our site."

– Construction Manager, Project One Team

The façade subcontractor was the key trade, carrying out activities that were thoroughly scrutinized.

Work health and safety was a key consideration, because the installation of the façade involved lifting very heavy elements using cranes and installing building façade elements at heights.

The façade subcontractor's thorough methodologies became part of their safe work method statements which workers on site then followed on a daily basis.

Information from the façade subcontractor's methodologies, presented in 3D, were used as a means for communicating exclusion zones on site.

The façade subcontractor modelled every single stage of installation, took a snapshot of each daily activity, and recorded the date that it was expected to happen.

Information was communicated to other trades, helping to ensure that people knew where they were going to be, what they were going to be doing and what they needed to be careful of.

The combination of BIM and WHS expertise as well as façade design and construction capability was evident with this particular façade subcontractor and critical to the successful execution of this project, resulting in Critical Incident and Lost Time Frequency rates of zero.

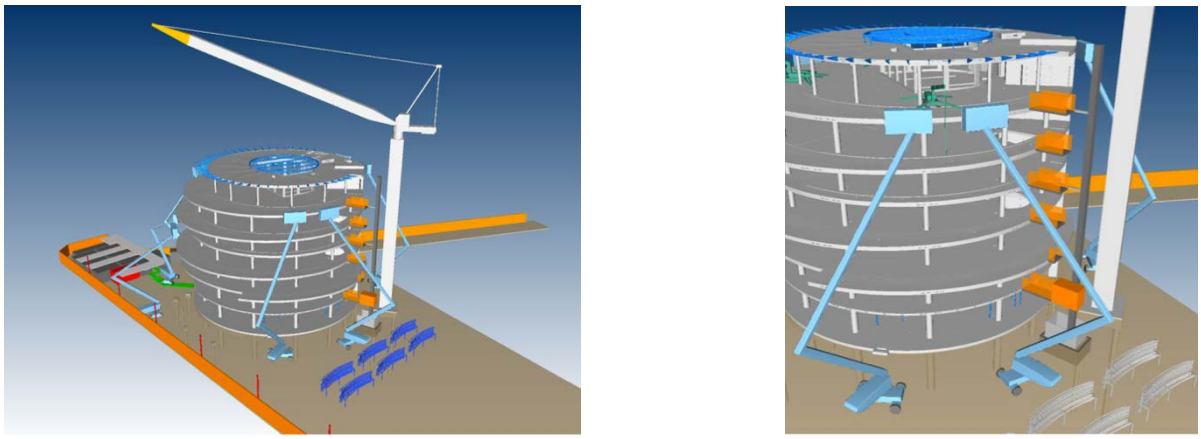

Figure 08. Use of 3D BIM to visualise the Project One Façade Installation Methodology. The Model was used to identify the capacity and type of cranes required and its positioning on a weekly basis. Safety was enhanced due to improved design and sequencing of activities and communication of high risk work activities across the entire site. *Source: Images used with permission from Alex Scotts, F&D Normoyle Engineering Pty Limited and XXX, LendLease (permission pending).*

TENDERING PHASES

PRE-TENDERING

DEFINING OUTCOMES, PRIORITIES AND REQUIREMENTS.

For some contractors, the increasing adoption of BIM in the industry has meant using digital models on a daily basis, while others are lagging behind. Some only use digital models if it is in their interest to do so or if they need to do so., e.g. the budget allows for it or the building is complex.

The client's decision to require contractors to use BIM for the project and for a model to be developed at tender requires thoughtful consideration.

"[The clients] clarify the type of modelling they require, the level of model development they require, the software that they will use, the file types they will incorporate."

– Project Manager, Façade Subcontractor, Project One Team

From a project perspective, clients need to be clear early on about their WHS management goals, processes and data requirements. Clients must understand the nature of the project and appreciate the purpose, benefits and limitations of BIM for managing WHS. If BIM for WHS management is an important outcome for the client then BIM and WHS expertise needs to be integrated throughout the supply chain.

Importantly, clients need to develop clear expectations through tender requirements and understand and evaluate the expertise required to deliver on those requirements. The Self-Assessment Matrix helps clients identify how well-developed their systems and processes are for using BIM as a WHS management tool. A sophisticated client who is competent and proficient at tendering is able to understand and justify project goals and processes with respect to WHS management and then translate these into information requirements for BIM.

Refer to the Guide Note to Developing Information Requirements and the Self-Assessment Matrix in this Decision Framework series for more information.

IDENTIFY RISKS AND OPPORTUNITIES.

Assembling a project team and defining WHS outcomes, priorities and requirements should be a collaborative process. Depending on the nature, level of risk and technical complexity of the project, clients benefit from consulting with architects, engineers and construction professionals and also asset operational staff and WHS professionals.

"I would say, majority of the time [risks are] not designed out, they're overlooked, and it becomes an issue for construction on the site and they're having to come up with solutions on the fly… once it gets to a project it is almost too late and you're trying to play catch-up."

– EHS Manager, Project Two Team

Collaboration helps identify risks and opportunities, leverage lessons learnt from other projects, and facilitates the crafting of appropriate tender requirements, goals and objectives for the use of BIM for WHS management.

Consulting early, broadly and on an ongoing basis with contractors, subcontractors and stakeholders through scheduled activities fosters genuine relationships, enhances communication and develops a culture of shared values that maximizes the likelihood of successful project outcomes.

ACHIEVING BALANCE IN REQUIREMENTS

"The larger ones engage and the smaller ones either fall by the wayside or have to work within the system somehow." ***– Senior Practice Director, Architectural consulting firm Project Three Team***

Tender requirements can range from prescriptive instructions to high-level or principles-based objectives. While non-prescriptive requirements encourage industry innovation, there are benefits to being specific. Specific requirements provide clearer direction and instruction and are easier to enforce. E.g., if client systems and processes for BIM and WHS have already been developed, it might be desirable to require contractors to comply with these processes.

However, being too prescriptive and not considering the systems, capacities and capabilities of the supply chain can discourage tenderers from submitting proposals. Broad consultation with organisations down construction supply chains and associated stakeholders will support achieving a project-appropriate balance between general and specific requirements of using BIM for WHS management.

COMMUNICATING EXPECTATIONS AND REQUIREMENTS

The majority of BIM requirements should be defined in tendering criteria and contract terms, or as part of supporting documents. Project expectations can also be made implicitly. Depending upon the procurement strategy and/or the project organisational structure, objectives can be aspirational rather than essential. Implicit requirements can encourage tenderers to rise above minimum expectations.

CAPABILITY ACROSS THE SUPPLY CHAIN

"So the first thing you need to do is assess the digital capabilities of your contractor … So you need to come up with a list of understanding their level, because there's no point asking them for something if they're not capable of doing it, right?"

– Digital Engineering Manager, Project One Team

Considering the advancement of technology and the availability of international standards and guidelines, digital technical capability across the sector is increasing. There has been a tangible shift in culture in recent years towards the adoption of BIM for project design and management purposes. Requiring BIM models at tender, and BIM for WHS management for the project and resulting asset, supports this trend and can encourage continued upskilling of the supply chain.

Having contractor capability and the established project priorities in mind, it is recommended to work with the project legal team to develop fit-for-purpose tender documents, including draft contracts, conditions, and response templates.

TENDER EVALUATION

INTRODUCTION

The tendering requirements and criteria, established though the project specific Project Information Requirement (PIR) document and supplied along with the invitation to tender, are used to compare and contrast the merit of tender proposals. Alignment with key priorities are commonly assessed and quantified by an evaluation panel consisting of a number of project stakeholders from diverse backgrounds.

KEY ISSUES TO CONSIDER

The evaluation panel commonly focuses on the key priorities for the project, giving stronger weight to priorities seen as more important. In addition to the key project boundaries of cost and time, other criteria such as WHS and quality can be assessed in a multitude of ways, depending on the nature and complexity of the project.

If the project includes the use of BIM for design, construction, asset and WHS management, it may be of interest to compare and contrast the proposed software applications along with the workers' capacity and capabilities in the selected technologies.

If the project has made use of high-level, non-prescriptive requirements to foster industry innovation, the level of innovation in the tenderers' proposals may be compared and contrasted against return on investment and the benefits provided by such innovation.

If tenderers play a major role in WHS management for the project or for particular tasks, it may be of interest to compare and contrast the tenderers' WHS culture, management records, processes and capabilities.

"So during the tender process, we have to prove that we have the experience that is required, the quality assurance systems that is required and they play, I guess, a strong part in the tender process, because having the right team on board and they have the right attitude, is really important to someone like [the client]".

– Senior Practice Director, Architectural consulting firm Project Three Team

EVALUATION PANEL AND EVALUATION CRITERIA

Project priorities vary among projects, evolve during project implementation, and differ among project stakeholders. The capability to critically assess and score the quality of tenderers' proposals may therefore be influenced by the evaluation panel members individual areas of expertise and experience. For example, an information manager would be best placed to comment on the information management plan and a WHS professional would be best placed to comment on the inherent risks of the project and the quality of the WHS management approach. Diversifying the evaluation panel and consulting broadly when developing evaluation criteria will enable the project team to capture the full scope of project priorities, weight their scores appropriately, and be confident criteria has been assessed in a valid and robust way.

USING BEST-PRACTICE BIM TO IDENTIFY RISKS

Refer to the Best Practice Matrix in this Decision Framework series for more information.

Clients should aim to be very clear about what they are looking for when evaluating tenders. BIM models, while not always required, can provide a more comprehensive understanding about what the tenderer is planning on doing than written documentation and 2D drawings. The use of BIM during tender evaluation interviews and in presentations should be encouraged to support discussion. The Best-Practice Matrix provides examples of ways BIM can be used for identifying WHS management risks and issues before the contract has been awarded.

POST TENDERING

COMPLIANCE AFTER TENDER

If not already developed before the tender, now is the time for contractors and subcontractors to develop detailed BIM and WHS plans for the various phases of the project along with the engagement plan, identifying how to communicate requirements through the supply chain.

The most effective approach is to use a range of written and verbal communication channels. Examples include contract terms and management plans, as well as programmed stakeholder meetings and reviews. Including requirements for regular meetings to review and discuss progress is an efficient way to monitor compliance with the scope and delivery program. Meetings can be complemented by requirements for regular monitoring and reporting. In some aspects, the BIM model can be used to support WHS monitoring and compliance by providing evidence of progress and documenting changes, roles and responsibilities.

"why is the requirement there, what is it, when's it going to be delivered, and then who's going to deliver it and in what form?"

– Health and Safety Inspector, UK BIM for WHS management

SUBCONTRACTING

INTRODUCTION

Once awarded a project, the Principal Contractor is generally responsible for sourcing materials and services through subcontracting. This often takes the form of tender packages which may be fully or partially subcontracted further down the supply chain.

COLLABORATION

The principles and concepts outlined in PRE-TENDER apply to subcontracting. Although client and Principal Contractor requirements need to be accommodated, further risk and opportunity assessment by the Appointed Party may identify ways the requirements can be built upon to generate further benefits.

Success is a result of early and ongoing collaboration; a clear understanding of the collective WHS and BIM goals, processes and data requirements; and tailoring the expectations to the nature of the tender package and the capabilities of the supply chain.

If the motivation, technical skills or resourcing are insufficient, consider whether additional guidance, resources or training might be provided to support and encourage participation by the supply chain.

Adopting new ways of working can be challenging. Highlighting the benefits; making the roles and responsibilities clear; keeping it simple; and providing contractors with easy access to required software and systems are ways to enhance collaboration and BIM adoption for WHS management.

"because of our intimacy with the project, for that length of time, rather than being just brought in at the end once they thought it was resolved and then having to build what they've — where they've ended up, we had done mountains of work on methodologies and systems which allowed us to put together a very comprehensive set of documents about how it was going to be built.."

– Project Manager, Façade Subcontractor, Project One Team

REQUIREMENTS

Refer to the Guide Note to Developing Information Requirements and the Self-Assessment Matrix in this Decision Framework series for more information.

The nature of subcontracting lends itself to having more specific and detailed information requirements. The project scope is generally more developed at the time of subcontracting; specific WHS and BIM plans may already have been developed; and clear instructions and processes are often more convenient for monitoring compliance than high-level principles.

However, desirable goals for the tender package and project principles may still be included (where the project allows) to leverage industry expertise and ensure shared values and attitudes.

EVALUATION

"when we factor in the cost of running these projects and doing what we consider to be doing it the right way, by doing this level of [BIM] analysis and going through it so it happens correctly, it happens efficiently and it happens safely, we factor that into our tendering, and others don't...It's difficult for us sometimes, where the cost of doing this could be factored in for one company and not another."

– Project Manager, Façade Subcontractor, Project One Team

The concepts and principles outlined in TENDER EVALUATION applies to subcontracting. Since priorities vary among stakeholders and may evolve as the project unfolds, it is important to engage broadly to confirm current positions and alignment with broader project objectives and principles.

The composition of the evaluation panel should include professionals with suitable expertise and experience across the priority areas relevant to the tender package. This approach ensures the full scope of priorities are captured, the evaluation scores are weighted appropriately, and the criteria are assessed in a valid and robust way.

Conducting tender interviews with shortlisted tenderers is an effective way to gather further information around proposed methods, capability and performance. Developing and following a checklist with questions relating to the tender package and the priority areas can be useful and supports equal treatment and comparison of tenderers. If a BIM model has been prepared, consider including it in the tender documents and use it as a communication tool as part of the tender interviews.

CHECKLIST OF ACTIONS TO CONSIDER PRIOR TO TENDERING

1 DEFINE OUTCOMES, PRIORITIES AND REQUIREMENTS

1. **Complete the Self-Assessment matrix** and take the following steps:
   - Clarify procurement strategy
   - Develop project information requirements for WHS
   - Develop position on extent of BIM for WHS management
2. **Draft or review** the OIR, SPIR and the PIR
3. **Seek feedback** from stakeholders to identify risks, opportunities and priorities

2 CONSULT EARLY, BROADLY AND REGULARLY

1. **Co-Identify stakeholders**
   - Identify who's work will be affected by the project decisions
2. **Develop an engagement plan**
   - Clarify how each stakeholder will be engaged
   - Establish the frequency of engagement
   - Identify what the engagement sessions will cover
   - Determine the stakeholder input level and how decisions will be made
3. **Ensure roles and needs adapt**.
   - Strategise on how the engagement plan will be a "living document"
   - Identify the frequency and regularity of reviews

3 ACHIEVE BALANCE BETWEEN GENERAL AND SPECIFIC REQUIREMENTS

1. Explore high-level goals tenderers can aspire to
2. Define principles tenderers can adhere to
3. Determine the level of innovation
4. Identify established systems and processes tenderers should adhere to
5. Seek feedback from stakeholders to identify risks, opportunities and priorities

4 USE EXPLICIT AND IMPLICIT MEANS TO COMMUNICATE EXPECTATIONS AND REQUIREMENTS

1. Separate "needs" from "wants"
   - Identify essential ("needs") requirements to be specified
   - Identify aspirational requirements ("wants") that could be encouraged but not required during procurement

5 CONSIDER CAPABILITY DOWN THE SUPPLY CHAIN

1. Provide sufficient time for proposal development
2. Provide sufficient information to enable the use of BIM at procurement
3. Provide project budget to enable innovation and the use of BIM
4. Work with the project legal team to develop tender documents
5. Seek feedback from stakeholders

6 DIVERSIFY THE EVALUATION PANEL AND EVALUATION CRITERIA

1. **Draft evaluation criteria**
   - Consider non-cost criteria, such as Design methodologies, Use of technology, Level of innovation, Change management processes, Management supervision processes, Quality assurance processes, Worker capabilities, WHS capabilities
2. **Seek feedback** from stakeholders to identify risks, opportunities and priorities
   - Consider priorities and assign criteria weightings accordingly
3. **Assemble an evaluation panel**
   - Consider the evaluation criteria and identify evaluation panel members with relevant expertise and experience.

7 IDENTIFY WHS RISKS USING BEST PRACTICE BIM

1. **Develop BIM WHS management assessment criteria**
   - Create a scoring regime for tenders
2. **Review Best-practice Matrix**
   - Identify examples of how BIM can be used for WHS. management

8 ENSURE TENDER COMPLIANCE

1. **Update plans**
   - Specifically BIM for WHS during design, construction and asset management and Engagement plan
2. **Implement engagement plan**
   - Schedule review meetings and communicate requirements down the supply chain
3. **Implement auditing and reporting programs**

CHECKLIST OF ACTIONS TO CONSIDER WHEN DEVELOPING TENDER DOCUMENTS

1 DESCRIBE THE TENDER PROCESS IN A STEP-BY-STEP MANNER THAT IS EASY TO FOLLOW

1. Establish a Project Information Protocol that specifically includes AIR, OIR, PIR and EIR detail as required in relation to WHS
2. Include the Information Protocol in the invitation to tender or request for service and include the Information Protocol in lead appointed party's appointment documents
3. Provide specifics about the **assessment of how WHS and BIM criteria**
4. Collect evidence that lead appointed party and delivery team can manage information as required

2 DESCRIBE THE PROJECT AND/OR TENDER PACKAGE

1. Provide a **detailed project and tender package description** to enhance understanding of what the works involve
   - include all relevant background information, such as specifications, drawings, plans and manuals.
   - include digital models, images, and/or videos of simulations or fly-throughs, where available, to enhance understanding of the planned structure and scope.

3 MAKE IT EASY TO LODGE A SUBMISSION

1. Facilitate the use of BIM for WHS through **electronic tender lodgment**
   - Acquire the systems needed for online tendering
   - Provide guidance to tenderers and support the lodgment of submissions, including the upload or linking to associated documents and digital models electronically.
2. **Develop BIM Execution Plan templates** to gather relevant WHS information to make it easier to compare tenderers.
   - If no template is used then indicate contents required to support evaluation criteria particularly in how WHS shall be integrated to modelling
3. **Pilot and Test understanding** of newly developed templates, assessment forms, questionnaires, and checklists with relevant stakeholders before use at tender to maximise effectiveness

4 DESCRIBE HOW TENDERERS CAN DEMONSTRATE COMPLIANCE WITH REQUIREMENTS FOR EASE OF ASSESSMENTS

1. **Provide specifics** on which **forms are to be completed**, which documents to provide and what type and level of detail to be included.
   - This may involve asking tenderers to provide their own plans or statements on how they will comply with requirements, existing plans (e.g., BIM and WHS) and other relevant regulations, codes, policies and manuals.
2. **Provide specifics** on what other **evidence** is needed
   - This may include resumes of key individuals, qualifications, certificates, licenses, permits and the like particularly in reference to key parties Design and/or Construction approaches and reviews to ensuring WHS risks are identified, mitigated and managed
   - History of WHS performance integrated with Building Information Modelling
   - Schedule of software, hardware and IT Infrastructure
3. Provide a delivery team **high level matrix of responsibilities**

SUPPLY CHAIN MONITORING GUIDE

INTRODUCTION

This section covers the characteristics of the supply chain that need to be considered for successful implementation of the BIM Execution Plan.

The three major areas that are discussed relate to:

1) designing the response to the new norms,

2) preparing the technical requirements, and

3) informing the supply chain of their WHS accountabilities.

ADAPTATION TO THE CULTURE, PRACTICE AND PROCESS

INTRODUCTION

The increasing use of BIM for WHS management is transforming the current individualistic nature of safety practices to a more team-based activity. The central position of digital models is a key characteristic of the safety culture that is emerging.

The client as the main driver of transformation needs to facilitate the supply chain's adaptation to the new culture by creating the environment that encourages collaborative practice and process.

FEEDBACK FROM THE SUPPLY CHAIN

The amount of WHS information that flows to and from construction sites impacts the ability of construction leaders and the members of the supply chain to fulfil their WHS responsibilities.

The level of information flow in BIM for WHS management should correspond to the level of risk of the construction tasks and the need of decision makers to access structured WHS information about those tasks. Input from key organisations along the supply chain is therefore critical to deciding the extent of WHS analysis that will be conducted.

"We have the architect's model open and we work with that subcontractor to understand how their elements of work come into play."

*- **Construction Manager, Private Client (Contractor), Project One Team***

The collection of supply chain feedback on the optimum level of WHS modelling is desirable and should therefore be prescribed and widely communicated to contractors and subcontractors. The level of information flow should then be adjusted and agreed to before the start of any contractual work.

Clarity in the level of WHS information and analysis that needs to be done increases the supply chain's confidence in the practicality and value of using BIM for WHS management.

SUPPORTING A DIGITAL-CULTURE

Using BIM for WHS management is a turning point in the construction industry's approach towards safety. However, the enhanced WHS standards that will result need to be appreciated and valued across the supply chain. Otherwise, the extra effort that is required to implement BIM for WHS management may be seen as an unnecessary burden rather than an improvement to collaborative management of WHS. A mismatch of the supply chain's stance on accuracy and certainty of WHS decision-making with the perspective promoted by the digital culture could substantially undermine the success of BIM for WHS management.

"[A] year before a shovel hit the ground, we started, all the stakeholders got together and visualised together, using 3D models."

*– **EHS Manager, Private Client (Contractor), Project Three Team***

Appropriate legal advice should be sought however It is important that if certain information requirements are requested in the tender between the Appointing Party and the Appointed Party then subsequent tenders are aligned down the supply chain. Appropriate legal advice should be sought on contractual details.

Clients play a pivotal role in driving the required cultural change. For example, success stories describing how WHS issues were overcome by the aid of BIM can be shared with the supply chain to highlight what can be achieved. Another approach is the creation of dedicated positions by the client to oversee effective execution of BIM for WHS management. The client can ensure the tender assessment framework is authentic and assigns sufficient weight to the integration of information protocols in tenders down the supply chain. Clients can help lead and build industry capacity to towards the use of BIM for WHS assurance on their own terms.

COMMITTING TO WHS OBJECTIVES ALONG THE SUPPLY CHAIN

"[digital modelling] helps the guys on-site pass that information on to other trades as to where we are going to be, what we are going to be doing, what they need to be careful of."

– Project Manager, Façade Subcontractor, Project One Team

Safety should not be a biproduct of shifting to 3D modelling and construction animation. The industry needs to recognise digital modelling as a standard platform for WHS information management that supports discussions such as toolbox meetings, site inductions, design reviews and risk workshops. Clients can develop a strategy to increase the use of BIM as the risk assessment platform. The strategy should ensure that the digitalised processes at the front end of the project continue to guide site activities with special emphasis on WHS objectives. The strategy should clarify that BIM for WHS management is to support higher WHS due diligence and that it is a means to an end to achieve safer workplaces.

TECHNICAL CAPACITY THROUGHOUT THE SUPPLY CHAIN

INTRODUCTION

Access by all to safety information underpins successful BIM for WHS management across the supply chain. The success of using BIM for WHS management, depends on the technical capacity of the industry. An accessible online platform, the flow of WHS information to and from site activities, and the reliability of the input to digital models are all prime technical concerns that clients can address. The aim of delivering the required WHS information to the right person at the right time hinges on the availability of the infrastructure and the responsiveness of the users to support the system with accurate and timely inputs.

DEVELOPING AN ACCESSIBLE ONLINE PLATFORM

Clients can consider the software, hardware and IT infrastructure environment in tender specifications. The collaborative environment is supported by clients who engage with the supply chain to establish the project's common data environment and the ability of everyone to be able to access models easily.

ACKNOWLEDGING RESOURCES REQUIRED

The ability and ease to interact with models is pivotal for its effective use towards site safety. Frequent updates to the digital model that reflect on-site conditions is a key factor to improve timeliness and accuracy of WHS decision-making and reporting. Supply-chain access to the model on-site can also facilitate prompt responses to automated BIM-generated WHS instructions.

Clients can evaluate the digital capability and capacity of their contractors and subcontractors against the requirements to ensure they are able to comply with the BIM Execution Plan. The contractor then needs to prescribe the resources that are required to implement BIM for WHS management on-site and the client to approve the prescribed resources.

To avoid BIM being used solely as a reporting tool, clients should monitor supply-chain needs and consider what resources are required to enable the full use of the model as an analysis and decision-making tool.

ESTABLISHING RESPONSIBILITY FOR ACCURACY

WHS management relies on multiple types of data being collected about site activities and conditions. There is a risk that collecting large volumes of data without purpose may impact upon data quality and impact upon authenticity of analysis and thus decisions. The quality of the data input into BIM for WHS management is a fundamental consideration.

"Junk in and junk out, you know [what] you're feeding into that BIM model –

Project Manager, Project Management Consulting Firm, Project Three Team

The use of BIM is likely to extend the types and details of the data that was traditionally collected for WHS purposes. The wider reach of WHS information in BIM for WHS management requires the client to be aware of each stakeholder's responsibilities in collecting and submitting accurate and current data. Metrics describing the quality of the WHS input and the responsible parties should be developed in collaboration with the supply chain by the contractor and be approved by the client.

HEIGHTENED STANDARD FOR SAFETY PERFORMANCE

INTRODUCTION

The use of BIM on a project is usually synonymous with more sophisticated designs. The increased complexity often translates to unusual or heightened construction risk profiles. At the same time, BIM offers an integrated approach to WHS management. The intended information-rich approach towards WHS decision-making predictably results in a more informed safety ecosystem. A consequence is that clearer roles, responsibilities and accountability can be assigned throughout the supply chain.

"So, the revolution of high-level 3D-modelling has made projects easier, but at the same time, because the modelling has become better and *has opened up different avenues for conceptualising buildings, everything's become more difficult" –*

Project Manager, Façade Subcontractor, Project One Team

INCREASING WHS ACCOUNTABILITY

The reform of WHS management practices as WHS is integrated into BIM to influence the decision-making processes may redefine the safety performance expected from the supply chain. The increased involvement of the project supply chain in WHS decisions

"3D visualisation tool was … a tool to expand our own knowledge and think about things in the next level of detail"

– Project Manager, Façade Subcontractor, Project One Team

multiplies their ability to impact and report on their WHS performance.

As clients are accountable to ensure WHS on their projects and contractors on their work sites, a key benefit of implementing BIM for WHS management is improved information management throughout the construction supply chain and thus a more holistic ecosystem of accountability.

CAPTURE, REVIEW AND TRANSFER LESSONS LEARNED

"The business of having one place where you can see models across, or look at several projects, or lessons learned from several projects, is really at an infancy over here."

- Health and Safety Inspector, UK Work Health and Safety Regulatory Agency

The use of BIM expands the level of details that the supply chain is expected to consider in making WHS decisions. This heightened level of details is unprecedented and is expected to expand as different WHS challenges are modelled and resolved in digital environment. Sharing and generalisation of new WHS solutions is part of the continued learning that facilitates the evolution of BIM for WHS management.

The supply chain participants are required to be equipped to capture the lessons learned by the supply chain on potentials and suitability of BIM to address different WHS challenges. The fitness of the revised WHS solution for the risk imposed by the certain task the solution addressed is essential to be reviewed after the execution of the solution. The supply chain then makes an informed decision to adopt the novel solution in future projects. The transfer of lessons learned between projects and within the supply chain is a fundamental support to be offered by the client to prepare the supply chain for the increased WHS accountability as the use of BIM prevails.

INNOVATE WHS SOLUTIONS

BIM for WHS management should not be perceived by the supply chain as only a tool. But it is a new WHS practice paradigm encouraging innovative solutions. BIM for WHS is an opportunity to rethink WHS solutions and integrate them across the supply chain.

In many WHS scenarios, an integrated solution that considers offsite production, delivery logistics, unloading, site storage and the construction sequence is the most effective. Different entities in the supply chain are expected to collaborate in BIM to develop innovative solutions that integrate as big a segment of the supply chain as possible.

1 DEVELOP CAPABILITY AND CAPACITY TO REDUCE RISK

1. Develop the list of attributes that is expected from supply chain players who can be trusted to successfully execute BIM for WHS management
2. Evaluate technological preparedness and skillset expected from different members of the supply chain to succeed in BIM for WHS management
3. Ensure the risk-bearing capacity of the supply chain matches the risk profile of the WHS concerns being resolved using BIM

2 IDENTIFY AND PRIORITISE KEY WHS MANAGEMENT ISSUES THROUGHOUT THE SUPPLY CHAIN

1. Prioritise construction activities
   - Identify in the design stage the construction activities that due to their complexity must be included in BIM for WHS management.
2. Consult with the supply chain the list of WHS issues that must be resolved in the BIM environment

3 DEVELOP INFORMATION REQUIREMENTS

1. Consider negotiating as appropriate with key organisations down the supply chain the amount and type of information to be included in the digital model
2. Define the criteria to distinguish a quality digital model suitable for supporting WHS management
3. Draft contractual provisions that maintain supply chain responsibility for providing the WHS data necessary for effective modelling of hazardous construction processes

4 FACILITATE THE CREATION, USE AND MANAGEMENT OF THE MODEL

1. **Address supply chain's needs and constraints** to access and work with digital models for WHS applications
2. **Standardise the use of digital models** for WHS conversations to assure an integrated approach, where every stakeholder remains on track with WHS decisions
3. **Inspire to document and generalise learning points** associated with the use of BIM for WHS management
4. **Utilise the opportunity to innovate WHS solutions** that integrate a range of supply chain activities and participants

EMERGING BEST PRACTICE: BIM FOR WHS MANAGEMENT DURING DESIGN REVIEWS

OVERVIEW

The systematic use of BIM to support WHS management during design reviews is still an emerging practice in Australia. However, leading government clients in New South Wales are now laying the groundwork for this. One example is the government client for health infrastructure, referred to here as Health Client. Health Client now mandates (1) the use BIM in all projects valued at AUD $ 30 million or more and (2) the use of a database management tool called dRofus in all projects valued at AUD $100 million or more. WHS management requirements are not explicitly specified prior too or during procurement. However, the mandatory use of these technologies, and dRofus in particular, is a powerful mechanism that supports safety in design as well as in operations.

Current practice is that at the start of BIM-enabled projects, supply chain participants are given four BIM-related requirements: a BIM brief, a dRofus brief, a Design BIM Management Plan and a Construction BIM Management plan. The capabilities of dRofus as a data management tool allow all consultants to use it for design, construction, and monitoring of what is happening with the build in a detailed way. Learnings from Health Client include the following:

BENCHMARKING AGAINST INTERNATIONAL BEST PRACTICE

The decision to use dRofus across a broad swathe of projects began when Health Client partnered an architectural firm that had adopted Revit as a 3D platform then paired it with dRofus. The architectural firm's decision to use dRofus was well-considered, and was made after considerable research and an examination of international best practice. Professionals from the architectural firm believe they influenced Health Client to adopt the new technology, a decision that was novel at the time.

COLLABORATION WITH INDUSTRY

A key investment payoff for the Health Client is that it now has a rich database and a set of templates and documents that define its standards, which then become inherited by consultants and contractors as new projects begin. The database is a library of components including for example doorways, beds and bathrooms and is continuously updated. The client has been using dRofus for many years and now has a growing library of Furniture, Fixture and Equipment elements with clearly defined specifications that supply chain partners are provided with through templates and are expected to comply with. dRofus has a bi-directional interface with the model, which allows users to access as well as make changes. dRofus thus supports quality control and service coordination, and more benefits are realised as more clients engage. Health Client has, over time, educated its supply chains about the use of digital models and database tools by transferring lessons learned across projects. At the same time, Health Client and in the process they have also learned from their counterparts on how to better use the system.

USE OF BIM WHEN DESIGNING FOR SAFETY

The mandatory use of dRofus substantially supports designing for safety. One senior director from a partner architectural practice noted

"From a health and safety point of view, we model every element that goes into the building, so we have the beds modelled, we have the doorways modelled. We have all the bathrooms modelled from an accessibility point of view. We can export all of that data. We can check that it's all working and where there are clashes and they're not working, we can export them out and address them." – Interviewee 13, Senior Practice Director, Architectural Consulting Firm

Elements that are included in the database are designed for safety, so departures from these specifications are easy to identify. One dRofus specialist noted that when people ask him to include

"*a cupboard that's 2100 high with a shelf on top, I say no, you're not having it. So you can actually control the design through the item library because if it doesn't exist in the database, then it doesn't exist."* – Interviewee 12, Senior BIM Software Specialist, Architectural Consulting Firm

SUPPLY CHAIN MONITORING

The mandatory use of dRofus also supports monitoring across the project life cycle. Health Client required its partner architectural firms to benchmark against the original project brief at certain review points. The architectural firm used the database tool to demonstrate compliance. For example, a quality tick-off process was carried out at the end of design development and dRofus was used to produce schedules showing where design complied with or departed from the original brief.