Building Information Modelling for Work Health and Safety Management

1A
Guide to Developing Information Requirements

CONTENTS

LIST OF FIGURES

TABLE OF ACRONYMS

AIR	Asset Information Requirements
BEP	BIM Execution Plan
BIM	Building Information Modelling/Building Information Model
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

TERMINOLOGIES

BIM

Building Information Modelling is a multi-dimensional digital information model-based process that maps the physical and functional characteristics of a structure.

Digital Twin

A digital twin is a virtual representation that serves as the real-time digital counterpart of a physical object or process.

Knowledge Domains

01 Scenario Planning: Using BIM to develop various scenarios and options for designs, construction methodologies (particularly including temporary works) and asset management regimes through visualisation and data analytics which assist to optimise WHS management. The identification of hazards and related risks can enable elimination or preventative strategies to be analysed and implemented in the virtual world, before physical work commences.

02 Requirement Briefing: Using BIM to develop WHS requirements and standards throughout the project lifecycle from inception, planning, design, construction, end-use, maintenance, decommissioning and demolition will enhance collaborations through a consistent and coherent repository of information. Crucial to developing information requirements are the ways in which the client/asset owner manage key activities such as the design consultant briefing phases and the tendering phase. Just as critical and often overlooked is the Model Phase handover.

03 Risk Assessment: Using BIM to identify, assess, mitigate and communicate risks in design can reduce unsafe work environments. Hazards and related risks can be identified and appropriate controls implemented to eliminate or minimise the risks. Unsafe work environments can include both the completed asset including its end use and maintenance and the construction site environment.

04 Education and Training: Using BIM to educate and train can involve a range of actions including; sharing design or other related information to raise awareness across different professions, paraprofessionals, consultants and trades; communicating expectations and performance; creating a community of practice; implementing formal and informal training and induction, and presenting virtual briefings to key stakeholders.

05 Monitoring and Assurance: Using BIM to regularly monitor WHS standards can ensure a safer work culture, better forward planning and scheduling and improved management and control of onsite construction activities. Monitoring WHS through the model during design reviews can also provide for more informed practices aligned with site specific design detail, interfacing or overlapping trade activities and related WHS management.

06 Reporting and Analysis: Using BIM to retrieve information, conduct analyses and generate reports against WHS performance, WHS codes, regulations, standards and client requirements can reduce time devoted to these tasks. Checking can be automated and streamlined

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
Associate Professor Yingbin Feng Western Sydney University
Dr Peng Zhang 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

EXTERNAL REVIEWERS

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

BACKGROUND CONCEPTS

ABOUT THIS GUIDE NOTE

The Guide Note provides information derived from a research study sponsored by Centre for Work Health and Safety and completed by Torrens University Australia and Western Sydney University. The Guide supports the NSW implementation of the Infrastructure Data Management Framework and the ISO 19650 series. This guide sits within an overall Decision Guidance Framework as shown in Figure 1. The purpose of this Guide Note is to provide tips and examples on principles and processes on developing information requirements to support BIM for WHS management. The Guide Note was commissioned for the state of New South Wales, Australia, however it is suitable for other states and other countries.

- Background concepts for information management in BIM environment
- Introduction to Organisational, Asset, Project and Exchange Information Requirements
- Self-assessment matrix on capabilities and capacity to integrate BIM and WHS management

GUIDE NOTE DOCUMENT HIERARCHY

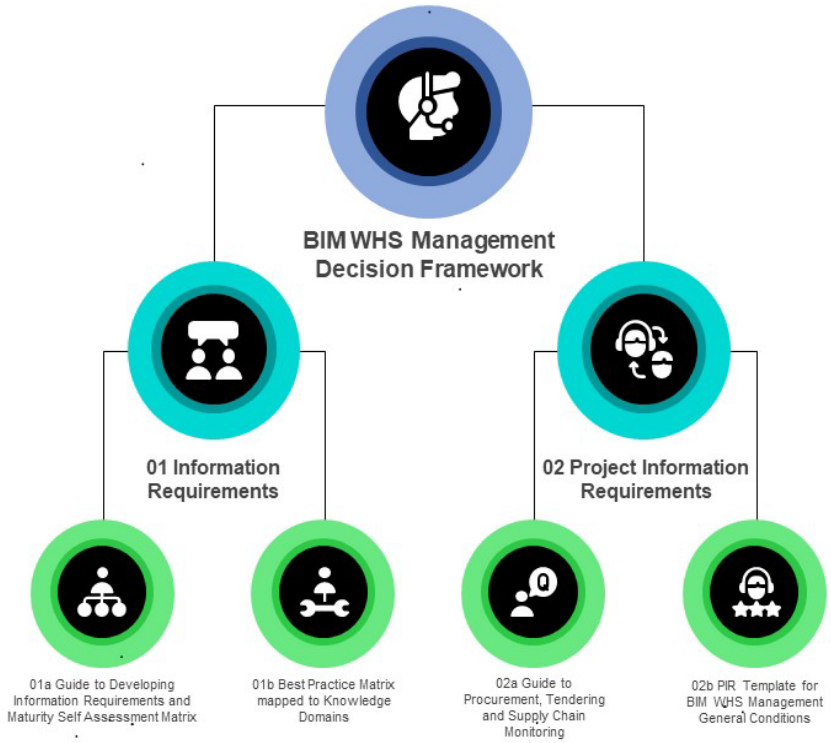

Figure 1 Guide Note Document Hierarchy

WHAT IS THE PURPOSE OF EACH GUIDE NOTE

GUIDE NOTE 01A DEVELOPING INFORMATION REQUIREMENTS

The purpose of this Guide Note is to assist leaders to collaborate to develop quality information for BIM for WHS integration. The self-assessment maturity matrix is useful for clients and the client leadership team including primary contractors and consultants to help to evaluate their own approach to

implementing BIM and WHS management integration both individually and as a team.

The Guide acknowledges that such client leadership is achieved through different pathways. Therefore, the Guide presents resources such as a Self-Assessment Matrix and construction project examples that acknowledge different levels of adoption and implementation across the industry, while showcasing possible next steps for supply chains in different stages of maturity.

In construction sectors in Australia and internationally, BIM and WHS are still treated as separate concepts. The opportunity that applying structured digital information requirements in relation to WHS management on projects can play is often overlooked. The Guide showcases case studies and promotes ideas that assist organisations and project leaders to adopt BIM and WHS management.

GUIDE NOTE 01B BEST PRACTICE MATRIX MAPPED TO KNOWLEDGE DOMAINS

The purpose of the Best Practice Matrix mapped to WHS Knowledge Domains is to provide specific examples to showcase different ways other clients and leadership teams have approached integrating BIM and WHS management. The example case studies are mapped across the six Knowledge Domains of Scenario Planning, Requirement Briefing, Risk Assessment, Education and Training, Monitoring and Assurance and Reporting and Analysis. Definitions of each of the Knowledge Domains is provided in the Definitions and Terminologies section of this Guide Note as well as in the Matrix.

GUIDE NOTE 02A GUIDE NOTE TO PROCUREMENT, TENDERING AND SUPPLY CHAIN MONITORING

The purpose of the Guide to Procurement, Tendering and Supply chain monitoring for BIM and WHS management is to provide tips on principles and process.

GUIDE NOTE 02B PROJECT INFORMATION REQUIREMENTS AND GENERAL CONDITIONS

The purpose of the PIR Template for BIM WHS General Conditions is to provide recommendations for developing project specific information requirements.

WHO IS THIS GUIDE NOTE WRITTEN FOR?

PRIMARY STAKEHOLDERS; INFRASTRUCTURE INFORMATION MANAGEMENT

This Guide Note is for individuals and organisations involved in developing information requirements to underpin BIM-supported projects that will pursue the integration of BIM and WHS management. Those individuals and organisation may be operating on behalf of the appointing party, lead appointed party and the appointed parties. The Guide is typically 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 executive and managers** who make decisions at a strategic level on assets and project design and construction delivery. It is useful for BIM professionals seeking to deepen their understanding of WHS management, as well as WHS professionals seeking to understand the capabilities of BIM.

The Guide is aimed at client organisations who wish to set the right environment and culture in relation to quality information management to support creating safe work environments during design, construction and operations.

WHO IS THIS GUIDE NOTE 'OF PARTICULAR INTEREST TO' AND WHY?

SECONDARY STAKEHOLDERS: INFRASTRUCTURE INFORMATION MANAGEMENT

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. The overall objectives of an organisation often relies upon quality information management that is well integrated to other portfolios in the organisation and the information systems that underpin these portfolios; for example, finance, human resource management, equipment procurement and asset maintenance.

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. Figure 2 provides a high level perspective within the context of key project phases.

CASCADING FROM INFORMATION REQUIREMENTS TO MODELS

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 use. Information requirements specify the precise information someone needs so that when it is received they can action that purposefully. 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 to create information with its use in mind.

OIRS, AIRS AND PIRS

The ISO 19650 series frames information requirement resources to include organizational information requirements (OIR), asset information requirements (AIR) and project information including WHS 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.

KNOWLEDGE DOMAINS

The six Knowledge Domains (refer to Terminology table for definitions) in varying ways, provide a frame of reference for integrating WHS management with BIM. The Knowledge Domains include six major initiatives; scenario planning, requirement briefing, risk assessment, reporting and analysis, monitoring and assurance and education and training. The first three tend to be event based whereby they occur periodically at specific times; for e.g. handover from one project phase to the next or 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.

LEVEL OF DEVELOPMENT

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 key concepts at a strategic level (refer to Figure 3).

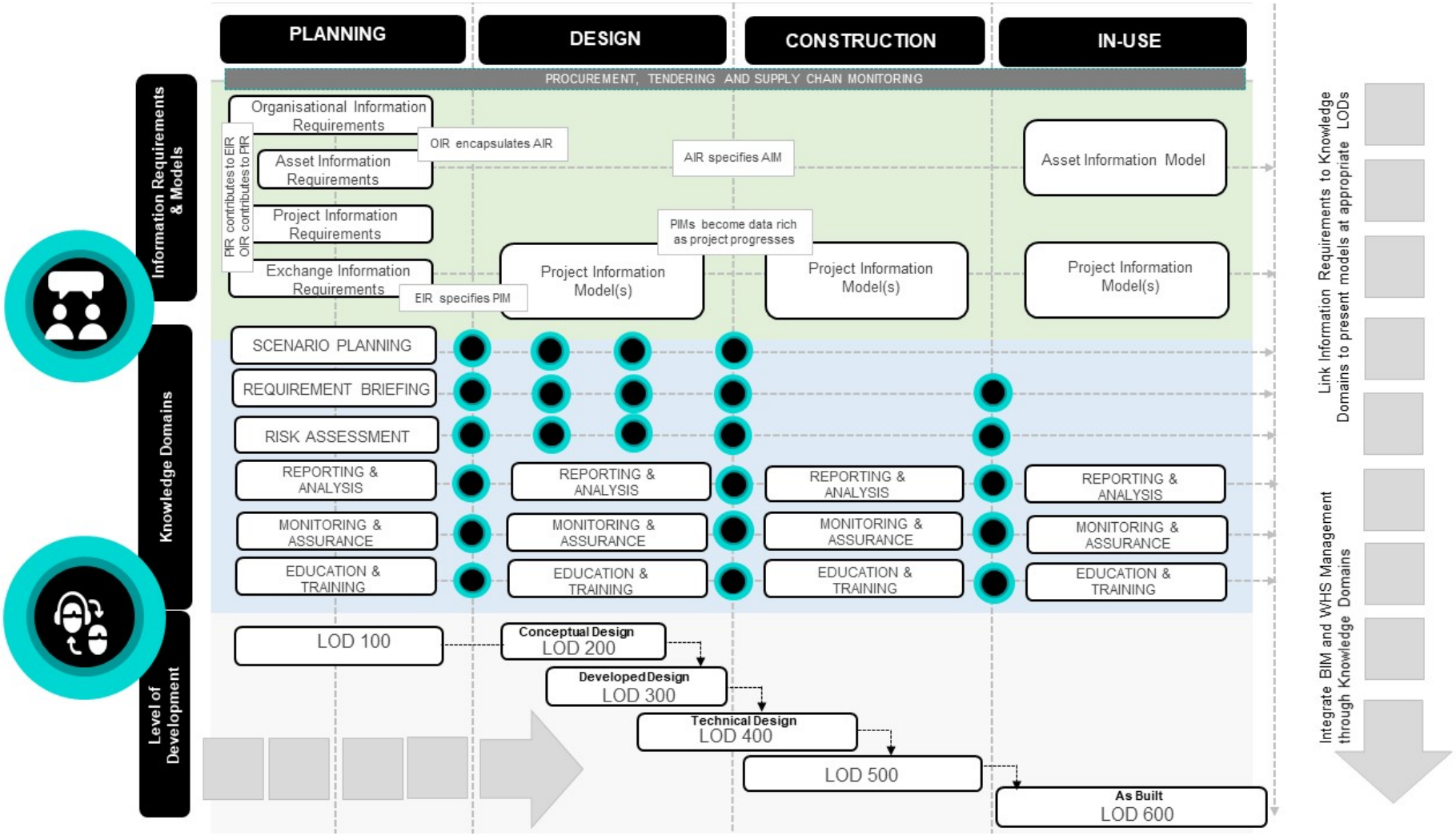

Figure 02 Integrating BIM and WHS Management Mapped to Information Requirements, Knowledge Domains and LODs

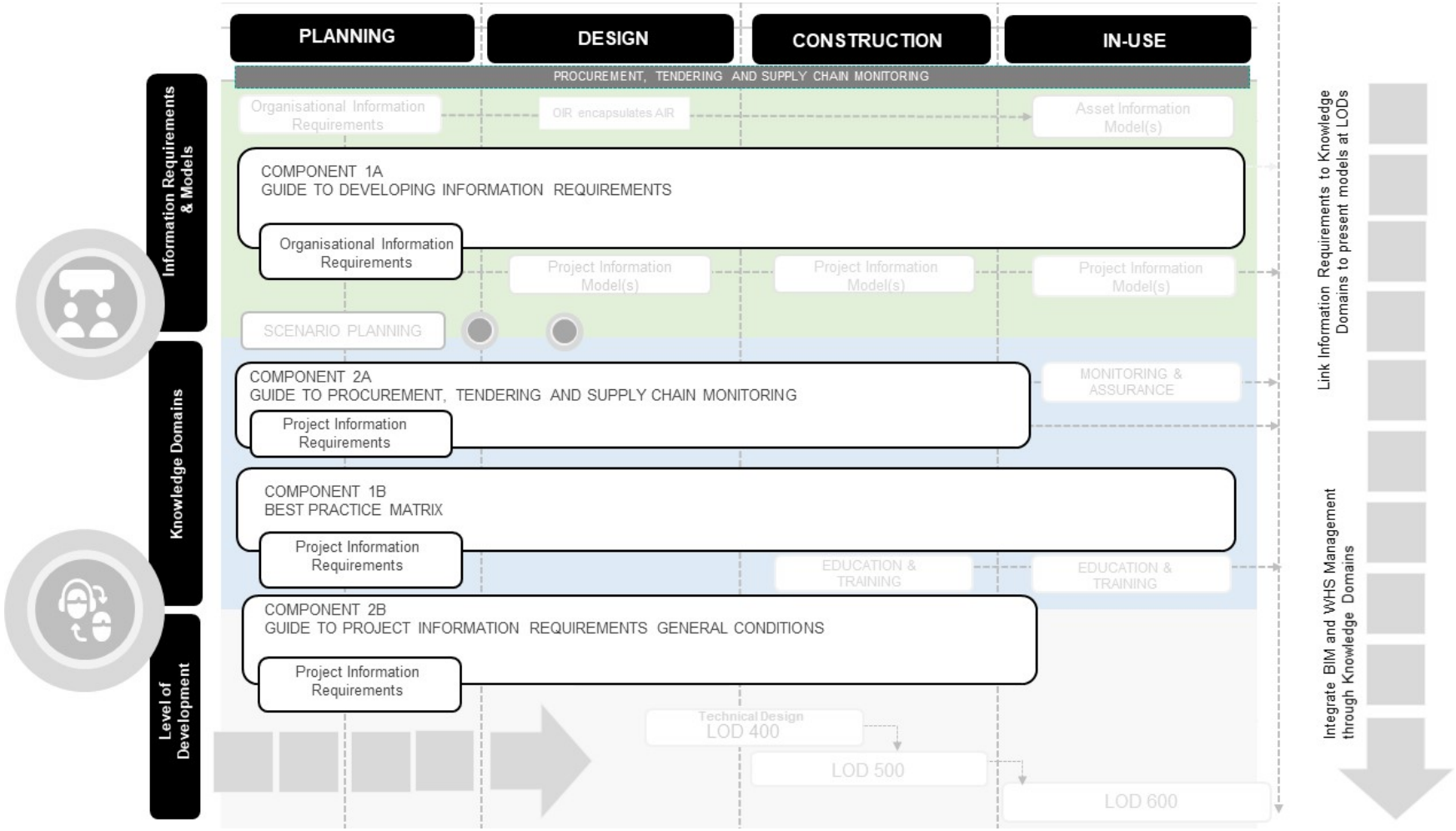

Figure 3 BIM WHS Management Decision Framework Components mapped to Information Requirements, Knowledge Domains, LOD and Project Phases

CONNECTING INTERNATIONAL BIM AND WHS STANDARDS AND GUIDANCE DOCUMENTS

The international standards ISO 19560 series establishes the requirements for all phases of 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.

ESTABLISHING THE CONNECTION TO THE 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. The BIM WHS Management Decision Framework aligns to the IDMF.

KEY TAKEAWAYS

OVERVIEW: LEADERSHIP AND COLLABORATIVE PRACTICE

This section describes the attributes of client leaders who have created the ideal environment for the collaborative sharing of structured digital information, in ways that improve WHS outcomes. The client leaders do much of the work of crafting a pathway that is counter to the current culture of adoption towards exemplary use of BIM for WHS management, a path that the rest of the supply chain can then follow. These are aspirational goals.

CASE STUDY

The case study aims to show that client leadership can be demonstrated even by organisations, teams and supply chains that are still on the journey to full maturity

The size of a company does impact the ability to be innovative and implement the adoption of BIM for WHS management.

SELF ASSESSMENT MATRIX

The Self-Assessment Matrix comprises 10 questions developed from semi-structured interviews, existing tools and guide notes and local and international standards. Users may find that some questions are more relevant to their contexts than others. Questions begin with “To what extent” to indicate that different levels of maturity are possible. There are three levels of maturity:

- base standard, regulatory compliance, moderate adopters
- best practice, innovation early adopters, exploratory, base standard well accomplished
- exemplar leaders, innovation initiators, experimental exception adopters

The 10 questions involve strategic and operational themes that clients and/or the client leadership team would ask of themselves. It also brings together

Clients can self-assess their level of maturity in this area by completing the Self Assessment Matrix at the end of the document. The purpose of the matrix and instructions for its use are also provided. The Self Assessment Matrix comprises the following ten questions:

- To what extent have you developed a strategic vision for WHS management, for communication to stakeholders including supply chain participants?
- To what extent have you developed a strategic vision on the value of the use of digital infrastructure data, for decision-making generally and for WHS management in particular?
- To what extent have you defined and systematised your processes for identifying hazards in planning, design, construction and operation, for communication to the supply chain?
- To what extent have you set conditions enabling supply chains to identify key opportunities for WHS process improvement, through automated data flows, digital engineering, or BIM?
- To what extent have you used formal and informal strategies to identify and recruit internal and external partners who are aligned to your vision for WHS management and the vision for the use of digital data?

- To what extent have you used formal and informal strategies to INTENTIONALLY DEVELOP internal and external partners who are aligned to your vision for WHS management and the vision for the use of digital data?
- To what extent have you established Organisational Information Requirements (OIR) and Asset Information Requirements (AIR) that are robust enough to facilitate the development of Project Information Requirements (PIR)?
- To what extent, and how early have you established conditions enabling the collaborative sharing of digital WHS data across the supply chain at critical decision points of the project?
- To what extent, and how early have you established conditions that enable the supply chain to use BIM as a tool for digital WHS data sharing at critical decision points?
- To what extent have you ensured that lessons learned in relation to WHS management through the use of BIM on projects are shared as widely as possible?

OVERVIEW: LEADERSHIP AND COLLABORATIVE PRACTICE

CLIENT LEADERSHIP

Clients who build, own and manage a significant portfolio of physical assets are increasingly 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) are often created by external organisations to the client organisation. It is in the best interests of clients to effectively manage asset data well throughout the entire project lifecycle. Ultimately the client is the organisation that has the most to gain from digital models and can influence the creation, use and management of the models. For example, clients can ensure 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.

PROJECT TEAM LEADERSHIP AND COLLABORATIVE PRACTICE

The client and asset owner have a responsibility to ensure that the manner in which they explain their data requirements is clear. Client leadership is needed to ensure that clear articulation of information requirements is made so that the project leadership team and their supply chain can deliver. Procurement, tendering and supply chain monitoring are critical activities that help to guide the creation, use and management of information requirement expectations.

CLARITY ON WHS GOALS, PROCESSES AND DATA

COMMITTING TO WHS MANAGEMENT

Client leaders articulate high-level vision(s) for work health and safety, then translate these ideals into well-defined outcomes. Ideally, these outcomes are integrated into well-established processes and systems that are applied across all projects, with opportunities for customisation based on project size and complexity.

PUBLIC AND PRIVATE SECTOR CLIENT COMMITMENTS TO WHS

For example, a private sector developer, a multinational with a strong ethos for WHS management, consistently uses a set of 18 standardised requirements for assessing and mitigating risks in all their projects worldwide. These standardised requirements are operationalised in every country, every business unit and every project through detailed workplace codes, health and safety plans, and health and safety sub-plans

Another example is a public sector client organisation that begins each project with a high-level vision on the use of digital information, which can then translate into improved work health and safety performance. This client takes up the opportunity offered by BIM as an enabler for safety for design as the strategic project documents include the initial BIM brief for each project. The brief includes a mandate on the use of a database tool linked to building elements with specifications predefined as "safe". The brief is then translated into more concrete standards and guidelines, often by progressively and collaboratively incorporating the input of other stakeholders; including consultant and end users.

TRANSLATING WHS MANAGEMENT PROCESSES INTO DATA REQUIREMENT: RISK ANALYSIS

Working from a vision to clearly-defined WHS processes is critical, since it is the details of WHS processes that provide traction for technological solutions such as BIM. Client leaders aspiring to adopt BIM should be prepared to raise important questions that help ensure that the entire supply chain has formalised WHS processes. Examples of questions include

- How is risk assessment being undertaken?
- How are safety hazards being assessed?
- Which risk matrix is being used (a five-by-five or a six-by-six matrix)?
- Who are the parties involved in risk assessment?
- What standardised processes, if any, are being used for assessing safety in design?
- How can the data to critical questions such as these be digitised, stored, shared and used collaboratively to improve WHS?

TRANSLATING WHS MANAGEMENT TO INFORMATION REQUIREMENTS: DATA FLOW

Commitment to WHS management is demonstrated through explicit WHS goals and processes. Well-defined processes are also the foundation for identifying appropriate technology-based solutions to WHS management issues. Robust systems for WHS management do not always translate automatically into BIM-supported WHS management. Some WHS management systems are comprehensive and well-established, but at the same time manual, paper-based, fragmented and onerous.

Moving to mature BIM-supported WHS management requires:

(1) ensuring the supply chain understands that “WHS requirements” are underpinned by “WHS *information* requirements”;

(2) building a supply chain culture that “speaks data”; and

(3) articulating a data philosophy, which can be “data-rich” or “data-purposive”, concepts which are explained shortly.

Sophisticated WHS management systems might clearly define WHS “requirements”, for example by including general statements about structural safety, steel work, or project performance. In NSW, for example, there are a number of safety requirements when working on roofs, one of which is preventing persons from falling from heights by designing out the need to work from heights, the use of elevated work platforms, edge protection or scaffolding or safety rails to prevent people or materials from falling. But “requirements” are different from “information requirements”. Shifting the focus to the latter means exploring the data flows behind these requirements, for example

- What are the WHS risks?
- Where is the evidence for this work health and safety requirement?
- In what place will this evidence be found?
- Who does one have to go to, to obtain this evidence?
- At what stage of the project will this evidence become available?
- Who is going to make sure that this evidence is there?

SHARED CULTURE OF THE VALUE OF DATA

Sound information requirements have clearly defined attributes: who creates it, who uses it, for what purpose, what form it should take, when it is created, where it is stored, and how it is validated. Data creation and information management thus become critical functions across the entire supply chain, along with the validation and verification of this information. Such data management functions should not be confined to a few technical specialists.

A leading government client in New South Wales strongly supports the view that an appreciation of data is a value that must be shared by all, not just a few.

DATA ECOSYSTEMS AND UNIVERSAL DATA

A universal appreciation for the centrality of data can then support the development of increasingly rich and expansive data ecosystems, or sets of data that are linked together using universal data standards. Supply chains are already making use of data ecosystems to support decision-making in relation to scheduling, cost and value engineering; they can then organically expand to support WHS management decisions as well. An important feature is the internal coherence of such an ecosystem. Specifically,

- Project data building blocks should be developed using a standardised or universal data scheme (a common language such as the Industry Foundation Classes or IFC) that can be applied to all the different project deliverables, to allow interoperability across the supply chain and, ultimately across projects and through the industry
- A clear universal data standard helps address a persistent challenge in the industry: the development of models for specific purposes at different project stages, often resulting in models that have to be reworked to be useful in later stages.

DATA AS AN ASSET: DEVELOPING A KNOWLEDGE BASE AND RECYCLING DATA

The creation of a BIM for WHS knowledge base must be carried out with the goal of eventually reusing/ recycling this knowledge base

Access to this knowledge base, along with the issue of storage, are matters that might possibly be addressed, possibly through shareware.

DATA RICH VS DATA PURPOSIVE

The matter of data centrality leads to the question of whether having more data is always better than having less. Debates persist about whether being "data-rich" is better than being "data-purposive". Existing guidance developed by the UK BIM Alliance suggests a preference for data purposive approaches. Our study has found evidence supporting both sides of the debate, so clients must make their own decision and it would be based upon how they are going to use the data and information.

"…all employees [must] learn how to speak data…they need to have an appreciation of how to use data and how they can create data that others could reuse." – Director, Government Client (Transport)

For example, one client specified detailed information requirements, but did not specify for WHS management data. Still, the supply chain was able to make enhanced WHS management decisions, simply because they had detailed data on hand. This supports the "data-rich" stance. Another client has been criticised for making requests for large volumes of data, with one supply chain partner suggesting that such sweeping requirements indicated a lack of knowledge about what the client wants and how the client plans to use this data.

CLARITY ON BIM PURPOSE, BENEFITS AND LIMITATIONS

IDENTIFYING RISKS AS OPPORTUNITIES TO IMPLEMENT WELL-DEFINED BIM SOLUTIONS

A move from "WHS requirements" to the more data-centred notion of "WHS information requirements" provides the opportunity to raise the awareness of all supply chain participants to the value of using technological solutions such as BIM.

By asking

"how could we make this WHS process better through automated data flows?",

clients begin to recognise BIM as a potential solution to a-defined problem.

In contrast, there have been cases where BIM has been advocated simply because it seems novel, not because a clear problem has been defined. Casting BIM as "a solution looking for a problem", is not helpful.

BENEFITS AND USES OF BIM FOR WHS MANAGEMENT

The possibilities of using BIM for WHS management are wide-ranging. Australian and international examples are presented in Component 1b Best Practice Matrix that is part of this Decision Framework. Some examples include using BIM as:

- A tool to support the "Prevention through Design" concept through the mobilisation of an 8D BIM that supported hazard audits and produced hazard profiles for elements rated with three levels of severity ratings; critical, moderate and low.
- A tool for design planning to determine the optimum location for cranes used to install a complex façade; tool for supporting daily site briefings, allowing construction teams to also identify potential WHS risks and management controls;
- A daily communication device through the use of a television screen displaying how the project was progressing and explaining activities on a daily basis;
- A tool for facilities managers to optimise the use of space in an asset, for example for crowd safety.

STARTING THE JOURNEY

A question that often arises with clients is how to begin the journey. These are just a few examples.

There are a broad range of possibilities for BIM for WHS management. There is also the perception that BIM adoption requires significant investment in resources. Using BIM to visualise work sequencing and construction methodology are appropriate starting points.

What is a good starting point for those beginning the BIM adoption journey? One practitioner from a company that has made extensive use of BIM in safe work statements has suggested: "I think the start of that process would be the methodological and sequencing side of it… you could take our sequencing and our modelling of the methodology and couple it with all the other trades, and identify where people are going to be working next to each other or over the top of each other, clashing with each other. [T]hat's the obvious starting point because that's kind of currently where I think the limit is what people are using the technology for. That would probably be the first step. I'm sure that would open up the door for more benefits, other ways of doing thing."- Project Manager, Subcontractor

For this, 4D models are ideal. A key consideration, though, is that using 4D models across all work sequences can be costly and resource intensive.

One alternative, is the use of targeted 4D, that is, using 4D models only for high risk activities.

When 4D is not possible, other simpler alternatives have also been proposed, for example supporting the visualisation of work sequencing and construction methodologies through snapshots of the 3D model shared on TV screens, or PDF versions of work sequencing shared through mobile devices or through flipbooks.

APPRECIATING THE BENEFITS AND LIMITATIONS OF BIM FOR WHS MANAGEMENT

A more fundamental question that arises beyond how to "start" using BIM, is to what extent clients should specify for the use of BIM for WHS management in all projects. At present, the industry is still in the early stages of this journey towards universal adoption. Rightly or wrongly, most of the industry still perceives BIM as a costly investment. Some have begun to counter this view, saying that the use of BIM, particularly at early project stages, leads to considerable savings for example when BIM is used to prevents costly mistakes in design and construction. The commonly held view is that requiring BIM at tender might result in costly overheads across the industry and could present a burdensome requirement particularly to tenderers on small projects.

Even leaders in BIM adoption, still refrain from making BIM mandatory for all projects. For example

- One government client responsible for health infrastructure required the use of BIM only for projects with a minimum value of AUD $30 million. This client also requires the use of a specific database management tool for all projects with a minimum value of $AUD 100 million.
- Another large government client responsible for transport infrastructure sets very clear standards and requirements on matters such as universal data schemas, but does not require the same technologies across all projects.
- Various countries have at different times mandated BIM; up to 2016 the UK had a BIM mandate; all government projects required BIM

Level 2. Since ISO there have been changes: England still requires Level 2, Scotland more advanced, Wales nothing.

These examples show that BIM models are not always required at tendering. There are a number of reasons for this, including differences in project priorities, varying levels of client leadership in the BIM space, and projects not being large or complex enough to justify its use.

Interesting trends are emerging. "Savvy" tenderers are beginning to use BIM more extensively when presenting proposals, even if not asked, to achieve a competitive edge. The recent release of the IDMF certainly strengthens the argument that the NSW industry is moving towards standardised processes and procedures for the management of data infrastructure, thus the universal adoption of BIM becomes a more compelling proposition.

As the journey progresses, client leaders must make an informed decision on when, and to what extent, BIM for WHS management is required.

Two extremes could eventuate; the first is not requiring BIM at all and having people "use it to the bare minimum to get by and to make their life easier". A second is going "all bells and whistles on data". To navigate this area, client leaders must take into consideration how specific capabilities of BIM can be mobilised in the context of well-defined opportunities and problems, which in turn are understood from a rigorous assessment of risk and WHS processes. The informed approach also considers other factors, such as project size and complexity and the skillsets of potential partners, discussed in the next section.

STRATEGIES FOR COMPLIANCE AND COLLABORATION

UNDERSTANDING AND OPTIMISING INTERNAL AND EXTERNAL SKILLSETS

A director from a major government client has noted there is "...an over-reliance on digital engineers....I think this is one of the reasons why BIM has failed in the past, it hasn't had that transformative effect, is because industry has been relying on sort of digital engineers or the people producing BIM models and stuff and what they call BIM managers, project-based." – Director, Government Client (Transport)

Client leaders and the leadership team for projects including project managers, design consultants, contractors and major subcontractors must collectively possess certain skillsets that allow them to collaboratively create, use and share accurate, verified digital WHS information. Supply chain participants must understand the value of WHS as well as the value of the information requirements and technologies that support WHS management.

A key challenge confronting clients and the leadership team is that BIM and WHS management are still generally perceived as distinct areas of specialisation. Skillsets that support the integration of BIM for WHS management are difficult to find. Many groups possess expertise in one area, but not in the other. Combining the two remains a foreign concept to many.

BIM as a discipline by itself also remains problematic. Specific BIM-related skillsets are often still scarce, for example in areas like 4D modelling. This shortage

of technical skillsets is systemic across the sector and requires large scale change. BIM and Digital Engineering positions have been in existence for some time, but tend to be narrowly defined.

Widespread structural reform to support digital engineering, through new position descriptions across the industry is needed. This could include the following:

- **Digital engineers**, who coordinate and exchange digital project deliverables
- **Digital engineer managers**, who are project focussed and champions that manage and assure digital engineering deliverables
- **Digital engineering developers**, who are business focussed, bring technical expertise and focus on framework development, change management, new data schemas and frameworks and business integration
- **Digital engineering advisors**, who focus on strategic planning, executive engagement, development of the vision, policy, roadmap, business case and funding strategy to enable the other three roles.

In selecting the right delivery team clients should understand that knowing, assessing and managing the skillsets of potential and existing partners is critical. When procuring a supply chain initially, an understanding of skillsets can come from reputations, or from a history of working with trusted parties. In cases where skill quality might be subject to uncertainties, clear tendering requirements are defined to highlight what the client is looking for and to define a minimum level of competency. The selection of the main contractor is crucial to achieving WHS management goals.

DEVELOPING AUTHENTIC INVOLVEMENT IN BIM-SUPPORTED DESIGN

"...we were able to do 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. And piece by piece, day by programs, which we then feed into our safe work method statements and our methodologies that we then go back to [Private Client] with, and we present to the site team." – Project Manager, Façade Subcontractor

Supply chain participants who are skilled and competent in either BIM or WHS management alone, will not automatically embrace the adoption of BIM for WHS management. To come to this shared commitment, it is more useful to initiate these discussions in the planning phase and involve key players who are going to influence WHS outcomes during early project stages, ideally during project planning and no later than the commencement of detailed design. The groundwork for this journey is best laid in a forum comprising

- the client and advisors (often project managers) representing in their interests
- an information manager representing information interests through the project, and
- a health and safety professional who will be focussed on risk assessment through the project

These three parties collaboratively develop high-level project information requirements, including those that address WHS management goals, even before any tendering takes place. This discussion

then provides context for rich partner involvement in BIM-supported design.

Successful outcomes involve a number of conditions:

- Clients bringing contractors on board, and partnering with them, to develop detailed technical design of the asset, as soon as the concept design had been finalised;
- Clients and contractors developing long-standing relationships. In one case, the partnership for detailed design development alone lasted three to four years, leading to a strong foundation for collaborative working that cascaded to the construction stage;
- Clients creating a space where subcontractors could push the limits for exploring opportunities for BIM for WHS safety. In one case, the client made the decision to make exceptionally intensive use of BIM (modelling to a very high level of detail). This allowed the subcontractor to develop detailed construction methodologies based on the earlier concept design and to embed BIM-supported descriptions of their methodologies into their safe work method statements, which had very positive implications for WHS on the construction site.

Partnerships can be significantly strengthened by collaborative technologies. One client mandated the use of a specific database management tool for large projects. All subcontractors created, shared and used structured information from this tool. The tool came with a library of elements (doors, walls, mirrors, etc.) that were already designed according to specifications that complied with safety standards. This was targeting Design for Safety rather than construction WHS safety then, the collaborative relationship was strengthened and even "disciplined" for compliance with safety standards, as supply chain participants worked with shared technical standards.

DRIVING SUPPLY CHAIN PARTICIPATION ACROSS PROJECT STAGES

Lessons in the previous section should not limited to selected bilateral relationships between the client and one or two partners. Client leaders must create an environment for the development of richly connected networks of relationships which then drive supply chain participation across all project stages for holistic, BIM-supported WHS management. Broad-based collaboration involving finance, design, construction, project managers, councils, regulators and other parties must be achieved. Yet a number of challenges to such participation can arise.

First, WHS management goals can be obscured or compromised in multistakeholder contexts. Some stakeholders may drive the supply chain towards more widely-accepted goals involving time, cost and quality. Other stakeholders may simply be passive and indifferent about WHS management. In one case,

supply chain participants' confusion about goals were rooted in a deeper confusion about who the real client was, since so many stakeholders were involved. Managing stakeholder engagement intentionally and clarifying client obligations contractually, can help address this challenge.

A second challenge is timing the commencement of collaboration and participation. The reality is that most multistakeholder meetings, including meetings where WHS information requirements are discussed, happen at the last minute, resulting in hastily-made decisions because stakeholders are pressed to "deliver something". The importance of early contractor involvement cannot be overemphasised.

USING FORMAL AND INFORMAL STRATEGIES TO ENCOURAGE BIM-SUPPORTED WHS COMPLIANCE

Systematic interactions leading to the collaborative creation, use and sharing of digital WHS information do not emerge in a vacuum. Client leaders should encourage and facilitate these interactions in intentional ways, securing BIM-supported WHS compliance through a combination of formal and informal strategies.

Formal strategies that compel supply chain partners to create, use and share structured data for WHS management can take the form of

- Tendering requirements (see Guidance Note on Procurement, Tendering and Supply Chain Management)
- Contractual requirements
- Legal requirements and guidelines

In addition, other formal strategies can be mobilised. As mentioned earlier, requiring the use of specific information-sharing tools (like a database management tool) or supplying a standardised data scheme are strategies that provide substantial foundations for collaborative information management, including information management for WHS. Standardised templates and reports issued by the clients can also be powerful mechanisms for formalising collaboration.

Formal strategies can at times be mobilised broadly (many strategies are used at once) or more selectively. For example, one government client did not specify its own set of contractual WHS requirements to its supply chain partners, on the assumption that all parties were already operating under legally mandated WHS requirements as well as national guidelines.

Finally, formal requirements do not have to be rebuilt from scratch at the commencement of each project. Over time, clients can build up an understanding of their requirements based on experience. A client who has developed information requirements in previous projects might already know that it needs a particular type of gantry, a certain type of access or a certain

type of clearances. As these requirements are documented, clients can form a set of stable, well-developed organisational information requirements and asset information requirements, which would make it a fairly easy move for them to pick out from those key high-level project information requirements.

Client leaders need not be concerned that it is only formal strategies that can drive partners towards the collaborative creation, use and sharing of structured data. Informal strategies can also encourage BIM-supported WHS compliance.

First, clients who have not made use of "explicit" BIM for WHS requirements, can still "imply" that they want these in other ways. In one of our case studies, the client stopped short of specifying the use of BIM for WHS management, but nevertheless signalled in tenderer interviews that they wanted subcontractors to design and present their methodology in 3D. During tender interviews with contractors, the client made sure that the 3D model played a central role. The client used the model to explain what their construction program was, how the model would be developed, and how the building would be constructed over time. This, in turn, allowed subcontractors to clarify what was expected of them in terms of their respective elements of work and to understand that the client expected them to use BIM. It also encouraged one particular subcontractor to include details of their construction methodology in their safework statements, and later share these methodologies in ways that supported safety on site.

Second, new technological trends can encourage subcontractors to explore new opportunities for BIM, even when they are not required to do so. Trends in computer modelling that make it easier to achieve higher levels of development (LOD) raise opportunities for better integration of WHS management and BIM, opportunities that would not have been possible 10 years ago.

Third, practices in the larger industry is evolving. As mentioned earlier, innovative subcontractors are now taking the initiative to use BIM, even without being required to do so, "to model everything and use it as a presentation on how they're going to execute our works". These subcontractors have started using BIM as a tool to strengthen their sales pitch, and as a signal to show how professional they are and how they are planning to execute their specific role in a project.

CASE STUDY: OIR, AIR, PIR AND EIR FOR LOGISTICS PLANNING

INTRODUCTION

The previous section describes the attributes of client leaders who have created the ideal environment for the collaborative sharing of structured digital information, in ways that improve WHS outcomes. The previous section therefore assumes that the innovative client leaders craft a pathway towards exemplary use of BIM for WHS management, a path that the rest of the supply chain can then follow. The section was thus written in largely aspirational language.

This section grounds the discussion in the construction sector's current realities by showing a case study of a client that has made some progress in the BIM for WHS journey, but continues to have room for growth in key areas. The case study aims to show that Client Leadership can be demonstrated even by organisations, teams and supply chains that are still on the journey to full maturity.

A construction project, which we shall refer to as "Project One", located in Sydney, Australia, involved the design and construction of a six-story, circular, commercial building. The façade was wrapped in 20 kilometers of prefabricated, sustainably-sourced, timber strips. The process of manufacturing, delivering, lifting and installing these timber strips was a complex logistical process. Because of this complexity, critical safety issues had to be considered, including cranage of façade elements and people working at heights. These risks were intensified given that the structure was constructed in an area surrounded by three other towers, limiting the available space.

The case study that follows is a mixture of real-life case data and hypothetical details, but it flows from a specific real-life context. The real-life client is 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 showed some ingredients of client leadership: strong commitment to work health and safety management, support for early contractor involvement, strong collaborative capacity, and an emerging interest in the use of BIM. What the client did not (yet) have was a formal hierarchy of information requirements as defined in ISO 19650; neither did it have the ability to systematically integrate BIM and WHS management.

The integration of BIM and WHS management in this case was driven mainly by an actor in the supply chain, an innovative façade subcontractor that was brought in four years before construction commenced, right after the building's concept design had been completed. The façade subcontractor was tasked with developing technical details of the building. Because the specialist subcontractor had expertise, and because specific features of the project made WHS critical, the façade subcontractor developed very digital models. A decision was made to use BIM extensively as a response to the complexity of Project One design and construction. The 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. The façade subcontractor used digital models not just to support constructability, but also to enrich its safework statements and to show the sequencing of construction activities, sometimes on a day-to-day basis, to other trades. Thus it was a supply chain partner that played a critical role in catalysing improved WHS through BIM.

Critical supply chain participants in this case thus included:

- The integrated global corporate which was involved as the developer, design manager and construction manager. The developer unit was the Appointing Party while the construction unit was the Lead Appointed Party.
- A façade subcontractor, a small-sized company with employees from multiple disciplines including various professional, para-professionals and trades people, as an Appointed Party.

Contextual details of the case are real, but readers should note that as the discussion moves on to OIR, PIR and EIR, details are either hypothetical (added to create a complete picture) or actual data that has been recast (in the sense that real details, like a clause in a contract, are reframed here as part of PIR even if it was not presented as such in real life)[1]. The purpose is to develop a complete case study showing information requirements cascading from OIR to PIR to EIR, in ways that reflect a supply approach. Because the research team had extensive data on the role of the façade subcontractor, a decision was made to focus on information requirements related to logistics planning.

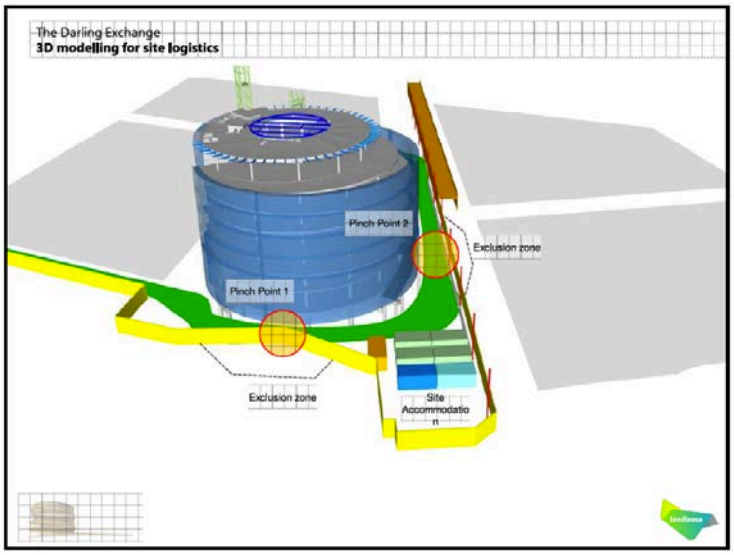

Figure 05 . Use of BIM for site logistics. The figure above shows how BIM facilitates the identification of exclusion zones.

[1] Sources of data include: actual interview data, a work-in-progress PIR template provided by the UK Health and Safety Executive (HSE), Guidance Note D developed by the UK BIM Alliance, an OIR template developed under the Victorian Digital Asset Strategy, and assorted documents and standards from the multinational referred to under the pseudonym “the integrated global corporate”.

ORGANISATIONAL INFORMATION REQUIREMENTS (OIR)

OIR are strategic business information requirements, rather than project-based or asset focussed. They are meant to support high-level decision-making, for example by allowing executive teams to track progress towards long-term business goals or to address comprehensive government reporting requirements (IDMF 2020). Currently, there is no single format for presenting OIR.

For this case study, we present three hypothetical OIR as examples for the integrated global corporate. These examples take into consideration that we are building up gradually towards more detailed information requirements to support planning and logistics in relation to the manufacture, delivery, lifting and installation of timber strips in Project One.

The first OIR is a short organisational vision for WHS management. Current practice often relegates WHS goals to the operational level. Including a WHS vision at a strategic level can help ensure that even before any procurement starts, WHS is foregrounded alongside cost, quality and safety goals of existing and future projects. The second and third OIR presented that are two sample work health and safety requirements upheld by the integrated global corporate for all projects worldwide. The two policies are part of well-defined set of 18 requirements in relation to the identification, elimination and mitigation of project risks.

(HYPOTHETICAL) VISION FOR WORK HEALTH AND SAFETY

EXAMPLES OF OIR

OIR 1: The integrated global corporate and its partners must implement work management practices and procedures that ensure the health and safety of all persons for whom they responsible, or over which they are capable of exercising control or influence, while performing their obligations. This includes members of the public or other workers. The integrated global corporate and its partners must also ensure that the environment is protected against potential or actual harm from the Supplier's performance of such obligations.

POLICY: WORK HEALTH AND SAFETY IN DESIGN REVIEWS

OIR 2: All operations that influence design must include design reviews which incorporate key design elements and related risks and opportunities. Design reviews must be progressive through the evolution of detailed design activity and must consider, as a minimum, constructability, maintainability, end use and operability, demolition and future proofing.

POLICY: METHODOLOGY REVIEWS IN CONSTRUCTION, ENGINEERING AND MANUFACTURING

OIR 3: All engineering and construction operations must review the delivery approach, techniques and methodologies to optimise work health and safety outcomes in construction, engineering or manufacturing delivery.

OIR 3 is particularly relevant as we progress towards PIR and EIR.

PROJECT INFORMATION REQUIREMENTS (PIR)

Project Information Requirements (PIR), like OIR, are high-level information requirements, but are created and managed to support strategic decision-making during critical project junctures. With the publication of ISO 19650, PIR have begun to play an increasingly central role. In the UK, the BIM4WHS Working Group has noted this shift and has begun to develop templates that support the systematic incorporation of WHS conditions as part of PIR. Supporting documents linked to the development of this template indicate the Working Group's stance that "Health & Safety PIR's... should be initiated as close as possible to the inception of a project, ideally by a combination of Client, Principal Designer and Project Information Manager, working closely together". The same supporting documents also note that "PIR's should form a key part of the Clients Brief, setting out the Information Requirements for a project to ensure that risks are correctly treated through planning, managing, monitoring and co-ordination."

The Working Group suggests that the PIR template should contain General Conditions for the project, as well as Specific Conditions for critical areas such as Fire Safety, Asbestos and Lifting. Users will be expected to customise the generic template, by assessing which elements of the template are most relevant to a given project. The use of General and Specific Conditions are reflected in the case study examples.

Other guidance about PIR has become available. The UK BIM Alliance, which also provides more general guidance on PIR development, suggests PIR can include a strategic brief for clients, a list of stakeholders and project tasks.

Noting these different guidelines, we present for this study sample PIR for Organisation X. We develop these hypothetical PIR based on

- the "vision" and "policies" above, which were taken from existing documents
- an ongoing project requirement of Organisation X: that all supply chain partners are required, for high risk construction work, to specify hazards and to describe control measures for these hazards
- actual case data that shows that during the actual project, Organisation X monitored a number of work health and safety indicators, two of which will be highlighted here

EXAMPLES OF PIR

The sample PIR we propose thus include

- Project WHS targets
- WHS stakeholders
- General conditions
- Specific conditions for Lifting Requirements, based on the BIM4WHS Working Group's template.

PROJECT WHS TARGETS

PIR 1: For this project, the Critical Incident Frequency Rate (for both potential and actual critical incidents) will be ZERO.

PIR 2: For this project, the Lost Time Injury Frequency Rate will be ZERO.

WHS STAKEHOLDERS

PIR 3: For this project, key WHS stakeholders are

- Supply chain partners
- General public
- Asset managers who will handle operations/ maintenance
- Users of the asset

GENERAL CONDITIONS FOR PROJECTS

PIR 4: Establish a structured standardised data schema that enables the WHS information to be accessed, filtered and used by other participants in planning, managing and controlling WHS risks.

SPECIFIC CONDITIONS FOR LIFTING

PIR 5: By collaboration between stakeholders, i.e., designers, principal contractor, sub-contractors, and end-users to develop Plans and 3D or 4D Digital Visualisation progressively throughout design for eliminating or minimising risk.

Reducing risk related to slinging and lifting complex lifts as follows:

1) each construction complex lift - design and construction complexity, scope of project and scale;

2) modelling of complex lifts including logistics and transport arrival at the site, slinging and lifting of the load including any tailing by another crane;

3) each identified complex lift and crane equipment specific to lifting people in construction, e.g., Workbox;

4) each operation and maintenance complex lift using a portable lifting apparatus, mobile crane or other;

5) each identified complex lift required in the operation or maintenance of the asset;

6) the installation, operational use and dismantling of each Tower Crane;

7) where the design of the permanent works involves complex geometry of structural elements or complex prefabrication installation.

PIR 6: From design outset, digitally develop 1) a Schedule of Construction Crane Lifts for all lifts that are complex; 2) a Schedule of Asset Operation and Maintenance Lifts for all significant lifts; 3) a Schedule of Mobile Plant for all operational and maintenance tasks that require people, materials and waste to be lifted and lowered associated to work activity purposes of the asset in-use; and 4) a Schedule of Fixed Lifting Appliances for all lifting equipment permanently installed in the asset.

Incorporate appropriate metrics into these Schedules relating to the significant lift and immediate locale that can be used for risk treatment by design and to plan and control the lift(s).

Maintain the Schedules throughout the work stages.

Denote all complex lifts supported with a visualisation on the Schedules and linked to the visualisation.

A 3D or 4D digital visualisation for each identified complex lift (eg each timber strip) shall be developed by the designer progressively throughout design and shared with the Main Contractor and contractor undertaking the lifting operation.

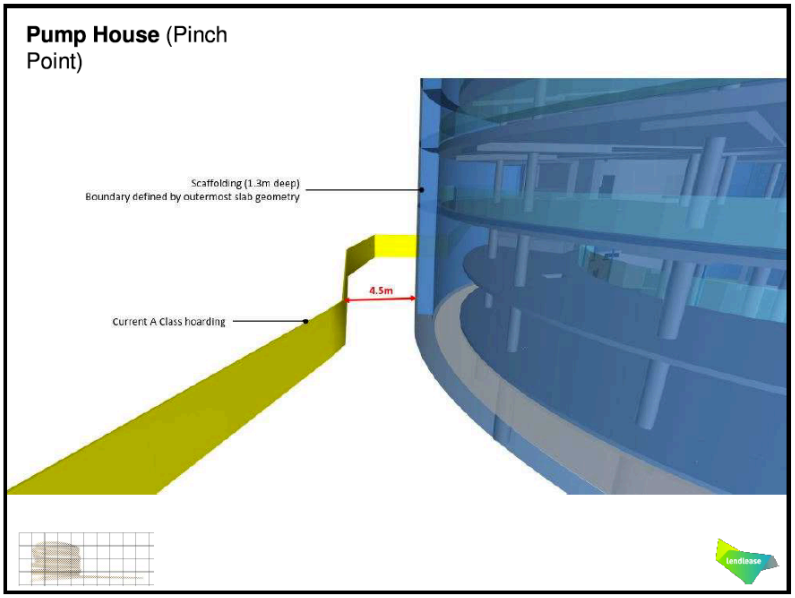

Figure 06. Use of BIM for site logistics. The figure above shows how BIM facilitates the identification of pinch points.

EXCHANGE INFORMATION REQUIREMENTS (EIR)

In our hypothetical scenario, Organisation X as the Appointing Party then moves from PIR, to develop detailed, rationalised Exchange Information Requirements (EIR). EIR will then be passed on the Lead Appointed Party. In this case, the Lead Appointing Party is an internal division, the integrated global corporate's construction unit. The Lead Appointed Party then passes on appointment-specific EIRs to the rest of the Appointed Parties in the supply chain, including in this case the façade subcontractor.

The logistical sequence involving manufacturing, loading, delivering, unloading, hoisting and finally installing timber strips on to the structure raises potential WHS incidents: fall of persons, fall of materials, crane and hoisting incidents, impact from moving parts and machines, failure of structures To address these issues through structured sharing of information requirements, the Lead Appointed Party can develop information requirements and purposes, with some examples are shown in the partial table below:

Table 02: Lead appointed party EIR summaries

PIR as indicated in previous section	EIR	Information purpose – to support
From design outset, digitally develop 1) a Schedule of Construction Crane Lifts for all lifts that are complex; 2) a Schedule of Asset Operation and Maintenance Lifts for all significant lifts; 3) a Schedule of Mobile Plant for all operational and maintenance tasks that require people, materials and waste to be lifted and lowered associated to work activity purposes of the asset in-use; and 4) a Schedule of Fixed Lifting Appliances for all lifting equipment permanently installed in the asset. Incorporate appropriate metrics into these Schedules relating to the significant lift and immediate locale that can be used for risk treatment by design and to plan and control the lift(s). Maintain the Schedules throughout the work stages. Denote all complex lifts supported with a visualisation on the Schedules and linked to the visualisation.	Manufacturer information concerning timelines, daily delivery schedules and product specifications such as timber strip sizes	Scheduling, analysis and planning
By collaboration between stakeholders, i.e., designers, principal contractor, sub-contractors, and end-users to develop Plans and 3D or 4D Digital Visualisation progressively throughout design for eliminating or minimising risk. Reducing risk related to slinging and lifting complex lifts as follows: 1) each construction complex lift - design and construction complexity, scope of project and scale; 2) modelling of complex lifts including logistics and transport arrival at the site, slinging and lifting of the load including any tailing by another crane; 3) each identified complex lift and crane equipment specific to lifting people in construction, e.g., Workbox; 4) each operation and maintenance complex lift using a portable lifting apparatus, mobile crane or other; 5) each identified complex lift required in the operation or maintenance of the asset;	Information on position of perimeter fencing did it include other objects ie buildings or structures within the working zone of the crane Information on position of temporary lifts, the shape and weight of the load Crane operator information on crane sizes and capacities Information on working zone of the crane and exclusion zones (people not being allowed to work under the crane)	Analysis, planning and simulation

6) the installation, operational use and dismantling of each Tower Crane; 7) where the design of the permanent works involves complex geometry of structural elements or complex prefabrication installation.		

SELF ASSESSMENT MATRIX INTRODUCTION

PURPOSE OF THE SELF ASSESSMENT MATRIX

The Self-Assessment Matrix is a tool that (1) assists clients and the leadership teams of projects to assess their level of maturity in adopting BIM for WHS management and (2) provides them with possible pathways to increased maturity, should they make a strategic decision to take the next step of the journey. The Self-Assessment Matrix is meant for internal reflection and planning and emphasizes qualitative characteristics that allow for a richer range of interpretations than more quantitative measures. The Self-Assessment Matrix is not meant as a tool for scoring, comparisons with other entities or quantitative performance aggregations across the industry

HOW TO USE THE SELF ASSESSMENT MATRIX

The Self Assessment Matrix comprises 10 questions developed from semi-structured interviews, existing tools and guide notes and local and international standards. Users may find that some questions are more relevant to their contexts than others. Questions begin with “To what extent” to indicate that different levels of maturity are possible. There are three levels of maturity:

- base standard, regulatory compliance, moderate adopters
- best practice, innovation early adopters, exploratory, base standard well accomplished
- exemplar leaders, innovation initiators, experimental exception adopters

SELF ASSESSMENT MATRIX

THEME 01 STRATEGIC VISION

To what extent have you developed a strategic vision for WHS management, for communication to stakeholders including supply chain participants?

MATURITY STEPS

LEVEL 1 BASE STANDARD REGULATORY COMPLIANCE MODERATE ADOPTERS	CHECK	LEVEL 2 BEST PRACTICE INNOVATION EARLY ADOPTERS EXPLORATORY BASE STANDARD WELL ACCOMPLISHED	CHECK	LEVEL 3 EXEMPLAR LEADERS INNOVATION INITIATORS EXPERIMENTAL EXCEPTIONAL ADOPTERS	CHECK
Vision is described explicitly in strategic documents but only partially operationalised with targets and policies		Vision is described explicitly in strategic documents and systematically operationalised through targets, KPIs, policy, processes, reporting and monitoring		Well established recognised industry leader etc	

THEME 02 VALUE OF DIGITAL INFRASTRUCTURE DATA

To what extent have you developed a strategic vision on the value of the use of digital infrastructure data, for decision-making generally and for WHS management in particular?

MATURITY STEPS

LEVEL 1 BASE STANDARD REGULATORY COMPLIANCE MODERATE ADOPTERS	CHECK	LEVEL 2 BEST PRACTICE INNOVATION EARLY ADOPTERS EXPLORATORY BASE STANDARD WELL ACCOMPLISHED	CHECK	LEVEL 3 MARKET LEADERS INNOVATION INITIATORS EXPERIMENTAL EXCEPTIONAL ADOPTERS	CHECK
Vision is described through statements in various operational documents		Vision is made explicit in strategic documents but only partially operationalised through risk analysis, scenario planning and some reporting		Vision is made explicit in strategic documents and systematically operationalised through linking the vision, targets etc with coherent BIM processes to ensure scenario planning, risk analysis, reporting, monitoring and analysis. Detailed decisions such as optimal levels of development (LOD) required for different decisions and depending on risk levels have been systematically considered.	

THEME 03 SYSTEMATIC PROCESSES FOR HAZARD IDENTIFICATION

To what extent have you defined and systematised your processes for identifying hazards in planning, design, construction and operation, for communication to the supply chain?

MATURITY STEPS

LEVEL 1 BASE STANDARD REGULATORY COMPLIANCE MODERATE ADOPTERS	CHECK	LEVEL 2 BEST PRACTICE INNOVATION EARLY ADOPTERS EXPLORATORY BASE STANDARD WELL ACCOMPLISHED	CHECK	LEVEL 3 MARKET LEADERS INNOVATION INITIATORS EXPERIMENTAL EXCEPTIONAL ADOPTERS	CHECK
WHS processes are defined and systematised mainly in ways that address compliance/ regulatory requirements		WHS are defined and systematised coherently but are not readily supported by digital data		WHS are defined and systematised coherently; processes are designed to be seamlessly integrated into digitally-supported WHS management systems	

THEME 04 OPPORTUNITIES FOR WHS PROCESS IMPROVEMENT THROUGH BIM

To what extent have you set conditions enabling supply chains to identify key opportunities for WHS process improvement, through automated data flows, digital engineering, or BIM?

MATURITY STEPS

LEVEL 1 BASE STANDARD REGULATORY COMPLIANCE MODERATE ADOPTERS	CHECK	LEVEL 2 BEST PRACTICE INNOVATION EARLY ADOPTERS EXPLORATORY BASE STANDARD WELL ACCOMPLISHED	CHECK	LEVEL 3 MARKET LEADERS INNOVATION INITIATORS EXPERIMENTAL EXCEPTIONAL ADOPTERS	CHECK
Low hanging fruit for technology/ BIM adoption targeted in specific areas (for example, affordable 3D resources rather than full-scale BIM)		Use of 3D/ 4D visualisation in high-risk aspects of construction methodologies		Comprehensive, sophisticated use of BIM in several ways: scenario planning, risk assessment, education and communication, etc. Articulates understanding of the limitations of technologies, including BIM	

THEME 05 FORMAL AND INFORMAL STRATEGIES TO RECRUIT ALIGNED PARTNERS

To what extent have you used formal and informal strategies to identify and recruit internal and external partners who are aligned to your vision for WHS management and the vision for the use of digital data?

MATURITY STEPS					
LEVEL 1 BASE STANDARD REGULATORY COMPLIANCE MODERATE ADOPTERS	CHECK	LEVEL 2 BEST PRACTICE INNOVATION EARLY ADOPTERS EXPLORATORY BASE STANDARD WELL ACCOMPLISHED	CHECK	LEVEL 3 MARKET LEADERS INNOVATION INITIATORS EXPERIMENTAL EXCEPTIONAL ADOPTERS	CHECK
Relies on informal mechanisms for recruiting like-minded partners, for example those who have been project partners in past projects		Has formal mechanisms for recruiting partners, for example robust selection criteria that considers WHS performance in ways that go beyond compliance		Lobbies for large-scale change across the industry, particularly for the development of new positions like Digital Engineering Advisors and Digital Engineering Developers	

THEME 06 SUPPLY CHAIN COLLABORATION AND ALIGNMENT FOR BIM AND WHS MANAGEMENT

To what extent have you used formal and informal strategies to INTENTIONALLY DEVELOP internal and external partners who are aligned to your vision for WHS management and the vision for the use of digital data?

MATURITY STEPS					
LEVEL 1 BASE STANDARD REGULATORY COMPLIANCE MODERATE ADOPTERS	CHECK	LEVEL 2 BEST PRACTICE INNOVATION EARLY ADOPTERS EXPLORATORY BASE STANDARD WELL ACCOMPLISHED	CHECK	LEVEL 3 MARKET LEADERS INNOVATION INITIATORS EXPERIMENTAL EXCEPTIONAL ADOPTERS	CHECK
Mobilises early contractor involvement to achieve authentic partnership		Mobilises the beginning of multistakeholder teams, for example by bringing together WHS, information management and client representatives at the start of a project to articulate multi-dimensional project goals that include safety		Mobilises, systematically and consistently, multi-stakeholder teams early in the project and at prescheduled review sessions from early project planning to asset handover Provides opportunities for multi-stakeholder feedback including contractors interrogating design and stakeholders interrogating asset constructability	

THEME 07 OIR, AIR AND PIR

To what extent have you established Organisational Information Requirements (OIR) and Asset Information Requirements (AIR) that are robust enough to facilitate the development of Project Information Requirements (PIR)?

MATURITY STEPS					
LEVEL 1 BASE STANDARD REGULATORY COMPLIANCE MODERATE ADOPTERS	CHECK	LEVEL 2 BEST PRACTICE INNOVATION EARLY ADOPTERS EXPLORATORY BASE STANDARD WELL ACCOMPLISHED	CHECK	LEVEL 3 MARKET LEADERS INNOVATION INITIATORS EXPERIMENTAL EXCEPTIONAL ADOPTERS	CHECK
Develops PIR that identifies risks for WHS management		Develops PIR in a multi-disciplinary team (see above) with well-defined conditions for WHS management		Development of OIR and AIR in a multi-disciplinary team such that the OIR and AIR incorporate WHS management goals, which inform the development of PIR with well-defined conditions for WHS management	

THEME 08 SHARING DIGITAL WHS DATA

To what extent, and how early have you established conditions enabling the collaborative sharing of digital WHS data across the supply chain at critical decision points of the project?

MATURITY STEPS					
LEVEL 1 BASE STANDARD REGULATORY COMPLIANCE MODERATE ADOPTERS	CHECK	LEVEL 2 BEST PRACTICE INNOVATION EARLY ADOPTERS EXPLORATORY BASE STANDARD WELL ACCOMPLISHED	CHECK	LEVEL 3 MARKET LEADERS INNOVATION INITIATORS EXPERIMENTAL EXCEPTIONAL ADOPTERS	CHECK
Initiates sharing of structured digital data Shared digital information is based on materials (for example survey results) that meet minimum legal requirements		Structured, digital WHS management data is shared, at regular intervals, to stakeholders at who are regularly engaged with digital models Shared digital information is based on materials (for example survey results) that are recent		Structured, digital WHS management data is shared, on an ongoing basis, to all stakeholders including trades that do not usually engage with digital models Formal and informal venues are available for data-sharing, leading to improved WHS management Shared digital information is based on materials (for example survey results) that are up to date due to timely investigations by the supply chain	

THEME 09 ENVIRONMENT FOR BIM AND WHS MANAGEMENT

To what extent, and how early have you established conditions that enable the supply chain to use BIM as a tool for digital WHS data sharing at critical decision points?

MATURITY STEPS

LEVEL 1 BASE STANDARD REGULATORY COMPLIANCE MODERATE ADOPTERS	CHECK	LEVEL 2 BEST PRACTICE INNOVATION EARLY ADOPTERS EXPLORATORY BASE STANDARD WELL ACCOMPLISHED	CHECK	LEVEL 3 MARKET LEADERS INNOVATION INITIATORS EXPERIMENTAL EXCEPTIONAL ADOPTERS	CHECK
Digital data is available but requires extensive processing and integration before it can support WHS management. Alternatively, WHS management information is available but in non-digital form.		Universal data scheme in support of traditional KPIs (cost, quality, time) is available and has begun to be organically extended to WHS management decisions		Universal data scheme in support of WHS management is created, managed, used and shared	

THEME10 LESSONS LEARNED ABOUT BIM AND WHS MANAGEMENT

To what extent have you ensured that lessons learned in relation to WHS management through the use of BIM on projects are shared as widely as possible?

MATURITY STEPS

LEVEL 1 BASE STANDARD REGULATORY COMPLIANCE MODERATE ADOPTERS	CHECK	LEVEL 2 BEST PRACTICE INNOVATION EARLY ADOPTERS EXPLORATORY BASE STANDARD WELL ACCOMPLISHED	CHECK	LEVEL 3 MARKET LEADERS INNOVATION INITIATORS EXPERIMENTAL EXCEPTIONAL ADOPTERS	CHECK
Client provides appropriate best practices and lessons learned		Client identifies lessons learned and benchmarks in relation to ISO 19650/ PAS 1192-6		Client shares generalisation of learning and improvements across industries for open learning	