University of Southern Queensland

School of Engineering

Challenges and Opportunities of Building Information Modelling for Infrastructure Management of Local Government Authorities

A dissertation submitted by

Jesse Wisselo

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Student Name: Jesse Wisselo

Student Number: [redacted]

_ [redacted] ___

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25 October 2024

ABSTRACT

This research investigates the current state of infrastructure management within local government and explores the potential opportunities and challenges associated with the adoption of Building Information Modelling (BIM). Through an industry engagement survey distributed to 125 NSW Local Government Authorities (LGA), the research gathered insights on existing infrastructure management processes and practices, challenges faced during the operation and maintenance phase, and the level of BIM awareness and utilisation within the industry.

The findings reveal significant variability in infrastructure management maturity, with many organisations operating under reactive maintenance practices and facing resource limitations. Despite a general awareness of BIM, its practical application remains limited due to financial constraints and a shortage of skilled professionals. The research highlights several key advantages of BIM, including improved planning, decision making, and life cycle management, while also identifying challenges, such as high initial outlay cost, the need for high-quality input data and adequate training of staff.

Based on these findings, the study offers recommendations to improve resource allocation, improve management practices and systems, and promote BIM adoption. These recommendations aim to support LGAs in overcoming existing challenges and improving infrastructure management efficiency and sustainability.

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I would like to thank my supervisor, David Thorpe, for their guidance and support during this dissertation. Their feedback and advice were appreciated throughout the process. Thank you for your assistance.

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GLOSSARY

LGA	=	Local Government Authorities
BIM	=	Building Information Modelling
O&M	=	Operation and Maintenance
D&C	=	Design and Construction
EPA	=	Environmental Protection Agency
FM	=	Facilities Management

CHAPTER 1 INTRODUCTION

Infrastructure management within Local Government Authorities (LGA) in Australia is a complex and multifaceted challenge. These authorities are responsible for a wide range of services, including asset management and maintenance, governance, project management, community engagement and service delivery, all while operating under strict budgetary constraints. With over 535 LGAs in Australia managing approximately 65% of all public infrastructure assets valued at $523 billion, effectively managing these assets is critical for maintaining service levels and extending the life span of infrastructure.

1.1 PROBLEM STATEMENT

Despite the critical role that LGAs play in managing a significant portion of Australia's public infrastructure, they face numerous challenges. These challenges include dealing with ageing infrastructure, navigating a complex regulatory environment, and balancing financial constraints. Additionally, decision-making is often hindered by incomplete, missing or hard-to-access data. While Building Information Modelling (BIM) has been widely adopted in the design and construction (D&C) phases of infrastructure projects and has proven benefits, its application in the operation and maintenance (O&M) phase remains limited. This gap between the utilisation of BIM in the D&C and O&M phases poses a significant problem, as the potential benefits of BIM, such as improved collaboration, improved efficiency, and informed decision-making, are not fully realised in this critical phase of infrastructure management.

1.2 RESEARCH OBJECTIVES

The main objective of this research is to explore the potential of Advanced Information Systems, specifically BIM, in enhancing the infrastructure management practices of LGAs

during the operation and maintenance phase. This research seeks to achieve the following specific objectives:

- Examine the current state of infrastructure management within the Local Government Industry.
- Identify the main challenges that LGAs face when managing infrastructure assets
- Determine the main barriers to implementing BIM within existing processes.
- Identify opportunities and benefits that could be transferred into the O&M phase, effectively improving infrastructure management for Local Government Authorities.

CHAPTER 2 BACKGROUND AND LITERATURE REVIEW

A preliminary examination of the literature has been undertaken and will continue throughout the term of the research project, with the intention of strengthening the project's outcomes as new information becomes available. The initial review delved into the infrastructure management of LGAs and the potential of BIM to enhance existing management practices. In the initial phase of the review, it was observed that several recurring themes emerged. These themes include:

- LGAs in Australia are tasked with effectively managing infrastructure assets with limited budgets,
- Infrastructure management is hindered by financial constraints, ageing infrastructure, and regulatory compliance, necessitating a balance between financial planning and expenditure to maintain service levels,
- Building Information Modelling proves valuable for collaboration, efficiency, and decision-making in infrastructure management, yet faces significant barriers to adoption during the operation and maintenance phase of the infrastructure.
- Effective decision-making in infrastructure management relies on data but faces challenges in storage, quality, availability, and interoperability.

2.1. LOCAL GOVERNMENT AUTHORITIES

In Australia, LGAs are responsible for governance, planning, community development, service delivery including, waste, water, and wastewater, as well as asset management and regulation. According to the Local Government National Report 2021 (Government 2023a), there are 535 Local Governments in Australia. These LGAs currently raise approximately 82.8% of their own revenue, with the remaining 17.2% coming from grants and subsidies,

highlighting the majority of the LGA income is from either taxpayers or ratepayers. It is estimated that 65% of all Local Government assets, valued at $523bn, are attributed to public works infrastructure with an average operational life of more than 60 years (Verity 2021). Effectively managing these assets is paramount to extending their in-service useful lives whilst minimising ongoing operational expenses. This entails ensuring that facilities management and asset management practices are efficient and effective, minimising expenses associated with the assets and optimising the performance of the infrastructure.

A 2022 Market Capacity report by Infrastructure Australia (Government 2023b) has found that the demand for public infrastructure works has been significantly increasing. Since their last report in 2021, there has been a $15 billion dollar increase, equivalent to 6.7% growth. This has contributed to the pressure faced by local governments to manage and maintain these assets once constructed. Furthermore, challenges such as labour shortages, increased demand for plant, equipment and materials, and supply chain issues further compound the challenges faced by LGAs.

The aim of this literature review is to understand the current state of BIM adoption, assess its impact on infrastructure management processes and to identify barriers to successful implementation.

2.2. CHALLENGES IN INFRASTRUCTURE MANAGEMENT

Having established the critical role of LGAs in managing infrastructure assets, it is important to delve deeper into the challenges they face, ensuring the functionality and efficiency of these assets.

The management of infrastructure assets is influenced by several critical factors that shape their ongoing viability and effectiveness. Factors such as financial climate, ageing infrastructure, and Regulations are among some of the challenges that impact local government. Additionally, LGAs are feeling pressure from stakeholders to maintain or improve service levels with limited budgets. Balancing expenditures and ensuring long-term performance becomes paramount in the decision-making processes (Parlikad & Jafari 2016).

As technology continues to grow at an increasingly fast pace, it has become evident that infrastructure must be designed for new and emerging technologies to optimise life cycle performance and extend their useful lives. Infrastructure Australia's National Study of Infrastructure Risk (Government 2021) has highlighted that poorly integrated infrastructure will be at risk of large benefit underruns and reduced economic viability. The integration component of a project can be often overlooked due to the majority of the costs coming from the construction phase. However, effective integration is paramount in the operation and maintenance phase of the project.

2.2.1. Financial Climate

Financial climate refers to the prevailing economic factors and budgetary constraints that influence the availability of funding, the allocation of resources, and the financial strategies adopted by LGAs to manage infrastructure assets. In practical terms, a favourable financial climate may see increase economic growth, stable government revenues, and ample funding allocation for infrastructure development. However, a challenging financial climate could involve economic downturns, budget deficits and limited access to external sources.

As infrastructure owners, LGAs face immense pressure to efficiently allocate appropriate resources in a constrained financial climate. Limited funding sources, usually gained from Government grants or the community (Government 2023a), and competing priorities necessitate careful financial planning and decision-making to ensure that infrastructure assets are adequately maintained and upgraded to meet community needs. A report by Infrastructure Partnerships Australia (Australia 2023) has concluded that in the financial year 2023-24, Australia's infrastructure expenditure grew marginally at $256.6 billion, an increase of $1.6 billion from the 2022-23 financial year. However, in real terms this equates to a $11.7 billion dollar decline, bringing infrastructure's share of the total budget funding down by 2.7%. This highlights that Government spending is decreasing while infrastructure needs are increasing, putting strain on LGAs.

2.2.2. Ageing Infrastructure

LGAs around Australia are facing infrastructure that is nearing its end of useful life. It is more prevalent in the Water industry, where infrastructure that was installed in the 1970's and 1980's is starting to fail. According to Perera et al. (2021), Australia has more than 650 Water Storage Dams, half of which are over 50 years old, and more than 50 dams that have been in operation for more than a century. Additionally, a study performed on behalf of the Queensland Government, Fearon & Cosgrove (2019) found that costs to maintain Queensland's ageing water supply and sewer infrastructure will increase in the coming years, and it is almost impossible to calculate the full economic impact due to the lack of accurate information and data. Addressing ageing infrastructure requires significant investments in rehabilitation, renewal, replacement, and modernisation to ensure continued reliability and functionality.

2.2.3. Regulations

LGAs have to navigate a complex regulatory environment with many legislative requirements. Legislation including the Local Government Act 1993, Civil Liability Act, Roads Act 1993, Work Health and Safety Act 2011 set the standard in which local government authorities must operate under. In particular, Section 8A of the Local Government Act lists the guiding principles for councils and clause (1) (f) states that "councils should manage lands and other assets so that current and future local community needs can be met in an affordable way". This statement highlights the need for LGAs to ensure infrastructure management is efficient and minimising expenditure.

Additionally, regulators such as the Office of Local Government NSW, EPA (Environmental Protection Agency), and Dam Safety NSW ensure that the infrastructure built will meet or exceed safety, environmental protection and quality standards. The main objective of the regulators is to ensure the well-being of the community. They are also tasked with ensuring compliance with appropriate legislation during the operational phase of the infrastructure's life cycle.

2.2.4. Dependencies and Interdependencies

Most commonly, an infrastructure network or system does not provide value on its own. It provides a link to a more complex system that relies on other assets to become useful. This means a multidisciplinary approach is often needed to effectively manage these assets (Parlikad & Jafari 2016). Different types of dependencies exist that affect the infrastructure throughout its lifecycle phases. Whilst there is an acknowledgement of the impact of dependencies on the network, it is rarely captured in the asset management process for the

infrastructure. However, emerging technologies offer promising avenues for better understanding, quantifying and measuring these relationships (Daulat et al. 2024).

2.2.5. Data

Ensuring effective decision-making in the context of Infrastructure management relies heavily on a diverse range of data, such as asset properties, asset conditions, asset performance, and network configuration. As technology advances, the volume of data that is relied upon increases. This data is used in current asset management procedures as well as in predicting future asset performance and maintenance. However, challenges exist in the storage, quality, availability, and interoperability of this data. Additionally, data collection processes are often costly to implement, particularly for smaller authorities (Daulat et al. 2024).

2.3. OPERATION AND MAINTENANCE / FACILITIES MANAGEMENT

The operation and maintenance phase of infrastructure, often termed Facilities Management (FM), is defined as the ongoing management, repair and upkeep of assets and infrastructure, and is the most expensive phase of the infrastructure life cycle.

ISO41011:2024 - Facilities Management, defines FM as an "organisational function which integrates people, place and process within the built environment with the purpose of improving the quality of life of people and the productivity of the core business".

According to Durdyev et al. (2022) & Zhao et al. (2022), FM costs make up 80-85% of all infrastructure lifecycle costs. This cost is significant to the LGA as they must ensure they have the required funds planned and forecasted in their long-term financial plan.

In addition to the FM costs, reports from Salzano et al. (2023) state that there are ongoing concerns about existing asset management practices due to the increasing complexity of maintenance operations and limited budgets. The increasing complexity is straining current maintenance practices resulting in an increase in reactive maintenance and a decrease in planned preventative maintenance. According to Durdyev et al. (2022), reactive maintenance is an inefficient method of operation that can greatly increase the time and resources needed to complete the required work.

2.4. BUILDING INFORMATION MODELLING

Building Information Modelling is a sophisticated digital process that creates a digital representation of physical and functional characteristics of infrastructure or a facility. It can be used as a tool for collaboration, mass data storage and sharing, and be viewed as a single source of truth throughout the design, construction, operation and decommissioning phases of the asset's life cycle (Durdyev et al. 2022).

Despite the FM phase attributing to the majority of the asset's overall cost, Patacas et al. (2020); Deng et al. (2021); Durdyev et al. (2022) argue that BIM has been mainly researched and implemented in the Design and Construction phases of infrastructure. Durdyev et al. (2022) conducted a survey with 180 active industry professionals and the results revealed only 7% used BIM for FM indicating a lack of awareness throughout the industry. However, results from Panah & Kioumarsi (2021) show that attitudes in the AEC industry shifting and that there is increasing interest in BIM for the FM phase, especially with the integration of

other tools such as the Internet of Things, which allows real-time monitoring, and Augmented Reality, which allows the user to view the design with a real-world experience.

Currently, there is a common theme among the reviewed literature of Patacas et al. (2020); Deng et al. (2021); Zhao et al. (2022) that generally, Facilities Managers are still relying on old technology in various formats and paper-based documents, which are manipulated by many different sources prior to handover from the construction phase. Patacas et al. (2020) found that not only was the data and information handed over poorly after the construction phase, which led to a labour-intensive and error-prone handover, but it also affected the verification and validation of the handed-over information, which is spread out across numerous platforms.

Most, if not all, of the studies reviewed, supported the idea that digitisation of the built environment is a significant factor for innovation in the AEC industry and will provide many benefits in the future. A study by Deloitte (2023) surveyed 229 construction and engineering professionals across Australia, Japan, and Singapore and found that 40% of businesses surveyed were currently using BIM, with 96% reporting digitisation had improved their business performance.

2.4.1. Current Uses and Benefits

BIM is currently being used across various sectors of the AEC industry and is proving to provide many benefits. According to Deng et al. (2021) & Zhao et al. (2022), BIM continues to play a critical role in improving collaboration, efficiency, and decision-making throughout the life cycle of infrastructure. The following BIM uses have been identified in the literature review:

- Design tool

- 3D modelling and visualisation.
- Project planning
- Clash detection of services
- Cost estimation and quantity take-offs
- Construction planning and sequencing

BIMs implementation during the project's planning and design phase is well recognised and accepted according to Mannino et al. (2021). The use as a design tool allows real time collaboration with various stakeholders. It's ability to develop and display 3D modelling and clash detection for real time visualisation has been instrumental in improving major decision points during project development. Identifying and minimising these issues early in the planning and design phase reduces the overall project costs associated with rework and issue rectification.

Project cost estimation and subsequent quantity take offs are another important use for BIM in the planning and design phases. Accurate cost estimation improves the confidence level in decision making when setting project construction budgets. A study by Fazeli et al. (2021) developed a BIM cost estimation based on a specific construction project and compared it to a professional Estimator. The results concluded that BIMs cost estimation model was more effective at estimating the cost for this project when compared to the actual cost of construction, showing a smaller margin of error when compared to the professional Estimator. This case study demonstrates the potential of BIMs approach to cost estimation.

Another case study by Salzano et al. (2023) looked at using BIM for a Building Condition Assessment for the Brunelleschi's Cloister in Florence. A 3D model was developed utilising Work As Executed drawings and photographs. Once the model was developed, all the remaining technical attributes and properties of the Cloister were inputted including, materials, previous inspection reports, current maintenance schedules etc. Once complete, each individual element was able to be queried for current condition. Furthermore, the elements were able to be colour coded according to defect as shown in Figures 1 & 2.

$i_d = 0$	Level 0	No decay
$0\% < i_d \leq 15\%$	Level 1	Good condition
$15\% < i_d \leq 30\%$	Level 2	Light decay
$30\% < i_d \leq 45\%$	Level 3	Moderate decay
$i_d > 45\%$	Level 4	Generalized decay

Figure 1: Level decay index (Salzano et al. 2023)

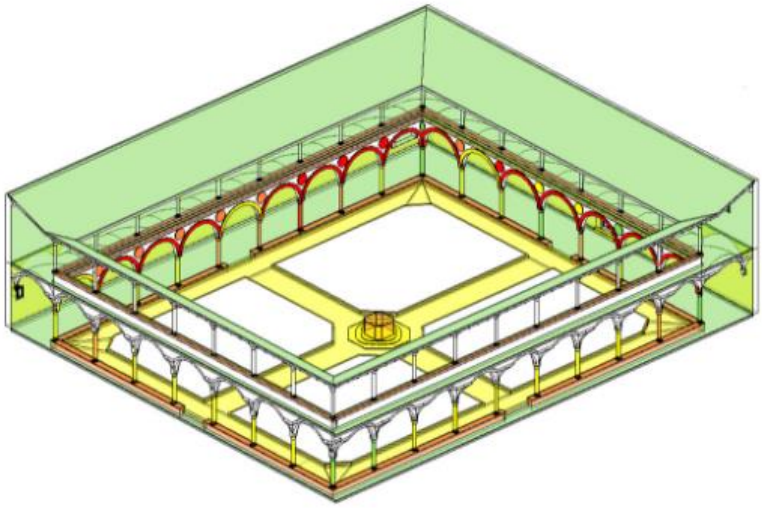

Figure 2: Digital visualisation of the degradation level of Brunelleschi's Cloister (Salzano et al. 2023)

It was agreed by Patacas et al. (2020); Deng et al. (2021); Mannino et al. (2021); Panah & Kioumarsi (2021); Zhao et al. (2022) that BIM was thoroughly researched and implemented in the planning, design and construction phases. However, they recognise the potential of BIM for Facilities Management. BIMS potential uses in FM include the following:

- Energy performance management
- Indoor environment monitoring
- Hazards monitoring
- Structural health monitoring
- Work order management

The results from a systematic review undertaken by Panah & Kiourmarsi (2021) determined that BIM can be integrated with other technologies to improve Facilities Management. The report goes on to detail a case study of American bridges that were equipped with monitoring sensors integrated with a BIM system. They found the efficiency of the system enhanced the quality of monitoring of the bridges, providing beneficial information for engineers during the life cycle of the bridges.

2.4.2. Barriers to Bim Adoption

Despite the wide range of uses and benefits associated with the implementation of BIM, there have been several barriers identified throughout the literature review. Durdyev et al. (2022) has identified that BIM is usually only carried through to the FM phase if it has been applied in the design and construct phases. This is due to the large upfront costs associated with developing and implementing BIM, including the software, hardware and training for staff. Patacas et al. (2020); Mannino et al. (2021); Zhao et al. (2022) agree that BIM lacks a

supported framework and integrated platform that addresses the entire BIM for FM workflow.

The general consensus was FM managers were unfamiliar and lack experience with the aspects of BIM and were still reliant on old paper-based procedures and practices. Durdyev et al. (2022) argues this lack of familiarity and experience has been attributed to the high cost of training, and awareness within the industry. Furthermore, it could be attributed to the disconnect between the Design and Construction phases and the appropriate handover, which is detailed in section 2.4 and is described as lacking. Durdyev et al. (2022) also goes on to say that perhaps with widespread adoption of BIM within the industry, there would be an increase in training providers and subsequently, a decline in the cost of implementation.

Other barriers identified during the literature review are listed below:

- Fragmented data management systems, where the data is not stored in one central location making it difficult to retrieve.
- Research and development for BIM for FM is far behind BIM for the design and construct phases.
- Potential benefits for BIM are unknown.
- Interoperability issues with existing software used by Facilities Managers.

2.5. LITERATURE REVIEW SUMMARY

After undertaking this literature review, it is clear that LGAs face significant challenges when managing infrastructure during the operation and maintenance phase of the infrastructure life cycle. The literature review highlighted the gap that this research is trying to bridge, which is to:

- Examine the current state of infrastructure management within the Local Government Industry.
- Identify the main challenges that Local Government Authorities face when managing infrastructure assets
- Determine the main barriers to implementing BIM within existing processes.
- Identify opportunities and benefits that could be transferred into Facilities Management, effectively improving infrastructure management for Local Government Authorities.

CHAPTER 3 METHODOLOGY

3.1. PROPOSED SCOPE

The initial scope of this project includes:

- Undertake a literature review to identify existing challenges and opportunities associated with implementing and utilising BIM for Infrastructure Management in a generalised context.
- Undertake an industry engagement survey of local government authorities to understand the current state of BIM adoption within the local government industry, assess its impact on infrastructure management processes, and identify barriers to successful implementation.
- Identify opportunities for improvement for local government authorities by utilising BIM for infrastructure management processes.
- Provide recommendations to local government authorities for successfully implementing BIM, including overcoming barriers identified during the survey.
- Assess the cost implications of adopting Bim for infrastructure management, including initial cost, ongoing maintenance cost and return on investment.

3.2. SCOPE REFINEMENT

During the literature review, it was identified that the scale and complexity of BIM utilisation varied across the numerous studies. Providing an accurate cost implication for BIM adoption would be challenging without engaging professional consultants within the BIM industry. Engaging with professional consultants would incur fees not established during this project's planning phase. It would be unreasonable to expect either the University

or the Student to incur these fees during this dissertation, and as such, this part of the scope has been removed from the project.

3.3. DETAILED METHODOLOGY

The methodology for this project is designed to investigate BIM and its potential benefits for local government authorities through a comprehensive desktop analysis. As this project relies on a mixture of first and secondary data sources and does not involve physical experiments, the approach is primarily qualitative. This approach was chosen due to the nature and complex objectives of infrastructure management processes. These processes are difficult to quantify without well-established BIM implementation and long-term trends within the industry, which the literature review has shown to be minimal.

The following parts of this section detail the project phases, tasks, safety management and resource requirements to ensure the ultimate aim of enhancing the effectiveness, efficiency, and sustainability of infrastructure management practices within the local government industry is met.

3.3.1. Project Phases

Due to the project's complexity, it has been broken down into phases linked to the scope objectives. These phases detail the tasks required to be completed and the expected output. Table 1 below shows the project breakdown:

Table 1: Project Phases

No	Phase	Tasks	Outputs
1	Literature Review and Project Background	Undertake a comprehensive review of literature relating to infrastructure management in general and, more specifically, in the context of local government authorities. Undertake a comprehensive review of literature relating to building information modelling in general and, more specifically, in the facilities management phase.	Determine the project background and further develop the aim of the research. Determine the existing challenges of infrastructure management in general and, more specifically, within the local government industry. Develop a deep understanding of the application of Building Information modelling in general, and more specifically, in infrastructure management.
2	Development of Survey	Develop a suitable survey that addresses gaps identified in the literature review. Determine the format and distribution method of the survey.	Survey questions identified and processed into a suitable survey format. The distribution method determined.

		This survey will be distributed to local government authorities that operate and manage infrastructure.	
3	Development of Ethics application for survey	Develop and submit an ethics application using the Ethics Monitor webpage for approval from the UniSQ's Human Research Ethics Committee to distribute the survey. The application addresses the project's ethical considerations. The project supervisor will review the ethics application before the final submission.	Ethics Committee approval to distribute survey.
4	Distribution of Survey	Distribute survey to local government authorities via method detailed in the ethics application. The method of distribution is via email correspondence direct to the Local Government email addresses found at the Office of Local Government's Website	Survey distributed to at least 100 Local Government Authorities

		https://www.olg.nsw.gov.au/public/local-government-directory/	
5	Analysis of the Survey Results	Complete a qualitative analysis of the survey results.	Determine details, trends and themes among the responses. These details, trends and themes will be used to develop recommendations for BIM implementation for Local Government Authorities.
6	Develop recommendations	Develop recommendations for the adoption and implementation of BIM in the management of infrastructure for local governments.	Recommendations developed to enhance and improve the efficiency and effectiveness of infrastructure management processes used by Local Government Authorities. The recommendations are intended to detail opportunities for improvement and ways to overcome challenges identified in the literature review and the survey analysis.

7	Dissertation development	Compile all work to date and develop an undergraduate dissertation that meets the requirements specified in ENP4111 course synopsis.	An acceptable undergraduate dissertation.

3.4 SURVEY DEVELOPMENT

A survey was developed to help address the research objectives by seeking information in the following areas:

- The current state of infrastructure management within the local government industry
- Any existing challenges that an organisation faces during the operation and maintenance phase of the infrastructure
- Current familiarity or utilisation of BIM within current local government practices.

The survey was made up of 15 questions in a combination of yes/no and short written responses. It was distributed to 125 NSW Local Government Authorities via email to their corresponding Customer Service email accounts. Once received by the LGAs, the email was intended to be directed to their infrastructure management experts within the organisation, which includes Directors, Group Managers, Coordinator/Supervisor, Team Leaders, and Workers. This was to ensure there was a diverse range of perspectives captured from different levels of the organisations.

The survey received 29 submissions, 19 of which were fully complete. This equates to a 15% return rate. Only fully completed submissions were analysed in the subsequent sections. A representative sample of the survey responses can be found in Appendix A.

3.4.1. Survey Analysis

The survey consisted of a mixture of yes/no and short written response questions. The quantitative data from the yes/no questions was analysed using direct comparative analysis. The qualitative data from the short written response questions was analysed using a thematic analysis approach, where patterns and themes were identified. This type of analysis allows for a deeper data exploration into insights into human experience.

3.4.2. Survey Limitations

A major part of this research's methodology is the survey aimed at gaining industry insight. As a result, there are limitations, which are listed below:

- The survey was completely anonymous and as such, there could have been numerous responses from the same organisations.
- The survey questions are subjective in nature and, depending on the respondent's experience, may show bias toward one area over another.

3.5 RISK ASSESSMENT AND MANAGEMENT

This project is predominantly desktop-based, and the risks associated are similar to those in an office environment. A risk assessment has been undertaken and submitted through UniSQ's Safety Management software, SAFETRAK. An excerpt from the current project risk assessment is shown below in Table 2. The risk assessment highlights the key risks and control measures associated with the project. If the scope were to change during the project, the RMP would be updated to reflect the change in risks.

Table 2: Project Risk Assessment

4796	RISK DESCRIPTION	STATUS	TREND	CURRENT	RESIDUAL
	ENP4111 Research Project - Challenges and Opportunities of Building Information Modelling for Facilities Management of Local Government Authorities	Awaiting Approval		Low	Low

RISK OWNER	RISK IDENTIFIED ON	LAST REVIEWED ON	NEXT SCHEDULED REVIEW
Jesse Wisselo	23/05/2024	23/05/2024	23/05/2025

RISK FACTOR(S)	EXISTING CONTROL(S)	CURRENT	PROPOSED CONTROL(S)	TREATMENT OWNER	DUE DATE	RESIDUAL
Musculoskeletal injuries, shoulder, neck, back pain. Slips and trips. Eye strain.	Control: Take regular breaks, use ergonomic furniture, and do exercises to prevent physical strain from sitting for extended periods. Ensure a clean work environment. Follow the 20-20-20 rule (every 20 mins, look at something 20 meters away for 20 seconds), adjust monitor brightness and contrast to prevent eye strain.	Low	No Control:			Low
Fatigue and dehydration	Control: Take regular breaks. Ensure a well-balanced diet with sufficient supply of fluids.	Very Low	No Control:			Very Low
Electrical and Fire Safety	Control: Ensure electrical and fire equipment is fit for purpose, in good working order, and installed correctly. Know the location of fire-fighting devices and practise emergency evacuation procedures.	Very Low	No Control:			Very Low

3.6 RESOURCE REQUIREMENTS

This research project was conducted via a desktop-based analysis and does not require physical experiments. The research component will predominately rely on the hours provided by the student. Additional resources that were required to complete the project are:

- A reliable computer with a stable internet connection.
- Access to the Microsoft Software suite for word processing and presentation development. UniSQ provides this software package.
- Project supervision in the form of a Project Supervisor. The role of the Project Supervisor is to review and provide feedback on project development. UniSQ provides the Project Supervisor
- Ethics application and approval support. This is provided by the Project Supervisor
- Access to UniSQ's Survey Tool for Survey development.
- Time provided by local government employees when completing the survey.

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CHAPTER 4 RESULTS AND DISCUSSIONS

4.1 SURVEY FINDINGS

4.1.1 Positions in Infrastructure Management

The survey was aimed at local government infrastructure management experts currently working with or managing infrastructure assets, and it was expected to be distributed to the

appropriate positions throughout the organisation. Analysing the results from questions one and two showed a broad representation of infrastructure management roles completed the survey. This result ensures that the trends and common themes identified in the following sub-sections are the views from various organisational levels. Furthermore, the survey was aimed at professional staff, and this has been demonstrated by the low numbers of 'Workers' and 'Other' positions. Figure 3 shows the results from question two.

Figure 3: Position held by survey respondent.

4.1.2 Current Processes and Practices

Question three was designed to determine the current processes and practices employed for the operation and maintenance of infrastructure assets. After analysing the responses, it is clear that each organisation has differing maturity levels. Some responses stated that their processes and practices for infrastructure management were well-defined and documented, while others acknowledged their systems are underdeveloped and in need of significant improvement. One respondent goes on to say "*Council's processes are quite mature. We*

have well documented Policies, Procedures and Systems". Another respondent states their processes are "*Juvenile*". These varying maturity levels may be related to the scale and size of the Councils, as larger Councils may face fewer financial constraints. However, this cannot be confirmed from the survey results alone.

There was agreement that the infrastructure was managed more effectively and efficiently if tied to the regulatory environment, particularly where laws mandate specific management practices, such as Declared Dams regulated by Dam Safety NSW and governed by the Dam Safety Act 2015 and Dam Safety Regulation 2019. However, the majority of respondents agreed there would be significant benefits if processes and practices could be improved for infrastructure that was not governed by regulation. This was also the case during the literature review, where most, if not all, of the studies reviewed supported the idea that digitisation of the built environment would provide many benefits, improving the efficiency of infrastructure management.

Several responses mention their reactive approach to operation and maintenance or their operation more generally as "*how we've always done it*". While there is the recognition that the systems are evolving, transitioning from a predominately reactive approach to a more proactive approach, they are still addressing issues as they arise rather than being planned for preventative maintenance. One respondent states "*The teams are beginning to become more proactive and show initiative in the way we complete out our tasks however we currently don't have the processes or technology in place to be able to deliver these to the highest potential*". Other reasons identified in the survey for the lack of proactive maintenance were limited resources, staffing limitations, and suboptimal technology-based systems.

Another recurring theme amongst the responses is the lack of a central or integrated system. The responses have suggested that they use different systems for different types of assets, leading to fragmentation in the infrastructure management practices. One response mentioned "*Council does not have a unified approach to operation and maintenance of infrastructure assets. Various systems are used for managing different areas*". The use of tools, such as the corporate Customer Relationship Management system, MEX Maintenance Scheduler, and various internal databases, further complicates the management and coordination of infrastructure maintenance. This is further supported by the studies of Patacas et al.(2020), Deng et al. (2021), and Zhao et al. (2022), who agree that Facilities Managers are still relying on outdated technology, including paper-based documents and legacy systems despite the potential benefits of digitisation.

4.1.3 Current Challenges

The survey responses highlighted several recurring challenges organisations face in managing infrastructure assets, particularly in the O&M phase. The three most significant challenges are listed and further expanded upon below:

1. Lack of resourcing - Budget, people and time.
2. Recruiting, securing, and retaining appropriately qualified technical staff.
3. Lack of consistent management practices and systems.

The most predominant challenge identified was resource limitations. A key issue noted was the absence of whole-of-life planning during the D&C phase of infrastructure projects. This lack of long-term planning and outdated or inadequate infrastructure management systems compounds the challenges faced during the O&M phase. The challenge in the O&M phase is that securing necessary budgets and funding becomes difficult without accurate data to

manage infrastructure assets efficiently. This data gap limits the resources available for workforce support and extends the time needed to address maintenance and operational issues effectively. Additionally, staffing shortages lead to an increase in reactive maintenance rather than preventative strategies. This further exacerbates the resource strain, as LGAs often spend more money on reactive work. Reports from Salzano et al. (2023) confirm that straining current maintenance practices increases reactive maintenance. It also found that reactive maintenance is an inefficient method of operation.

Another key challenge is the ability of the LGAs to recruit, secure and retain appropriately qualified technical staff with the knowledge and experience to develop and maintain new technologies. One respondent reported their biggest challenge is "*Securing appropriate resourcing to recruit technical staff with the knowledge and experience to develop and maintain technical software*". There was general consensus on this point, as the majority of responses supported this idea. Furthermore, the shortage of skilled professionals is more pronounced in the regional Councils as they are believed to be a stepping stone for people to become more experienced in higher positions before moving back to coastal areas. This disruption in staffing continuity during the O&M phase compromises the efficiency and effectiveness of infrastructure management systems, as critical knowledge transfer is often lost. Several responses mentioned that they still rely on paper-based records or outdated software for asset tracking, a challenge also identified in the literature review. This disconnect makes it difficult for new staff to access necessary historical data and understand the current state of assets. Without the necessary professional and technical staff to help bridge the gap between the legacy system and modern technologies, the LGAs will face difficulties adapting to evolving technologies.

4.1.4 Awareness of BIM

A part of the survey was designed to capture the respondents' awareness of BIM. It asked whether an individual is familiar with BIM and whether the individual knows if the organisation is currently utilising BIM for infrastructure management purposes. The results revealed that 58% of all respondents are familiar with BIM and its application within infrastructure management. However, many responses indicate that BIM is not currently integrated into their respective infrastructure management practices. There is a general consensus that BIM and BIM methodologies are not used within their organisation. Several responses note that financial constraints prevent the adoption or expansion of BIM technologies. One response expressed "*It is not integrated at all. We would love to move into this space, but budget constraints mean we do not have the resources to apply to this*". Furthermore, the survey identified a general awareness of BIM, but this did not translate into actual implementation.

Another question was aimed at determining the experience and awareness of BIM among the teams of the respondents. The results showed that 95% of respondents believe that only 0 - 25% of their team possess experience of or are aware of BIM. This lack of awareness among the respondents is supported by the results of the survey conducted by Durdyev et al. (2022), which found that only 7% of 180 active industry professionals were using BIM during the O&M phase of infrastructure.

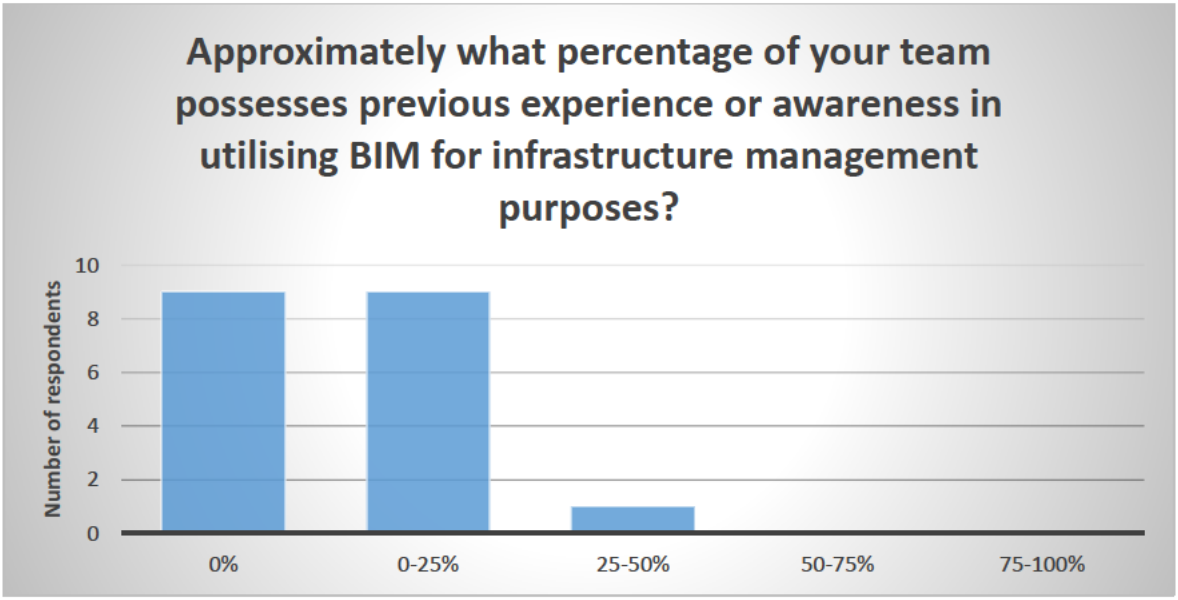

Figure 4: Team experience and awareness of BIM

4.1.5 Advantages and Disadvantages of BIM

The respondents were asked to evaluate the potential advantages or disadvantages of adopting BIM for their organisation's infrastructure management systems. The responses were largely positive, and the consensus is that adopting BIM would offer numerous benefits. The benefits highlighted within the responses include:

- Better planning, decision-making ability and resource utilisation.
- Improved auditing for infrastructure assets and higher confidence in financial statements.
- The ability to hold all information in a central system, improving transparency and accountability in asset management processes.
- Improved lifecycle management, leading to reduced renewal and maintenance costs.

While there was general agreement that BIM would provide significant benefits, there were concerns about potential challenges, including the need for good initial data and a skilled workforce to manage the system's upkeep. If the initial data entry is poor, the system may not function as intended.

4.1.6 Main Barriers to BIM Integration

Numerous barriers to BIM integration were identified in the analysis of responses. The four main barriers are listed below:

- Resource Limitations
- Resistance to Change
- Knowledge and Understanding
- Cost of Implementation

Many responses highlighted that financial and staffing constraints are critical barriers to BIM adoption. One respondent identified their main barriers as being "*Cost, knowledge and awareness*", whilst another response was "*Cost and upkeep*". The majority of responses expressed concerns the financial burden of implementing BIM, such as the initial setup costs and ongoing maintenance expenses, outweigh the perceived benefits. They also noted that their current systems are already under-resourced, and adding BIM would further strain their budgets and staff. Additionally, due to the large upfront costs associated with developing and implementing BIM, the study of Durdyev et al. (2022) revealed that BIM is usually only carried through to the O&M phase when it is applied in the D&C phase further supporting the respondent's concerns.

The responses also acknowledged that there will be resistance to change when adopting BIM. This barrier stems from the difficulties of integrating BIM with existing systems, as

many LGAs are already operating many systems, which makes the integration of new technologies challenging.

Another major barrier was a lack of knowledge and understanding of BIM's capabilities. Many respondents admitted that their familiarity with BIM is limited, which contributes to their reluctance to adopt new technology. Durdyev et al. (2022) found that this lack of familiarity and experience is largely due to the high cost of training within the industry. However, Durdyev et al. (2022) also suggested that widespread adoption of BIM could lead to an increase in training providers, ultimately driving down the cost of implementation. This suggests that the current reluctance to adopt BIM may be more of a temporary barrier, rather than a permanent limitation. As training becomes more accessible and affordable, it is likely that more councils will be able to invest in BIM technologies.

4.2 SUMMARY OF SURVEY RESPONSES

The survey responses provided valuable data that supported the findings of the literature review. It also provided significant insights into the current processes, practices and challenges LGAs face in the O&M phase of infrastructure management.

The analysis found that most LGAs operate under a reactive approach during the O&M phase, mainly due to resource limitations. The literature review deemed this approach to be both inefficient and costly in the long term, and the LGAs should focus on preventative maintenance strategies.

Additionally, the survey revealed a lack of awareness of BIM and its potential benefits. 58% of respondents were aware of BIM, but only a small fraction of LGAs had implemented it. The main barriers to BIM adoption identified were resource limitations, lack of awareness, and technical knowledge. Despite these challenges, the consensus among the responses

acknowledges that BIM has the potential to significantly improve infrastructure management practices.

Overall, the survey demonstrated the need for improvement of infrastructure management within the local government industry, particularly in terms of adopting a more proactive approach to operations and maintenance and utilising technologies like BIM to improve efficiency and reduce long-term costs.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The conclusion of this research project is that the demand for infrastructure is significantly increasing, which shows the need to manage infrastructure efficiently. While LGAs face immense pressure to effectively allocate the appropriate resources in a constrained financial climate, improving infrastructure management processes and systems is crucial for maintaining the community's service standards. Utilising new technologies to streamline and improve the capabilities of the LGAs must be considered to reduce costs and improve long-term financial outcomes.

The aim of this research was to evaluate the current state of infrastructure management within LGAs, identify key challenges faced during the O&M phase and assess the potential opportunities and challenges associated with new technologies, specifically BIM. The industry engagement survey results provided valuable insight into these areas and a solid foundation for future improvements.

Various challenges exist within the industry, including resource constraints, outdated systems, and knowledge loss during high staff turnover. While general awareness and experience of new technologies are limited, the respondents agree that new emerging technologies can improve how infrastructure is managed.

This research has also highlighted the critical need for LGAs to improve their infrastructure management practices. BIM could be a tool used to improve efficiency and help LGAs better manage their infrastructure assets and achieve long-term sustainability by addressing the identified challenges.

5.2 RECOMMENDATIONS

Four recommendations are provided based on the literature review and industry engagement survey findings. These recommendations will help LGAs to address the challenges and offer opportunities to improve their infrastructure management processes.

5.2.1 Recommendation 1 - Improve Resources, Long Term Planning, and Increase Infrastructure Funding

Resource constraints were a significant challenge identified by the survey respondents and within the literature review, leading to reactive maintenance and general inefficiencies. By improving long-term asset planning and securing additional funding, LGAs can mitigate these challenges, moving toward a more proactive approach to operations and improving infrastructure management processes.

LGAs should prioritise long-term asset planning during the D&C phase, ensuring the whole-of-life asset management is captured and effectively transferred to the O&M phase. Additionally, LGAs should actively seek and apply for funding grants from both the state and federal government to address the identified resource shortages, ensuring sufficient financial support for proactive maintenance, technology upgrades, and development of a skilled workforce.

5.2.2 Recommendation 2 - Adoption of a Centralised System and Digitisation of Outdated Processes

The results of this research indicated that many LGAs rely on fragmented, inaccurate, or missing information during the O&M phase of infrastructure management due to the lack of a centralised system and outdated technology. This issue limits efficiency and becomes more

expensive as the asset ages. By moving toward a centralised system, such as BIM, LGAs can streamline operations, improve data management and handover, and enhance decision making, improving the overall management of infrastructure and reduce maintenance costs.

LGAs could engage with industry experts and investigate and explore the implementation of BIM for infrastructure and asset management.

5.2.3 Recommendation 3 - Gradual Implementation of BIM

Many respondents acknowledge the potential benefits of BIM but expressed concerns about the cost and complexity of full implementation throughout their networks.

LGAs could consider a phased approach to BIM implementation, starting with a pilot project to thoroughly assess its benefits and challenges before widespread adoption. Factors such as infrastructure class, new or existing infrastructure, and service provided will all impact the benefits.

Furthermore, LGAs could use the data obtained from the pilot project to build upon a business case and present it to key management staff. This would ensure sufficient buy-in prior to widespread adoption.

5.2.4 Recommendation 4 - Improve Awareness of BIM and Training of Staff

Throughout the survey responses, awareness of BIM was limited, and LGAs find it challenging to attract and retain appropriately qualified staff. Offering specific BIM training and improving career development opportunities may help reduce staff turnover, especially in regional areas, and ensure continuity of knowledge and management of infrastructure systems.

LGAs could engage with industry experts to implement training programs for BIM and its benefits. Additionally, LGAs could offer competitive incentives to attract and retain skilled professionals with expertise in modern infrastructure management technologies such as BIM.

5.3 FUTURE RESEARCH

Following on from this project, there are many paths for future research. Suggestions are listed below:

1. Investigate and complete a detailed review of Australian LGAs to determine if any have implemented BIM for their infrastructure management and what benefits or challenges exist.
2. Collaborate with industry experts to implement a pilot program at an LGA, focussing on a smaller infrastructure asset to determine real-world benefits and challenges. A partnership of this scale could see benefits introduced for both parties. Additionally, State and Federal governments may offer funding grants for innovation within an LGA. This grant would ease the financial burden on the LGA.
3. Improve the response rate for the survey to get a more detailed view of the current state of infrastructure management. This could be done by targeting infrastructure managers in all Australian states, not just New South Wales.

REFERENCES

Australia, IP 2023, Australian Infrastructure Budget Monitor 2023-24, Infrastructure Partnerships Australia.

Daulat, S, Rokstad, MM, Klein-Paste, A, Langeveld, J & Tscheikner-Gratl, F 2024, *'Challenges of integrated multi-infrastructure asset management: a review of pavement, sewer, and water distribution networks'*, Structure and Infrastructure Engineering, vol. 20, no. 4, pp. 546-65.

Deloitte 2023, The State of Digital Adoption in Construction Report, Deloitte Access Economics, Autodesk

Deng, M, Menassa, CC & Kamat, VR 2021, *'From BIM to digital twins: a systematic review of the evolution of intelligent building representations in the AEC-FM industry'*, Journal of Information Technology in Construction, vol. 26, pp. 58-83.

Durdyev, S, Ashour, M, Connelly, S & Mahdiyar, A 2022, *'Barriers to the implementation of Building Information Modelling (BIM) for facility management'*, Journal of Building Engineering, vol. 46, p. 103736.

Fazeli, A, Dashti, MS, Jalaei, F & Khanzadi, M 2021, *'An integrated BIM-based approach for cost estimation in construction projects'*, Engineering, Construction and Architectural Management, vol. 28, no. 9, pp. 2828-54.

Fearon, R & Cosgrove, R 2019, Infrastructure Cliff? Queensland's Ageing Water and Sewerage Assets. 2. Const implications for in-ground assets., Local Government Association of Queensland.

Government, A 2021, A National Study of Infrastructure Risk, I Australia.

Government, A 2023a, Local Government National Report 2020-21, T Department of Infrastructure, Regional Development, Communications and the Arts.

Government, A 2023b, Infrastructure Market Capacity 2022 Report, I Australia.

Mannino, A, Dejaco, MC & Re Cecconi, F 2021, *'Building information modelling and internet of things integration for facility management—Literature review and future needs'*, Applied Sciences, vol. 11, no. 7, p. 3062.

Panah, RS & Kioumarsi, M 2021, *'Application of building information modelling (BIM) in the health monitoring and maintenance process: A systematic review'*, Sensors, vol. 21, no. 3, p. 837.

Parlikad, AK & Jafari, M 2016, *'Challenges in infrastructure asset management'*, IFAC-PapersOnLine, vol. 49, no. 28, pp. 185-90.

Patacas, J, Dawood, N & Kassem, M 2020, *'BIM for facilities management: A framework and a common data environment using open standards'*, Automation in Construction, vol. 120, p. 103366.

Perera, D, Smakhtin, V, Williams, S, North, T & Curry, A 2021, *'Ageing water storage infrastructure: An emerging global risk'*, UNU-INWEH Report Series, vol. 11, p. 25.

Salzano, A, Parisi, CM, Acampa, G & Nicolella, M 2023, *'Existing assets maintenance management: Optimizing maintenance procedures and costs through BIM tools'*, Automation in Construction, vol. 149.

Zhao, J, Feng, H, Chen, Q & Garcia de Soto, B 2022, *'Developing a conceptual framework for the application of digital twin technologies to revamp building operation and maintenance processes'*, Journal of Building Engineering, vol. 49.

APPENDIX A – REPRESENTATIVE SAMPLE OF SURVEY RESPONSES

The following appendix provides a representative sample of responses from the anonymous survey conducted as part of this research. The responses have been anonymised, and no personally identifying information is included.

1. Do you work in infrastructure management for Local Government?

   100% of respondents selected “Yes”

2. What position do you hold within your organisation?

   16% respondents selected “Team Leader”

   16% respondents selected “Coordinator/Supervisor”

   52% respondents selected “Manager”

   16% respondents selected “Director”

3. How would you describe your current processes/practices for the operation and maintenance of infrastructure assets?

   Respondent 9

   “*Our practices are aiming to be best practices across the board. From a day to day practice with staff on the ground we are managing infrastructure well but operating in a more reactive sense. The teams are beginning to become more proactive and show initiative in the way we complete works and how we carry out our tasks*

however we currently don't have processes or technology in place to be able to deliver these to the highest potential"

Respondent 12

"Council does not have a unified approach to operation and maintenance of infrastructure assets. Various systems are used for managing different areas. For example, building operation maintenance is managed by individual facility managers who issue maintenance requests to council's Maintenance Coordinator via the corporate CRM system. Water and sewer plant maintenance is managed via MEX. Transport assets are managed via Reflect and in house databases. There are no BIM systems in place"

Respondent 25

"Where required by law/regulation, these things are implemented, but rarely anything beyond that. Where it is not required (or not audited/checked), the maintenance is lacklustre and limited. Also, preventative maintenance barely exists, everything is reactive. Operation is generally 'as we've always done it', not necessarily how is best for the organisation or the asset"

4. What are the main challenges your organisation faces when managing infrastructure assets, particularly in terms of operation and maintenance?

Respondent 6

"Maintaining people in the same roles and within the organisation to get continuity of asset information system improvements. Council is located regionally and struggles to maintain its people due to being used as a 'stepping stone' (people come

here to get experience in higher roles prior to moving back to coastal areas) and competition with other industries (i.e. mining).”

Respondent 8

“For my team specifically, incorrect or incomplete data. We are at a pivot point in history where we are reliant on data, so we are really good at capturing data on newly acquired assets, but the information on existing assets is lacking or of poor reliability.”

Respondent 25

“Resource limitation (people & budget), understanding of asset management and its importance, lack of desire to change how things have always been done, confusion over who owns the asset and should therefore be responsible and fund this, and in some cases lack of understanding of the assets and what really is required.”

5. Are you familiar with Building Information Modelling (BIM) and its applications within infrastructure management?

   58% of respondents selected “Yes”

   42% of respondents selected “No”

6. Do you know if your organisation utilises BIM for infrastructure management?

   47% of respondents selected “Yes”

   53% of respondents selected “No”

7. Could you provide details on the extent to which BIM is currently integrated into your council's infrastructure management practices?

Respondent 8

"It is not being integrated at all. We would love to move into this space, but budget constraints mean we do not have resources to apply to this."

Respondent 16

"Our organization is aware of BIM, however it isn't currently integrated into Council's infrastructure management practices"

Respondent 29

"BIM is not utilised or integrated within asset management practices."

8. Please specify the particular areas or projects where BIM is utilised within your council's infrastructure management practices. Include details on its application and functionalities.

Respondent 9

"Usually on major construction projects such as Sewerage treatment plant builds, above ground structures like reservoirs or pumping stations"

Respondent 12

"There is not BIM. There is no incentive or direction for staff to record maintenance activities in a system that is accessible. Information on maintenance activates is not

readily available. The only records that are accessible via our corporate system are poorly described financial transactions."

Respondent 18

"The management and maintenance of community facilities"

9. In what ways has BIM positively or negatively impacted your operational efficiency?

Respondent 5

"Using the ADAC system reduces the time spent in data entry of contributed infrastructure assets. It also increases the detail and accuracy of data stored in relation to contributed infrastructure assets, which improves maintenance and operational outcomes, as well as strategic infrastructure planning in the long-term."

Respondent 9

"BIM where it has been available has been very beneficial for operations as staff and contractors can refer immediately to drawings that show the location of lines, structure, infrastructure and its appurtenances"

Respondent 18

"Provides greater planning and budget control"

10. Do you think there are any advantages/disadvantages in adopting BIM for your organisation's infrastructure management?

Respondent 5

"There are definite advantages, particularly in relation to auditing of Council's annual financial statements, as BIM processes provide auditors with confidence that Council is recognising its contributed infrastructure assets appropriately. To fully recognise other advantages really requires more staff that are trained and experienced in the use of systems related to infrastructure asset management."

Respondent 16

"Having not seen a BIM system before it's hard to comment. Council does have a Strategic Modelling system which captures works completed on an asset and predicts future works programs. The positives of a system like BIM would be to hold all information together so that decisions are made cohesively taking into account all elements of an asset. It would also provide greater transparency and accountability with Council's decision making. The negatives would be the upkeep of the system (they always sound good initially but poor information in will give poor information out)."

Respondent 30

"Council requires accurate and complete information at its disposal, alongside clear strategies for the purpose of infrastructure management, if it is to make good decisions relating to the lifecycle of asset management. Should it not have this information, assets will age prematurely, resulting in far greater renewal and maintenance costs."

11. How do you envision integrating BIM into your current practices?

Respondent 5

"There are other BIM products that could be of use, but my priority at my Council is on appropriately resourcing the management of our asset management and works management systems before expanding into more advanced systems like BIM. Given all Councils funding challenges across Australia, I'm not sure that resourcing will ever be provided for infrastructure systems to the extent that infrastructure professionals recommend. To some extent, Councils may always have to make the best out of sub-optimal resourcing of infrastructure systems."

Respondent 12

"Due to budget constraints, resistance to change and lack of direction I don't believe it will be possible to implement BIM at this council"

Respondent 28

"A review of opportunities for additional collaboration within the organisation. Historical data review and education. Better data management"

12. What do you perceive as the main barriers to implementing BIM in your organisation?

Respondent 5

"Appropriate resourcing. Change management is a big factor, but this in itself is a resourcing issue. I think generally across Australia, the technical understanding of systems by executive staff is lacking and as a result, systems are generally underappreciated and under-resourced. I think this may change over time as a new generation of leaders emerge."

Respondent 16

"Cost and upkeep. Council has limited resources to maintain and update data in our current system, I couldn't see that this would be any different if we moved across to a BIM system."

Respondent 29

"Cost, knowledge and awareness"

13. Approximately what percentage of your team possesses previous experience or awareness in utlilising BIM for infrastructure management purposes?

    47% of respondents selected "0%"

    47% of respondents selected "0-25%"

    6% of respondents selected "25-50%"

14. What factors do you think influence the level of exposure and experience of BIM among you team members?

    Respondent 5

    "Resourcing. My limited number of staff have their time consumed with more operational, day-to-day tasks than more strategic and technical tasks like interacting with BIM."

    Respondent 16

    "Once organisations such as IPWEA and other reputable industry sources start talking about this technology within a Local Government space, I think the level of exposure would increase."

Respondent 30

"Resourcing. For the most part, most employees are entirely utilised for tasks like disaster recovery etc. At times, it can be difficult to focus on longer-term objectives like lifecycle asset management."

15. What steps do you think could be taken to improve training and awareness for BIM regarding infrastructure management?

Respondent 8

"I think exposure at our professional conferences where we see use cases of how it is helping other organisations is the best way to increase awareness and exposure."

Respondent 9

"Engaging with suppliers of software or data collection teams to understand the implications, constraints and opportunities for this work"

Respondent 28

"Training sessions on how to utilise BIM and what tools are available."

APPENDIX B – BLANK SURVEY QUESTIONNAIRE

The following appendix provides a blank survey questionnaire that was distributed as part of this research.

Challenges and Opportunities of Building Information Modelling for Infrastructure Management of Local Government Authorities

This survey has been designed to determine the current state of Building Information Modelling implementation within the Operation and Maintenance section of Local Government. The data collected will be analysed and presented in UniSQ's student Jesse Wisselo's undergraduate dissertation.

Clicking on the ‘Submit’ button at the conclusion of this questionnaire is accepted as an indication of your consent to participate in this project.

There are 15 questions in this survey.

Questions

Do you work in infrastructure management for Local Government?

Check all that apply

Please choose **all** that apply:

- [ ] Yes
- [ ] No

What position do you hold within your organisation?

❗ Choose one of the following answers
Please choose **only one** of the following:

- ◯ Director
- ◯ Group Manager
- ◯ Manager
- ◯ Coordinator/Supervisor
- ◯ Team Leader
- ◯ Worker
- ◯ Other

How would you describe your current processes/practices for the operation and maintenance of infrastructure assets?

Please write your answer here:

What are the main challenges your organisation faces when managing infrastructure assets, particularly in terms of operation and maintenance?

Please write your answer here:

Are you familiar with Building Information Modelling (BIM) and its applications within infrastructure management?

Check all that apply

Please choose **all** that apply:

- [ ] Yes
- [ ] No

Do you know if your organisation utilises BIM for infrastructure management?

Check all that apply

Please choose **all** that apply:

- [ ] Yes
- [ ] No

Could you provide details on the extent to which BIM is currently integrated into your council's infrastructure management practices?

Please write your answer here:

Please specify the particular areas or projects where BIM is utilised within your council's infrastructure management practices. Include details on its applications and functionalities.

Please write your answer here:

In what ways has BIM positively or negatively impacted your operational efficiency?

Please write your answer here:

Do you think there are any advantages/disadvantages in adopting BIM for your organisation's infrastructure management?

Please write your answer here:

How do you envision integrating BIM into your current practices?

Please write your answer here:

What do you perceive as the main barriers to implementing BIM in your organisation?

Please write your answer here:

Approximately what percentage of your team possesses previous experience or awareness in utilising BIM for infrastructure management purposes?

Check all that apply

Please choose **all** that apply:

- [ ] 0%
- [ ] 0 - 25%
- [ ] 25 - 50%
- [ ] 50 - 75%
- [ ] 75 - 100%

What factors do you think influence the level of exposure and experience of BIM among your team members?

Please write your answer here:

What steps do you think could be taken to improve training and awareness for BIM regarding infrastructure management?

Please write your answer here:

Thank you for completing the survey.
10.10.2024 – 14:09

Submit your survey.
Thank you for completing this survey.