University of Southern Queensland

Faculty of Health, Engineering and Sciences

A mixed methods study exploring the relationship between approaches to BIM training and factors affecting BIM transformation.

A dissertation submitted by

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In fulfilment of the requirements of

ENG4111 and ENG4112 Research Project

towards the degree of

Bachelor of Engineering [Honours] [Civil]

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Abstract:

Purpose:

The widespread adoption of Building Information Modelling is advocated across the AEC industries due to its many designs, constructional, organisational, managerial, and financial benefits. Despite the emphasis on ambitions for industry-wide BIM adoption, the pace of implementation this has not met expectations. There have been several barriers to BIM adaption and implementation identified in the literature. One of these factors is the provision of appropriate training. This project is concerned with exploring the nature of BIM training and the potential impacts on professionals' attitudes toward and implementation of BIM in the AEC industries.

Methodology

This study used a mixed method approach for the purposes of triangulating data from both quantitative and qualitative research methods. Quantitative data was collected from thirty- eight respondents via an online survey. Statistical Product and Service Solution [SPSS] was used to analyse the data.

A focus group was facilitated with six BIM experienced professionals. The purpose of the focus group was to expand on the quantitative findings by obtaining qualitatively richer more in-depth data into the attitudes, training, and the nature of BIM use of research participants. Focus group data was analysed using Thematic Analysis.

Results

Descriptive and demographic data for the 38 survey respondents are reported. The majority of respondents had five or more years work experience with an engineering background. In general, respondents indicated favourable attitudes toward BIM training and BIM use. They identified the initial time and financial costs, together with disruption to business output and negative perceptions of BIM in AEC industry as some of the challenges to BIM transformation.

Ten hypotheses were generated for statistical analysis. Four hypotheses were unable to be statistically analysed due to too few responses per category and missing values. There was no statistically significant relationship found between years of work experience and self-rating of BIM expertise and between years of work experience and confidence using BIM. There was also no statistically significant relationship found between level of self-rated BIM expertise and confidence in BIM skills. Confidence using BIM skills was strongly related to frequency of BIM use and likelihood of recommending BIM as an information workflow. There was a moderately strong relationship between

frequency of BIM use and the likelihood of recommending BIM as an information workflow.

Three themes emerged from the qualitative analysis ‘The Road to BIM’, ‘Misconceptions of BIM and ‘Skilling Versus Specific Course’. Both the quantitative and qualitative findings highlighted significant variance in BIM training, BIM understanding and BIM usage all of which are underpinned by misconceptions of BIM. Organisational factors re affecting successful BIM transformation are also identified and discussed.

Implications:

The findings of the present study point to the importance of in-house mentoring BIM training programmes as a means of addressing the variance which permeates attitudes toward BIM, BIM training and use in the AEC industry. This research distinguishes between attending a BIM training course and being skilled in BIM. Participants emphasised the importance of organisations facilitating ‘BIM skilling’ for employees. This skilling needs to incorporate bottom-up and top-down BIM training for all relevant stakeholders with a view to counteracting some of the misconceptions of BIM that exist in AEC industry. It is also recommended that each organisation facilitate access to a repository of quality BIM training resources for staff. This research study adds to the body of work which identifies the multi-factorial cultural (people)02, training, and organisational factors which can support of hinder BIM transformation.

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Glossary

ADAM	-	Automated Drafting And Machining
AEC	-	Architectural, Engineering and Construction
BIM	-	Building Information Modelling
CAD	-	Computer Aided Design
CADWorx	-	3D Piping Software
CAM	-	Computer Aided Manufacturing
CPD	-	Continuing Professional Development
CPM	-	Construction Project Management
LOD	-	Level of Development
OOCAD		Object - oriented CAD
PDF	-	Portable Document format
Revit	-	3D Building information Modelling Software
RFI	-	Request for Information
SPSS	-	Statistical Package for the Social Sciences
TEKLA	-	Abbreviation of the Finnish words Teknillinen laskenta, or technical computation
UK	-	United Kingdom
2D	-	A flat figure or shape that has two dimensions.
3D	-	A figure, object or shape that has three dimensions.

Chapter 1 Introduction and Relevance

The evolving digital transformation in the global architectural, engineering, and construction industry has been a driving factor for firms and practitioners to adopt Building Information Modelling (BIM_Acceleration_Committee ; Leśniak et al. 2021; Shojaei et al. 2022). BIM creates detailed digital representations from multi-disciplinary data inputs, managed in real time in an open cloud platform (Autodesk). BIM is viewed as an environmentally sustainable approach to better information sharing, better decision -making, and cost savings; with even some asserting that "BIM is the future" (Routledge 2021)

Despite the seemingly clear reasons for BIM adoption, this has not directly translated into its widespread use. Previous research has identified a number of contributing factors to hesitancy in industry professionals and companies in using BIM as an informational management took (van Neuren 2020).While, the barriers to BIM implementation can differ from one country to another based on differing domestic contexts (Sriyolja et al. 2021), there have been some universal challenges to BIM implementation identified in the literature including: awareness, demand, industry culture, cost, project scale, technology laws and standards, processes, management, interoperability, technology, and skills, (Abdulfattah et al. 2017; van Neuren 2020; Sriyolja et al. 2021). In terms of the latter, the existence of a skilled workforce has a direct impact on the adoption BIM (Ghaffarianhoseini et al. 2017). Consequently, training has been identified as a pivotal element in the successful uptake and implementation of BIM, not only as a modelling tool but in its wider intended use as an information flow management tool (Autodesk 2008; Pena 2011).

There appears to be inconsistency in what constitutes as BIM training in AEC industries, this varies from short CPD courses, to BIM training integrated into formal bachelors and masters' programmes, to PhD research, to formalised inhouse training and 'learning on the job' (Pena 2011). The thesis behind this proposal came from my own professional experience as a qualified BIM trainer in the AEC industries, that is; in addition to learning BIM and introduction to programmes such as Revit, professionals need to be afforded the time and support to integrate their learning into their everyday professional practice. This learning consolidation process needs to be acknowledged and supported by industry with clear formal support pathways identified within companies via which this can be facilitated. (Shojaei et al. 2022)

This research proposes to build on previous research conducted by (van Neuren 2020) that examined the relationship between the use of BIM software as an information management tool and the users' own perceptions of BIM. Specifically, this project proposes to examine the relationships between the length and quality of participants BIM training/experience, their length of time working in the industry, perceptions and attitudes toward BIM and the manner in which they utilise it in their work.

Chapter 2 Literature Review:

2.1 Introduction

The implementation of BIM in an organisation has been referred to as organisational BIM transformation (Olugboyega 2022). Any exploration of the factors affecting BIM transformation and its relationship to training benefits from an understanding of the context from which the software platform first emerged. Specifically, the metamorphosis of design from an isolated process in the chain of construction to what we presently have at our fingertips, the additional capacity to manage information flow from multiple sources in real time. Drafting design in its earliest incarnation can be traced to Ivan Sutherland's invention of the Sketchpad [1963] which is universally considered the first form of CAD. In 1971, Automated Drafting And Machining [ADAM] was introduced by Dr. Patrick Hanratty, an American computer scientist and businessman who is universally acknowledged as the "father of CADCAM". Testament to his impact on the industry, it has been estimated that "70 percent of all 3-D mechanical CAD/CAM systems available today can trace their origins back to Hanratty's original code" (UCI 2012). Initially, there was slow adoption of CAD as most design continued to be done by hand (Abdulfattah et al.). 1982, saw the introduction of ArchiCAD, the first software to create 3D models and store complete data of all the building processes. This dual functionality is the reason it is viewed as the first prototype of Building Information Modelling (BIM_Acceleration_Committee). The 1980s saw the widespread replacement of drafting stations with CAD workstations and the introduction of the well-known 2D 'AutoCAD'. The original focus of CAD applications was to represent 2D geometry via graphical elements such as lines and arcs. Object -oriented CAD structure [OOCAD] replaced the two-dimensional symbols with "objects" or building elements, with ability of representing the behaviour of the building elements.

Abdulfattah et al (2017) forward that due to the uncertainty inherent in construction, designers are required to build their projects virtually prior to the commencement of the actual building works. They contend that it is within this ambiguous context that BIM technology, which represents a virtual approach to design and construction emerged. Another seismic shift in the evolution of BIM technologies occurred with the development of Revit software (2000), a single database for the lifecycle of the building project in its entirety, this latest development is considered revolutionary in BIM progression (Quirk 2012). The 'revolutionary' impact of BIM is attributable to its capacity to create a platform that utilizes a visual programming to create parametric families while allowing for a 'fourth dimension' of time to be associated with the building model. In practice, this means that construction schedules can be based on the BIM models and simulate the construction process in real time (Quirk 2012). So, it is clear, that the transition from conventional paper drafting to BIM was not a short-term period; it extended over a few decades and featured mammoth changes.

2.2 Benefits of BIM

The literature has broadly subdivided the many benefits of BIM into four main categories: (i) organisational, (ii) design-related, (iii) managerial, and (iv) construction-related benefits. BIM can facilitate the process for accessing information, improve clash or conflict detection and facilitate the coordination process between the various agents involved in a project. Regarding design-related benefits, BIM improves the visualizations including comprehensive details of all building elements resulting in fewer errors, the capacity to detect errors earlier in design which means changes can be made incurring minimal costs. In terms of the managerial benefits, BIM reduces errors, request for information (RFIs) and change orders. The fourth category refers to the benefits of BIM during the construction stage namely: improved project planning and monitoring, reduced need for construction reworking, easier quantity take-off process and reduced instances of construction rework, (Wang & Leite 2014; Abdulfattah et al. 2017; van Neuren 2020),. One study looking at the use of BIM in the construction of a twenty-story building in Indonesia found that the implementation of BIM concepts can accelerate project planning time by around ±50%, decrease the need for human resources by 26.66 %, and save personnel costs by 52.25% when compared to conventional methods (Sriyolja et al. 2021). So, given it has been clearly demonstrated that the use of 'revolutionary' BIM technologies in the design, construction, and project operation stages of construction maximises the quality, productivity and speed of building while simultaneously reducing costs, then the question needs to be asked: "*what factors have affected the relatively slow industry implementation of BIM, as the next generation in design evolution?*" (Abdulfattah et al 2017,p. 1112)

Each of these stages in the evolution of design technologies required a concomitant shift in how professionals understand and adapt to the new emerging technology. This is because technology and the use of technology cannot be separated from the people that use it (Sriyolja et al. 2021). Previous studies have identified numerous barriers including human resource related factors that prevent organisations in implementing BIM, such as poor motivation to change BIM practices, insufficient technological infrastructure and support, interoperability challenges regarding software, limited data exchange and increased cost at initial point of implementation (Pena 2011; Chien et al. 2014; Siebelink et al. 2021). It has been forwarded that many of the recognised barriers to BIM implementation could be addressed by the provision of appropriate training (Pena 2011)

2.3 Misconceptions of BIM

(Ibrahim 2006) forwards that while both industry and academia in the design domain see the benefits, feasibility, and importance of adopting BIM technology, there exists significant misconceptions on the ground as to what this actually involves and how this can be done effectively. She cites erroneous beliefs about 'the reality of BIM' and the lack of understanding the full potential of the applications as commonplace. Specifically, she references the novelty of the technology and the dilemma of teaching one application versus teaching the wider technology and constructs behind it as crucial factors. She highlights the need to follow a different path than the approach taken to teach traditional CAD with a shift in focus

toward core concepts rather than the application interface and functionalities.

Ibrahim's (2006) paper contains a collection of observations that she has formed from her wide-ranging experience teaching in architectural schools and working as a CAD manager in industry. She accompanies her observations with an associated set of proposed strategies that could potential address some of the barriers to effective BIM teaching and adoption. Firstly, BIM is not just another incarnation of CAD; rather it involves the move away from presenting information about the building to the representation of this information. BIM is a mindset it shapes how people think about and approach modelling, and information flow as opposed to just a programme to run on a computer. II) BIM solutions have failed to empower their users with an intuitive interface that would celebrate the capabilities rather than the functionalities. This has led to a misconception for many that BIM solutions are for example, only useful for standard repetitive buildings. III) The three-dimensional nature of BIM application is being confused with three-dimensional modelling in CAD packages thereby ignoring the functional capabilities of the programme. Interestingly, Ibrahim (2006) builds on this by asserting that in general, there exists a lack of understanding the full potentials of even the most widely used applications, including AutoCAD, adding that you find very few people who can customize AutoCAD, write macros, or create applications. "*The same applies to BIM based applications which are even harder to manipulate*" (p. 5).

2.4 The "Rush" versus "wait" debate (Ibrahim and Krawczyk, 2003)

Ibrahim and Krawczyk (2003), identified six concerns that would affect the teaching and professional implementation of BIM based CAD systems: the master apprentice relationship, the customisation issues, the object creation inside the system, the impact on innovation and creativity, the dependability on the software industry and the change in the education. While, in this case the latter is referencing architectural education, closer examination of these concerns reveals that they are equally applicable to BIM training and adoption by the wider AEC industry.

There also exists an argument from some quarters that the more knowledge implemented into a system the more dependable the user becomes on that system (Ibrahim 2006). This can have differential impacts. For a skilled professional who is familiar with the underlying concepts, codes, assemblies, and specifications, adopting BIM application would likely result in productivity boast. However, the same application used by a student or less experienced professional may leave them in a vastly different position. This 'rush to adopt or wait debate' (Ibrahim and Krawczyk, 2003) permeates the literature with some advocating for the immediate integration of BIM into formal training and education Ibrahim (2006) refers to this as an "*idealistic point of view*" (p. 657) citing the failure to acknowledge the cumulative nature of learning as the reason i.e. BIM is more than just learning a package it is the mindset or shift in thinking that is often acquired through experience that is fundamental to the learning. Other authors have called for the slower adoption of BIM to ensure the appropriate introduction to and utilisation of BIM (Cheng 2006), with commentary on this latter

point highlighting the fact that slowing down the introduction of BIM in education to offset poor understanding and implementation fundamentally ignores the rapid uptake of BIM in industry. Despite the controversy in the literature, it is very clear that the manner in which BIM is taught is crucial for its successful uptake and implementation in across both AEC academic and industry arenas.

Sriyolja, Harwin and Yahya (2021) in a recent systematic review specifically explored barriers to implementing BIM in the construction industry. Their review of 26 journal articles and papers (2013-2019) identified 15 categories of barriers; cost, law, experts, interoperability, awareness, culture, processes, management, demand, project scale, technology, skills, training, contract, and standard .A full review of all 15 factors is beyond the scope of this paper, instead the top four factors will be explored in greater details: cost, law, demand and culture.

Cost emerged as the primary barrier to BIM implementation (frequency of 21). There are initial set up costs such as; software, staff training and the engagement of BIM experts. In their review, Sriyolja et al (2021), found that BIM did not offer guaranteed financial benefits to support its use as the benefits of implementing BIM did not exceed the implementation costs. 2) Law, they found no internationally uniform laws mandating the use of BIM and no legal certainty in work contracts. This is particularly important given the commonality of international projects in the AEC industries. The authors found that the countries that had no regulations for BIM usage also had no laws regulating their national BIM standards. 3) Demand, the construction market was just simply not ready to use BIM. This was attributed to the uncertainty surrounding the potential benefits of BIM particularly in the planning stage and the inability to reduce drafting times when compared to more traditional drafting approaches. 4) Culture, this encompasses resistance to change, on closer examination, this can be further broken down into the reluctance to start new workflows and/or to train staff. What the authors term social resistance was present across organisational, managerial and worker perspectives. While the former are discussed previously, resistance from on the ground workers seemed to stem from perceptions of BIM as too complex and too hard to source. People use what they know. Put simply, constructors question the benefits of using BIM and refused changes in favour of tried and tested drafting programmes and felt that the benefits of BIM were not real and cannot be realised directly.

Cultural (people) factors are proven barriers to IT change and implementation in the AEC industry. Davis and Songer (2002) analysed data from 156 AEC professionals investigating relationships between differing demographic groups and their resistance to IT change. They identified that factors such as profession, gender, general IT understanding and experience, and familiarity with past and future changes within the organisation that the person worked in, affected resistance to IT change. Age and education were shown to have no impact on resistance to change, an interesting finding given the stereotypes regarding older professionals and resistance to IT change that exist in the industry. It appears that experience and skill is more discerning that chronological age in predicting resistance (Davis & Songer 2002).

So, there are significant hurdles for BIM transformation including cultural factors, business disruption and the need to balance BIM transformation in the context of existing legacy business and maintaining profitability. Consequently, business must adapt their current operations to the BIM paradigm by developing new organisational capabilities Olugboyega (2022). Farouk et al (2023) strongly assert that "*every person involved in a BIM-based construction project must improve their attitudes, awareness, ability, and knowledge levels*" (p.18). It is clear that any change in attitudes towards BIM adoption and implementation will require seismic cultural changes across all levels of academia and industry: from the 'top-down' and 'the bottom-up' (Martinez 1999). It is therefore essential that any approach to BIM training in the broadest use of the term, integrates the findings from the research literature to ensure that these clearer identified barriers to BIM adoption and implementation are systematically addressed.

2.5 BIM Training

Continuing professional development is vital in the construction and related industries due to the continuous and rapid changes in regulations, procurement practices and the ever -increasing specialisation in technologies. It is the latter, technologies that this research proposal is concerned with. The capabilities required to execute a BIM project are multi-faceted, requiring the development of BIM competencies on the level of the individual professional and on a broader company level (Succar & Sher 2013). Training in IT technologies has been linked to diminished anxiety and uncertainty with a concomitant increase in user awareness, acceptance, and commitment to use(Marler et al. 2006). It follows that a workforce with the relevant expertise influences successful BIM adoption (Ghaffarianhoseini et al. 2017). The converse also holds true that the lack of key expertise and skilled personnel are critical barriers to the uptake of BIM and his outlined benefits (Gledson et al. 2012; Oraee et al. 2019; Shojaei et al. 2022).

While there seems to be a general consensus that training in BIM is a priority in the construction industry, and that 'proper training is critical' to increase productivity gain, there is no consensus or standard on what actually constitutes 'BIM training' (Pena 2011).BIM competencies in Construction Project Management (CPM) range from the ability to create, manipulate, navigate and review a 3D model, to understand BIM based construction programming methods and to implement a BIM information flow management environment (BIM Acceleration Committee, 2014). Yet, the training landscape for BIM is hugely variable from short courses to master's degree and PhD level. Training necessitates the opportunity to practice and integrate what is learned in the everyday working environment These requirements involve slower initial output and increased financial and time costs, both factors identified as negatively impacting motivation to adopt BIM practices (Pena, 2011; Van Neuren 2020)

Much of the existing literature on BIM training in the construction industry tends to focus on formal education and specialised, institution-based courses (Shojaei et al 2022). Whilst certain aspects of BIM training needs e.g. technical and software-related competencies can be realised via formal training, practical

competencies are often gained through internal, firm-based training or on projects (Harris & Alves, 2020). An argument has been forwarded that that BIM training in educational institutions lacks the component of collaborative interdisciplinary engagement, which is central to its practical application 'in the real world', thereby highlighting the relevance of firm-based BIM training if BIM adoption is to be improved (Herrera et al. 2021; Shojaei et al. 2022)

Shojaei et al 2022 research involved case studies of two leading UK construction companies in addition to seven qualitative interviews with industry professionals operating at a managerial level with experience in delivering BIM training. The purpose of this research was to develop deeper understanding of what approach companies need to adopt to provide the requisite skills and training for their workforce and professional partners to successfully support and sustain the implementation of BIM. The findings demonstrate that successful implementers employed an "in-house" training strategy at intra-organisational level and a "growing together" approach for their project partners. The latter refers to the larger companies treating suppliers like employees, upskilling those suppliers with which they have an established working relationship to support their understanding and use of BIM. This stemmed from the fact that, the companies in question had discovered that few of the sub-contractors were able to meet the requirements of the lead contractor with regard to digital competencies.

The qualitative data generated by this research Shojaei et al. 2022 also provides valuable insights into what is and is not comprehensive BIM training

> "*going to external training is helpful, but also, it depends on how intensive [the courses] are. I don't think that people without any knowledge can be learning a lot from these courses because I suppose that mentally we are not ready to learn the whole discipline in three days. The internal trainer provides higher, more extended, and consistent support*" (p.11).

So, while there is a clear need for formal approaches to training, learning is best supported by access to continued support and the opportunity to integrate learning into everyday practice beyond the confines of stand-alone training. Moreover, the provision of additional inhouse supported BIM training addressed the challenges of heterogeneity in digital literacy and competencies together with the development of soft skills, and greater understanding into the benefits of using BIM (Shojaei et al 2022). The insights from this research study positively contribute to the growing literature on BIM training, complementing the existing literature that has a tendency to focus mainly on BIM training through course-based education.

2.6 Differential Learning Approaches in BIM Education

Whilst traditional didactic based learning approaches synonymous with abstract, passive, and lecture -based delivery continue to be the mainstay in engineering education, there exists a growing body of research

challenging its predominance and utility (Felder and Silverman,200; (Tsai 2019). A number of different approaches including active, interactive, and constructive learning have emerged in part from the critiques of passive learning (Tsai 2019) Active learning refers to a form of instruction that involves an element of physical activity. At the simplest level, this can involve underlining material, taking notes, or summarising information. Constructive learning approaches result in learner output beyond the presented material itself e.g., case comparisons or concept maps. Finally, Interactive learning activities are typically constructive in nature but also involve more than one participant e.g., group work. These emerging educational approaches have gained traction in the training of engineers with the move from teaching-oriented to more diverse and arguably more efficient learning-oriented styles (Tsai 2019). The evidence shows that more active learning approaches facilitates the longer- term information retention, enhanced motivation, and problem-solving abilities (Magana et al. 2015). Whilst certain aspects of BIM training needs e.g., technical, and software-related competencies can be realised via formal training, 'real world learning' can only be gained through internal, firm-based training or on projects (Harris & Alves 2020). Real world learning is inherently collaborative necessitating the need to liaise and negotiate with multiple stakeholders. Therefore, real world/industry-based learning meets many of the pre-requisites of "active, instructive and constructive learning" in a move away from more passive class-based instruction. Olugboyega's is clear in his (2022) paper that BIM capability emerging from digital and staff transformation is not sufficient in and of itself to move people from established ways of working toward organisational BIM transformation. Moreover, he asserts that employees that have just undergone BIM training do not immediately display BIM proficiency, that in fact BIM skilling involves continuous learning and growth advocating for each individual employee to have a personal BIM transformation strategy.

BIM digitalisation driven changes in the construction industry are driving changes in requisite knowledge, skills, and the attitudes of AEC professionals. These factors in turn compel the need to adapt and change industry approaches to education and training. The term BIM enabled education has been mentioned in the literature, referring to the use of BIM as a vehicle for knowledge creation, sharing, transmission, and evaluation. They highlight the need for an integrated, BIM-enabled Learning Environment in which educators and trainers can effectively carry out BIM-enabled education and training to match the ever-growing industry need. In summary, there now exists a challenge to the AEC industry, to integrate the body of knowledge from academic research and on the ground industry experience in approaches to BIM training. This paper proposes that it is only through taking an informed comprehensive approach to BIM training can the widespread barriers to BIM uptake be successfully addressed (Underwood et al. 2013).

2.7 Gaps in the Literature and Proposed Study

This study proposes to explore the recognised variation and differing approaches in the literature as to what is considered BIM training in the AEC industry. It will attempt to identify whether the type of training professionals engage in/receive i.e., formal training courses and/or the provision of/absence of in house

continued support for learning and implementation affects the nature of their BIM usage. This research will also attempt to explore the potential relationships between the identified barriers to BIM adoption and implementation in the literature, participants' training experiences and BIM usage.

2.8 Research Aim

The overarching aim of this study is to explore the relationship between differential approaches to BIM training and attitudes toward BIM and the use of BIM technologies in Architectural, Engineering and Construction Industries.

2.9 Research Objectives

1. Investigate the impact of differential approaches to BIM training on BIM use.

2. Investigate the impact of BIM training on attitudes toward BIM.

3. Determine whether years of industry experience and self-rated BIM expertise impacts participants' attitudes towards and use of BIM?

4. Identify potential barriers to BIM adoption.

Chapter 3 Methodology

This study used a mixed methods approach for the purposes of triangulating data from both quantitative and qualitative research methods. Quantitative data was collected via survey research methods. Survey research involves the collection of information from a population sample through responses to questions (Check & Schutt 2011) The term "survey" can reflect a range of research aims, sampling and recruitment strategies, data collection instruments, and methods of survey administration (Ponto 2015). In this specific research project, the quantitative data collection method used was an online questionnaire using industry contacts and user platforms such as BIMhero (www.bimhero.io) to request participants to complete survey questions using the UniSQ Survey Tool. (Survey ID: 599927)

The questionnaire explored topics related to (i) training in BIM, (ii) BIM use, (iii) attitudes toward BIM and (iv) organisational factors. The exact survey questionnaires were based on the relevant research literature and developed in conjunction with the research supervisor. This was both a collaborative and iterative process. Participants were asked to provide demographic information including the type and nature of BIM training a. Participants were also specifically asked to state whether they are an Engineering /Architectural or Construction professional and the level achieved i.e., Graduate, B-Tech, Degree, whether they had formal BIM training and/or the opportunity to practice “on the job”, i.e., regular opportunities to integrate any learned material into their work practices. Length of time using BIM and length of time working in the industry were also be asked.

In addition to demographic information, the survey included structured questions with fixed Likert Scale response options. A Likert scale is an ordered scale from which respondents choose one option that best represents their view. It is often used to measure respondents' attitudes by asking the extent to which they agree or disagree with a particular question or statement. There were also opportunities for respondents to provide more detailed answers in free text boxes (see Appendix F for copy of survey)

3.1 Ethical Approval

Ethical approval for the proposed survey questions was obtained prior to commencing the research proposal in accordance with UniSQ ethical approval processes and guidelines. (See appendix C for the Ethical application and date of approval).

3.2 Sampling

The goal of sampling strategies in survey research is to obtain a sufficient sample that is representative of the population of interest (Ponto 2015). Participant recruitment strategies can affect the adequacy and representativeness of the sample obtained (Ponto 2015). There is evidence that facilitating multimode methods of returning surveys i.e. e-mail and/or mailed options increases survey response rates (Converse et

al. 2008; Fincham 2008). in a comparative study, found that mailed surveys alone or combined with e-mail/web follow-up yielded greater response rates than an e-mail-web survey followed up by a mailed contact to non-respondents. Previous research found that response rates to both web and mailed survey instruments were increased if preceded by an initial contact to potential respondents (Kaplowitz et al. 2004).

In keeping with this research, the author contacted prospective participants by either email, industry interest group web platform or in person. The researcher introduced the purpose of the research and research procedures via a survey questionnaire information sheet (see appendix D) and a link to the survey itself. As the target sample were professionals proficient in design software use, it was not expected that the provision of on an online survey would disadvantage the sample in anyway. Participants were offered the option to respond anonymously to the survey questionnaire. This has been demonstrated to reduce the potential impact of social desirability on participant responses. 'Social desirability' bias is the tendency to underreport socially undesirable attitudes and behaviours and to over report more desirable attributes. In the case of this specific research social desirability bias may manifest as attempts to influence impression management, which is the purposeful presentation of self to fit into a situation or please an audience (Latkin et al. 2017)

Qualitative data was collected via a focus group. Purposeful sampling was used to recruit six participants. The researcher contacted industry contacts with BIM experience by phone or via email and invited them to attend the focus group. Six participants agreed to attend. The researcher provided participants with three alternative day scheduling options each consisting of two separate time slots with a view to maximising attendance. Participants selected their preferred date and time. The focus group was held online via Microsoft Teams Meeting and recorded using same. Based on the literature review and survey responses participants in the focus group were asked seven questions designed to gather richer more in-depth information re BIM training, use, attitude towards BIM, barriers to BIM transformation and organisational factors (see Appendix G for questions)

Once the focus group was completed, the recording was immediately transferred to an encrypted laptop and wiped from the recording device. The data was then transcribed by the researcher using two methods, the first being an automated transcription service performing the bulk of the transcription via cloud-based platform. The second was undertaken by the researcher themselves to review and complete sections of the transcription not able to be adequately completed via method one. All identifying information was removed and pseudonyms assigned to focus group participants to protect individual identities (See Appendix H for copy of transcription). Once this was completed, the audio-recording was deleted. The anonymized transcript was the only remaining data stored in accordance with UniSQ data storage stipulations. A sample of the transcribed focus group was then coded by another person for the purposes of reliability.

3.3 Quantitative Data Analysis

The survey responses were displayed and described on a series of bar charts [see pages 14-24].

3.3.1 Statistical Package for the Social Sciences [SPSS]

Firstly, a codebook was created in MS Excel using the raw data. A unique identifier was assigned to each questionnaire prior to data entry. Each question/variable was assigned a short identifier (e.g. age, duration of work, confidence level .). Variables were represented in MS Excel column represented the variables, while the rows represented the respondents. Levels of measurement were assigned to the variables i.e. the Likert scale responses used in the survey were coded as ordinal data. The coded data was then imported from MS Excel into the SPSS statistical analysis programme. The categories that were collapsed were coded directly in SPSS as separate variables with new values e.g. age was collapsed from five categories to two, and level of expertise from four to two.

The following tests were used to statistically analyse the survey data using the SPSS programme. The number of participants and data analysed for each test differed and depended on the matched pairs and comparison of data available for each participant on different variables. Missing data was excluded on a test-by-test basis. Analysis revealed that there were too few responses in some of the survey categories for statistical analysis to be meaningfully conducted. Specifically, hypotheses 1, 2, 5, and 6 [see Results section for further details].

3.3.2 Chi-Square Test

A Chi-Square test is a nonparametric test used when testing hypothesis relating to the distribution of a categorical variable. Categorical variables e.g., age or experience, can be nominal or ordinal. They cannot have a normal distribution due to the limitation of the collected values. The test is used to identify whether a difference between collected data and predicted results based on collected data can be attributed to chance or if a relationship between the data can be established. The degrees of freedom in a statistical calculation represents the number of variables that can vary in a calculation. The degrees of freedom can be calculated to ensure that chi-square tests are statistically valid (Biswal 2023).

3.3.3 Spearman Rank Order Correlation

A Spearman rank-order correlation coefficient is a nonparametric measure of the strength and direction of association that exists between two variables. The test is used for either ordinal variables or for continuous data that has failed the assumptions necessary for conducting the Pearson's product-moment correlation’ (Laerd Statistics 2018).

3.4 Qualitative Data Analysis

Thematic analysis was used to analyse the qualitative data. The steps in this process are outlined in figure 1.

A sample of the transcribed focus group was coded by another person for the purposes of reliability.

Figure 3-1 Illustrates the six phases of Thematic Analysis (Clarke & Braun 2013)

Chapter 4 Results

4.1 Quantitative Analysis

4.1.1 Survey Questionnaire

The survey consisted of a total of 30 questions grouped into five domains, (i) Demographics, (ii) BIM Use, (iii) BIM Training, (iv) Attitudes toward BIM, and finally (v) Organisational factors,

Fifty respondents participated in the survey. Eleven respondents (11) failed to either complete or submit the questionnaire, therefore, there were thirty-nine respondents in total who completed the questionnaire.

4.1.1.1 (i) Demographics

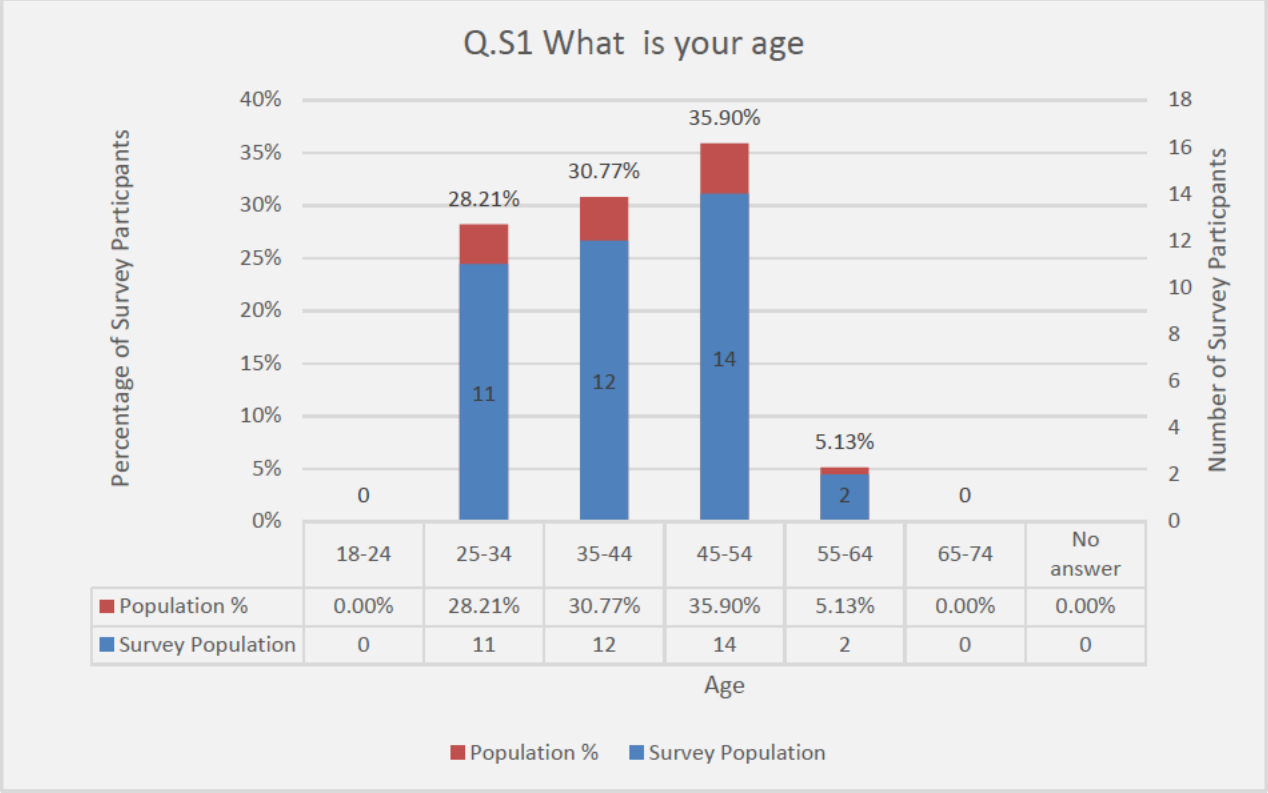

Figure 4-1: Age Range

Figure 4-1 illustrates the age range of survey respondents. There was a relatively equal split between the three ranges 25-34 years, 35-44 years, and 45-54 years.

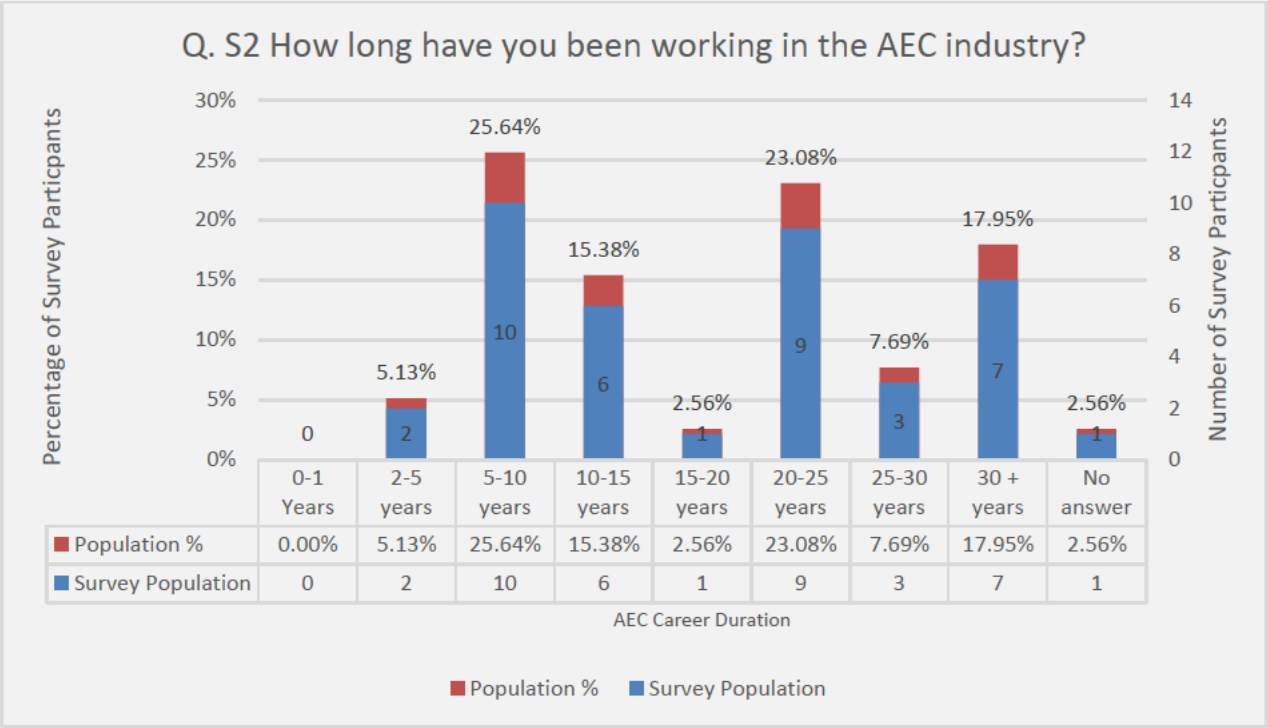

Figure 4-2: Years working in the AEC industry.

Figure 4-2 illustrates the number of years respondents had been working in the AEC industries. It also depicts each age range as a percentage of the overall population.

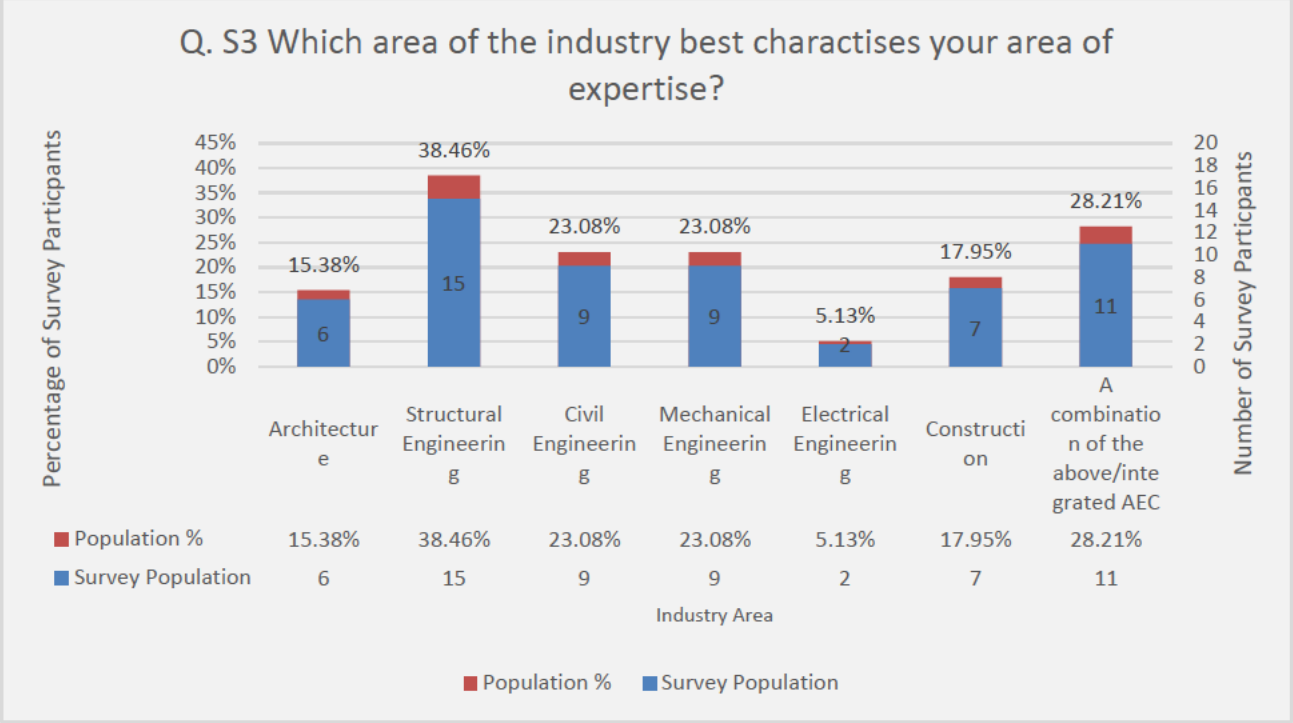

Figure 4-3: Industry Area

Figure 4-3 outlines a breakdown of which area of the AEC industries respondents worked in. The majority of respondents (38.46%) came from a structural engineering background followed by a relatively even split between civil, mechanical engineering and a combination of disciplines. the fewest respondents came from electrical engineering (5.13%)

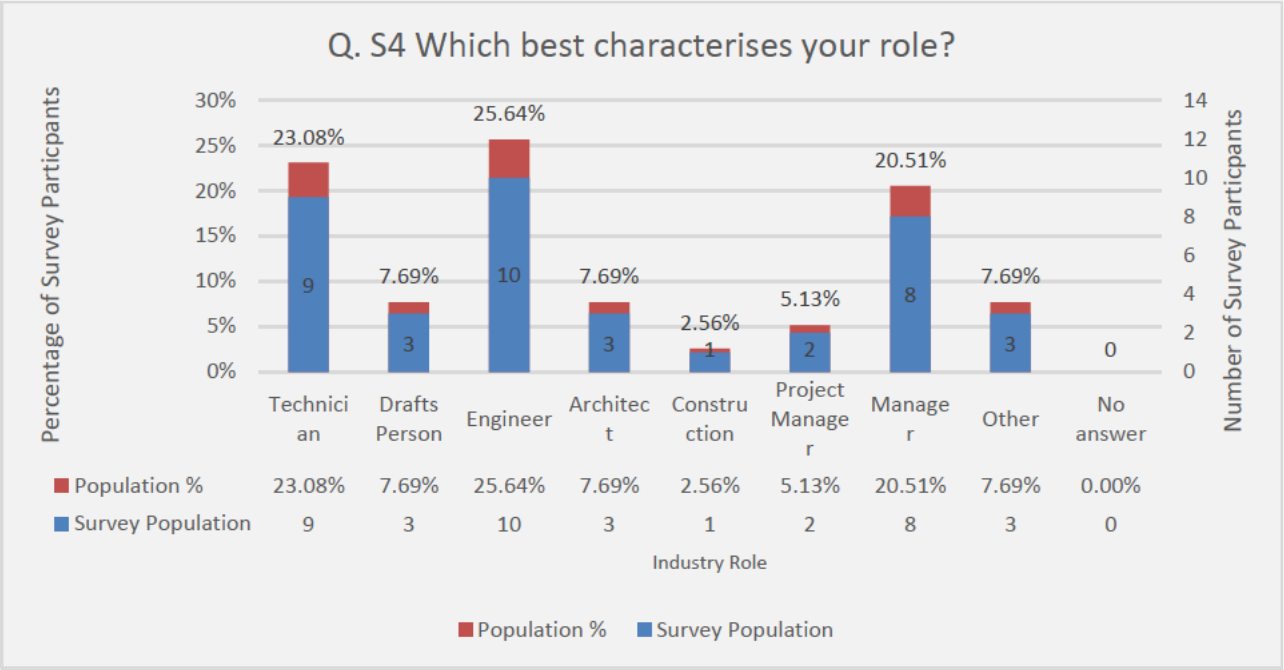

Figure 4-4: Industry Role

Figure 4-4 outlines the professional role that best characterises each respondent's current employment. There was a relatively even distribution between the top three roles engineering, technician, and manager respectively.

4.1.1.2 (ii) BIM Use

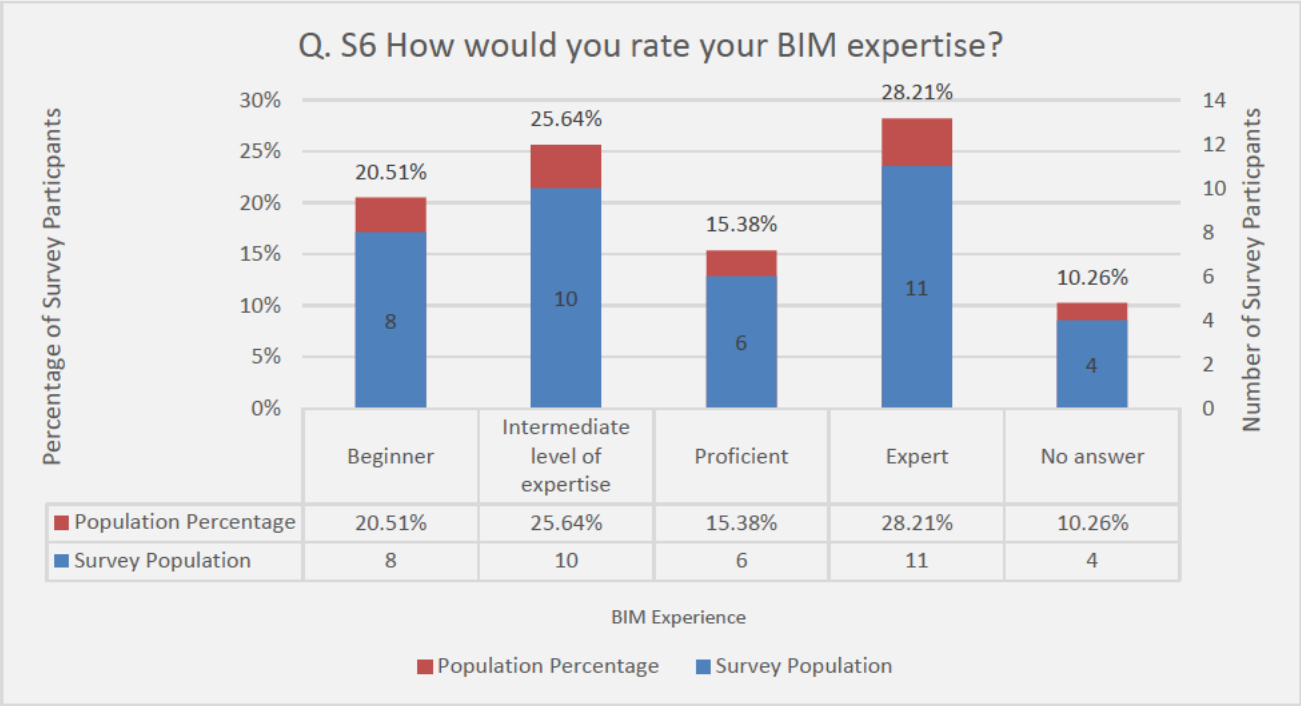

Figure 4-5: BIM Experience

Figure 4-5 outlines respondents' self-ratings re their BIM expertise. The majority of respondents rated themselves as having Expert (28.21 %) or Intermediate level (25.64%) of BIM skills with 20.51% of respondents rating themselves as beginner level.

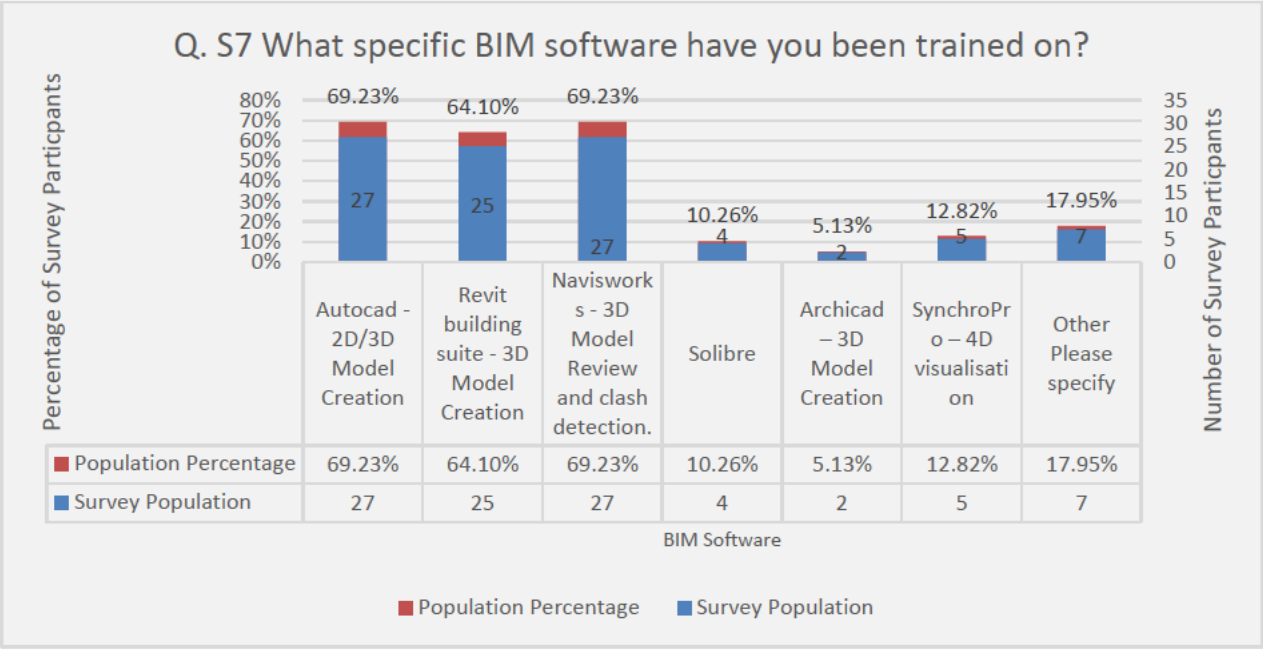

Figure 4-6: BIM Software Training

Figure 4-6 outlines the BIM specific software that participants had been trained on. Approximately 1/3 of participants had not received any training on AutoCAD 2D/3D modelling, Revit or Navisworks.

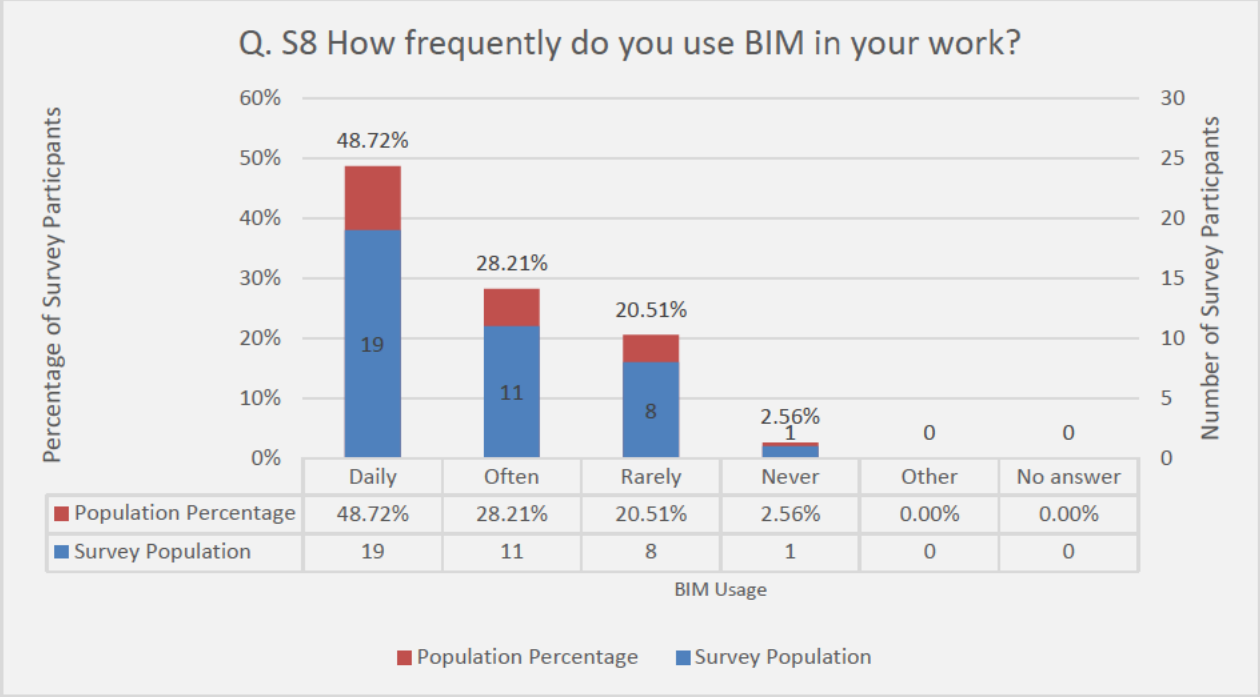

Figure 4-7: BIM Usage

Figure 4-7 outlines the frequency of respondents BIM usage. The majority (48.72%) of respondents used BIM daily with 28.21% using BIM often. Almost 21% of respondents rarely used BIM in their work.

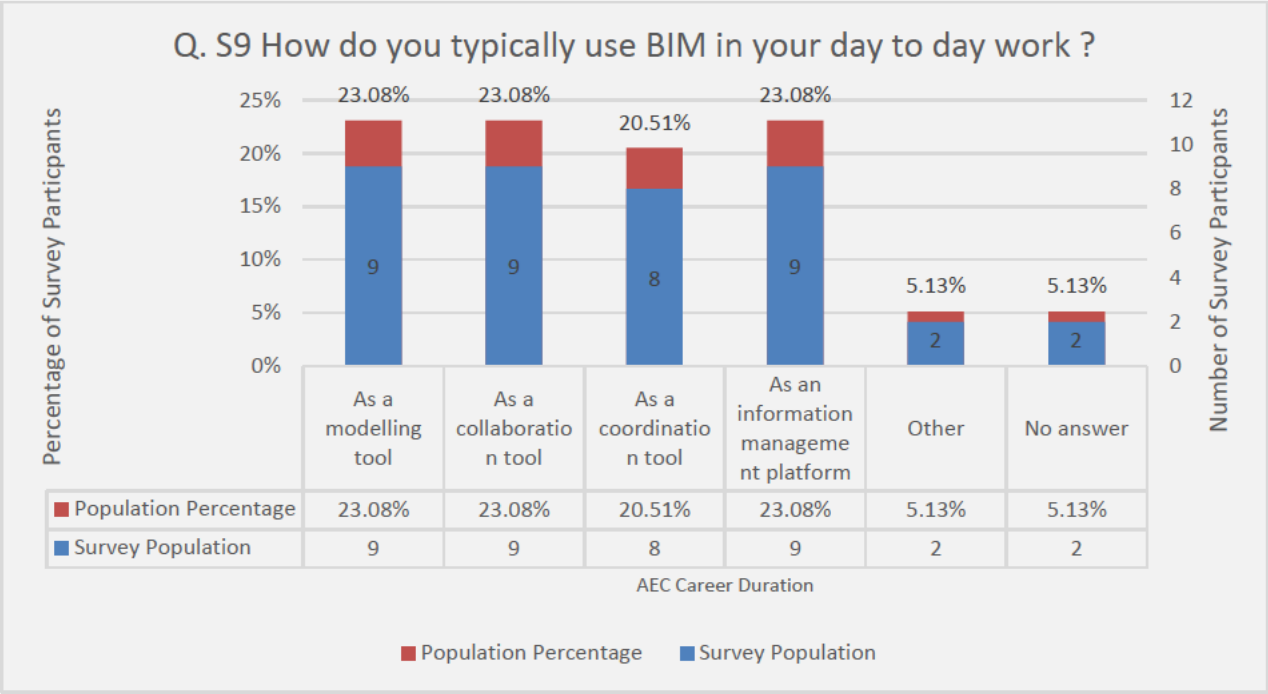

Figure 4-8: Career Duration

Figure 4-8 shows a relatively even split between how the various facets of BIM was used by participants in their work. The same % of participants (23.08%) used BIM as a modelling tool as an information management platform.

4.1.1.3 (iii) BIM Training

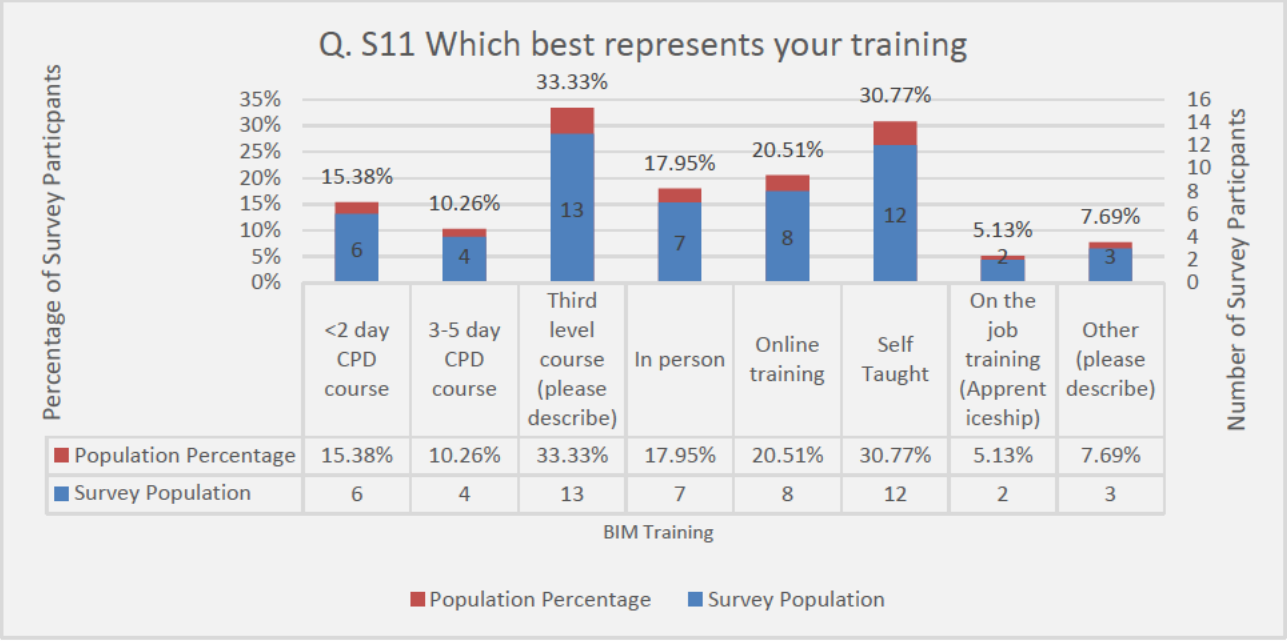

Figure 4-9: BIM Training

Figure 4-9 outlines the form of respondents training. It demonstrates a wide range of training backgrounds with approximately the same % of participants receiving formal third level training as were self-taught.

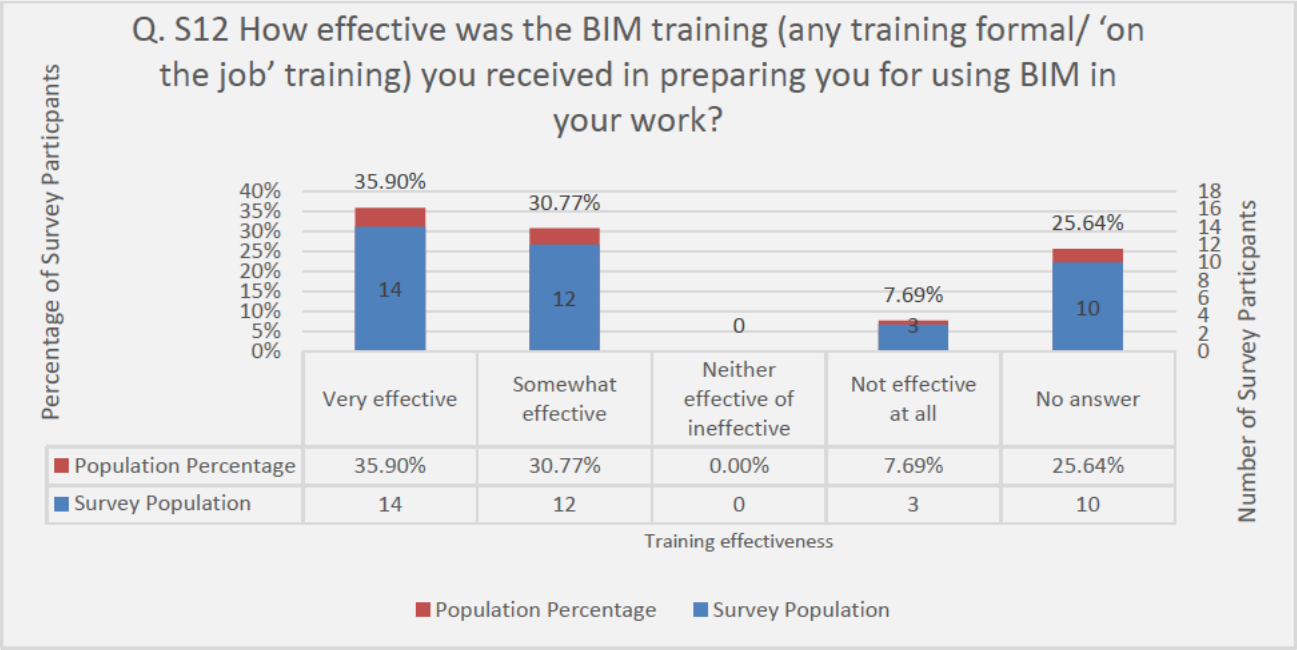

Figure 4-10: Training Effectiveness

Figure 4-10 outlines participants ratings of the training they received. The majority of respondents found their training very or somewhat effective with 3 participants rating their training as not effective at all. Just over a quarter of participants did not answer this question.

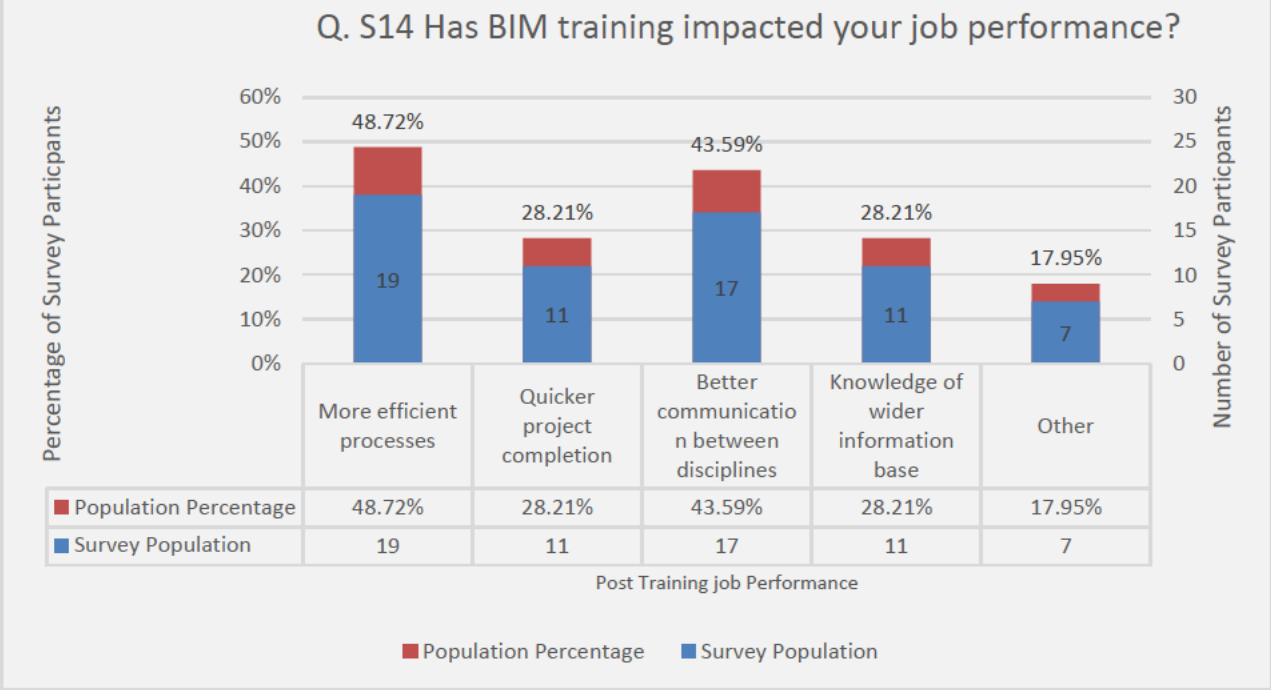

Figure 4-11:Post training job performance

Figure 4-11 outlines how BIM training impacted different facets of the respondent's job performance. More efficient processes and better communication between disciplines were the top-rated benefits.

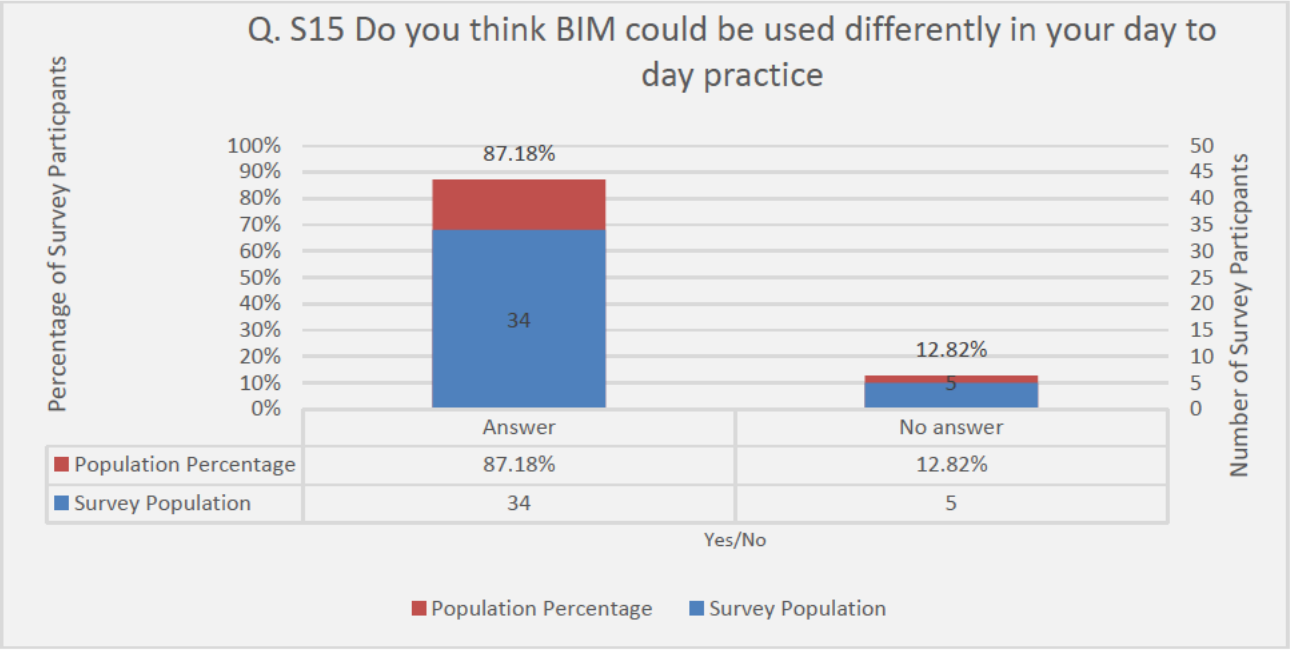

Figure 4-12 Bim Usage day-to-day

Figure 4-12 illustrates respondents over whelming desire for Bim to be implemented in a different way to its current usage, with the majority (87.18%) the majority (34 respondents) implying BIM could be used in a different way.

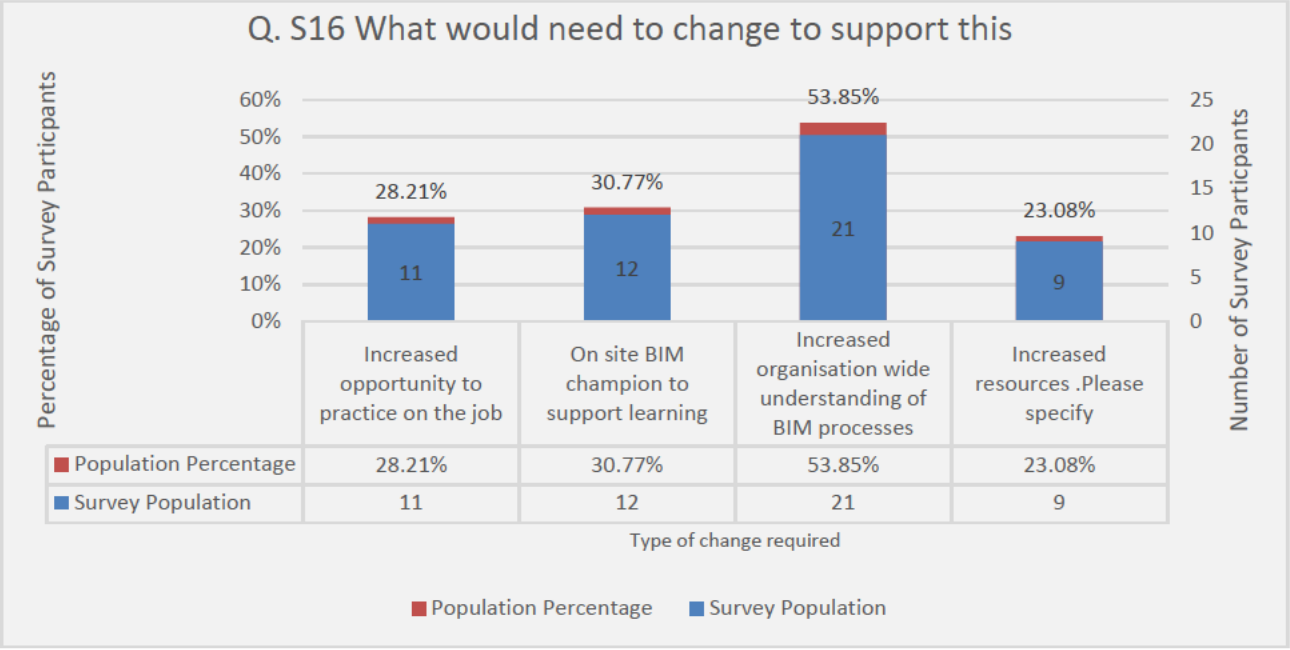

Figure 4-13: Type of change required.

Figure 4-13 illustrates respondents' desire for change within Bim and the areas they feel would make the most significant impact in their daily use of BIM. The majority (21 respondents) regarded greater organisational understanding of BIM processes would benefit the BIM process.

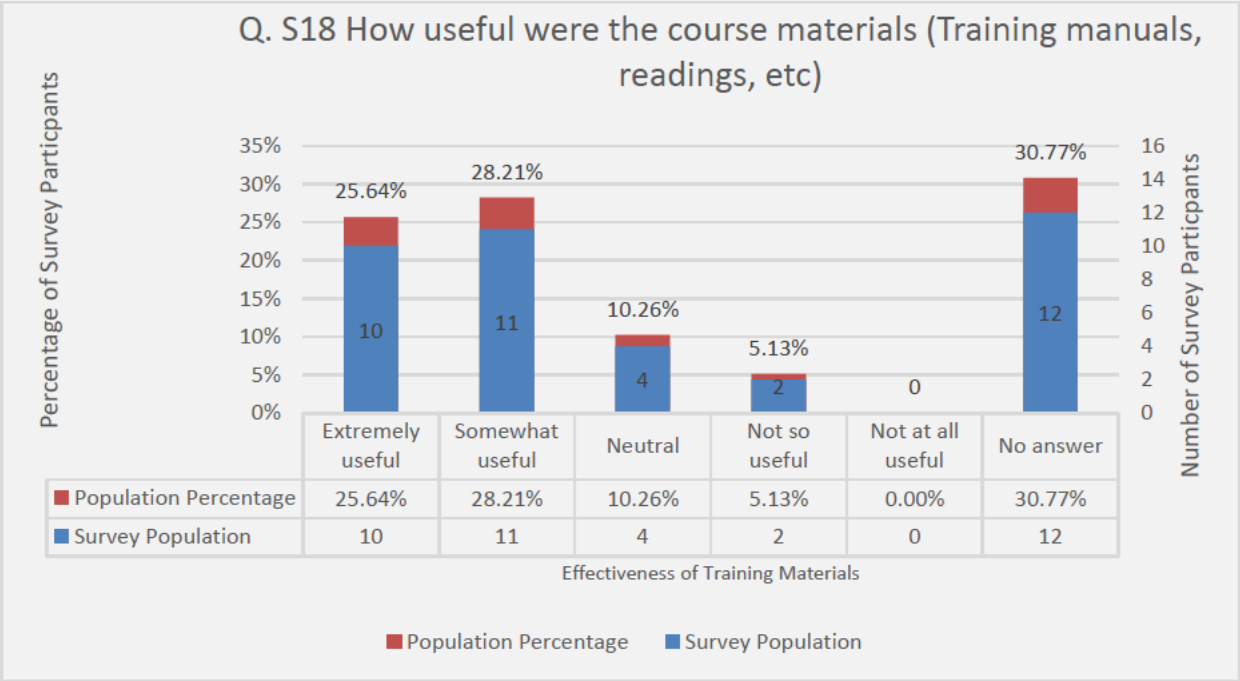

Figure 4-14: Effectiveness of training materials

Figure 4-14 illustrates respondents' ratings of the training materials they received. The majority (21 respondents) rated the materials as somewhat or extremely useful with 0 endorsements of not useful at all. 12 participants did not answer that question.

4.1.1.4 (iv) Attitudes toward BIM

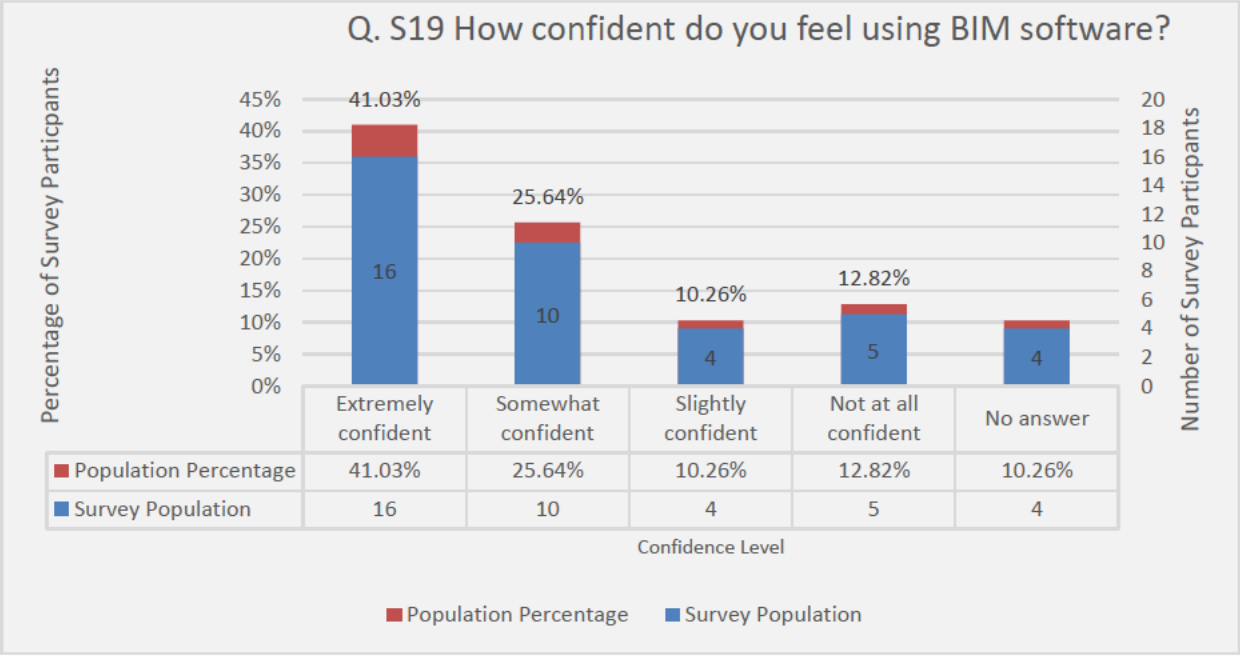

Figure 4-15: Confidence Levels

Figure 4-15 illustrates respondents' self -rated confidence levels using BIM. The majority of respondents (16) felt extremely confident or somewhat confident (10) with a total of 9 participants rating themselves as slightly or not at all confident.

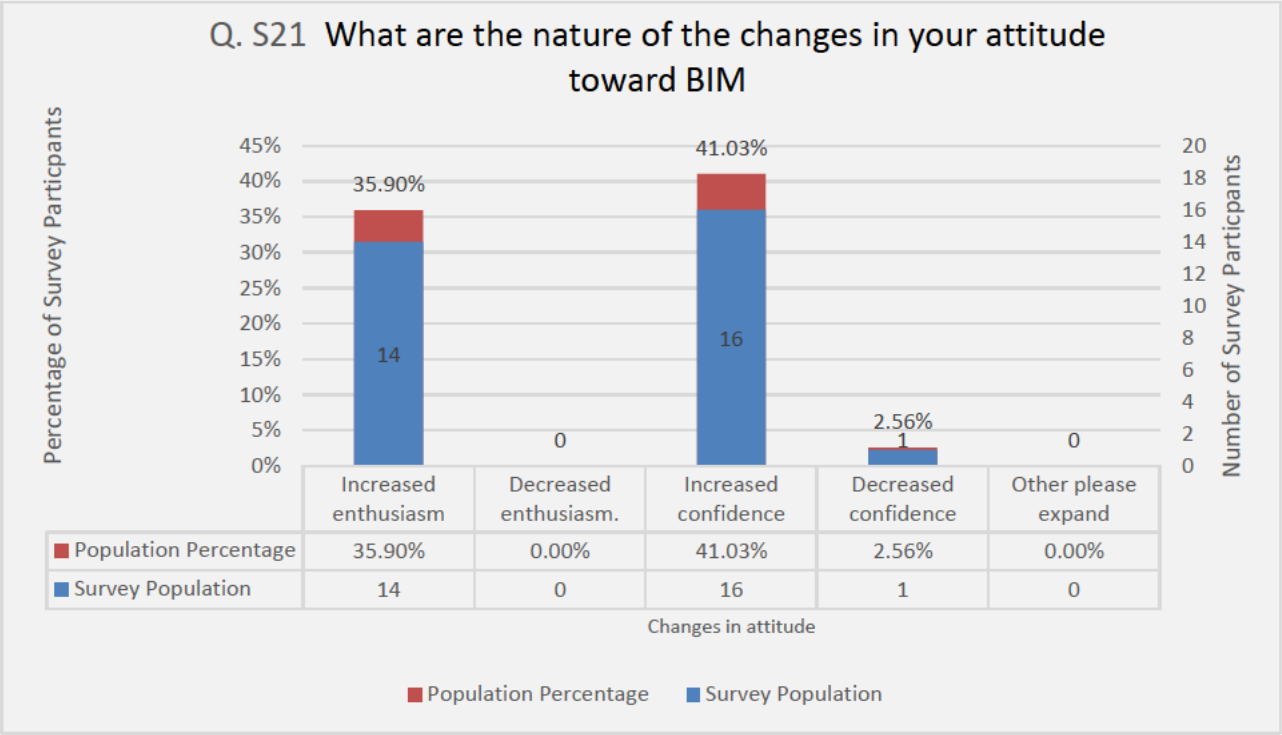

Figure 4-16: Changes in Attitude

Figure 4-16 illustrates the impact that BIM training had on respondents' attitudes toward BIM. The majority of respondents identified increased enthusiasm and confidence following training. One participant noted that training had a negative impact on their attitude toward BIM.

4.1.1.5 (v) Organisational factors

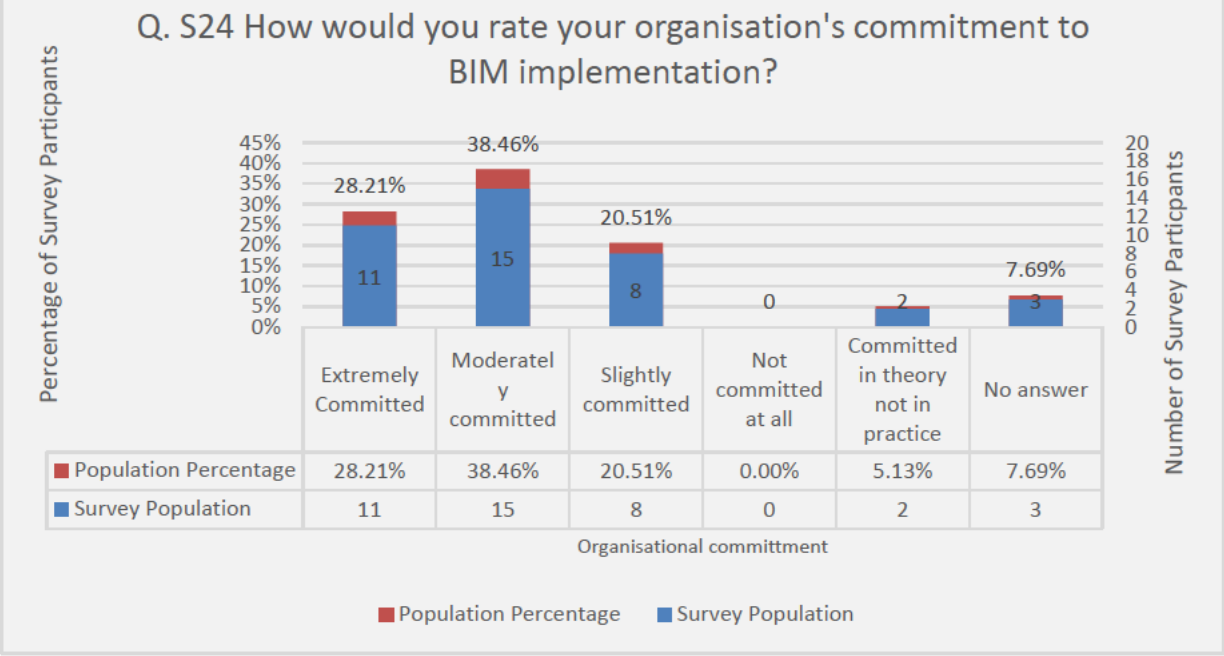

Figure 4-17: Organisational Change

Figure 4-17 illustrates respondents' ratings of their respective organisation to BIM implementation. The majority (38.46%) endorse moderately committed followed by extremely and slightly committed. Interestingly 2 participants rated their organisations as committed in theory but not in practice.

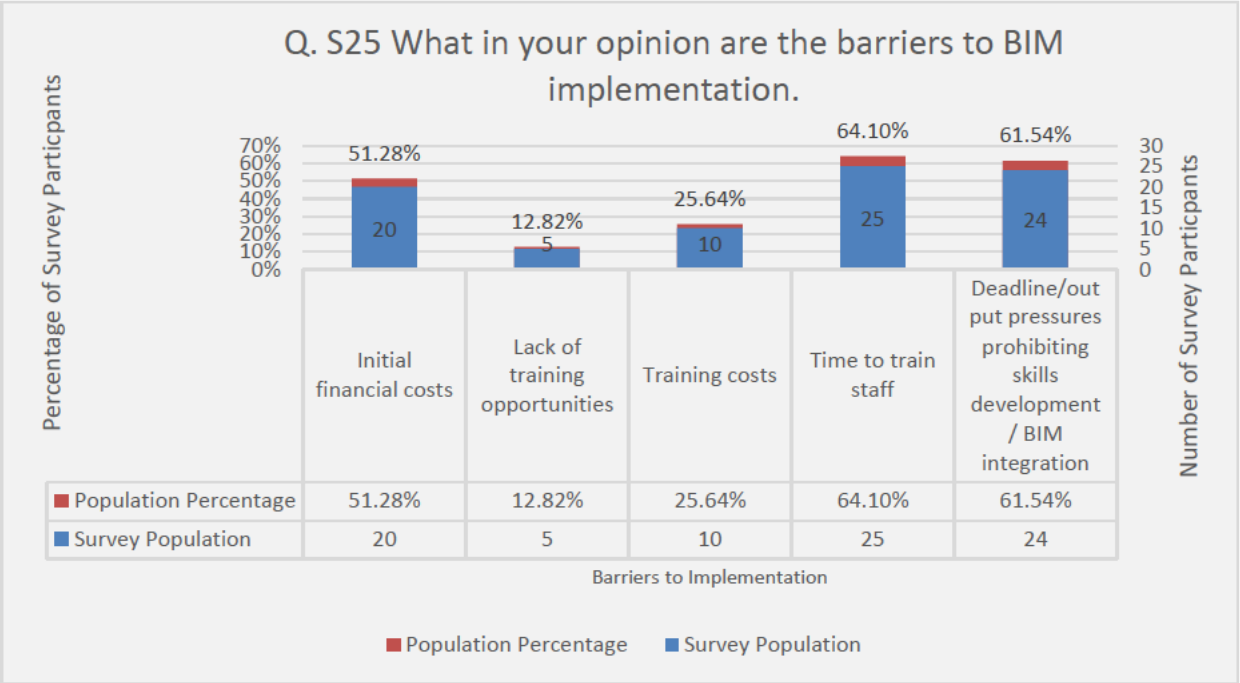

Figure 4-18: Barriers to Implementation

Figure 4-18 highlights respondents' endorsements of barriers to BIM implementation. The top three barriers were deadline/output pressures, time to train staff and initial financial costs respectively. Training costs and lack of opportunities were also highlighted.

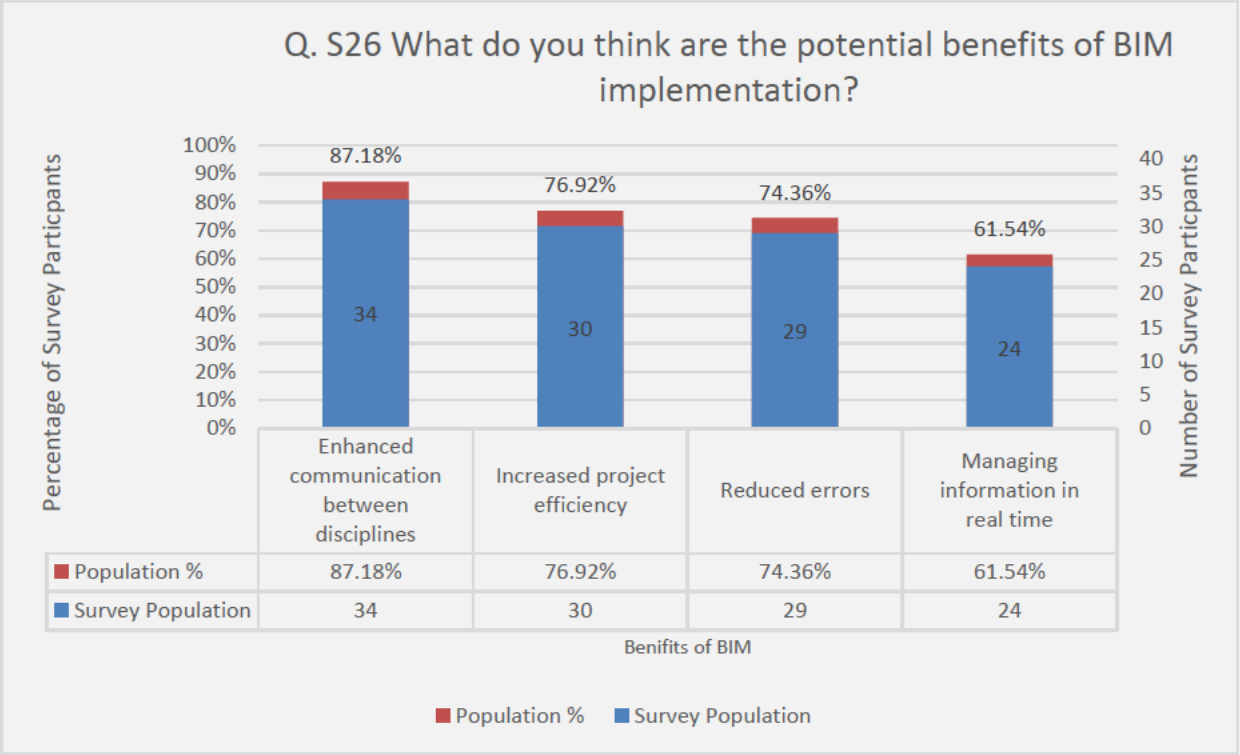

Figure 4-19: Benefits of BIM

Figure 4-19 illustrates the wide range of potential benefits of BIM implementation as rated by respondents. The positive benefits include enhanced communication, efficiencies, and information management.

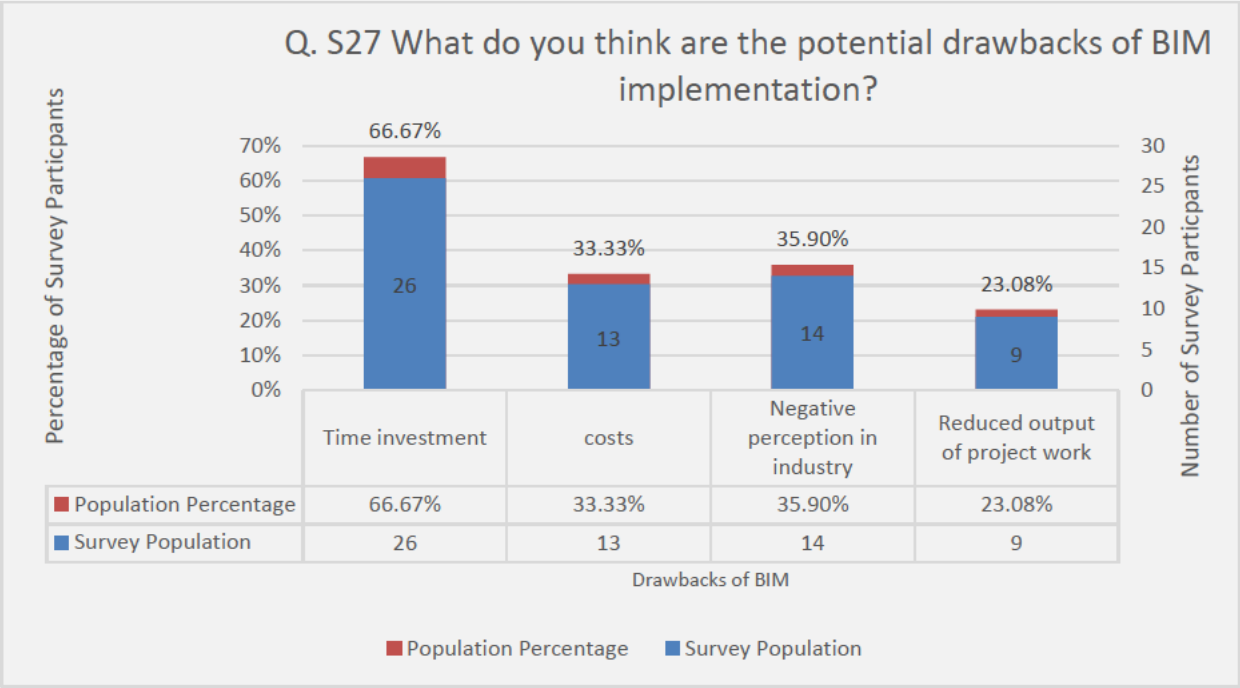

Figure 4-20: Drawbacks of BIM

Figure 4-20 illustrates respondent's ratings of potential drawbacks of BIM implementation. Time investment was the Top-rated drawback with negative perceptions and costs the second and third rated options respectively. Just over 23% of participants endorsed reduced output as a factor.

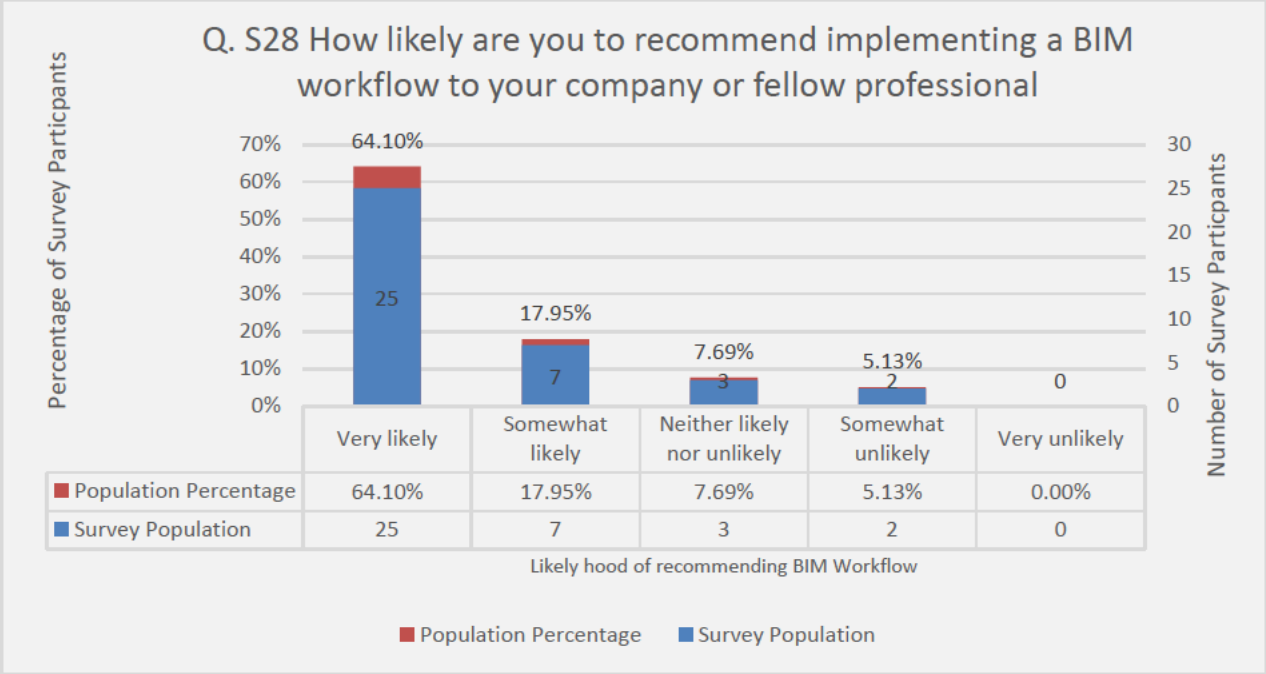

Figure 4-21: BIM Workflow Recommendations

Figure 4-21 illustrates that a significant majority (64.10%) were very likely to recommend implementing a BIM workflow in the industry with only 5.13% of respondents somewhat unlikely to recommend BIM. No respondents endorsed being very unlikely to recommend a BIM workflow to fellow professionals.

4.1.2 Statistical Results

4.1.2.1 H1 There is an association between age and how BIM is used.

A chi-square test of independence and association was conducted between age and type of use of BIM. The sample data did not meet the test assumptions in the crosstabulation exploration. Five cells (62.5%) had expected counts of less than 5, therefore violating the assumption that 80% of cells had an expected count greater than or equal to five. The minimum expected count was 3.37 (Co-ordination and Over 45), followed by 3.8 (Collaboration & Over 45), 4.2 (Modelling and Over 45), 4.6 (Information Mgnt. & Over 45) and 4.6 (Co-ordination & Under 45), even after age categories were transformed and collapsed from 4 categories to 2 (Under 45 or Over 45) and type of use of BIM categories was collapsed from 5 to 4 categories (to include 'other' in the Information Management & Other category). The p-value cannot meaningfully be interpreted as the independence and association between these variables was invalid and therefore unable to establish any significance, $\chi 2$ (3, N = 38) = 3.229, p = .358.

Table H1: A goodness of fit chi-square test of independence and association was conducted between age and type of use of BIM.

Age Under or over 50 * HowBIMUsed Crosstabulation

			HowBIMUsed				
			Modelling	Collaboration	Co-ordination	Information Manager or Other	Total
Age Under or over 50	Under 45	Count	5	7	3	7	22
		Expected Count	5.8	5.2	4.6	6.4	22.0
		% within Age Under or over 50	22.7%	31.8%	13.6%	31.8%	100.0%
		% within HowBIMUsed	50.0%	77.8%	37.5%	63.6%	57.9%
		Adjusted Residual	-.6	1.4	-1.3	.5	
	Over 45	Count	5	2	5	4	16
		Expected Count	4.2	3.8	3.4	4.6	16.0
		% within Age Under or over 50	31.3%	12.5%	31.3%	25.0%	100.0%
		% within HowBIMUsed	50.0%	22.2%	62.5%	36.4%	42.1%
		Adjusted Residual	.6	-1.4	1.3	-.5	
Total		Count	10	9	8	11	38
		Expected Count	10.0	9.0	8.0	11.0	38.0
		% within Age Under or over 50	26.3%	23.7%	21.1%	28.9%	100.0%
		% within HowBIMUsed	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

				Monte Carlo Sig. (2-sided)			Monte Carlo Sig. (1-sided)		
					99% Confidence Interval			99% Confidence Interval	
	Value	df	Asymptotic Significance (2-sided)	Significance	Lower Bound	Upper Bound	Significance	Lower Bound	Upper Bound
Pearson Chi-Square	3.229[a]	3	.358	.380[b]	.367	.392			
Likelihood Ratio	3.325	3	.344	.380[b]	.367	.392			
Fisher-Freeman-Halton Exact Test	3.157			.380[b]	.367	.392			
Linear-by-Linear Association	.014[c]	1	.907	1.000[b]	1.000	1.000	.507[b]	.495	.520
N of Valid Cases	38								

a. 5 cells (62.5%) have expected count less than 5. The minimum expected count is 3.37.

b. Based on 10000 sampled tables with starting seed 334431365.

c. The standardized statistic is -.117.

4.1.2.2 H2 There is an association between years of work experience & type of use of BIM.

A chi-square test of independence and association was conducted between years of work experience and type of use of BIM. The sample data did not meet the test assumptions in the crosstabulation exploration. Sixteen cells (100.0%) had expected counts of less than 5. The minimum expected count is 1.30, (Co-ordination and Under 40 years of experience). The assumption that 80% of cells had an expected count greater than or equal to five was violated even after the years of work experience had been transformed and collapsed from 8 to 4 categories and type of use of BIM categories was collapsed from 5 to 4 categories (to include 'other' in the Information Management & Other category). The p-value cannot meaningfully be interpreted as the independence and association between these variables was invalid and therefore unable to establish any significance, $\chi 2$ (9, N = 37) = 10.825, p = .288.

Table H2:A chi-square test of independence and association was conducted between Years of Work Experience & Type of Use of BIM

U10, U20, U30, U40 * HowBIMUsed Crosstabulation

			HowBIMUsed				
			Modelling	Collaboration	Co-ordination	Information Manager or Other	Total
U10, U20, U30, U40	1	Count	4	3	1	4	12
		Expected Count	3.2	2.9	2.6	3.2	12.0
		% within U10, U20, U30, U40	33.3%	25.0%	8.3%	33.3%	100.0%
		% within HowBIMUsed	40.0%	33.3%	12.5%	40.0%	32.4%
		Adjusted Residual	.6	.1	-1.4	.6	
	2	Count	1	3	1	2	7
		Expected Count	1.9	1.7	1.5	1.9	7.0
		% within U10, U20, U30, U40	14.3%	42.9%	14.3%	28.6%	100.0%
		% within HowBIMUsed	10.0%	33.3%	12.5%	20.0%	18.9%
		Adjusted Residual	-.8	1.3	-.5	.1	
	3	Count	4	3	2	3	12
		Expected Count	3.2	2.9	2.6	3.2	12.0
		% within U10, U20, U30, U40	33.3%	25.0%	16.7%	25.0%	100.0%
		% within HowBIMUsed	40.0%	33.3%	25.0%	30.0%	32.4%
		Adjusted Residual	.6	.1	-.5	-.2	
	4	Count	1	0	4	1	6
		Expected Count	1.6	1.5	1.3	1.6	6.0
		% within U10, U20, U30, U40	16.7%	0.0%	66.7%	16.7%	100.0%
		% within HowBIMUsed	10.0%	0.0%	50.0%	10.0%	16.2%
		Adjusted Residual	-.6	-1.5	2.9	-.6	
Total		Count	10	9	8	10	37

	Expected Count	10.0	9.0	8.0	10.0	37.0
	% within U10, U20, U30, U40	27.0%	24.3%	21.6%	27.0%	100.0%
	% within HowBIMUsed	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests									
				Monte Carlo Sig. (2-sided)			Monte Carlo Sig. (1-sided)		
					99% Confidence Interval			99% Confidence Interval	
	Value	df	Asymptotic Significance (2-sided)	Significance	Lower Bound	Upper Bound	Significance	Lower Bound	Upper Bound
Pearson Chi-Square	10.825[a]	9	.288	.307[b]	.295	.319			
Likelihood Ratio	10.537	9	.309	.484[b]	.472	.497			
Fisher-Freeman-Halton Exact Test	8.659			.475[b]	.462	.487			
Linear-by-Linear Association	.166[c]	1	.684	.706[b]	.694	.718	.373[b]	.360	.385
N of Valid Cases	37								
a. 16 cells (100.0%) have expected count less than 5. The minimum expected count is 1.30.									
b. Based on 10000 sampled tables with starting seed 1535910591.									
c. The standardized statistic is .407.									

4.1.2.3 H3 There is an association between between years of work experience and level of expertise.

A Spearman's rank-order correlation was completed to assess the relationship between years of work experience and level of confidence, which was not significant, rs (32) = .258, p = .141. Missing values were excluded pairwise, and preliminary analysis had shown the relationship to be monotonic, as assessed by visual inspection of a scatterplot. Therefore, we accept the null hypothesis that there will be no association between variables.

Table H3: Spearman's Rho non-parametric test of association between years of work experience and self-rating of level of expertise

Correlations				
			DurationOfWork	ExpertiseLevel
Spearman's rho	DurationOfWork	Correlation Coefficient	1.000	.258
		Sig. (2-tailed)	.	.141
		N	44	34
	ExpertiseLevel	Correlation Coefficient	.258	1.000
		Sig. (2-tailed)	.141	.
		N	34	37

Confidence Intervals of Spearman's rho				
			95% Confidence Intervals (2-tailed)[a,b]	
	Spearman's rho	Significance(2-tailed)	Lower	Upper
DurationOfWork - ExpertiseLevel	.258	.141	-.098	.555
a. Estimation is based on Fisher's r-to-z transformation.				
b. Estimation of standard error is based on the formula proposed by Fieller, Hartley, and Pearson.				

4.1.2.4 H4 There is an association between between years of work experience and level of confidence using BIM.

A Spearman's rank-order correlation was completed to assess the relationship between years of work experience and level of confidence using BIM, which was not significant, rs (33) =.-.030, p = .864. Missing values were excluded pairwise, and preliminary analysis had shown the relationship to be monotonic, as assessed by visual inspection of a scatterplot. Therefore, we accept the null hypothesis that there will be no association between variables.

Table H4:Spearman's Rho non-parametric test of association between years of work experience and self-rating of level of confidence.

Correlations				
			DurationOfWork	ConfidenceLevel
Spearman's rho	DurationOfWork	Correlation Coefficient	1.000	-.030
		Sig. (2-tailed)	.	.864
		N	44	35
	ConfidenceLevel	Correlation Coefficient	-.030	1.000
		Sig. (2-tailed)	.864	.
		N	35	36

Confidence Intervals of Spearman's rho				
			95% Confidence Intervals (2-tailed)[a,b]	
	Spearman's rho	Significance(2-tailed)	Lower	Upper
DurationOfWork - ConfidenceLevel	-.030	.864	-.369	.316
a. Estimation is based on Fisher's r-to-z transformation.				
b. Estimation of standard error is based on the formula proposed by Fieller, Hartley, and Pearson.				

4.1.2.5 H5 There is an association between formal training received and & type of use of BIM.

A chi-square test of independence and association was conducted between formal training received and & type of use of BIM. The sample data did not meet the test assumptions in the crosstabulation exploration. Four cells (50.0%) have expected count less than 5, therefore violating the assumption that 80% of cells had an expected count greater than or equal to five. The minimum expected count was 2.53 (Co-ordination & No Formal BIM Training), followed by 2.8 (Collaboration & No Formal BIM Training), 3.2 (Modelling & No Formal BIM Training), and 3.5 (Information Mgnt. Or Other & No Formal BIM Training) even after the type of use of BIM categories was collapsed from 5 to 4 categories (to include 'other' in the Information Management & Other category). The p-value cannot meaningfully be interpreted as the independence and association between these variables was invalid and therefore unable to establish any significance, χ^2 (3, N = 38) = 1.984, p = .576.

Table H5: A goodness of fit chi-square test of independence and association was conducted between formal training received and & type of use of BIM.

FormalBIMTraining * HowBIMUsed Crosstabulation

			HowBIMUsed				
			Modelling	Collaboration	Co-ordination	Information Manager or Other	Total
FormalBIMTraining	No	Count	2	3	4	3	12
		Expected Count	3.2	2.8	2.5	3.5	12.0
		% within FormalBIMTraining	16.7%	25.0%	33.3%	25.0%	100.0%
		% within HowBIMUsed	20.0%	33.3%	50.0%	27.3%	31.6%
		Adjusted Residual	-.9	.1	1.3	-.4	
	Yes	Count	8	6	4	8	26
		Expected Count	6.8	6.2	5.5	7.5	26.0
		% within FormalBIMTraining	30.8%	23.1%	15.4%	30.8%	100.0%
		% within HowBIMUsed	80.0%	66.7%	50.0%	72.7%	68.4%
		Adjusted Residual	.9	-.1	-1.3	.4	
Total		Count	10	9	8	11	38
		Expected Count	10.0	9.0	8.0	11.0	38.0
		% within FormalBIMTraining	26.3%	23.7%	21.1%	28.9%	100.0%
		% within HowBIMUsed	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

				Monte Carlo Sig. (2-sided)			Monte Carlo Sig. (1-sided)		
					99% Confidence Interval			99% Confidence Interval	
	Value	df	Asymptotic Significance (2-sided)	Significance	Lower Bound	Upper Bound	Significance	Lower Bound	Upper Bound
Pearson Chi-Square	1.984[a]	3	.576	.621[b]	.608	.633			
Likelihood Ratio	1.951	3	.583	.639[b]	.627	.651			
Fisher-Freeman-Halton Exact Test	1.998			.621[b]	.608	.633			
Linear-by-Linear Association	.248[c]	1	.618	.659[b]	.647	.671	.364[b]	.352	.377
N of Valid Cases	38								

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is 2.53.

b. Based on 10000 sampled tables with starting seed 79654295.

c. The standardized statistic is -.498.

4.1.2.6 H6 There is an association between level of expertise and & type of use of BIM.

A goodness of fit chi-square test of independence and association was conducted between level of expertise and & type of use of BIM. The sample data did not meet the test assumptions in the crosstabulation exploration. Six cells (75.0%) have expected count less than 5. The minimum expected count was 1.73 (Co-ordination and Beginner-Intermediate Level of Expertise), followed by 2.3 (Co-ordination and Proficient-Expert Level), 2.6 and 3.4 (Collaboration and Beginner-Intermediate Level of Expertise and Collaboration and Proficient-Expert Level of Expertise), 4.3 (Modelling and Beginner-Intermediate Level of Expertise) and 4.3 (Information Management & Other and Beginner-Intermediate Level of Expertise). This violates the assumption that 80% of cells had an expected count greater than or equal to five. Level of expertise categories had been transformed and collapsed from four categories to 2 (Beginner to Intermediate Level and Proficient to Expert Level) and type of use of BIM categories was collapsed from 5 to 4 categories (to include 'other' in the Information Management & Other category). The p-value cannot meaningfully be interpreted as the independence and association between these variables was invalid and therefore unable to establish any significance, χ^2 (3, N = 30) = 1.154, p = .764.

Table H6:A goodness of fit chi-square test of independence and association was conducted between level of expertise and & type of use of BIM.

Beg-Int, Prof-Expert * HowBIMUsed Crosstabulation

			HowBIMUsed				
			Modelling	Collaboration	Co-ordination	Information Manager or Other	Total
Beg-Int, Prof-Expert	1	Count	5	2	1	5	13
		Expected Count	4.3	2.6	1.7	4.3	13.0
		% within Beg-Int, Prof-Expert	38.5%	15.4%	7.7%	38.5%	100.0%
		% within HowBIMUsed	50.0%	33.3%	25.0%	50.0%	43.3%
		Adjusted Residual	.5	-.6	-.8	.5	
	2	Count	5	4	3	5	17
		Expected Count	5.7	3.4	2.3	5.7	17.0
		% within Beg-Int, Prof-Expert	29.4%	23.5%	17.6%	29.4%	100.0%
		% within HowBIMUsed	50.0%	66.7%	75.0%	50.0%	56.7%
		Adjusted Residual	-.5	.6	.8	-.5	
Total		Count	10	6	4	10	30
		Expected Count	10.0	6.0	4.0	10.0	30.0
		% within Beg-Int, Prof-Expert	33.3%	20.0%	13.3%	33.3%	100.0%
		% within HowBIMUsed	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

				Monte Carlo Sig. (2-sided)			Monte Carlo Sig. (1-sided)		
					99% Confidence Interval			99% Confidence Interval	
	Value	df	Asymptotic Significance (2-sided)	Significance	Lower Bound	Upper Bound	Significance	Lower Bound	Upper Bound
Pearson Chi-Square	1.154[a]	3	.764	.747[b]	.735	.758			
Likelihood Ratio	1.191	3	.755	.747[b]	.735	.758			
Fisher-Freeman-Halton Exact Test	1.213			.806[b]	.796	.816			
Linear-by-Linear Association	.000[c]	1	.985	1.000[b]	1.000	1.000	.546[b]	.533	.559
N of Valid Cases	30								

a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is 1.73.

b. Based on 10000 sampled tables with starting seed 1310155034.

c. The standardized statistic is .019.

4.1.2.7 H7 There is an association between level of expertise and level of confidence using BIM.

A Spearman's rank-order correlation was completed to assess the relationship between level of expertise and level of confidence using BIM, which was not significant, rs (27) = .231, p = .228. Missing values were excluded pairwise, and preliminary analysis had shown the relationship to be monotonic, as assessed by visual inspection of a scatterplot. Therefore, we accept the null hypothesis that there will be no association between variables.

Table H7: Spearman's Rho non-parametric test of association between level of expertise and level of confidence using BIM.

Correlations				
			ExpertiseLevel	ConfidenceLevel
Spearman's rho	ExpertiseLevel	Correlation Coefficient	1.000	.231
		Sig. (2-tailed)	.	.228
		N	37	29
	ConfidenceLevel	Correlation Coefficient	.231	1.000
		Sig. (2-tailed)	.228	.
		N	29	36

Correlations				
			ExpertiseLevel	ConfidenceLevel
Spearman's rho	ExpertiseLevel	Correlation Coefficient	1.000	.231
		Sig. (2-tailed)	.	.228
		N	37	29
	ConfidenceLevel	Correlation Coefficient	.231	1.000
		Sig. (2-tailed)	.228	.
		N	29	36

4.1.2.8 H8 There is an association between confidence using BIM and the frequency of the use of BIM in work.

A Spearman's rank-order correlation was completed to assess the relationship between confidence using BIM and the frequency of use of BIM in work. 50 participants were recruited, missing values were excluded pairwise. 36 sets of data were analysed. Preliminary analysis showed the relationship to be monotonic, as assessed by visual inspection of a scatterplot. There was a statistically significant, strong positive correlation between confidence using BIM and the frequency of use of BIM in work, r_s (32) = .738, p < .001. 95% CI (534, .861) as illustrated in the table below. Participants who were more confident in their use of BIM also reported more frequency of use of BIM. Therefore, we can reject the null hypothesis that there will be no association between variables, and we can accept the alternative hypothesis.

Table H8: Spearman's Rho non-parametric test of association between confidence level and frequency of use.

Correlations				
			FreqOfUse	ConfidenceLevel
Spearman's rho	FrequencyOfUse	Correlation Coefficient	1.000	.738**
		Sig. (2-tailed)	.	<.001
		N	40	36
	ConfidenceLevel	Correlation Coefficient	.738**	1.000
		Sig. (2-tailed)	<.001	.
		N	36	36
**. Correlation is significant at the 0.01 level (2-tailed).				

Correlations				
			FreqOfUse	ConfidenceLevel
Spearman's rho	FrequencyOfUse	Correlation Coefficient	1.000	.738**
		Sig. (2-tailed)	.	<.001
		N	40	36
	ConfidenceLevel	Correlation Coefficient	.738**	1.000
		Sig. (2-tailed)	<.001	.
		N	36	36
**. Correlation is significant at the 0.01 level (2-tailed).				

4.1.2.9 H9 There is an association between confidence using BIM and the likelihood of a person recommending the implementation of BIM workflow to their company or fellow professional.

A Spearman's rank-order correlation was completed to assess the relationship between confidence using BIM and the likelihood of a person recommending the implementation of BIM workflow to their company or fellow professional. 50 participants were recruited, missing values were excluded pairwise. 33 sets of data were analysed. Preliminary analysis showed the relationship to be monotonic, as assessed by visual inspection of a scatterplot. There was a statistically significant, strong positive correlation between confidence using BIM and the frequency of use of BIM in work, r_s (31) = .586, p < .001. 95% CI (.295, .778) as shown in the table below. Participants who reported higher levels of confidence in their use of BIM also reported a higher likelihood of recommending the implementation of BIM workflow to their company or fellow professional use of BIM. Therefore, we can reject the null hypothesis that there will be no association between variables, and we can accept the alternative hypothesis.

Table H9: Spearman's Rho non-parametric test of association between confidence level and the likelihood of a person recommending the implementation of BIM workflow to their company or fellow professional.

Correlations

			Confidence Level	LikelyTo RecBIMUse
Spearman's rho	ConfidenceLevel	Correlation Coefficient	1.000	.586**
		Sig. (2-tailed)	.	<.001
		N	36	33
	LikelyToRecBIMUse	Correlation Coefficient	.586**	1.000
		Sig. (2-tailed)	<.001	.
		N	33	37

**. Correlation is significant at the 0.01 level (2-tailed).

Confidence Intervals of Spearman's rho

	Spearman's rho	Significance(2-tailed)	95% Confidence Intervals (2-tailed)[a,b]	
			Lower	Upper
ConfidenceLevel - LikelyToRecBIMUse	.586	<.001	.295	.778

a. Estimation is based on Fisher's r-to-z transformation.

b. Estimation of standard error is based on the formula proposed by Fieller, Hartley, and Pearson.

4.1.2.10 H10 There is an association between the frequency of the use of BIM in work and the likelihood of a person recommending the implementation of BIM workflow to their company or fellow professional.

A Spearman's rank-order correlation was completed to assess the relationship between the frequency of the use of BIM in work and the likelihood of a person recommending the implementation of BIM workflow to their company or fellow professional. 50 participants were recruited, missing values were excluded pairwise. 37 sets of data were analysed. Preliminary analysis showed the relationship to be monotonic, as assessed by visual inspection of a scatterplot. There was a statistically significant, moderately strong positive correlation between confidence using BIM and the frequency of use of BIM in work, r_s (35) = .576, p < .001. Participants who reported higher levels of frequency of use of BIM in their also reported a higher likelihood of recommending the implementation of BIM workflow to their company or fellow professional use of BIM. Therefore, we can reject the null hypothesis that there will be no association between variables, and we can accept the alternative hypothesis.

Table H10: Spearman's Rho non-parametric test of association between the relationship between the frequency of the use of BIM in work and the likelihood of a person recommending the implementation of BIM workflow to their company or fellow professional.

Correlations				
			LikelyToRec BIMUse	Frequency OfUse
Spearman's rho	LikelyToRecBIMUse	Correlation Coefficient	1.000	.576**
		Sig. (2-tailed)	.	<.001
		N	37	37
	FrequencyOfUse	Correlation Coefficient	.576**	1.000
		Sig. (2-tailed)	<.001	.
		N	37	40
**. Correlation is significant at the 0.01 level (2-tailed).				

Confidence Intervals of Spearman's rho				
			95% Confidence Intervals (2-tailed)[a,b]	
	Spearman's rho	Significance(2-tailed)	Lower	Upper
LikelyToRecBIMUse - FrequencyOfUse	.576	<.001	.301	.763
a. Estimation is based on Fisher's r-to-z transformation.				
b. Estimation of standard error is based on the formula proposed by Fieller, Hartley, and Pearson.				

4.2 Qualitative Analysis

4.2.1 Focus Group

The focus group consisted of 7 questions generated from the literature review and data collected in the initial survey questionnaire with a view to gain further clarity around the use and implementation of BIM in the AEC industry. A copy of the questionnaire can be found in Appendix F A copy of the focus group questions can be found in Appendix G

Three main themes emerged from the data coding and analysis (i) The Road to BIM, (ii) Misconceptions of BIM, (iii)

Skilling Versus Training.

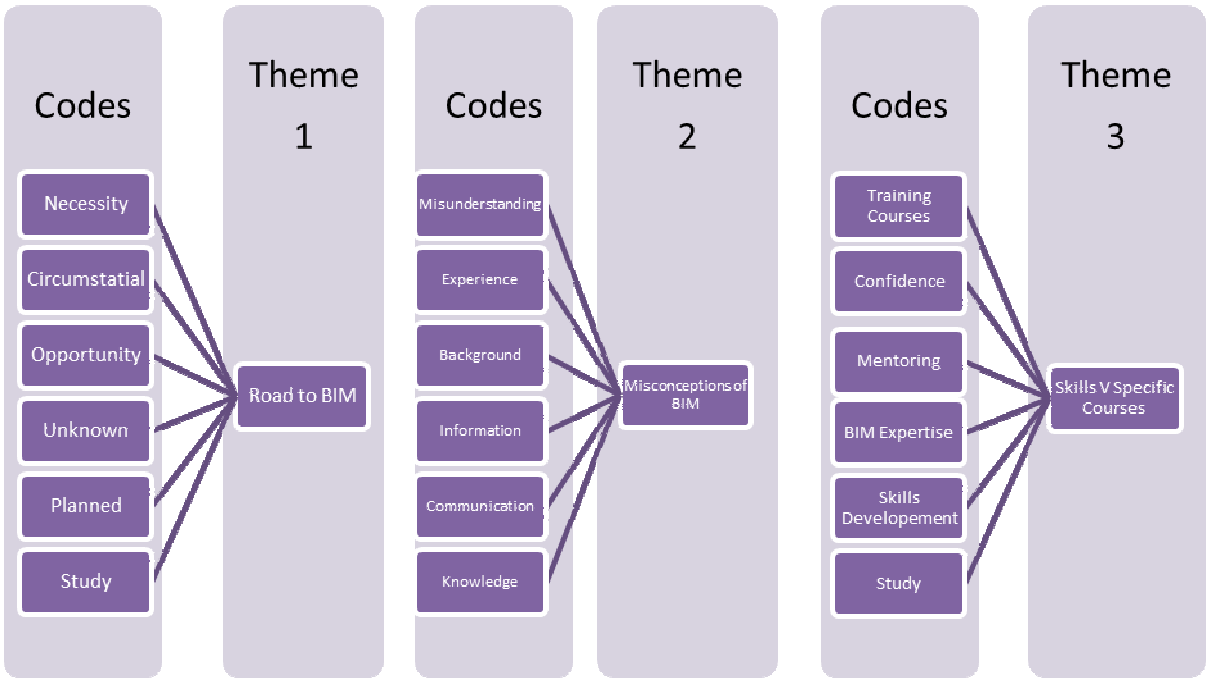

Figure: Illustrates the codes and the themes from the data analysis

Figure 4-22: Data Analysis Coding and Themes

4.2.1.1 Theme 1: The Road to BIM

Participants described different trajectories re how they found themselves working in their BIM related positions. Some participants described assuming a BIM role out of organisational necessity.

Speaker 2: “We had significant enough project in the office and we kind of blindly stepped into the world of BIM. And it was a disaster, and it was great at the same time. We ended up having to scrap a model and start again. But um that was like, I guess I didn’t know at that stage what I didn’t know. And I just thought, sure it’s just a model and it’s fine and what could possibly go wrong”.

Speaker 4: “From my point of view, it’s been quite strange because I’ve sort of come at it from CAD point of view to then sort of, as I said, joining a BIM group, which sort of was in a room of technician’s sort of look at the back end and delivery teams requirements to then sort of being thrown in at the deep end producing large projects. The next progression for me then was where I am at the moment, taking the reins and setting up the BIM requirements. So, it’s been a different journey for me. I wouldn’t say it is simple and clean, but I’ve been learning a lot in different and it’s all sort of coming together. I suppose it’s a natural progression and that’s the most of it”.

Speaker 5: So, for me it was more of doing things faster. And when it comes to revisions of drawings, it was more of the quick way to do it instead of going back and forth with the cutting. So that’s why we had to jump

into BIM.

Speaker 6: “Well from my point of view, it was a case of they just needed someone to fill in. They didn’t have enough personnel at the time for a project and I fell in with my CAD background and my doc control background and all that kind of stuff. They just thought that, you know, and my efficiency that I’d be the best man for the job at that time. And that’s what I done, went in and came out again and took over the CAD department again in the CADWorx and became CAD coordinator manager. So, it was necessity for the company. But it was a learning curve for me, something new, a new stepping ladder basically.

For other participants, their pathway to BIM was more structured and planned. However, even with participants deliberate pursuit of formal BIM training, circumstance and opportunity also played a part in finding themselves working in professional BIM roles.

Speaker 3: “I am an architectural technologist and I studied in Revit. As a software that we as technologist use as an architectural took. And we also had for final year loads of modules covering BIM in full. So, I had a very, very good overview of what is BIM, and how the projects have to be run on the contractual side. And for me it was always just the tool, like an architect using CAD the same for me was as a technologist using Revit was, I need to produce……. I had a very good understanding what is the level of details have to be in a model of a specific stage”.

Speaker 6: “Well I went back and did the course in St. John’s College, and I went to see a CIT or MTU done the BIM course MTU as well……. ya circumstance, yeah, basically in a nutshell, circumstance. I wasn’t looking to go into it”.

Speaker 7: “I’m attending a course in REVIT right now. To be honest, I joined the course because I found the opportunity. That was a free course, um apart from that it was essential to the way we work here in the company. So, that’s the reason I joined the course”.

It is important to note different factors were at play from a management perspective where despite a will to adopt BIM technologies a balance needed to be struck between facilitating the development of BIM within a company and maintaining productivity. In this situation, time, and allocating time in the right project were identified as the crucial factors in the companies’ journey on the road to BIM.

Speaker 2: I suppose (from a management) point of view, like we are a company, we have a situation where people are transitioning from CAD to Revit. And I suppose one thing we are trying to manage is the expectation from a management point of view of the time it takes for people to work on a project and to try to select the right project where schedule isn’t so critical that people have the time that they need to actually learn it properly, that is kind of a roadblock for us. So, for every project there is a pressure with it in terms of

time. And it was just finding the right project where we would not revert to the easy option of getting it out the door quickly in CAD. And you know obviously paying the price later on when it wasn't developed in Revit so.

4.2.1.2 Theme 2: Misconceptions of BIM.

Participants felt that there are fundamental misconceptions within the AEC industries regarding what BIM is and how it can be used.

Speaker 3: "There is a misconception, a misunderstanding of BIM software Bim process, um even BIM technology" ……. I've had experience where designers use Revit, and they think that's what BIM is".

Speaker 3: "If someone says something negative to me (about BIM) to me sounds like the person doesn't have good knowledge, good experience, doesn't know what the software can actually do".

Speaker 6: "Well one negative, I suppose, is most people if they're not sure (of what BIM is). They think BIM is just clash detection only tool, and that's all we do every day is clash detection. Yes, it's a big part of what the BIM coordinator has to do because at the end of the day, you are trying to have a clash free model, It's not the only thing. And I think a lot of people do think that's what BIM was and is when it's a lot more than that obviously as we all know. But I still even to this day people are unsure fully how it works".

Speaker 6: "There is project managers who don't understand how BIM works, and why we have it. They just want to get their job done and just get a model out, but they don't understand the full implementation of BIM in the background……. people are just naïve to think that (clash detection) that's what it is all about. You know you are basically like a project manager in the co-ordinator. You're co-ordinating everybody. You still have to be on top of everything. You have to watch everybody. There's a lot more to it then what people think so. Um, that's my perception that people have as clash detection mainly as just keeping an eye on the model after that, does that make sense?"

There was a consensus between participants that professional background was one factor which impacted the understanding and misunderstanding about what constitutes BIM.

Speaker 2: "A lot of what I've come across is depending on people's backgrounds, like from an engineering point of view, when you mention BIM, it's, um, seen as just modelling and drawings as opposed to, you know, information of a project or asset through its entire lifecycle…….and you didn't think to look any deeper into it, you know".

Speaker 3: "I absolutely agree with this, it is true it depends from what background you come, and I think myself, in my opinion…. Like for example, designers have their own way of controls in contrast to

contractors and then obviously facility managers, what they have from what is being needed. You know, that's a different reason people use BIM.

Speaker 4: "There is a scale of sort of knowledge of what BIM is and who you ask. So, you know, from front end sort of design common data environments, sort of trying to get sort of the design team in what they believe what BIM is to what the contractor sort of needs for his information. And I suppose it's all the same thing at the end of the day. But it's just you have a scale of views from front to back".
Participants felt that access to information/guideline and enhanced communication were two concrete ways in which the misconceptions regarding BIM could be addressed.

Speaker 6: Knowledge. It's as simple as that. The day-to-day knowledge and the use of the package"

Speaker 6: He (BIM manager) along with a couple of fellas in the department, have put on guidelines for guidance, hierarchy for people to understand how it all works, especially for project managers, because they love asking for guidelines, especially when going into a meeting, you have to have a guideline. How does the agenda work? How does that work? How does clash detection work? So, guidelines are key for everything for BIM to run smoothy within any company".

Speaker 3: "People need to communicate more about it. I am sorry but they don't go deeply into it. ……And I think it's a lot of misconception, then I don't know how it can be addressed. That is probably hard work, and it is all about communication".

This is hampered by the lack of regulation in the industry and clear signposting as to where to find the most comprehensive and up to date information regarding what constitutes BIM and its implementation and the differing needs of users. Participants described the difficulties inherent in self-directed learning.

Speaker 2: "Like knowing where to go and what to look for …. I'm not interested in using Revit. I would be interested in knowing more about BIM, um just so I can, you know work and manage within that world. So, I suppose understanding what courses are out there and if you having a one stop shop for comparing courses"?

Speaker 3: "Or you have to be crazy kind of into it that I want to be, and I will do it myself. Searching and searching yourself, watching YouTube. But that is not easy. When you are an adult, when you have a family, you have kids".

Participants views on how misconceptions of BIM could potentially be addressed highlights the importance of knowledge, information, and training, which is directly related to theme three: Skilling Versus Training

4.2.1.3 Theme 3: Skilling Versus Specific Courses

Participants identified the differences between attending a BIM training course and being skilled in BIM. They highlighted the importance of knowledge, experience and confidence in learning and applying BIM to real world settings to maximise acquisition.

Speaker 7: "I can tell you about my experience, for example at work at the small project we have in the office, we have a couple of drawings. I feel very dependent. If, for example I detect a small typo or an error or something. I don't feel like I can go to the model or to the drawing and change that thing, all sorted. That's something that could happen with AutoCAD for example. But with Revit, I have to speak with a Revit manager or a draftsman or whoever to say, Look I have detected this, could you do that? …….. so, I feel very depending on that, basically that is because I don't have the knowledge. I mean, I suppose that will change. So, once I get the tools and do it there and then".

Speaker 3: "In terms of training……even if someone does the course (Revit) and companies welcome paying for the courses, if they have no support, it is very hard to begin with. No support"

Speaker 6: "Outside of what college give ya, college give you so much, but I think experience is everything and someone else's knowledge".

Speaker 7: I mean it is difficult to start with a course or with training if you don't have a real purpose. So, I mean you could say, I want to learn Revit, but for what? I mean it's just to have a basic knowledge. I mean I think it's better to have a real project or a real target …a real objective, then you say this is when you can manage your time to find what you need specifically".

Participants also described shared experiences of working with professionals who described themselves as BIM proficient and how this did not translate into their work.

Speaker 3: I recently had someone I interviewed to work with myself, and the design team and the person was saying in the CV, BIM expert and da da da and you know, when you ask about at least one contractual document or what is the information management system ….the person was looking at me blankly…….and the person was so sure he was a BIM expert".

Speaker 6: "I never say anybody that I know everything because I certainly don't. And I'm very honest about that. I know where my limits are, and I know where I struggle. And I am not afraid to say …co-ordinates wasn't my strong point. I know I have an understanding of it, but I'm always honest with people. I'm not a bluffer. I know people who come into this industry and come into BIM, and they can bluff it and they'll get away with it for so long, but eventually they get caught.

Participants advocated for AEC industries to adopt the role of a BIM mentor who would facilitate staff continuing professional development and build staff skills and confidence in BIM usage via a number of differing support pathways. There was a recognition of the continuous learning process involved in adopting and implementing BIM technologies.

Speaker 3: “New project will be a new thing. You know, I am quite experienced, and I am still learning ……. You need someone in the company, someone a person who is always there for in house training kind of baby steps, that a person can slowly build that experience. Yeah, even organising in house trainings, may be once a week someone to come over in the office and give some sort kind of, you know, open, open training. Let people ask questions, You know……. silly questions that the other people don’t feel let’s say don’t feel afraid to ask.”

Speaker 6: “Mentor is definitely important, alright. You know just having someone to turn too……you definitely need the one person right. You need someone who has the knowledge that you can bounce off”.

The importance of BIM mentoring not being just added to the remit of a potentially already over stretched BIM manager or coordinator was also emphasised. BIM mentor was seen as a role in itself and assuming more that direct support including signposting to relevant resources. This echoes the importance of accessing relevant information outlined in Theme 1 as a means to address Misconceptions of BIM. It was also suggested that the person who is appointed in the BIM mentorship role not only needs to have the practical skills but also a genuine enthusiasm for BIM and its usage.

Speaker 2: “Because if the BIM manager is under pressure and he’s being pulled in every direction, nothing is going to work great for the company. So, like, you know the manager has to free himself up so he can, you know, focus on his day-to day jobs, and well keep everyone moving. So, I think a combination of, you know, one person having the answers or maybe that person knowing where to get the answers or to get the support is more important that one person being the solution, you know”?

Speaker 3: “It’s all about the BIM model, BIM specialists who actually develop their skills. And, yes right sometimes BIM managers could be absolutely amazing with Revit BIM modelling, you know, even TEKLA or stuff but some managers could have no idea about it…… it could be a good lead, a good BIM experienced person who actually fancies the work and is interested in developing himself, and encouraging to share the knowledge…….And I would say that companies should hire people who are passionate about them that can bring the experience….someone who is really, really interested to implement the new stuff…….when we are sharing , when we are helping someone , we are looking for a solution, and we are also developing and we are also growing. And that’s the way it should be.”

Chapter 5 Discussion

The implementation of BIM in an organisation has been referred to as organisational BIM transformation. Organisational BIM transformational is multi- faceted. On a macro level it involves the entire process of conceptualising BIM as a medium through which the fundamental work, production, business, and economic elements of industry are changed. On a more micro level, this requires the substitution of digital technologies and the innovative use of BIM to gather, process and manage information with the view to enhancing efficiencies (Olugboyega 2022).

This research is broadly concerned with factors which affect successful BIM transformation with a particular focus what constitutes effective BIM training. Specifically, the research objectives of this study were to (i)Investigate the impact of differential approaches to BIM training on BIM use (ii) Investigate the impact of training on attitudes toward BIM (iii) Determine whether years of industry experience and self-rated BIM expertise impacts participants' attitudes towards and use of BIM? and (iv) Identify potential barriers to BIM adoption. These research objectives were explored using a mixed methods approach. An online survey questionnaire explored the relationships between demographic factors such as; the length and quality of participants BIM career, training, and experience, BIM Use, attitudes toward BIM and organisational factors. The findings of the survey questionnaire were used in addition to the relevant research literature as the basis to generate the questions for a focus group of industry professionals, run with the purpose of attaining more in-depth, qualitative data to expand on data acquired from the quantitative findings.

5.1 Quantitative Findings

5.1.1 Survey Results

The variation in what constitutes BIM usage and training in the literature (Pena 2011, Shojaei et al. 2022) was echoed in both the quantitative and qualitative findings of this present study. The majority of survey respondents identified as engineers. Over 92% of respondents had five or more experience working in the AEC industry. In addition to demographics, the survey addressed questions related to BIM training, BIM use, attitudes toward BIM and organisational factors. Based on the survey results there was an equal spilt between (23.08%) respondents use of BIM as a modelling tool and as an information management platform. Interestingly, an equal number of participants indicated that they had undergone formal BIM training as being self-taught with, the majority of participants (66.67%) rating the training they had received as somewhat or very effective. Approximately one third of participants received no training in AutoCAD 2/3D modelling, Revit or Navisworks. Despite, the variation in BIM usage and training BIM training was viewed as having positive benefits on enthusiasm and confidence in BIM skills. In addition, BIM training was viewed as positively impacting job performance. Specifically, BIM training was rated as improving work process, communication, knowledge, and project completion times in that order. Taken together the survey

results confirm the importance of training on attitudes toward BIM and BIM usage. This is consistent with the research literature which repeatedly references the importance of training in successful BIM transformation (Pena, 2011, Ghaffarianhoseini et al. 2017, Shojaei et al. 2022, Olugboyega's ,2022)

Survey respondents endorsed initial time costs, financial costs, negative perception of BIM and initial reduced output as challenges to BIM transformation. Again, this very much reinforces the research literature which identifies awareness, demand, industry culture, cost, project scale, technology, laws and standards, processes, management, interoperability, technology, and skills as challenges to BIM adoption. (Abdulfattah et al. 2017; van Neuren 2020; Sriyolja et al. 2021). In terms of organisational support, a substantial majority (87%) of respondents felt that BIM could be used differently in their work environments. Participants rated increased organisational understanding of BIM as the most important change that would be required to facilitate this. This is in keeping with the literature on the widespread misconceptions of BIM in the AEC industry (Ibrahim 2006) and the importance of educating all relevant stakeholders in BIM training to address these (Farouk et al. 2023). Respondents to the survey also endorsed the importance of an onsite BIM mentor, increased opportunity to practice on the job and increased resources as important factors. Increased opportunity to practice on the job has been identified in the literature as important. There is an acknowledgment that completing isolated courses without organisational support to consolidate and progress learning within the work setting is ineffective approach to BIM training (Olugboyega's, 2022)

5.1.2 Statistical Analysis

The present study was unable to determine whether there was a statistically significant relationship between i) H1: participants age and BIM use ii) H2: years of work experience and type of BIM use iii) H5: type of BIM training and BIM use and iv) H6: self -rated level of expertise and BIM use.

There was no statistically significant relationship found between years of work experience and self-rating of BIM expertise (H3) and between years of work experience and confidence using BIM (H4).

There was a strong positive correlation between confidence in BIM use and frequency of use (H8). There was a strong positive correlation between confidence using BIM and the likelihood of a person recommending the implementation of BIM workflow to their company and/or fellow professional (H9). There was a moderately strong relationship found between frequency of using BIM and the likelihood of recommending BIM as a workflow. So, people who are confident in their BIM skills use BIM more often and are more likely to recommend using BIM as a workflow in a work setting. This is important because recommending BIM as a workflow is using BIM in high level function as an information management platform beyond it's more basic use as a modelling tool.

People who use BIM more frequently are more likely to recommend BIM to be used. While there are no

specific statistical results regarding training that can be discussed, it is reasonable to countenance that confidence in BIM skills could potentially be related to training. The strong relationship between confidence and BIM usage also points to the importance of cultural factors. Specifically, confidence as an attitude towards how someone approaches BIM directly impacts how often it is used and how it is used. The literature shows that some of barriers to BIM usage derive from perceptions that BIM is too complex and too hard to access (Sriyolja et al, 2021). Enhancing employee confidence in their BIM skills, via training as one potential medium could directly address this barrier.

BIM transformation is seen as crucial to making meaning of BIM implementation in industry (Troiani et al 2020). However, the findings of this present study highlight the existence of a wide variation in knowledge, understanding, training, expertise, and implementation of BIM; and in how people come to work in BIM in the AEC industries (Theme 1: The Road to BIM), variations that seem both underpinned and driven in part by "Misconceptions of BIM" all of which are discussed in more detail in the qualitative analysis.

5.2 Qualitative Findings

The focus group was designed to obtain more information re participants experiences of BIM training, implementation, and the barriers to same. Three themes emerged from the qualitative data analysis (i) The Road to BIM (ii) Misconceptions of BIM and (iii) Skilling Versus Specific course. Variation in career pathway, knowledge, attitudes, understanding and misunderstanding in addition to BIM implementation and training underpinned all three themes.

5.2.1 Road to BIM

Participants described significant variation in how they came to be working in a BIM role, some participants pursued formal training in the area while other participants described themselves as responding to industry necessity *"blindly stepping into the world of BIM*". The lack of a clear pathway was mirrored by a lack of quality, validated information repositories to consult. Participants referenced the variation in BIM skills that exist in the AEC industries together with an occasional disparity between individuals' self-ratings of their BIM expertise and their practical abilities. Participants in this study referenced their experience of companies being committed to BIM transformation in theory but not in practice, with some citing the lack of time and support to practice and develop their skills as barriers to successful BIM transformation. From a managerial perspective, it was felt that time was a crucial factor, specifically allocating time in the right project as pivotal in progressing a companies' journey on the road to BIM. The importance of finding the balance between the initial costs, outlays and disruption to legacy business when actively pursuing BIM transformation is well established in the literature (Sriyolja et al 2021, Olugboyega 2022)

5.2.2 Misconceptions of BIM

Participants in the focus group felt that there were fundamental misconceptions as to what BIM is and how it

is used. This echoes the body of work by Ibrahim (2006) who emphasises the need to shift focus from traditional ways of introducing BIM technologies from interface and functionalities to a more comprehensive understanding of core concepts, in order to address the significant misconceptions that exist with regard to BIM in AEC. Participants also felt that the professional background and the varying perspective and priorities of individual disciplines 'to get the job done' influenced misunderstanding and conceptions of BIM. Davis and Songer (2002) too found that professional background was an influencing factor on resistance to IT change in the AEC industries.

In order to address the widespread misconceptions of BIM negatively impacting BIM transformation, researchers have called for BIM knowledge, skills, and capabilities to be emphasised and encouraged across all strata of the AEC industries with both bottom up and top-down approaches. It has been forwarded that BIM implementation will necessitate steadily larger modifications to the organisations work practices, BIM mentoring and tutoring and the creation of new roles (Olugboyega 2022). This present study identified the need for one such new role; one of a formalised in-house BIM mentor/mentoring programme. Both the literature and participants in the present study assert that the individuals appointed to these roles need to be skilled and passionate about BIM transformation viewing "*BIM transformation as an opportunity rather than a danger, such individuals would greatly contribute to BIM transformational efforts* (Olugboyega's 2022, p.14).

Theme 3 "Skilling Versus Specific Course" of the qualitative thematic analysis of the present study further expands on the skills element of BIM training and transformation.

5.2.3 Skilling versus specific course

Much of the existing literature on BIM training in the construction industry tends to focus on formal education and specific, institution-based courses (Shojaei et al 2022). However, participants in the focus group highlighted the importance of knowledge, experience and confidence in learning and applying BIM to real world settings to maximise acquisition. This mirrors the importance of real-world context in 'skilling', real world competencies necessitate collaborative interdisciplinary working. This 'skilling' as opposed to being trained is the context in which BIM transformation happens on the ground (Harris & Alves, 2020, Herrera et al. 2021). This finding is in line with Olugboyega's (2022) paper suggesting that employees that have just undergone BIM training do not immediately display BIM proficiency, that rather BIM skilling involves continuous learning and growth while advocating for each individual employee to have a personal BIM transformation plan.

Again, the findings of this study firmly support this assertion while also identifying a formal in -house mentoring scheme as a medium through which personal BIM transformation strategies could be pursued. The participants in the focus group highlighted the need for the person fulfilling the role of BIM mentor to have the correct attributes, to be knowledgeable, positive, and enthusiastic regarding BIM transformation. The

importance of this is also echoed in the research. In addition to the importance of technical ability, Olugboyega (2022) points to the importance of accomplished interpersonal attributes of a BIM leader including a positive attitude toward creating a cultural of collaboration to progress BIM transformation.

Linking this to the research on cultural change, it is possible that such a formalised mentoring system could address many of the cultural factors identified in the literature as negatively impacting BIM transformation such as attitudes toward BIM and resistance to change (Davis and Songer, 2002). Whilst certain aspects of BIM training needs e.g. technical and software-related competencies can be realised via formal training, this real -world learning can only be gained through internal, firm-based training or on projects (Harris & Alves, 2020, Herrera et al. 2021). This is extremely important highlighting the relevance, in fact the necessity of firm-based BIM mentoring/training if BIM transformation is to be successful (Shojaei et al 2022).

5.3 Limitations and future studies.

There were a number of limitations of this study. There were too many category options included in some of the survey questions. Consequently, too few responses in these categories precluded statistical analysis on some of the questions including the training questions. The ability to statistically analysis the relationship between training and the other research variables would have strengthened the findings of this study. In addition, not all participants answered all of the survey questions. It is difficult to ascertain whether this was by deliberate or accidental omission. These missing values also impacted the statistical analysis that was able to be conducted. As the survey was digital in nature, it would have been of potential benefit to include a notification of missing responses to participants, while they were completing the survey tool with a view to prompting them to complete the questions thus reducing the number of missing values.

This study did not specifically target BIM training providers as participants. This would have been informative as to the specific types of BIM training currently available and the providers experiences of the relationship between BIM training and knowledge, usage, and implementation. Future research could include focusing on the relationship between specific disciplines in the AEC industries and BIM understanding, training, and application.

Future studies could conduct specific focus groups with different professional groups and participants with different industry roles i.e. technicians, BIM managers, construction managers, architects etc., to further elucidate the relationship between training, BIM expertise, BIM implementation together with the individual and organisational factors that both facilitative and hamper this.

Comparative studies between organisations with in-house mentoring programmes and those without and the consequential impact on a variety of BIM related factors such as attitudes, confidence, understanding, expertise, usage, productivity, and economic outcomes could also be explored.

Chapter 6 Implications of this study

The findings of this research strongly support the need for formal BIM training pathways, in addition to the provision of in-house mentoring programmes in the AEC industries. These mentoring programmes need to facilitate the time to consolidate learning that is acquired from the wide variety of avenues that professionals acquire their BIM skills and find themselves working in BIM roles such as; transitioning into roles out of organisational necessity, learning on the job, formal training and/or a mix of the aforementioned.

Formal inhouse mentoring programmes need to be a specific designated role, valued, and recognised by employers and not just another task added onto the BIM managers workload.

It is recommended that each organisation either maintains their own repository of quality, evidence-based BIM education and training materials and/or facilitates access for employees at all levels to same.

People that are more confident in their BIM skills are more likely to use BIM more frequently and recommend it as a workflow on an organisational level. All relevant parties in the AEC industry should be trained in the core concepts of BIM, to enhance confidence, understanding of the processes and technologies counteracting the inter disciplinary and inter role disparities which currently exists.

This study highlights the fundamental role that training specifically the addition of in-house mentoring programmes could also play in providing i) clear pathways via which people could pursue careers in the BIM, ii) addressing the fundamental misconceptions which exist regarding BIM and iii) crucially ensuring that BIM transformation is successfully driven by skilling and not the lesser effective dependence on specific courses or training isolated from real world practice and applicability.

Chapter 7 Conclusion:

This study used mixed methodologies to explore the relationship between approaches to BIM training and successful BIM transformation in the AEC industry.

Thirty-eight participants completed an online survey designed to investigate (i) demographic factors, (ii) BIM training (iii) BIM use (iii) attitudes toward BIM (iv) organisational factors. The survey findings formed the basis of the quantitative analysis. The significance of training emerged as an important variable in BIM transformation both in the quantitative and qualitative findings. A similar number of survey respondents indicated that they had received formal BIM training as had those that categorised themselves as self-taught. BIM training was viewed as positively impacting enthusiasm for BIM, confidence in using BIM skills and improved job performance.

Despite not being able to statistically investigate the relationship between training, attitudes toward BIM and BIM use. Statistical analysis revealed a strong relationship between confidence in use of BIM skills, frequency of BIM use and likelihood of recommending BIM to be used in its high-level capacity as a workflow management system. A moderately strong relationship was revealed between frequency of BIM use and likelihood of recommending it as a workflow practice. This highlights the importance of attitudes and cultural (people) factors in BIM transformation.

A focus group was conducted to obtain more in-depth information on participants experiences of BIM training, BIM use and the barriers to successful BIM transformation in the AEC industry. Thematic Analysis revealed three qualitative themes i) The Road to BIM ii) Misconceptions of BIM and iii) Skilling Versus Specific Course. Variation in how people came to work in BIM, variation in people's understanding of BIM and variation in training processes permeated the results.

Focus group participants distinguished between attending a specific BIM training course and 'skilling' in BIM. The latter synonymous with 'on the job' consolidation of learning and real-world applicability. The importance of organisational support as an influential factor in successful BIM training and BIM transformation was highlighted. The value of 'bottom up' and 'top down' approaches to BIM training including all relevant stakeholders is emphasised. The importance of organisations facilitating employee access to quality BIM training and support materials was also highlighted.

It is clear from the literature and the findings of the present study that significant change initiatives such as BIM transformation are not easily implemented in the AEC industry (Songer and Davis, 2002 Olugboyega 2022). This current study identified the initial time and financial costs associated with BIM adoption in addition to negative perceptions of BIM in the AEC industry and the initial negative impact on productivity and output as challenges to BIM transformation.

In order for organisations to overcome barriers to BIM transformation, it is necessary to extend/ refine current training practices and/or innovate with strategic thinking and enhanced organisational structures (Lindblad & Gustavsson,2021). The findings of the present study point to the importance of an in-house mentoring programme as one of those necessary strategic and innovative changes.

Based on the research literature and the findings of the present study, an in-house mentoring programme is forwarded as a means of addressing the variation that exists in BIM training and BIM implementation. This pathway needs to be recognised as a distinct role within organisations and not just additional to the BIM managers workload in order for it to be effective. It needs to be championed by people not only with BIM knowledge but also those with the enthusiasm and leadership skills to address business and cultural factors in BIM transformation.

The widespread adoption of formal in-house mentoring/training programmes could function to address differences in attitudes toward BIM and remediate some of the misconceptions that currently exist and function as barriers to BIM transformation. Such guidance would help to minimise the disruption to legacy business during the initial process of BIM transformation. Internal mentoring programmes would also address the current variation in individual employee's BIM skills while simultaneously structuring formal career pathways which lead to BIM roles, all of the aforementioned factors are identified in the current study as barriers to BIM transformation. So, taken together, the findings of this study affirm the importance of BIM training, ideally including in-house formal mentoring programmes in successful BIM transformation in the AEC industry.

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Appendix A: Project Specification

ENG4111/4112 Research Project

Project Specification

For: Cameron Sunnerdale

Title: Mixed methods study exploring the relationship between approaches to BIM training and the use of BIM as an information management platform

Major: Bachelor of Engineering (Honours) Civil

Supervisors: Belal Yousif, David Thorpe

Enrolment: ENG4111 – EXT S1, 2023
ENG4112 – EXT S2, 2023

Project Aim: This project is concerned with exploring the nature of BIM training and the potential impacts on professionals' attitudes toward and implementation of BIM in the AEC industries.

Programme: Version 1, 15th March 2023

1. Research subject matter and complete literature reviews on same
2. Survey Development –
    a. Liaise with project supervisor on research format and questionnaire scoring so data can be analysed.
    b. Create questionnaire.
3. Quantitative data collection:
    a. Make initial contact with participants outlining nature and purpose of study.
    b. Obtain participant consent to send questionnaire.
    c. Publish questionnaire and await response, (suggested time frame of 20 days (4 work weeks))
4. Qualitative Data collection:
    a. Prepare for focus group – setup web meeting parameters.
5. Data analysis:
    a. Run a number of statistical analyses to develop qualitative results.
6. Review results and write up conclusions discussing potential outcomes and recommendations of the research.

Appendix B: Risk Assessment

University of Southern Queensland **Offline Version**

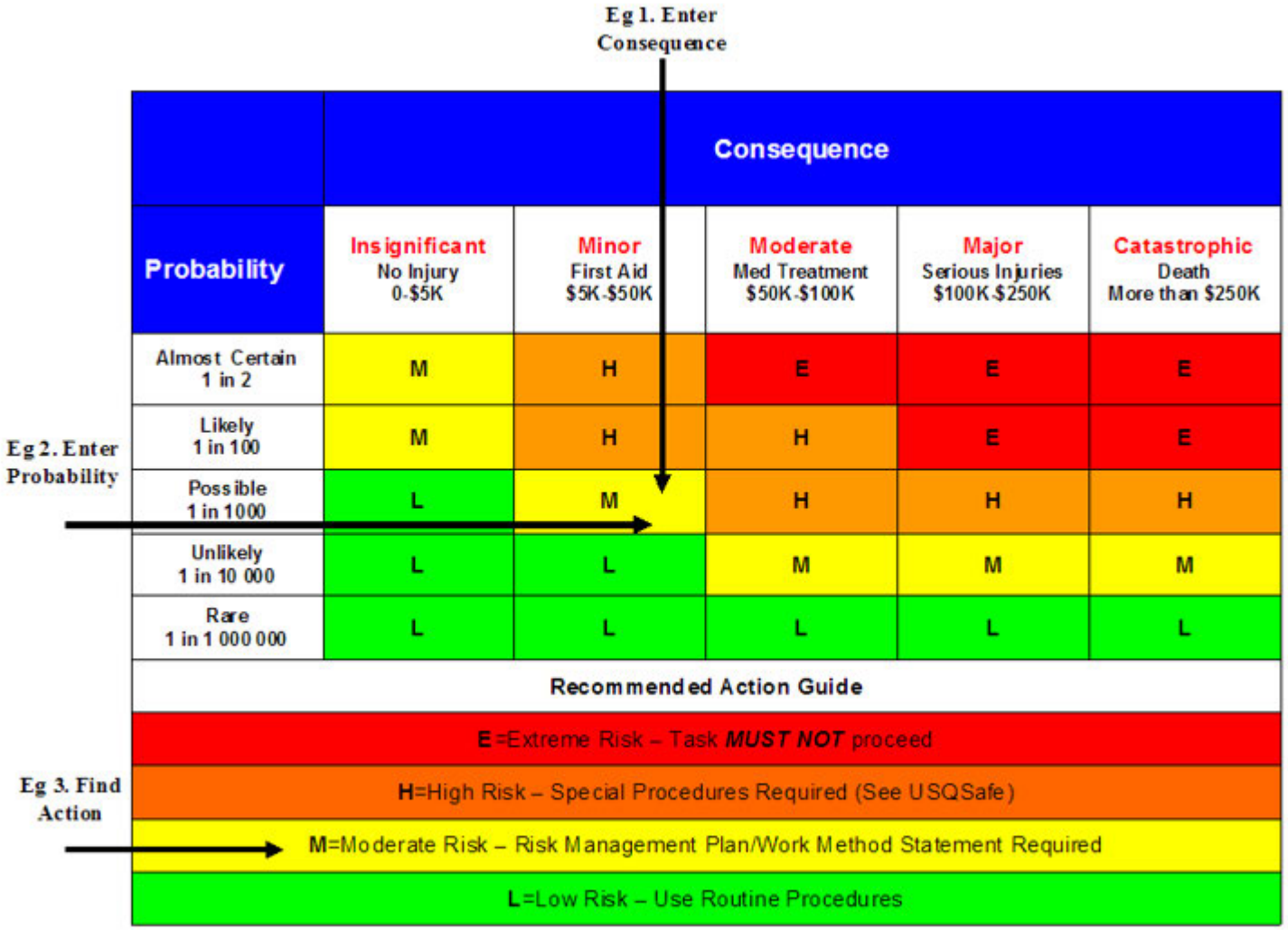
USQ Safety Risk Management System

Note: This is the offline version of the Safety Risk Management System (SRMS) Risk Management Plan (RMP) and is only to be used for planning and drafting sessions, and when working in remote areas or on field activities. It must be transferred to the online SRMS at the first opportunity.

Safety Risk Management Plan – Offline Version			
Assessment Title:	Assignment 3 - Potential Research Proposal	Assessment Date:	12/10/2022
Workplace (Division/Faculty/Section):	School of Engineering	Review Date:(5 Years Max)	20/02/2023

Context			
Description:			
What is the task/event/purchase/project/procedure?	Acadmic Reseach Project in to the effect/impact of training in BIM and implimentation rates		
Why is it being conducted?	This research is being undertaken to explore in depth the factors impacting perceptions and adoption of BIM software as an information management tool with a focus on an overarching relationship to training between the length and quality of participants BIM training/experience and their perceptions, motivations and use of BIM technologies and processess		
Where is it being conducted?	This research will be conducted via email, on line forms and the assembly of a single focus group		
Course code (if applicable)	ENG4110 - Research Methodology	Chemical name (if applicable)	N/A
What other nominal conditions?			
Personnel involved	Cameron Sunnerdale, From industry - Online survey participants, Focus group participants		
Equipment	Folding tables, chairs, projector, Desktop Computers, computer mice & keyboard, web camera's, paper, writing impliments		
Environment	Online, Hotel Conference room for focus group meeting		
Other	N/A		
Briefly explain the procedure/process	This study will use a mixed method methodology. Quantitative data will be collected by survey questions. Survey questions will examine participants use of BIM an information management tool and also their respective levels of training and opportunities to practice/integrate BIM into their daily practice post training. A convenience sample will be used with surveys sent to professional contacts. Potential participants will be contacted first via phone/		

	online/ in person where appropriate to explain the purpose of the study and to seek consent to participate. Surveys will be sent via the preferred method indicated at initial contact (i.e., emailed/mailed) .The qualitative data will be collected via an online focus group, which will consist of eight participants that completed the survey. The focus group session will be recorded for the purposes of data analysis. The focus group will aim to explore in depth participants experience of BIM, barriers and facilitators to adoption/implementation and the relationship if any to their experience of training. Thematic Analysis will be used to analyse the qualitative data.
Assessment Team - who is conducting the assessment?	
Assessor(s)	Cameron Sunnerdale
Others consulted:	Dr Marcia ward - Clinical Nueropsychologist for planing of survey questions and setup of environment controls


Eg 1. Enter Consequence
Eg 2. Enter Probability
Eg 3. Find Action
Consequence
Probability
Insignificant
No Injury
0-$5K
Minor
First Aid
$5K-$50K
Moderate
Med Treatment
$50K-$100K
Major
Serious Injuries
$100K-$250K
Catastrophic
Death
More than $250K
Almost Certain
1 in 2
M H E E E
Likely
1 in 100
M H H E E
Possible
1 in 1000
L M H H H
Unlikely
1 in 10 000
L L M M M
Rare
1 in 1 000 000
L L L L L
Recommended Action Guide
E=Extreme Risk – Task MUST NOT proceed
H=High Risk – Special Procedures Required (See USQSafe)
M=Moderate Risk – Risk Management Plan/Work Method Statement Required
L=Low Risk – Use Routine Procedures

Step 1 (cont)	Step 2	Step 2a	Step 2b	Step 3			Step 4				
Hazards: From step 1 or more if identified	***The Risk:*** What can happen if exposed to the hazard without existing controls in place?	***Consequence:*** What is the harm that can be caused by the hazard without existing controls in place?	***Existing Controls:*** What are the existing controls that are already in place?	***Risk Assessment:*** Consequence x Probability = Risk Level			***Additional controls:*** Enter additional controls if required to reduce the risk level	***Risk assessment with additional controls:***			
				Probability	**Risk Level**	**ALARP? Yes/no**		**Consequence**	**Probability**	**Risk Level**	**ALARP? Yes/no**
Example											
Working in temperatures over 35° C	Heat stress/heat stroke/exhaustion leading to serious personal injury/death	catastrophic	Regular breaks, chilled water available, loose clothing, fatigue management policy.	possible	high	No	temporary shade shelters, essential tasks only, close supervision, buddy system	catastrophic	unlikely	mod	Yes
Exposure to COVID-19 from contaminated surfaces and/or another person	Contracting the virus and subsequent illness	Major	Compliance with the Industry Approved COVID Safe Plan for Events (completed COVID Safety checklist and signed Statement of Compliance attached). Adjustments for vulnerable persons included in plans.	Unlikely	Moderate	Yes	Ensuring windows are left open with adequate ventilation, face masks worn at all times, and required social distance of min 1.5m maintained between participants	Minor	Unlikely	Low	Yes
Venue emergency evacuation incase of fire	unable to escape from premises due to malfunctioning safety equipment or blocked egress	Catastrophic	regular review and testing of warning/alert systems and review of egress routing to ensure clear path of travel, ensure al trip hazards have been removed	Rare	Low	Yes	Peform check of venue prior to commencment to ensure all safety requirements are met and functioning	Insignificant	Rare	Low	Yes
travelling to focus group venue	potential for motor vehicle accidents or personal injury	Major	following of road rules whilst using motor vehicle, following instruction on safe use of public transport, watching for change in grade on approach to venue	Unlikely	Low	Yes	emsure plenty of rest taken prior to driving, no alcohol or drugs have been consumed	Minor	Possible	Low	Yes
Manual handling from equipment	Injury from inappropriate handling of heavy equipment	Moderate	Trolleys, team lift and manual handling training has been provided	Unlikely	Moderate	Yes	mechanical liftng equioment to be provided if required	Minor	Unlikely	Low	Yes

Step 1 (cont)	Step 2	Step 2a	Step 2b	Step 3			Step 4				
Hazards: From step 1 or more if identified	***The Risk:*** What can happen if exposed to the hazard without existing controls in place?	***Consequence:*** What is the harm that can be caused by the hazard without existing controls in place?	***Existing Controls:*** What are the existing controls that are already in place?	***Risk Assessment:*** Consequence x Probability = Risk Level			***Additional controls:*** Enter additional controls if required to reduce the risk level	***Risk assessment with additional controls:***			
				Probability	**Risk Level**	**ALARP? Yes/no**		**Consequence**	**Probability**	**Risk Level**	**ALARP? Yes/no**
Example											
Working in temperatures over 35° C	Heat stress/heat stroke/exhaustion leading to serious personal injury/death	catastrophic	Regular breaks, chilled water available, loose clothing, fatigue management policy.	possible	high	No	temporary shade shelters, essential tasks only, close supervision, buddy system	catastrophic	unlikely	mod	Yes
and collateral movement											
Consumption of provided food	food poisoning or choking, food based alergic reactins	Major	ensure food is free of alergens as practicably poosible and food contents are visible for review, ensure food is free from or reduced risk of causing choking (ie no chicken wings as bones can be swallowed)	Rare	Low	Yes	n/a	Minor	Possible	Low	Yes
		Select a consequence		Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No
		Select a consequence		Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No
		Select a consequence		Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No
		Select a consequence		Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No
		Select a consequence		Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No
		Select a consequence		Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No
		Select a consequence		Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No
		Select a consequence		Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No
				Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No
				Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No
				Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No

Step 1 (cont)	Step 2	Step 2a	Step 2b	Step 3			Step 4				
Hazards: From step 1 or more if identified	***The Risk:*** What can happen if exposed to the hazard without existing controls in place?	***Consequence:*** What is the harm that can be caused by the hazard without existing controls in place?	***Existing Controls:*** What are the existing controls that are already in place?	***Risk Assessment:*** Consequence x Probability = Risk Level			***Additional controls:*** Enter additional controls if required to reduce the risk level	***Risk assessment with additional controls:***			
				Probability	**Risk Level**	**ALARP? Yes/no**		**Consequence**	**Probability**	**Risk Level**	**ALARP? Yes/no**
Example											
Working in temperatures over 35° C	Heat stress/heat stroke/exhaustion leading to serious personal injury/death	catastrophic	Regular breaks, chilled water available, loose clothing, fatigue management policy.	possible	high	No	temporary shade shelters, essential tasks only, close supervision, buddy system	catastrophic	unlikely	mod	Yes
				Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No
				Select a probability	Select a Risk Level	Yes or No		Select a consequence	Select a probability	Select a Risk Level	Yes or No

Step 5 - Action Plan (for controls not already in place)			
Additional controls:	*Resources:*	*Persons responsible:*	*Proposed implementation date:*
			Click here to enter a date.
			Click here to enter a date.
			Click here to enter a date.

Step 6 - Approval					
Drafter's name:	Cameron Sunnerdale			Draft date:	5/10/2022
Drafter's comments:	Final year research project - no laboratory work required, al research conducted via email and focus groups				
Approver's name:	Dr David Thorpe	Approver's title/position:	Associate Professor (Engineering/Technology Management) | B418		
Approver's comments:					
I am satisfied that the risks are as low as reasonably practicable and that the resources required will be provided.					
Approver's signature:				Approval date:	Click here to enter a date.

Appendix C: Human Ethics Application ETH2023-0200

HREC Project approval date: 20/09/2023

Ethics ETH2023-0200 (HREC): Mr Cameron Sunnerdale (Student) (Low risk): Application

Home

Institution Root

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Accessibility

Title	Mixed methods study exploring the relationship between approaches to BIM training and the use of BIM as an information management platform
Principal Investigator	A/Pr David Thorpe
Host Department	School of Engineering
Co-Investigator	Mr Cameron Sunnerdale (Student) (School of Engineering)

Show comments Show changes

Overview

Application initiated by:

Mr Cameron Sunnerdale (Student)

Ethical Considerations

Are you working with animals or humans?

Humans

Do you have a current approval from another Ethics Committee to conduct this project?

No

Project title

Mixed methods study exploring the relationship between approaches to BIM training and the use of BIM as an information management platform.

Project summary

This study will use a mixed methods methodology. Quantitative data will be collected by survey questions. Survey questions will examine participants use of BIM an information management tool and also their respective levels of training and opportunities to practice/integrate BIM into their daily practice post training. A convenience sample will be used with surveys sent to professional contacts. Potential participants will be contacted first via phone/ online/ in person where appropriate to explain the purpose of the study and to seek consent to participate. Surveys will be sent via the preferred method indicated at initial contact (i.e., emailed/mailed). The qualitative data will be collected via an online focus group, which will consist of eight participants that completed the survey. The focus group session will be recorded for the purposes of data analysis. The focus group will aim to explore in depth participants experience of BIM, barriers and facilitators to adoption/implementation and the relationship if any to their experience of training.

Host department

School of Engineering

Project duration

1 year

Is your research being conducted within Australia?

No

If your project is outside of Australia, provide further details of where you plan to conduct this project.

This project will be undertaken from Ireland where I reside. Using online forums and my own industry contacts I will conduct survey and online focus group.

Does this project relate to, and/or extend on a previously approved project.

No

Is this project funded?

No

Investigators

Principal Investigator

A/Pr David Thorpe

UniSQ ID

[redacted]

Person type

Staff

Organisational area

School of Surveying and Built Environment

Other affiliations

Field of Research (FoR)

400599. Civil engineering not elsewhere classified; 409999. Other engineering not elsewhere classified.

Co-investigator (UniSQ Staff)

Co-investigator (UniSQ Student)

Mr Cameron Sunnerdale (Student)

UniSQ Student ID

[redacted]

Type of student:UGRD Student

Program

BENH - Bachelor of Engineering (Honours)

Organisational area

School of Engineering

Field of Research (FoR)

Does the project involve co-investigators from another university or organisation?

No

Conflict of interest

Does the Principal Investigator have an actual, perceived, or potential personal or financial Conflict of Interest (CoI) in relation to the project?

No

Do any of the Co-Investigators or External Investigators have an actual, perceived, or potential personal or financial Conflict of Interest (CoI) in relation to the project?

No

Outline the Conflict of Interest (CoI) and advise on how it will be managed.

Qualifications and Experience

Principal Investigator - qualifications and experience

Principal Investigator

A/Pr David Thorpe

Qualifications relevant to project

Name David Thorpe

Position Associate Professor (Engineering/Technology Management)

Section School of Surveying and Built Environment

Experience relevant to project

Research interests

Sustainability and resilience, including the sustainable use of materials and methods in engineering projects.

Engineering and technology management (for example, asset, project, risk, innovation management).

Developing the knowledge and skills in professionals to engineer positive change.

Co-Investigator - qualifications and experience

Co-Investigator

Mr Cameron Sunnerdale (Student)

Qualifications relevant to project

Qualified Structural draftsperson (Diploma of Civil engineering, Toowoomba Tafe 1995) and BIM Manager BIM Level 2 Certification to iso19650

Experience relevant to project

5+ years' experience as a BIM Manager within the engineering and pharmaceutical sector in Ireland.

Company BIM Manager responsible for training and development of BIM processes and outcomes

Autodesk Certified Revit Instructor/Trainer

Operational Items

Does this project include:

not applicable

The following options were available for selection:

- Genetically Modified Organism (GMO)
- biological material (non-GMO), e.g. work with toxins, mutagens, teratogens, carcinogens etc.
- biological material native to Australia that was (or will be) collected in Queensland for commercial purposes.
- radioactive substances and/or ionising radiation? (e.g. DXA, X-ray)

Does this project include:

not applicable

The following options were available for selection:

- the export, supply, publishing, or brokering of controlled goods, software, or technology.
- an arrangement with a foreign government or foreign university that does not have institutional autonomy not applicable.
- not applicable

If you have not previously submitted a Research Data Management Plan (RDMP) please provide details around 1. Storage, 2. Access, 3. ownership and 4. sharing research data.

There will be three (3) copies made of the electronic data and associated documentation for this research, which will be stored as follows.

The primary research storage will be the Principal Investigator's password protected desktop computer

supplied by the University.

A back-up copy of this will be stored on the Principal Investigator's password protected University of Southern Queensland One Drive storage facility.

A second back-up copy of this electronic data and backup will be stored on the University's Redbank cloud storage facility.

Data will be kept for 5 years. Consent forms will be retained for 15 years.

Data will be the property of the University of Southern Queensland, will not be shared with other parties other than as outlined under "Data Collection and Access."

Additional Information

Do you have a UniSQ Risk Management Plan relating to the activities being undertaken in this project?

No

Ethical considerations - Human

Participant involvement

In what way are human participants involved in your project:

Direct recruitment and/or observation of human participants

Yes

How many groups of participants will you be recruiting and/or observing for this research project?

2

Existing data sets and/or archival data

No

Existing Human biospecimens

No

Genomic research (includes full scope of genetic research)

No

Clinical trials

No

Aims and significance.

Background

Information Modelling BIM Acceleration Committee (WEF, 2018). BIM creates detailed digital representations from multi-disciplinary data inputs, managed in real time in an open cloud platform (BIM Benefits | Why Use BIM? | Autodesk). BIM is viewed as an environmentally sustainable approach to better information sharing, better decision -making, and cost savings; with even some asserting that "BIM is the future" (Routledge 2021)

The evolving digital transformation in the global architectural, engineering, and construction (AEC) industry has been a driving factor for firms and practitioners to adopt Building Information Modelling BIM

Acceleration Committee (Shojaei et al. 2022). BIM creates detailed digital representations from multi-disciplinary data inputs, managed in real time in an open cloud platform (Autodesk). BIM is viewed as an environmentally sustainable approach to better information sharing, better decision -making, and cost savings; with even some asserting that "BIM is the future" (Routledge 2021)

Despite the seemingly clear reasons for BIM adoption, this has not directly translated into its widespread use. Previous research has identified a number of contributing factors to hesitancy in industry professionals and companies in using BIM as an informational management took (van Neuren 2020).While, the barriers to BIM implementation can differ from one country to another based on differing domestic contexts (Sriyolja et al. 2021) ,there have been some universal challenges to BIM implementation identified in the literature including: awareness, demand, industry culture, cost, project scale, technology laws and standards, processes, management, interoperability, technology, and skills, ((Abdulfattah et al. 2017), (van Neuren 2020),(Sriyolja et al. 2021)). In terms of the latter, the existence of a skilled workforce has a direct impact on the adoption BIM (Ghaffarianhoseini et al. 2017). Consequently, training has been identified as a pivotal element in the successful uptake and implementation of BIM, not only as a modelling tool but in its wider intended use as an information flow management tool ((Autodesk 2008) ;(Pena 2011)).

There appears to be no consistency in what constitutes BIM training in AEC industries, this varies from short CPD courses to BIM training integrated into formal bachelors and masters' programmes, to PhD research, to formalised inhouse training and 'learning on the job' (Pena 2011). The thesis behind this proposal came from my own professional experience as a qualified BIM trainer in the AEC industries, that is; in addition to learning BIM and introduction to programmes such as Revit, professionals need to be afforded the time and support to integrate their learning into their everyday professional practice. This learning consolidation process needs to be acknowledged and supported by industry with clear formal support pathways identified within companies via which this can be facilitated. Upon exploration, my personal experience and this thesis is supported in the expanding research literature (Shojaei et al. 2022)

This research proposes to build on previous research conducted by (van Neuren 2020) that examined the relationship between the use of BIM software as an information management tool and the users' own perceptions of BIM. Specifically, this project proposes to examine the relationships between the length and quality of participants BIM training/experience, their length of time working in the industry, perceptions and attitudes toward BIM and the manner in which they utilise it in their work.

Aims

This study will use a mixed methods methodology. Quantitative data will be collected by survey questions. Survey questions will examine participants use of BIM an information management tool and also their respective levels of training and opportunities to practice/integrate BIM into their daily practice post training. The qualitative data will be collected via an online focus group, which will consist of eight participants that completed the survey. The focus group will aim to explore in depth participants experience of BIM, barriers and facilitators to adoption/implementation and the relationship if any to their experience of training.

Specific Questions

Does the type of training received i.e., formal (typical 3-day CPD course) versus informal 'on the job

training' or a combination of both (formal training and the support to integrate learning into practice) impact participants 1) attitudes toward BIM usage 2) How they use BIM i.e. as a modelling tool or its full capacity as an information management platform?

Does years of industry experience and comfort with new technology impact participants attitudes and use of BIM?

Hypotheses

Participants who have completed formal training and have continued support from employers to integrate their learning into practice will be more likely to use BIM as an information management platform.

The initial costs (slowed productivity and increased human and financial resources) are barriers to BIM adoption.

Justification and significance

Understanding the impact of the different experiences of the study participants around BIM training is paramount to developing a better understanding of how individuals learn and process training information. By further exploring how post training support for individuals and companies can be better provided we can develop a training framework that can be delivered and implemented through not only the AEC industry but potentially across all industry streamlining the approach to BIM training and education.

Making training more accessible

Has your project been peer reviewed?

No

Type of Research

Do you have adequate resources available for this research project?

Yes

What type of research are you undertaking in this project?

quantitative

qualitative

The following options were available for selection:

- medical (can be interventional, observational, or lab-based)
- clinical
- biomedical
- epidemiological
- clinical trial
- use of drug or therapeutic device
- mental health
- public health
- dental
- action

- quantitative
- qualitative
- case study
- social science
- oral history/biographical
- other

Identifying participant group/s

Will there be direct recruitment or use of existing data and/or tissue from any of the following participant groups?

people residing outside Australia.

people who would be considered to use English as a Second Language (ESL)

people who would be considered to use English as a Foreign Language (EFL)

The following options were available for selection:

- women who are pregnant, the human foetus, or human foetal tissue
- children or young people under the age of 18 years
- people with a cognitive impairment, an intellectual disability, or a mental illness
- people considered to be a forensic or involuntary patient.
- people with impaired capacity for communication
- prisoners or people on parole
- people highly dependent on medical care, including a person who is unconscious.
- military personnel
- military veterans
- people who would not usually be considered vulnerable but would be considered vulnerable in the context of this project.
- Aboriginal and/or Torres Strait Islander peoples
- hospital patients
- people residing outside Australia.
- people who would be considered to use English as a Second Language (ESL)
- people who would be considered to use English as a Foreign Language (EFL)
- n/a (none of the participant groups above are target groups for this project)

Benefits and Risks

Benefits

The potential benefits of the project are:

- gains in knowledge, insight and understanding

Yes

Explain how this benefit will be achieved as a result of this research being conducted.

The results of the research will be reviewed and used to better inform BIM training practices. Specifically, factors identified to support BIM adoption and usage and any identified barriers will be highlighted. It is hoped that the research would be of sufficient quality to be presented at relevant industry events/conferences to disseminate the findings.

- improved social welfare

No

- improved individual wellbeing

No

- Other

No

Risks

The following types of risks (either short or long term) may occur due to participation in this project:

- physical (including injury, illness, pain)

No

- psychological (including feelings of worthlessness, distress, guilt, anger, or fear related, for example, to disclosure of sensitive or embarrassing information)

No

- social (including damage to social networks or relationships with others; discrimination in access to benefits, services, employment or insurance; social stigmatisation)

No

- devaluation of personal worth (including being humiliated, manipulated or in other ways treated disrespectfully or unjustly)

No

- economic (including the imposition of direct or indirect costs on participants)

No

- legal (including discovery and prosecution of criminal conduct)

No

- inconvenience (including taking the time to fill in the survey, participate in an interview etc)

Yes

Expand on this risk and its relevance to your project. Outline arrangements you will put in place to minimise this risk.

Individuals will be required to allot a small amount of time to complete the survey. Eight additional participants will be required to participate in a focus group. Survey and focus group will be facilitated by online platforms. A group contract will be drawn up at the beginning of the focus group. This will cover confidentiality, the management and storage of data, the voluntary nature of the group and the right of

participants to withdraw at any time. All participants will be provided with the researcher's professional contact details (work phone/email) should they require more information and/or have any queries at any stage of the research process.

- discomfort (including minor side-effects of medication, the discomforts related to measuring blood pressure, and anxiety induced by an interview)

No

- Other

No

Would any of the risk factors that you have identified above be potentially considered to be more than low risk factors?

No

Project Team

What is the level of risk for the project team?

Low

Outline the strategies that you have in place to address the level of risk to the project team?

In order to mitigate risk to the research in meeting unfamiliar people/in unfamiliar places to gather data (disseminate surveys/conduct in person focus groups) all data collection and research will be conducted via online mediums. This will remove the requirement for researchers to conduct in-person face to face interviews in favour of remote online interviews.

All questionnaires will be delivered to participants via online means such as email or industry forums and networking sites thus removing the requirement for the research team to visit the locations of potential be participants.

The focus group research will be conducted via online means only with a purposeful sample of individuals, thus removing the requirement for in person interaction. The researcher will have control of the software platform that the focus group will be hosted on, and as such will be able to use technological functions e.g. to mute participants in the un-anticipated event that a research participants behaviour becomes inappropriate to the context.

Data collection and access

Data Collection

Data Collection considerations

none of the above apply to this project.

The following options were available for selection:

- collection of data in a rural and remote setting
- travelling overseas to collect data.
- physiological or psychological testing of participants

- none of the above apply to this project.

Data Access

Will any research data be made available or shared via open access, restricted access, mediated access or as metadata only?

Yes

Provide further details about the data that will be made available/shared, and via what method.

All comments and responses will be treated confidentially unless required by law. The names of individual persons are not required in any of the responses.

As a participant the data collected may be made available for future and similar research purposes. The data will be stored and shared as non-identifiable data. If you would like the project summary of results you can request them by contacting the Research Team (contact details at the bottom of this form).

Any data collected as a part of this project will be stored securely as per University of Southern Queensland's Research Data Management policy.

Will any individual or organisation external to UniSQ (i.e. a third party) have access to the research data during the project?

No

Other Considerations

UniSQ Course projects

Are you a course leader intending to undertake this project as a UniSQ Course project?

No

Upload any relevant or supporting documentation.

Course information

Permissions to access participants

Are you required to obtain permission to access your group/s of participants?

No

Does your project include the recruitment of UniSQ staff or students?

No

Evidence of approval/endorsement

Monitoring your project

What will you do in cases where unexpected events or emergencies occur as a result of participation in this project?

All participants will be provided with the researchers contact details. Participants invited to the focus group will receive a reminder email detailing the day/ time of the group. Participants will then receive and email with the link to the meeting. The biggest potential risk in this research is likely to be participant/research technical difficulties. Should this happen, all participants will have the researchers' contact details and they can ring and receive support from the researcher re problem solving any technical difficulties.

Communication of findings

Publishing your findings

Method of Communication

research thesis

journal article

conference presentation (not published in proceedings)

If providing individual test results to each participant, what arrangements will be in place to deal with participant's distress in the case of adverse results?

The following options were available for selection:

- research thesis
- journal article
- book or book chapter conference presentation (not published in a proceedings)
- open access dataset
- published report to organisation or community group.
- private report to organisation or community group
- report to all participants
- executive summary of results
- individual test results to each participant (e.g. from physiological or psychological testing)
- media (e.g. article in "The Conversation")
- creative output
- other

Will the participants and/or other interested stakeholders be able to access these findings and/or request a copy of the summary of results?

Yes

Provide further information with regards to accessibility of these results

Once the research is completed. Each participant will be provided will a link to which they can access an online Executive Summary of the research.

When disseminating your findings, will participants be

non-identifiable (i.e. no individual or organisation can be identified)

The following options were available for selection:

- non-identifiable

- re-identifiable
- identifiable or presented in a manner which may allow some participants to be identified.
- other

Participant - Group 1

Group 1 name

Survey

How many individual participants are expected to be recruited in this group?

35

Describe the participants in this group:

A sample of convenience of 35 people working in Architecture, Construction and Engineering Industry who use BIM software in some capacity. There are no specific inclusion or exclusion criteria,

Where will this group of participants be recruited from?

The researcher will firstly contact prospective participants by either email or phone to introduce the research purpose and procedures. These prospective participants will be industry contacts of the researcher. Once consent to participate is obtained a survey link will be emailed to each individual. As the target sample are professionals proficient in design software use, it is not expected that the provision of on an online survey will disadvantage the sample in anyway.

Purposeful sampling will be used to recruit participants for the focus group. Eight individuals will be invited to attend on the basis of consent at the initial contact and also their knowledge and depth of experience in the area, with a view to maximising the richness of the date obtained.

Will any potential participants in this group be under 18?

No

Is there a pre-existing relationship between the participants and anyone involved in recruiting and/or collecting data from this group.

Yes

What is the nature of the pre-existing relationship, and will you be implementing any special precautions if these are unequal pre-existing relationships?

The researcher will use industry contacts to advertise and recruit for this research i.e., via linked in, contacting businesses directly. Potential participants will not be negatively impacted by a decision not to participate and there are no unequal relationships/power imbalances expected in the study.

Do these participants have any cultural needs?

No

Recruitment of Participants

How will you recruit participants?

Email

Personal contacts

Telephone

Mail-out

Other

If other, explain how these participants will be invited to be involved in the project.

Industry contacts and internet-based forums

Indicate how you will obtain the contact details of these participants.

from participants themselves

If from private or third party, or other source, provide further information around the source.

Provide details of who will be inviting participants and further explain the method/s they will use, as identified above.

The researcher (Cameron Sunnerdale) will be inviting participants directly.

Will you be offering payment or any other incentives to this group of participants?

No

Recruitment information

Data Collection

Method of collection

survey/questionnaire

Provide further details for this data collection method.

The researcher will firstly contact prospective participants by either email or phone to introduce the research purpose and procedures. These prospective participants will be industry contacts of the researcher. Once consent to participate is obtained a survey link will be emailed to each individual. As the target sample are professionals proficient in design software use, it is not expected that the provision of on an online survey will disadvantage the sample in anyway. Participants will be offered the option to respond anonymously to survey questionnaires.

Are particular qualifications required to use this method?

No

Will you be recording participants?

No

Documents you have referred to for this group which may include Survey instrument, question list, protocol for administering a substance

Data Collection documentation specific to this group

survey questionnaires.pdf

Participation

What are you asking participants in this group to do or what is to be done to them?

Step 1. Participants will be asked to provide consent to collect data entered via survey questions.

Step 2. The participants if they have provided consent will be asked to complete survey questions.

Step 3. based on individual responses an 8 participants from a cross section of responses will be asked to be part of group 2 for the Focus Group.

Step 4. The focus group will be conducted, and responses collated and analysed.

How much time are you asking of participants in this group and when will this time be required?

less than 30 minutes

Specifically, where will this data be collected?

Via internet based and hosted questionnaire website i.e. UniSQ survey tool.

Does the research involve measures or procedures that are diagnostic or indicative of any medical or clinical condition, or any other situation of concern?

No

Will a Participant Information Sheet be provided to the participants?

Yes

It is strongly recommended that you use the UniSQ template which has all required fields including purpose, risks, benefits and referral services.

Participant Information Sheet

Information Sheet Questionnaire v12 010822.pdf

If you are not using a Participant Information Sheet (or similar), how will this project be communicated to participants?

Will participants be referred to support services?

No

Consent

Are these participants able to consent for themselves?

Yes

Will participants be fully informed about the true nature of the research?

Yes

Consent type

How will you obtain consent from this group of participants?

Implied consent

Participant Consent Type - Group 1

Implied consent

How you will gauge that consent to participate has been implied by this group of participants?

By taking part in this online survey and submitting survey results consent has been implied.

Participant - Group 2

Group 2 name

Focus group.

How many individual participants are expected to be recruited in this group?

8

Describe the participants in this group:

the focus group is intended to consist of AEC Industry professionals from across a broad spectrum of industry back grounds and is open to all. there will be no mandatory exclusion except where language will cause results to be compromised.

Where will this group of participants be recruited from?

The group participant will be recruited from the pool of participants engaged with the online survey/questionnaire.

Will any potential participants in this group be under 18?

No

Is there a pre-existing relationship between the participants and anyone involved in recruiting and/or collecting data from this group.

No

Do these participants have any cultural needs?

No

Recruitment of Participants

How will you recruit participants?

Email

Personal contacts

Mail-out

Approached in-person.

Indicate how you will obtain the contact details of these participants.

from participants themselves

If from private or third party, or other source, provide further information around the source.

Provide details of who will be inviting participants and further explain the method/s they will use, as identified above.

The Co-Investigator Cameron Sunnerdale will be extending the invitation to participate via online industry

forum and email.

Will you be offering payment or any other incentives to this group of participants?

No

Recruitment information

Data Collection

Method of collection

focus group.

videography

Provide further details for this data collection method.

It is intended that a single focus group meeting be held consisting of 8 members from the original questionnaire responses, the Focus group meeting itself will be conducted during normal business hours via the use of an online meeting forum such as Microsoft Teams or similar and should last approximately one hour in duration.

As part of the research team and Co-Investigator Cameron Sunnerdale will be in attendance at all times throughout the focus group meeting process and will also chair the meeting.

Due to the nature of content discussed within this focus group it is not envisaged that a debriefing process will be required for participants at this time.

The content of the focus group discussion will be developed from the original questionnaire and supplementary questions may be added to develop further information based on questionnaire responses.

Additional question content remains unknown at this time until responses have been collated and reviewed.

Are particular qualifications required to use this method?

No

Will you be recording participants?

Yes

How will you record them?

Audio recording

Video recording

Indicate whether you will arrange for transcription of the recording/s and how this will be handled.

The focus group recording will be conducted via Microsoft Teams, or similar and all recorded information will be made available to participants upon request.

Documents you have referred to for this group which may include Survey instrument, question list, protocol for administering a substance.

Data Collection documentation specific to this group

survey questionnaires.pdf

Participation

What are you asking participants in this group to do or what is to be done to them?

The participants will be asked a number of questions developed from the results of the online questionnaire and asked to respond either via group verbal or written discussion.

How much time are you asking of participants in this group and when will this time be required?

90 minutes at an agreed time based on participant time zones etc.

Specifically, where will this data be collected?

This data will be collected via online means.

Does the research involve measures or procedures that are diagnostic or indicative of any medical or clinical condition, or any other situation of concern?

No

Will a Participant Information Sheet be provided to the participants?

Yes

It is strongly recommended that you use the UniSQ template which has all required fields including purpose, risks, benefits, and referral services.

Participant Information Sheet

Information Sheet Focus Group v12 020822.pdf

If you are not using a Participant Information Sheet (or similar), how will this project be communicated to participants?

Will participants be referred to support services?

No

Consent

Are these participants able to consent for themselves?

Yes

Will participants be fully informed about the true nature of the research?

Yes

Consent type

How will you obtain consent from this group of participants?

Consent form

Participant Consent Type - Group 2

Consent form

Outline the process by which the participants will give consent and how they return the consent form to the

researchers.

The focus group once selected will be issued a consent form to filled in and returned acknowledging consent to participate in the focus group and for all collected data to be used in the research both verbale and recorded material.

Attach consent forms.

Consent form/s

Consent form Focus Group v11 030822.pdf

Additional Documentation

Do you need to upload any additional documentation?

No

Appendix D: Information Sheet- Survey Questionnaire

University of Southern Queensland

University of Southern Queensland
Participant Information Sheet
Questionnaire

UniSQ HREC Approval number: HXXREAXXX

Project Title

Mixed Method Study exploring the relationship between approaches to BIM training and the use of BIM as an information management platform.

Research team contact details	
Principal Investigator Details	**Supervisor/Co-investigator details**
Mr Cameron Sunnerdale Email: [redacted] Mobile: [redacted]	Associate Professor David Thorpe Email: [redacted] Telephone: [redacted] Mobile: [redacted]

Description

This project is being undertaken as part of an Bachelor of Engineering Honours (Civil Engineering), through the University of Southern Queensland.

The purpose of this project is to understand the relationships between the type of BIM training people have undergone, attitudes toward BIM technologies and how it is used in everyday work practice. The findings of this study will provide insights and recommendations into the actions industry can take to best support their employees successful acquisition and use of BIM technologies.

Participation

Your participation will involve completion of a online questionnaire that will take approximately 20 minutes of your time.

Questions will include: What is your current level of BIM proficiency?, What specific BIM software have you been trained on?, How has BIM training impacted your attitudes toward BIM?.

Your participation in this project is entirely voluntary. If you do not wish to take part, you are not obliged to. If you decide to take part and later change your mind, you are free to withdraw from the project at any stage. You will be unable to withdraw data collected about yourself after the data has been analysed.

If you do wish to withdraw from this project or withdraw data collected about yourself prior to the data being analysed, please contact the Research Team (contact details at the top of this form).

Your decision whether you take part, do not take part, or take part and then withdraw, will in no way impact your current or future rights.

Expected benefits

It is expected that this project will not directly benefit you. However, it may benefit the wider implementation of training programs across the AEC industry.

Risks

In participating in the questionnaire, there are no anticipated risks beyond normal day-to-day living.

Privacy and confidentiality

All comments and responses are confidential unless required by law. The names of individual persons are not required in any of the responses.

Please note that non-identifiable data from this project may be used as comparative data in future projects or stored on secure database for secondary analysis.

Research outcomes from this project will be published in peer-reviewed literature (including only non-identifiable participant information).

Any data collected as a part of this project will be stored securely, as per University of Southern Queensland's Research Data and Primary Materials Management Procedure.

Consent to participate

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

Questions

Please refer to the Research team contact details at the top of the form to have any questions answered or to request further information about this project.

If a participant wishes to contact the researchers for a summary of results, it will be provided to them. This will not have any effect on the anonymity of participants providing answers to the survey.

Concerns or complaints

If you have any concerns or complaints about the ethical conduct of the project, you may contact the University of Southern Queensland, Manager of Research Integrity and Ethics on +61 7 4631 1839 or email researchintegrity@usq.edu.au. The Manager of Research Integrity and Ethics is not connected with the research project and can address your concern in an unbiased manner.

Thank you for taking the time to help with this research project. Please keep this document for your information.

Appendix E: Participant Information Sheet Focus Group

University of Southern Queensland

University of Southern Queensland
Participant Information Sheet
Focus Group

UniSQ HREC Approval number: HXXREAXXX

Project Title

Mixed Method Study exploring the relationship between approaches to BIM training and the use of BIM as an information management platform.

Research team contact details

Principal Investigator Details

Mr Cameron Sunnerdale
Email: [redacted]
Mobile: + [redacted]

[Supervisor/Co-investigator details]

Associate Professor David Thorpe
Email: [redacted]
Telephone: [redacted]
Mobile: + [redacted]

Description

This project is being undertaken as part of an Bachelor of Engineering Honours (Civil Engineering), through the University of Southern Queensland.

The purpose of this project is to understand the relationships between the type of BIM training people have undergone, attitudes toward BIM technologies and how it is used in everyday work practice. The findings of this study will provide insights and recommendations into the actions industry can take to best support their employees successful acquisition and use of BIM technologies.

Participation

Your participation will involve completion of the online attendance that will take approximately 90 minutes of your time.

Questions will include: What is your current level of BIM proficiency?, What specific BIM software have you been trained on?, How has BIM training impacted your attitudes toward BIM?.

Your participation in this project is entirely voluntary. If you do not wish to take part, you are not obliged to. If you decide to take part and later change your mind, you are free to withdraw from the project at any stage. You will be unable to withdraw data collected about yourself after the data has been analysed.

If you do wish to withdraw from this project or withdraw data collected about yourself prior to the commencement of recording starting, please contact the Research Team (contact details at the top of this form).

Your decision whether you take part, do not take part, or take part and then withdraw, will in no way impact your current or future rights.

Expected benefits

It is expected that this project will not directly benefit you. However, it may benefit the wider implementation of training programs across the AEC industry.

Risks

In participating in the focus group, there are no anticipated risks beyond normal day-to-day living.

Privacy and confidentiality

All comments and responses are confidential unless required by law.

Please be advised that although the research team will take every precaution to maintain the confidentiality of the data, the nature of focus groups prevents the research team from guaranteeing confidentiality. Please respect the privacy of other participants and not repeat what is discussed during the focus group with others.

It is not possible to participate in the focus group without being audio/video recorded.

Once the focus group is completed, the recording will immediately be transferred to an encrypted laptop and wiped from the recording device. The data will then be transcribed by the researcher, and all identifying information will be removed. Once this is done, the audio-recording will also be deleted and only the anonymized transcript will remain.

The information you provide may contribute to research publications and/or conference presentations.

Any data collected as a part of this project will be stored securely, as per University of Southern Queensland's Research Data and Primary Materials Management Procedure.

Consent to participate

You will be invited to attend an online focus group. Your email address will be held for the purposes of communication before and during the focus group, but this will not be passed on to any third parties. It will kept securely in a password-protected folder and will only be accessible to the researchers. We will then contact you to let you know the date and time of the focus group and the information you will need to join the group.

Once you have agreed to take part, we will send you an email with the full details of the date, time and link to the online focus group. There will be eight people in the focus group. It is scheduled to run for 90 minutes. Participants will be asked questions designed to elicit their experiences and opinions regarding BIM training and adoption and implementation of BIM in their respective practices. Should you choose to do so you can refuse to answer specific questions. Due to the interdependence of the data collected in a Focus Group, you may withdraw your consent up to the time that recording of the focus group commences. On signing up to participate in this research, all participants will be asked to respect the confidentiality of the group discussions.

Questions

Please refer to the Research team contact details at the top of the form to have any questions answered or to request further information about this project.

Concerns or complaints

If you have any concerns or complaints about the ethical conduct of the project, you may contact the University of Southern Queensland, Manager of Research Integrity and Ethics on +61 7 4631 1839 or email researchintegrity@usq.edu.au. The Manager of Research Integrity and Ethics is not connected with the research project and can address your concern in an unbiased manner.

Thank you for taking the time to help with this research project. Please keep this document for your information.

Appendix F: Questionnaire Survey

There are 30 questions in this survey, from 5 question groups.

Demographics

S1. What is your age?

- ◉ 18-24
- ☐ 25-34
- ☐ 35-44
- ☐ 45-54
- ☐ 55-64
- ☐ 65-74
- ☐ No answer

S2. How long have you been working in the AEC industry?

- ☐ <1 years
- ☐ 2-5 years
- ☐ 5-10 years
- ☐ 10-15 years
- ☐ 15-20 years
- ☐ 20-25 years
- ☐ 25-30 years
- ☐ 30 + years
- ☐ No answer

S3. Which area of the industry best characterizes your area of expertise?

- ◉ Architecture
- ☐ Structural Engineering
- ☐ Civil Engineering
- ☐ Mechanical Engineering
- ☐ Electrical Engineering

☐ Construction

☐ A combination of the above/integrated AEC

S4. Which best characterises your role?

☐ Technician

☐ Draftsperson

☐ Engineer

☐ Architect

☐ Construction

☐ Project Manager

☐ Manager

☐ Other

☐ No answer

BIM Use

S5. What is your understanding of what BIM is?

S6. How would you rate your BIM expertise?

Choose one of the following answers

☐ Beginner

☐ Intermediate level of expertise

☐ Proficient

☐ Expert

☐ No answer

S7. What specific BIM software have you been trained on?

Comment only when you choose an answer.

☐ AutoCAD - 2D/3D Model Creation

☐ Revit building suite - 3D Model Creation

☐ Navisworks - 3D Model Review and clash detection.

☐ Solibre

☐ ArchiCAD – 3D Model Creation

☐ SynchroPro – 4D visualisation

☐ Other Please specify.

S8. How frequently do you use BIM in your work?

Choose one of the following answers.

☐ Daily

☐ Often

☐ Rarely

☐ Never

☐ Other

☐ No answer

S9. How do you typically use BIM in your day-to-day work ?

Choose one of the following answers.

☐ As a modelling tool

☐ As a collaboration tool

☐ As a coordination tool

☐ As an information management platform

☐ Other

☐ No answer

BIM Training

S10. Have you undertaken formal BIM training?

Choose one of the following answers.

☐ Yes

☐ No

☐ No answer

S11. If you answered yes, which best represents your training.

Comment only when you choose an answer.

- ☐ <2-day CPD course
- ☐ 3–5-day CPD course
- ☐ Third level course (please describe)
- ☐ In person
- ☐ Online training
- ☐ Self-Taught
- ☐ On the job training (Apprenticeship)
- ☐ Other (please describe)

S12. How effective was the BIM training (any training formal/ 'on the job' training) you received in preparing you for using BIM in your work?

Choose one of the following answers.

- ☐ Very effective
- ☐ Somewhat effective
- ☐ Neither effective of ineffective
- ☐ Not effective at all
- ☐ No answer

S13. What in your opinion would have increased the relevance of the training to your day-to-day work?

S14. Has BIM training impacted your job performance, if so, how? Tick all that apply.

Comment only when you choose an answer.

- ☐ More efficient processes
- ☐ Quicker project completion
- ☐ Better communication between disciplines
- ☐ Knowledge of wider information base
- ☐ Other

S15. Do you think BIM could be used differently in your day-to-day practice . How?

S16. What would need to change to support this? Tick all that apply.

☐ Comment only when you choose an answer.

☐ On site BIM champion to support learning

☐ Increased organisation wide understanding of BIM processes.

☐ Increased resources. Please specify

S17. was your course funded?

Choose one of the following answers.

☐ Employer funded my course.

☐ Self-funded

☐ Course taken during work time with employer support.

☐ Course taken in own time.

☐ No answer

Only answer questions this question if you have completed a formal BIM course.

S18.How useful were the course materials (Training manuals, readings, etc)

Choose one of the following answers.

☐ Extremely useful

☐ Somewhat useful

☐ Neutral

☐ Not so useful

☐ Not at all useful

☐ No answer

Only answer questions this question if you have completed a formal BIM course.

Attitudes toward BIM

This section will help identify how people feel about BIM in its current form.

S19. How confident do you feel using BIM software?

Choose one of the following answers.

☐ Extremely confident

☐ Somewhat confident

☐ Slightly confident

☐ Not at all confident

☐ No answer

S20. Did BIM training impact your attitudes toward BIM?

Check all that apply.

☐ Yes

☐ No

S21. If you answered "yes" to question 20, please indicate the nature of the changes in your attitude toward

Comment only when you choose an answer.

☐ Increased enthusiasm

☐ Decreased enthusiasm.

☐ Increased confidence

☐ Decreased confidence.

☐ Other please expand.

Organisational factors

This section will help Identify how industry are supporting individuals to develop BIM skills.

S22. Did your employer/organisation support you to integrate BIM into your practice?

Check all that apply.

☐ Yes

☐ No

S23. If you answered yes, how did your organisation provide support?

Choose one of the following answers.

☐ Understanding that it takes time initially to become proficient.

☐ On the job BIM champion to support learning

☐ Allowance for skill development during project execution

☐ Paid/Unpaid time off.

☐ No answer

S24. How would you rate your organisation's commitment to BIM implementation?

Choose one of the following answers.

- ☐ Extremely Committed
- ☐ Moderately committed.
- ☐ Slightly committed.
- ☐ Not committed at all
- ☐ Committed in theory not in practice.
- ☐ No answer

S25. What in your opinion are the barriers to BIM implementation. Tick all that apply.

Check all that apply.

- ☐ Initial financial costs
- ☐ Lack of training opportunities
- ☐ Training costs
- ☐ Time to train staff.
- ☐ Deadline/output pressures prohibiting skills development/ BIM integration.

S26. What do you think are the potential benefits of BIM implementation? Tick all that apply.

Check all that apply.

- ☐ Enhanced communication between disciplines
- ☐ Increased project efficiency
- ☐ Reduced errors
- ☐ Managing information in real time

S27. What do you think are the potential drawbacks of BIM implementation? Tick all that apply.

Check all that apply.

- ☐ Time investment
- ☐ costs
- ☐ Negative perception in industry

☐ Reduced output of project work

S28. How likely are you to recommend implementing a BIM workflow to your company or fellow professional.

Check all that apply.

☐ Very likely

☐ Somewhat likely

☐ Neither likely nor unlikely

☐ Somewhat unlikely

☐ Very unlikely

S29. Is there anything else you would like to add that hasn't been asked about of your experience in the industry.

S30.What Country/Region/Industry or company BIM standard have you been involved in implementing and why.

Appendix G: Focus group Questions.

1) When asked what is your understanding of BIM one respondent wrote ‘ If you ask 10 BIM people to describe what BIM is , you’d get 11 different answers. It is very much a developing concept’.

    a. What is your understanding of the reasons for such variability is how BIM is perceived in industry? ……. how do you think this could be addressed?

2) The survey highlighted a range of approaches in how people acquired their BIM related knowledge and applied skills. About 2/3 of respondents underwent formal BIM training with the remaining 1/3 learning on the job/self- directed learning.

    a. What abilities and/or skills would you consider necessary for someone to be deemed as proficient in BIM?

    b. What additional skills/abilities then distinguish someone who is proficient in BIM from an expert BIM technician?

3) Can anyone speak to your experience of the factors which helped you to learn/integrate BIM into your practice?

4) Can anyone speak about the barriers they have encountered with regard to learning/training in BIM and its implementation? (prompts some factors such as its time intensity particularly at the beginning etc)

5) Approximately 35 % of respondents indicated that one of the potential drawbacks of BIM implementation is “negative perceptions in the industry”,

    a. what do you think these negative perceptions are and have you your own experiences of this?

    b. How do you think these can be addressed.

6) One finding from the survey is the need for the entire design and the management team to understand the function of BIM as an information platform “*and not just about producing drawings*?”, what are your thoughts/opinions/ experiences with regard to this? ……. how do you think this could be achieved? (prompt re standard if necessary 19650)

7) The survey highlighted the need for on-the-job mentoring/buddy system to support people’s learning

and implementation of BIM, while also identifying time to train staff as the number 1 barrier to BIM implementation. How do you think these factors could be balanced?

Appendix H: Focus group Transcript.

Mixed Methods Study exploring the relationship between approaches to BIM training and the use of BIM as an information management platform - 20231107_170402-Meeting Recording.mp4

SPEAKER1	00:02	The point of today is just for me to ask a couple of questions and get some feedback on your opinions on what you think is the reasons slash solutions behind some of these issues. So, first question, when asked what is your understanding of BIM, one respondent wrote, If you asked ten people to describe what BIM is, you get 11 different answers. It's very much a developing concept. So, with that in mind, what is your understanding of the reasons of such variability in how BIM is perceived in the industry and how do you think this could be addressed? So, I put that question to the floor.
SPEAKER2	00:51	A lot of what I've come across Scott is depending on people's backgrounds, like from an engineering point of view. When when you mention BIM, it's, um, it's seen as just modelling and drawings as opposed to, you know, information of a project or asset through its entire lifecycle. So, I guess that was my initial understanding of Bim was like, it's just Bim and Revit are the one thing that, that was, that was my before meeting you. That was my, that was my understanding of what it was. And you didn't think to look any deeper into it, you know.
SPEAKER1	01:28	So, is there anyone else you'd like to comment?
SPEAKER3	01:31	I, I, I am absolutely agree with this true it depends from what background you come, and I think myself, in my opinion, people need more communicate about. What is being communicated to and explain what is actually some reason people just here BIM an end. I'm sorry, but they don't go deeply in it. You know, you can hear any time people talking about the BIM as a model absolutely agree. But this is not the case. And, you know, I recently had someone I interviewed for to work with myself, and design team and a person was in the CV saying BIM expert and da da da . And, you know, when you ask about at least one contractual document or what is the information management system, what the CD was you of the person was looking at me blanking. Scott, That's so upset you just like you're like and I feel like I am disappointing the person, and the person was so sure that he's an BIM expert, an architect. with all these da da da's like ops now in construction I think and construction. We know more about information

		management, not just models and about, you know, ahh kind of ooh as built stage. When the information passed to the clients, via models with the information. And I think it's a lot of misconception, then I don't know how that can be addressed. That's probably hard work and it's all about us also communicated.
SPEAKER1	03:11	Do we think perhaps that it's because on the construction site, it's the back end of the design phase and people are actually looking for the information. So, it's probably more minutia detail required. So, when you're doing a design, you're trying to complete an overall exercise, but when they're constructing it, they're only focused on that wall that week. So, they need all that information and they're starting to find this missing information. Do we think that's possibly. Or where because we were working remotely all the time. You know, we have CDE's. The common data environments, they're more and more common these days. But you know, people are looking for better and easier ways to access that information.
SPEAKER4	04:03	I was involved in BIM before I really became involved in Revit. And that was because I was part of a BIM group. And even at the initial stages of becoming involved in the BIM group, I found that the majority of the group was pushing towards the back end, which was facilities management um. Because they were driven towards the use of design and build and trying to document what they wanted from the contractor. So, you know, you actually it's not just two sides. There're three sides almost, or a scale of sort of knowledge of what BIM is and and who you ask. So, you know, from front end sort of design common data environments, sort of trying to get sort of the design team in what they believe what BIM is to what the contractor sort of needs for his information. And I suppose it's all the same thing at the end of the day. But it's just you have a scale of views from front end to back end.
SPEAKER1	05:28	Very good. How do you think we can address sort of that scale of knowledge or variability? Do you think?
SPEAKER3	05:45	Skilling people versus specific courses, just as an overview for everyone so people understand and know in general what is BIM, is at least. And maybe splitting the difference. Like, for example, designers have their own way control in contrast to contractors and then obviously facility managers, what they have from being what is needed, what is why do we do that? Even the simple thing that some companies decided to use of BIM for more rigid and are robust way of working more efficient for. You know, that's that's a different reason people use BIM. Not only because client wanted

		it's not because it's the requirements because that's how the company wants to do their work from day to day, you know, kind of scale.
SPEAKER1	06:44	So, looking for efficient ways to deliver projects?
SPEAKER3	06:47	Yeah.
SPEAKER4	06:48	And yeah. And it didn't define sort of the, the key benefits I think, at each stage. Sorry for interrupting. Mary. Yeah. identifying key benefits, I think the whole way true. I think you know, highlighting the key benefits is is a way of improving .um Building on education.
SPEAKER1	07:13	Very good.
SPEAKER3	07:17	You've even organising and how in house trainings? Maybe once a week someone to come over in office and give some kind of, you know, open. Open training. Let people ask questions, maybe ask those questions. You know, by these trainers' silly questions that the other people don't feel let's say don't afraid to ask. They'll say no because people afraid to ask, afraid to feel, to be silly, maybe by asking this. And that's where kind of we are. Now.
SPEAKER1	07:48	It's an interesting statement because we go to training because we don't know something. And then to ask a question about something we don't know and be embarrassed by that seems to be odd.
SPEAKER3	07:58	Yeah.
SPEAKER1	07:59	It's a very good point. Okay, I might move on because I'm conscious of time. Question two The survey highlighted a range of approaches in how people acquire their BIM related knowledge and applied skills. About two thirds of the respondents. There were 39 respondents underwent formal BIM training, with the remaining third learning on job or self-directed learning. So, what abilities or skills would you consider necessary for someone to be deemed proficient in BIM?
SPEAKER5	08:31	I think mentally it's more of. If we look at the use of BIM is more into the the technician than in the engineers and role like majorly now. So, it's more of like the simple cad rules and then maybe migrating into into a BIM majorly.
SPEAKER1	09:04	Okay. So, would you think some BIM abilities would be a good knowledge of the likes of Excel, Revit? 3D viewing platforms, PDF Viewers, Word documentation. You know, like I see all of these elements as being part of the BIM process.
SPEAKER5	09:30	Yeah. And the mental is more of the normal day to day use of the computer for sort of technical use, really. So, I think if one is able to do stuff as a technical person, it can be.

SPEAKER1	09:54	Would anyone else care to comment?
SPEAKER2	09:56	No.
SPEAKER3	09:58	Sorry. Yes. No, no, no. You go first. Go ahead.
SPEAKER6	10:02	thanks um. Yeah. the use of Revit obviously is a big Addition to BIM, the understanding of Revit, the understanding of coordinates. um As you well know, at this stage. um And then obviously use of all those other packages, AutoCAD, 3D and all Microsoft to benefit BIM widely.
SPEAKER1	10:25	Yeah, I suppose the question was and Mary highlighted earlier, people say they're proficient in something and then we often find out by talking to them that perhaps they're not as proficient as they believe themselves to be. So, the question is what abilities do we think someone should have to be deemed proficient? And then the obvious follow-on question for that is if you're deemed proficient, what additional skills would you need to have to be distinguished as an expert?
SPEAKER6	10:56	Knowledge, It's as simple as that. The day-to-day knowledge and use of the package.
SPEAKER7	11:02	And management, I suppose, management skills, because I suppose that one of the key of Revit is to to manage different teams or to have different sectors and then even models, I suppose that you have to have a basic management skills.
SPEAKER3	11:23	Yeah, I would maybe clarify kind of more. When we say BIM, we say BIM. We are talking about softwares because, you know, if you are coming from design background, you're probably thinking BIM is all software or technical part and you're coming from the main contractor. You know, BIM is actually a process that's information management from the start of the design all the way through the stages to the facility stage. So, it's it's information management how we do that. And we're starting with the contractual part where to be proficient or efficient or I don't know only experience the BIM will be it will be determined by your job kind of title or even roles you have. We will be not never the same You can be BIM expert BIM expert for the specific area whether you will be manager that you overseeing everything and you might not know all the nitty gritty part and using the 3D softwares that all BIM softwares are not part of. You just know about them and what we need to kind of. During the process in such a way that is helping depends of what discipline you are. It's all about who do you work for? Either you design or what you need for this process. I have in my experience where the designers would use just Revit for Revit and they think that's that's BIM what it is. It's a BIM where you can see

		subcontractors when they taking the designers models and develop them for them and develop them for the design. Detailed design high LOD, high level, low level of information where it's coming to a new stage and all the stages. So, all this let's say data drops are all determined by the contractual part the BIM contracts that are drawn by either client, either coming from main contractor for a reason. So, I think this is missed when the designers are not involved, and they don't know what is actually final product. We don't ask this question what is the final product of this? um. asset. It's a miss miss misconception is a mis misunderstanding of BIM software BIM process. um BIM even technology?
SPEAKER1	13:58	I think what We might be trying to say there is um there's a knowledge gap between the implementation of BIM through design and the use of BIM through and its implementation, through the construction phase and where those two elements cross over. I think some people are maybe saying, well, sure, they'll take care of that on the construction side, the construction side of hoping they take care of it on the design side. Would that be a fair comment?
SPEAKER3	14:28	No, I think it's all contractual. Whatever is contracted, the design model will be contracted, say, for example, to be developed to LOD 300. And it's no, no details in that model. That was a pure for viewing and you know obviously all detailed to high level of details 2D then contractor taking now this is whatever is build or will be build have to be in a model developed for the LOD 400, for example. And what I see when it was built is different. We think it's all contractual, whatever. Is the data drop agreed by, you know, by contract, that's what. Determining it cannot be that designers are thinking about main contractor will develop as a main contractor would expect from design. More design and team more than they was contracted to. So, coming back to money.
SPEAKER1	15:18	Would anyone else like to? Okay. Question 3. Can anyone speak to their experience of the factors which help them to learn and integrate BIM into their practices? So, were you self-taught? Were you, was it forced upon you, was it an interest that you had and look to seek his ability to to bring to your company where you forced to do it by a client? What led you to be involved in BIM?
SPEAKER6	15:56	well from my point of view, it was a case of they just needed somebody else to fill in. They didn't have enough the personnel at the time for a project. And I fell in with my cad background and my doc control background and all that kind of stuff. They just thought that, you know,

		and my efficiency that I'd be the best man for the job at that time. And that's what I done, went in and came out again and took over the CAD department again in the CADWorx and became CAD coordinator manager. So, And then back into BIM here again. So, it was necessity for the company. But it was a learning curve for me. Something new, a new stepping ladder, basically.
SPEAKER1	16:39	And would you say circumstance was involved?
SPEAKER6	16:41	Yeah. Circumstance? Yeah, Basically. In a nutshell. Circumstance. I wasn't looking to go into it
SPEAKER1	16:50	It presented itself. Yeah.
SPEAKER7	16:52	Yeah. Well, I can tell you about me Scott. You know that I'm attending a course in Revit right now. To be honest, I joined that course because I found that opportunity. That was a free course, um apart from that I. I saw that it was essential to to in the way we work here in the company. So that's the reason I joined the course.
SPEAKER2	17:30	UM my first experience Scott was, I suppose maybe 4 or 5 years ago, we had we had to a significant enough project in the office and we kind of we kind of blindly stepped into the world of BIM. And it was a disaster. It was great. At the same time, we ended up having to scrap a model and start again. But um that was like I guess I didn't know at that stage what I didn't know. And I can I just thought, sure, it's just a model and it's fine and what could possibly go wrong. But um that's I suppose we we had people in the office who were able to do Revit. We were working with consultants who were also working in the world Revit. And we decided to just proceed and work this project in Revit. And instead of it being a small project that we just do a test case on, it was quite a large project and it worked out well in the end, but it did. I guess it showed us the benefits when we came to the submittal stage on like structure steel drawings, for example. Like we could, we saw straightaway that, Hold on a second. No, this is quite a complex frame and the whole review process is much more straightforward when we can bring in a model and overlay it on our model and the amount of RFI's that we didn't have as a result of things being thought through at the design stage just opened our eyes to to how you sort of can be so.
SPEAKER3	18:53	And I still.
SPEAKER1	18:55	Know. I thought John was going to say something earlier that was.
SPEAKER3	18:59	I'm keep interrupting. Apologies.
SPEAKER4	19:01	Go ahead. Go ahead.
SPEAKER3	19:03	From my point of view. Thank you. I am an architectural technologist and

		was studied in TUD. Revit. As a software that we as a technologist to use it as an architectural tool. And we also had for, for final year loads of modules covering the BIM in full. So, I had a very, very good overview of what is BIM project, how the projects have to be run on the contractual side. And for me it was always just the tool, like architect using CAD same for me was as Technologist using Revit to produce what I need to produce. And that's where I came from. And when I was hired for Henry J Lyons that was specifically for project was Amazon, Project was a client requirement. We were BIM Level 2 project. So that's how we jumped in, and I didn't feel any frustrations kind of, yeah, it was small things. Was the contractual not experience. Well, in terms of Revit, not, you know, there was no issues how to say. And I had a very good understanding what is the level of details have to be in a model of specific stage. You know Scott I didn't have that. let's say struggling path from the modelling point of view but I noticed many people over modelling don't understand what's needed. What's not needed would spend time on specific items that are not required and have no value. You know, those little things which I didn't from for me, that was kind of quiet. I was quite sure what I'm doing and that's what my my experience was. And I was kind of very passionate about it. And that was something that was not new, but it was something from the beginning I knew what I'm doing, you know? So, I think that was kind of easier for me. Apologies, John, But your.
SPEAKER4	20:59	Um, yeah. From my point of view , it's been quite strange because I've sort of come at it from CAD point of view to then sort of , as I said , joining a BIM group, which sort of was in a room of technicians sort of looking at the back end and delivery and terms of employers requirements to then sort of being thrown in the deep end in sort of producing models of Large blocks of apartments in Cherrywood. So, they the next progression for me then was sort of where I am at the moment, which is actually taking the reins and setting up the BIM requirements sort of for design team prior to actually designing starting. So, it's it's been it's been a different journey for me. I wouldn't say it's been simple and clean, but I've I've been learning a lot in different areas um and it's all sort of coming together. Now, I don't know. It's, I suppose it's natural progression and that's that's most of it.
SPEAKER1	22:22	Would you say your experience is? You know, as a professional, experienced architect gave you help in your approach towards payment, how to use it? or do you think it was contradictory to what you

		understood.?
SPEAKER4	22:38	No, if anything, I think my mindset um set strict requirements and allowed me to maintain those requirements and the standards that I was setting. And so yeah, I suppose it complemented what I was doing. A And it's in addition to the skills that I have.
SPEAKER5	23:01	Okay. So, for me, it was more of doing things faster. And I'm more of as an engineer, being able to maybe back in Nigeria and doing a scheme. For example, you can easily see where the column is falling out from a room or something, clash detection and the like. So, it was more of an. Doing things faster. And then when it comes to revisions of drawings, it was more of the quick way to do it instead of going back and forth with the cutting. So that's why we we had to. Jump into BIM.
SPEAKER1	23:54	So, you're saying that the parametric elements of the Revit software aided the ability to reduce time frames and deliver?
SPEAKER5	24:03	Exactly. Exactly.
SPEAKER1	24:08	Would anyone like to add anything else? So, we'll move on to question 4 if you don’t mind. Can anyone speak about the barriers that they've encountered with regard to learning slash training and its implementation? So, time cost. When I say time, I mean schedule as opposed to hours of the day.
SPEAKER2	24:38	And knowing where to. Knowing where to go or what to look for, I suppose. Scott as well. like You know when you Google it, there's so much out there. um if there was. Like one one known place to go could kind of steer you towards a suitable kind of level of a course, you know, given your time available and then what you want to know as well. And I don't use Revit. I'm not interested in using Revit. I would be interested in knowing more about BIM um just so I can. You know, work, and manage within that world. So, Suppose. Understanding what courses what courses are out there. And. And. If you having having a one stop shop for comparing courses.
SPEAKER1	25:29	Okay. Anyone else like to contribute?
SPEAKER7	25:36	I'd say that it's difficult to start with a course or with training if you don't have a real purpose. Mean you can say, Look, I want to learn to Revit, but for what? I mean it's just to have a basic knowledge. I mean, I think it's better to have a real project or have a real target. So, look, I want to learn how to model a steel structure. I want to model how to tunnel. So, once you have a real target, a real objective, then you say that this is when you can manage your time to find what you need specifically.

SPEAKER1	26:23	Okay. Bill, John, Mary. You're all kind of in many positions. Are there certain barriers that you see every day? And when trying to get the teams to use the software?
SPEAKER6	26:41	So
SPEAKER3	26:43	Apologies. You go, Bill. Your first now.
SPEAKER6	26:47	barriers for using software. I suppose would be the case of, um. Is that like, within the Navisworks? Now. Or things like that I.
SPEAKER1	26:59	No, for instance, you mentioned earlier coordinate systems. Do you think that people struggle with coordinate system? So, then you say, well, look, this is too much work. I can't be bothered. I'll just stick to CAD.
SPEAKER6	27:10	Yeah, I would say, there's definitely a bit of that. But with people alright and if there's something that they're not sure of to stick to what they know instead of trying to find out what they don't know. Um, whereas I'm the opposite. As you know, I try to get as much as I can. I'm not an expert on the coordinate system fully, but I got a great understanding the last two projects so and the third one on my now. So, I actually know understand how it works better, then what I did because I wanted to, and I was used to the use of Revit and is very that kind of software. So, it's down to the people, it's down to the individual alright. If they feel that is going to hinder them getting something done, they won't I would say they stay old school.
SPEAKER1	27:58	And would you have said you found that information within your own organisation or did you have to look outside your organisation?
SPEAKER6	28:05	Well, I went back. I done the course in St John's, and I went to see a CIT or MTU done the course, done the BIM course MTU as well. And then came back in and is just even talking like even with yourself now and anyone in my in my company who have Revit who understand it a bit more people from E&I know who'd be bringing in the drawings and stuff and getting the coordinates right and HVAC. So, between even, like I said, with DJF even talking to me, which yourself going through it. That's how I learnt my other little bits. Outside of say what college give ya college, give you so much. But I think experience is everything. And someone else's knowledge. So that's what I think it is.
SPEAKER1	28:56	Thats great, Mary You were going say something?
SPEAKER3	28:59	Yeah, I am in terms of training. And um I noticed, Scott, that if company don't have an appointed person that is there available always for the team there, it's hard for you. Even if someone do the course say I want to do it Revit you know and companies welcoming paying the courses if they have

		no support. It's very hard to begin with. No support. You need someone in the company, someone a person who is there always in house training kind of baby steps, that the person can slowly build that experience. Or you have to be crazy your, Kind of into that I want to be, and I will do it myself. Searching or searching yourself watching YouTube. But that's not easy. When you are an adult, when you have a family, you have kids. You know, I think it's very important that company have something in place that is. Like daily support when somebody.
SPEAKER1	30:02	So that Actually leads me to one of my final questions on mentoring actually but ah. Yes, a great a great point.
SPEAKER3	30:10	That's my personal experience.
SPEAKER1	30:13	Yeah, absolutely. Is there any other sort of people want to contribute? towards the barriers, we might skip on to the next question. Okay. Question 5. Approximately 35% of the respondents indicated that one of the potential drawbacks of BIM implementation is the negative perceptions in the industry. So, what do you think these negative perceptions are and have your own experience of this? Have you your own experience of this? So have, as someone said, like like, for instance, some of the respondents in the. In a survey kind of said I use PDMS and Revit is crap. End of was whole explanation. And if you were to read on further in the comments that were trying to use Revit for a purpose, it wasn't made for either. We're trying to use it for piping. When it's not designed to be a typing software. If you understand what I'm saying.
SPEAKER6	31:18	Just Repeat that question again. Because I am thinking there about that on alright
SPEAKER1	31:22	So So, the question is. 35% of the respondents said one of the potential drawbacks to the baby implementation was negative perception of the environment in the industry. And the negative impact is different for everyone. So, what do you think these negative perceptions are for you in your environment and what are your own experience of this, if any? And how do you think these can be addressed?
SPEAKER6	31:52	Well, one negative, I suppose, is most people if they're not sure. They think the BIM is just a clash detection only tool. And that's all we do every day is clash detection. Yes, it's a big part of what the BIM coordinator has to do because at the end of the day you are trying to have a clash free model. Um, what's your. It's not the only thing. And I think a lot of people do think that that's what BIM was and is when it's a lot more than that obviously as we all know. But I still I still even get that to this day people who are

		unsure fully how it works, they come into meetings that it's going to be a clash detection meeting, but it's not at all totally separate. side to BIM. It's a part of it, but it's not the main component.
SPEAKER1	32:46	Well, it's an activity. It's one activity within the BIM process.
SPEAKER6	32:49	Exactly. But people are just naive to think that that's what it's all about. You know, you're basically like a project manager in the coordinator. You're coordinating everybody. You still have to be on top of everything. You have to watch everybody. You're. There's a lot more to it. then what people think so. Um, that's my perception that people have as clash detection mainly and just keeping an eye on the model after that. Does that make sense?
SPEAKER1	33:21	Yeah, absolutely. I suppose, Potentially. I think there's possibly some people in in in management roles that are very single discipline focused and wouldn't necessarily have an overall Appreciation for the entire construction. Breadth, I suppose you know. E&I, Mechanical, Electrical, Like, you don't have to be the master of all. But if you know enough about each of them, I think that helps. So, I would see some people who don't understand how other disciplines work. Make negative comments and. Implications on the BIM software. I don't know how people feel about that as a statement.
SPEAKER6	34:15	There is project managers like that who don't understand how BIM works. And why we have it. They just want to get their job done. And just get a model out. But they don't understand the full implementation of BIM in the background. So, it's just a bit of naive thinking on some some project managers in general you know. from My experience.
SPEAKER2	34:41	Mm hmm.
SPEAKER1	34:44	Peter, Would you care to comment or Mary?
SPEAKER5	34:49	I would say remember we spoke about when we have collaborations with different disciplines where maybe two people are working on the same model and maybe you get to have to lose your information during. when you are synchronizing the 2 models maybe two people synching at the same time and then the model gets to have issues during that process. So, I think that might also be a perception where people tend to put it out there, oh, this particular thing I maybe, maybe one person having that particular issue and then put it in our data or when two people are working on this thing and then it's a problem like during the collaboration process. So maybe that would be one of the negative things that would be out there for. The users Really.

SPEAKER3	36:05	I am very passionate about Revit and BIM and all the software, and I was working with time consuming. I am very passionate. If someone say something negative to me sounds like person don't have good experience, good knowledge, don't know what actually the software can do, especially specifically Revit. Revit can do fantastic things and you can do amazing things to our add-ins and plugins. And I just don't. Take these comments as.
SPEAKER7	36:32	And if you don't, if you don't know them, it's difficult. For example, I can tell you about my experience, for example, at work of those at the small project we have in the office, we have a couple of drawings. I feel very dependent. I, for example, if I detect a small typo or an error or something, I, I don't feel like I can go to the, to the model or to the drawing and change that thing all sorted. That's something that could happen with AutoCAD, for example. But with Revit I feel I have to speak with a Revit manager or the draftsman or whoever to say, Look, I have detected this, could you do that? And then I say, No, look, I'm very busy with another thing. So, I feel very depending on that, that basically that that is because I don't have the knowledge. I mean, I suppose that will change. So, once I get the tools and there and there and then.
SPEAKER3	37:29	That's what is I'm trying to say when someone have not enough experience to do with the software what you want to do it, then you frustrate, you get frustrated, you get upset, and it's like, Oh, this software is not working for me . And that's where it coming is coming from, not enough experience to do your your job. You know, that's only from here and that's why I will not take on board any comments for me straight away person don't know the software Revit it is stunning. can do miracle you can do in one day a skyscraper. One of the guys who can pull all the information for me were you, you know, if you have that experience or this at the beginning or big time, big time is not happens overnight, am I right Scott?
SPEAKER1	38:17	Absolutely. And I would have a couple of examples such as that here where people have said, you know, Navisworks is horrible programming. It won't turn, it won't twist. I can't cut a section. And I don't understand where these section marks come from. And then I've explained where they've come from, like, oh, that's going to be much easier. Like I can see how that would work now. So, it is I think you're right. It's a lack of knowledge. I think it's probably. A lack of understanding that whilst most of these BIM softwares are inherently the same in terms of the function that they perform, they obviously. Have different ways of going about it. And that's

		their differentiator within the market, I guess. And that's how they sell a product. And like anything it was mentioned earlier, exposure like that. The more you work with something, the more things you going to work that you don't know. And therefore, as a result will end up knowing more because you will have investigated more, I guess.
SPEAKER6	39:25	you need something to go wrong to learn as well.
SPEAKER1	39:29	Yeah, exactly. So, I mean, I think, again, one of the common themes coming through here is that access to immediate information, i.e., an experienced individual, an overseer, or a mentor. Is probably important there to address some of these issues. So just conscious of the time there again, So I'm going to move on to question six if you don't mind. One finding from the survey is the need for the entire design and management team to understand the function of BIM as an information platform and not just about producing drawings. What are your thoughts, opinions, and experience with regard to this? How do you think this could be achieved and. And delivered. So, is it better company standards? Is it a better industry standard? Is it a higher
SPEAKER1	40:22	Higher expectations and higher level of adherence. I personally think people coming from a CAD background when they use Revit and similar programs, they try and cut corners like they used to in CAD, and then when things don't work out later on, they blame the software. I don’t know how other people have experienced that or feel about that.
SPEAKER3	40:56	And I would say that companies should hire people who are passionate about them that can bring the experience. They're not pressurized and ask to learn something new. Because you know yourself, if you don't find something you don't want to do it, then it will not work out. Someone who actually really, really interested to implement that new stuff. So, these people need to be hired, at least one in a company who can support the others, who wants to follow him? Who wants to follow this new way of doing things, the new way of information model, new way of modelling, a new way of communicating between different disciplines. And that's, I think, something that works well when a company pushing someone, or you are project manager. Now, we need to learn how this works and you need to understand all these contracts. And, you know, people don't want to get out of their comfort zone. They like me. I'm comfortable like that. Why should I? That's how I see things going for me. That's my perspective.

SPEAKER7	42:00	And that's fine because Both Revit and AutoCAD belong to the same company Autodesk, the first thought is that they are similar, so Revit is a 3D version of AutoCAD. So, once you start. testing Revit and see that is not the same at all. I understand that people can feel a bit confused or don't know lost.
SPEAKER2	42:33	I suppose Scott like from from our own point of view, like we are a company, we have a situation where people are transitioning from CAD to Revit. And I suppose one thing that we're trying to manage is the expectation from a management point of view of the time it takes for people to work on a project and try to select the right project where schedule isn't so critical that people have the time that they need to actually learn it properly that that's that's been a kind of big roadblock for us. So, it's every project is, is is there is pressure associated with it in terms of time? And it was just finding the right project where we would not revert to the easy option of getting it outdoor quickly in CAD. And you know obviously paying the price later on when it wasn't developed Revit so.
SPEAKER1	43:28	And do you think it's the case of your company now? Has. A couple of individuals that have a level of experience using Revit. That's that's taking some of the pressure off. On the business to to assign individuals who want to learn the software to some of these smaller projects because more experienced people are able to pick up the slack. If needed.
SPEAKER2	43:57	Yeah, it definitely would. As in, if something goes wrong, we know we can move it up to someone who can do the same or quicker if we need it to. You know what happens if we have to start again like that? That does come up in conversation and that that definitely does help. Yeah.
SPEAKER1	44:17	Okay. Bill. have You got any sort of. Experience with that?
SPEAKER6	44:22	Yeah, you definitely need the one person, right? You need someone who. Who has the knowledge that you can bounce off like we have, as I call him. Ger BIM. You know, he's the expert, like in Revit, the expert in the AutoCAD, he is the expert in BIM. He is the one to, you know, along with a couple of fella's in the department, have put on guidelines of guidance, hierarchy for people to understand how it all works, especially for product managers, because they love asking for guidelines, you know , especially when going into a meeting , you have to have a guideline . How does the agenda work? How does that work? How does a clash detection work? So, guidelines are key for everything for BIM to run smoothly within any company. Guidelines, I believe are essential along with one person at least

		who has the knowledge to answer any questions that you don't have.
SPEAKER1	45:20	I mean. So, what you're referring to there really is the industry requirement for execution plans and., clear requirements.
SPEAKER6	45:27	Yeah.
SPEAKER1	45:30	That be fair to say?
SPEAKER6	45:31	Yeah, definitely.
SPEAKER1	45:35	Okay. And last question there. We can wrap it all up. The survey highlighted the need for the on job mentoring buddy system to support people's learning and implementation of BIM, while also identifying time to train staff as the number one barrier to implementation. How do you think these factors could be balanced? So, what what I mean, what I mean by that question is it's been mentioned a number of times here that we need to have that one person in the company that is our go to person. Not every company has the luxury of employing someone as a team manager who's. Entire day revolves around supporting and implementing BIM. Quite often you do a dual role where you're to deliver projects and you happen to be knowledgeable in the area and help your colleagues out. I think that obviously puts pressures on on certain people. A The individual who is asking the questions I think is can be conscious and cognizant of the fact that they're taking you away from what you have to do. True. So maybe they feel like they can't ask as many questions as they would need to.
SPEAKER6	46:46	True
SPEAKER1	46:47	B The management might be going, well, how come this person's having to ask so many questions and how come you're not getting things done? You know, which might be a great question, is have we implemented enough training or so on? So, I'll leave it there and let everyone have a speak to that if they don't want.
SPEAKER6	47:07	I think we nearly touched on a lot of that throughout the whole session there really. Yeah, it is. Mentor is definitely important, alright? I think Mary said the same thing earlier on. you know, just having someone to turn to especially. Will you just come in to look from my point of view? When I first came into it, I didn't really have I know a lot of people to talk to, so I was thrown in the deep end and the first one I ever done back in 2019 and it turned out fine. The factories built and everything. And we've had no issues since. You know, most definitely you need you need someone to be there with you. And as you know, Scott I'm not afraid to ask questions. I never say to anybody that I know everything because I certainly don’t. And I'm very honest about that. I know where my limits are, and I know where I

		struggle. And I'm not afraid to say I've got you know as well as I do coordinates wasn't my strong point. I know I have an understanding of it, but I'm always honest with people. I'm not a bluffer. I know people who come into this industry and come into BIM, and they can bluff it and they'll get away with it for so long, but eventually they get caught out.
SPEAKER3	48:23	And that's great to hear of. People actually can say it and it's true How much we will not know. New project will be new thing. You know, I'm quite experienced. I'm still learning, and I absolutely agree. We need to talk and ask for help. I disagree that to be manager should be there in place and helping people BIM managers more. A person who looks out of the contractual past and not to say I heard from someone that architectural practice have a BIM manager now and I will be manager doing the families for us, Wow, that's not right. BIM managers shouldn't do families for the team and shouldn't be preparing everything for team to to to use it let's say.
SPEAKER6	49:07	That.
SPEAKER3	49:08	Would be the same thing as an architect doing things in AutoCAD and then what he needs to put windows. He needs to ask someone else, the CAD manager, to prepare this window, whatever block for example. I am saying that we need someone in company doesn't have to be a be manager. It could be someone a good lead, good BIM experienced person who actually fancies work and is very interested in developing himself, and I am encouraging to share the knowledge. I'm saying that while helping someone, we learn I don't know if you heard by any chance a chicken speech that speech about chicken productivity And it's it's more about sharing. You know, when we are sharing, when we are helping someone, we are looking for the solution. And we are also developing are we also growing? And that's the way it should be. And it's good to hear that people are actually do asking, seeking for help.
SPEAKER1	50:03	Do you think the responsibility being laid at the feet of the big managers is a byproduct of the fact that they tend to be the most experienced person? In the area. And it's probably incumbent upon them to train the others. And it's just getting time on the ground to bring those skills up to. Feel confident to be able to delegate some of those tasks.
SPEAKER3	50:30	Yeah Scott, but not to sit with the team and showing them how to model, how to do, how to prepare this family, how to make the family parametrical, how to add information in. Yeah, the manager the manager could oversee. You can guide the team, make sure that all overall team going to the right direction. So, it's all about the BIM model BIM

		specialists who actually develop their skills. And yes, right. Sometimes BIM managers could be absolutely amazing with a Revit BIM modelling, you know, even TEKLA or stuff like but some Managers could have no idea about it. They could be fantastic great and contractual side on a team management on the overall project delivery. So, it's again depends where you work, you know, working for designers, for main contractor. It will be always that kind of differentiation between. In my view.
SPEAKER2	51:32	This. I guess part of managing anything is there's got to as a manager, it's knowing your own limitations. Well like, you know. And here's one thing One person's so. But it's important for companies to understand or people to understand what external resources are available as well to, you know, to support to be a manager. Because if the BIM manager is under pressure and he's been pulled in every direction, nothing's going to work great for the company. So, like, you know, the manager has he has to free himself up so he can, you know, focus on his day-to-day jobs as well and keep everything moving. So, I think a combination of, you know, one person having the answers or maybe that person knowing where to get the answers or to get the support is probably more important than that person being the solution, you know?
SPEAKER6	52:32	Yep that makes sense.