Approaches for Assessing BIM Adoption in Countries: a Comparative Study within Qatar

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Abstract

The adoption of Building Information Modelling (BIM) is now examined at different scales ranging from organisations, through supply chains, and across whole countries and markets. For the assessment of BIM adoption at country and market scale, two main approaches are being utilised. The first traditional approach utilises a survey of industry stakeholders operating within a defined market/country to assess BIM diffusion. The second emerging approach adopts specialised macro BIM adoption models and metrics. In this paper, we aim to apply and compare these two approaches for investigating BIM adoption within Qatar.

In the implementation of the survey approach, we selected key client, contractor and consultant organisations and conducted 28 face-to-face interviews in an attempt to overcome some of typical limitations that might occur in traditional survey-based approaches (e.g. unknown and biased population). The obtained results included: BIM is increasingly specified by clients on large construction projects; BIM experience has become part of the pre-qualification criteria; traditional Design Bid & Build (DBB) is the predominant procurement route with an increasing use of the Design & Build (DB); lack of national BIM standards or guidelines and adoption of a combination of UK and US standards. Although these results provide a general understanding of the BIM landscape in Qatar, they remain qualitative and not actionable for policy makers, e.g. for developing BIM adoption strategies. Then, we applied two specialised macro BIM adoption models – i.e. Diffusion Areas model and Macro-Maturity component model developed by Succar and Kassem (2015). This second approach was capable of providing a rating of the different areas of BIM diffusion and a holistic discovery assessment of the country BIM maturity. Using the same approach, the results from Qatar can be benchmarked against those of a target country and can be utilised to inform a Qatari-specific BIM adoption policy. Based on this result, the research concluded that new approaches such as the macro BIM maturity approaches should be increasingly encouraged and used to complement the traditional market BIM surveys.

Keywords: BIM, Diffusion Areas, Macro BIM adoption, Macro Maturity Components.

1. Introduction

Building Information Modelling is now widely acknowledged as a revolutionary change in the technologies, processes and policies underlying the Design, Construction and Operation (DCO) industry. BIM transformative impact on the DCO industry includes a technological and procedural shift (Succar, 2009; Eastman et al., 2011). It is also considered a disruptive impact forcing the industry to rethink deliverables, roles and relationships (Eastman et al., 2008; Smith and Tardiff, 2009).

Following years of escalating connotation and impact of BIM, industry associations, governmental bodies and academic communities across several countries are increasingly releasing a wide variety of Noteworthy BIM Publications (NBPs) (Kassem et al., 2015). One of the NBP types are the BIM surveys that aim to assess BIM diffusion – defined as the spread of innovation adoption within a given population (Rogers et al., 2005) – within a defined market for a single discipline or across all disciplines. For example, a nationwide survey of architects, engineers, contractors, owners, manufacturers and others (facility managers, software vendors, and project managers) has been conducted in Australia (BEIIC, 2010). Similarly in the UK, the National Building Specification (NBS) conducts annual surveys of Architecture, Engineering and Construction (AEC) professionals (NBS, 2015). In North America, a survey of 582 professional was performed by McGraw-Hill Construction (2012) to assess BIM diffusion rates. These surveys often lack the support of a theoretical framework and may involve an unknown population.

This paper aims to compare the findings from two approaches for assessing market-wide BIM adoption. The first approach is the traditional survey-based approach with enhancement – selection of a known and representative sample and inclusion of all BIM fields namely, process, policy, technology and people (Vukovic et al., 2015; Kassem et al., 2013).

The second approach involves the utilisation of emerging models for assessing macro BIM adoption within a defined market. In recent years, several countries have launched their BIM adoption strategies and national initiatives. Research has responded to this need by developing specialised models that can be used to assess the market wide BIM adoption. One of the earliest studies in this domain is the one proposed by Succar and Kassem (2015). This study has developed five macro BIM adoption models, namely, these are Model A: diffusion areas, Model B: macro-maturity components, Model C: macro-diffusion dynamics; Model D: policy actions, and Model

E: macro-diffusion responsibilities. This research will implement '*Model A: Diffusion Areas'* and '*Model B: macro-maturity components'* and their accompanying metrics to assess BIM adoption in Qatar.

The implementation and results from both approaches, i.e. (a) the survey-based approach and (b) the specialised models for macro BIM adoption, are respectively described in the subsequent two sections.

2. Market-wide BIM Adoption: Survey-based Approach

The interviewees included stakeholders from Client (N=9; 32%), Contractor (N=5; 18%) and Consultant (N=14; 50%) organizations working on several ongoing projects in Qatar. The interviews covered four domains of interest: Policy, People, Process and Technology (Grys and Westhorpe, 2011; Kassem et al., 2014), containing a total of 18 questions/discussion topics with 36 subtopics.

The policy section of the interviews investigated project delivery methods and types of contracts used in Qatar. The people section investigated professional BIM related roles and the challenges around the availability of BIM skills and knowledge and the corresponding learning and training opportunities within the Qatari construction industry. The process section aimed to analyse topics such as the BIM requirements, availability and use of BIM execution plans, standard project phases or plan of work, the adopted Levels of Detail (LoD), and the roles and responsibilities of different stakeholders towards such process related topics. Finally, the technology section aimed to survey the BIM tools used across the project lifecycle in Qatar. The following sections highlight the results in each of the four domains of interest.

2.1 Policy

The common two project delivery methods utilised in Qatar are Design and Build (68%)[1] and the Design-Bid-Build (75%). The predominantly used contract types are FIDIC (International Federation of Consulting Engineers) contracts (68%) and American Institute of Architects (AIA) contracts (18%). Other contracts included the New Engineering Contract (NEC) (4%), Public Works Authority contracts (7%) and professional service agreements with consultants.

BIM standards are required on the majority of projects (68%) and 75% of interviewees think that BIM should be enforced on projects. The BS 1192: 2007 is the most widely used standard on projects in Qatar (61%) followed by the PAS 1192-2: 2013 (39%). Other BIM related standards identified with a lower frequency include: AEC (UK) CAD standards (AEC, 2012), AIA Integrated project delivery BIM protocol exhibit (AIA, 2008), National BIM standard (NIBS, 2012), Singapore BIM guide (BCA, 2012), BIM project execution planning by Penn State University (PSU, 2010), and the Global Sustainability Assessment System (GORD, 2014). The

[1] Values in brackets refer to the percentage of respondents.

majority of respondents (89%) believed that the government should be developing the required BIM standards for the industry with the participation of educational institutions and private organisations.

2.2 People

The BIM related roles identified within the Qatar construction industry according to the interviewees are summarised in Figure 1. Under 'other', roles including BIM project managers and BIM interface managers were mentioned by 30% of respondents. As to the sourcing and skilling up of individuals playing these BIM roles, 75% mentioned in-house training complemented with the hiring of external BIM construction in 36% of cases. The majority of respondents (96%) complained about the lack of BIM skilled professionals in their supply chains and highlighted the need for training. At the same time, 46% of respondents reported challenges facing their organisations in the development of BIM professionals – i.e. difficulty in convincing people to enrol on training courses and the availability of appropriate BIM training and learning opportunities.

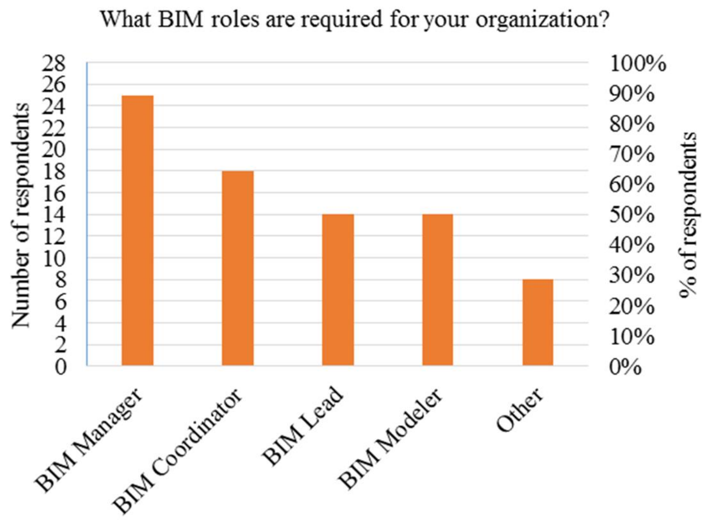

Figure 1: BIM-specific roles in Qatar

2.3 Process

There was a unanimous agreement among all interviewees (28) that BIM is used on projects in Qatar when it is required by clients and 70% of respondents highlighted the increasing inclusion of BIM related assessment in the tender prequalification and selection process. The prevalent use of BIM, according to 75% of respondents, is the federated BIM in common data environment. The most frequently required (indicated by 64% of respondents) Level of Development (LOD) is the LOD 300. Other LOD required are LOD 100 (7%), LOD200 (18%), LOD 400 (32%) and LOD 500 (11%).

Several types and labels for the BIM documents used on project to help manage the process were identified: BIM execution plan (68%), BIM implementation plan (46%), BIM strategy (39%), modelling guidelines (36%) and 'other' documents – i.e. BIM manual, owner's guide and CAD manual - (7%). The responsibility for defining the LOD is attributed to the client (71%), the designer (29%) or the contractor (7%).

A wide variety of project stages or plan of works is adopted in Qatar including the RIBA Plan of Work (29%) and the AIA five phase of design (14%), the CIC Scope of Services and the PMI project management processes (7%). 'Other' plan of works such the BSRIA Design Framework for Building Services and client specific project phases was reported by 46% of respondents. As a consequence of these multiple project stages, interviewees reported issues such as the misinterpretation and the lack of adherence to project stages. They concurred about the need for developing standard project stages and BIM process maps for Qatar's construction industry and the joint responsibilities of government bodies, educational institutions and the private sector in this task.

2.4 Technology

This part of the interview aimed to identify the technologies used across all phases of the project lifecycle in Qatar. A summary of the result is depicted in Figure 1. It is clear from Figure 1 that for each of the four project purposes, there is a technology that is predominantly used. This exercise was intended to inform the development of lifecycle BIM information flow which is one of the overarching goals of the funded research project. Hence, in addition to identifying the technologies used on projects, this interview part aimed to capture information about the used file exchange formats. Predominantly used exchange formats include: IFC (68%), 3D PDF (25%), COBie (21%), NWC/NWD (50%) and 'other' proprietary file formats (57%).

3. Market-wide BIM Adoption: Specialised Models

Six experts and practitioners operating in Qatar were invited to apply the two models (i.e. Model A and Model B). The experts were selected using the snowball sampling procedure. The snowball sampling procedure occurs when the researcher accesses participants through contact information that is provided by other participants (Noy, 2008). The initial subjects serve as 'seeds' through which wave 1 subjects are recruited; wave 1 subjects in turn recruit wave 2 subjects, etc. (Heckathorn, 2015). The snowball effect enabled the implementation of a non-probabilistic sampling approach. This enabled the research to start with an exploratory sample – not a representative one – that could lead to generalizable results through either (a) cumulative approach (further identification and participation of experts until data saturation, convergence or statistical validity is achieved) or (b) Delphi technique to achieve consensus about the results. In this case, the generalisation was achieved using a mini Delphi approach (a single round) where the mean, excluding the most deviating ratings from it, was circulated to all experts to achieve consensus about the measurement. The two models and the results from their applications within Qatar are described and analysed in the subsequent two sections.

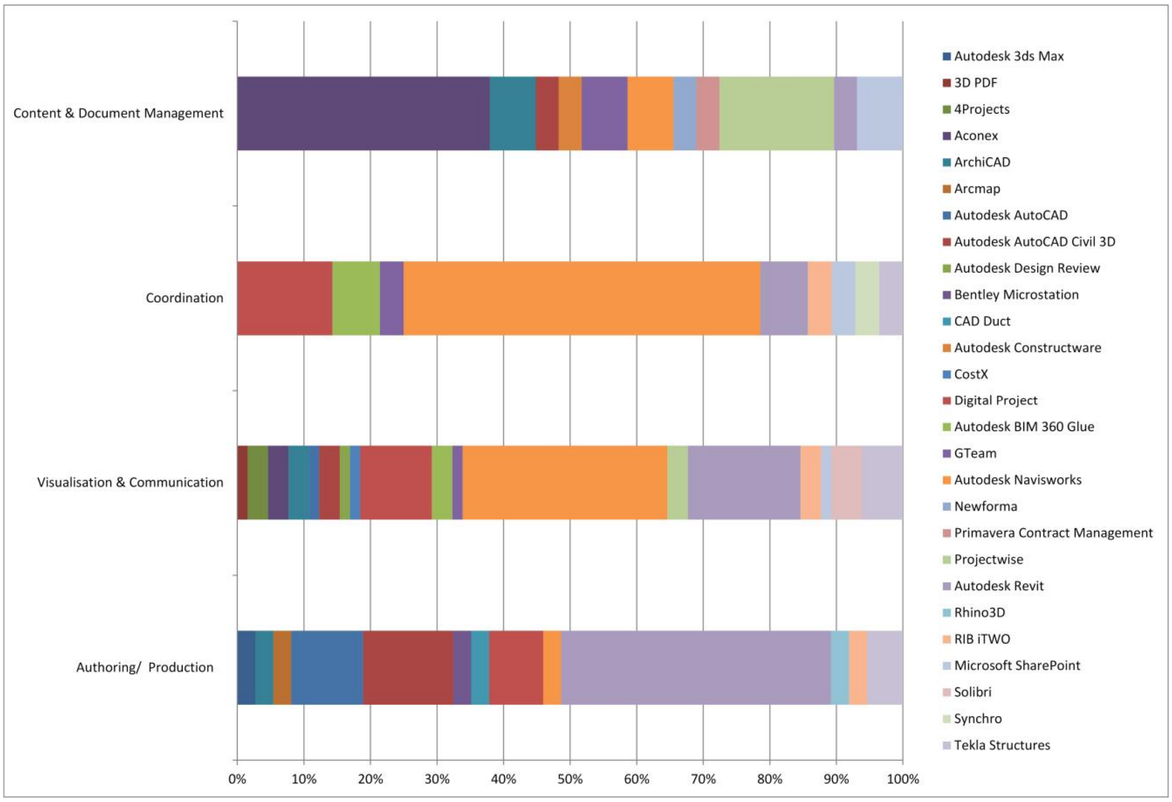

Figure 2: Technologies used on construction projects in Qatar

3.1 Assessing the Areas of Diffusion in Qatar

The Diffusion Areas model establishes nine areas for targeted BIM diffusion analysis and planning which can be assessed independently or collectively. These nine areas of diffusion are the result of overlaying the three BIM field types (technology, process and policy) and three BIM capability stages (modelling, collaboration and integration). This model can be used to assess the extent of BIM diffusion within organisations and across markets. The six experts were asked to rate the level of each BIM diffusion area according to a five-level scale: [0] low; [1] medium-low; [2] medium; [3] medium–high; and [4] high.

Figure 3 (upper part) displays the mean for the levels of diffusion of the nine areas. The results show that all areas of diffusions, with the exception of modelling technologies, are rated below medium. This is a reasonable outcome as modelling technologies are considered one of the capability sets (software step) required to move into the first BIM capability stage – i.e. modelling stage (Succar, 2009). This result is complemented with the results obtained from the survey-based approach (Figure 2) where the spread of modelling technologies was found to be prevalent in Qatar's construction industry. This result can be better understood in the lower part of Figure 4, which aggregates the score of the three fields (i.e. policy, process, technology) for each capability stage. It shows that the highest concentration of BIM diffusion rates is in low-level modelling capabilities followed respectively by lower mid-level collaboration capabilities and high-level integration capabilities.

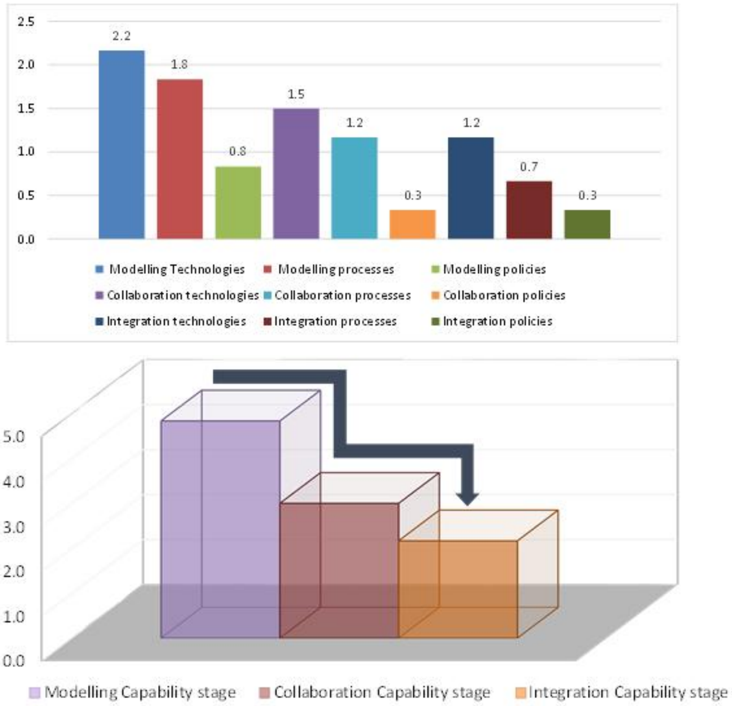

Figure 3: Assessment of BIM Diffusion Areas in Qatar

The levels of diffusion of three areas of policy (i.e. modelling policies, collaboration policies, and integration policies) are all rated below medium-low. The integration policy area has the lowest diffusion. This area refers to e.g. the rate of adoption of integrated supply-chain standards, protocols and contractual agreements; rate of proliferation of interdisciplinary educational programmes. Analysing the level of diffusion obtained for this area in conjunction with the survey results for the policy domain (Section 2.1), the result can be considered reasonable and complementary. Indeed, the survey showed the lack of Qatari specific collaboration protocols and the simultaneous coexistence of several standards and protocols within Qatar leading to misapprehension among organisations of the supply chain. Similarly, the results for the three process related areas of diffusions (i.e. modelling processes, collaboration processes and integration processes) are complementary and congruent between the survey and the Diffusion Area model.

There are key differences between the two approaches. Despite the adequate design and structuring of the survey into topics (i.e. people, process, policy and technology), the survey results can be used only for a general understanding or a situational analysis of a market. Indeed, they do not differentiate or recognise the different BIM capabilities that coexist within a market as demonstrated by the Diffusion Areas model and consequently, they are unable to provide a corresponding assessment of such areas. Moreover, the results from the survey are not actionable by policy makers interested in targeting a specific BIM diffusion area (e.g. achieve a high diffusion level in collaborative technologies). The Diffusion Areas model provides such capabilities through the generation of targeted ratings for comparative market analysis.

3.2 Assessing the Macro-BIM Maturity of Qatar

The second model (Model B: Macro-maturity components) identifies eight components that must be measured and compared in order to establish the BIM maturity of a market (Figure 4). These eight components are: 1. Objectives, stages and milestones, 2. Champions and drivers, 3. Regulatory framework, 4. Noteworthy publications, 5. Learning and education, 6. Measurements and benchmarks, 7. Standardised parts and deliverables, and 8. Technology infrastructure. These components are assessed using the BIM Maturity Index (BIMMI) which includes five maturity levels: [a] Ad-hoc or low maturity (0); [b] Defined or medium–low maturity (1); [c] Managed or medium maturity (2); [d] Integrated or medium–high maturity (3); and [e] Optimised or high maturity (5) (Succar, 2010). The assessment can be made holistically (low detail discovery assessment) or granularly (higher detail evaluation assessment). The discovery assessment is beneficial for comparing the relative maturity for each macro-component against the other seven components; while ‘evaluation’ assessment enable the detailed analysis of each component using specialised metrics applicable to that component only (Succar and Kassem, 2015).

Figure 6 reports the assessment result for the eight components. The maturity of all macro components in Qatar, with the exception of the ‘technology infrastructure’, falls within the interval ‘low’ and ‘medium-low’. ‘Learning and Education’ and ‘Measurements and Benchmarks’ have the lowest maturity rating. While the survey did not provide distinct components and metrics for their assessment, some of its qualitative results (e.g. limited training and learning opportunities, lack of country specific standards and protocols) support the assessment conducted using the macro maturity component. From the comparison of the application and results from both approaches (i.e. survey based and Macro-Maturity Components model), key advantages that can be attributed to the macro maturity model are: (a) it identifies and measures eight distinct but complementary components underpinning the BIM maturity of a market; (b) Improvement targets, in terms of maturity level, can be set for each of the eight components, and (c) Can promote learning in policy development and implementation for each of the eight components. For example, targets can be established against the other markets when new markets are added to the assessment and benchmark (e.g. benchmark countries 1 and 2 in Figure 5). Countries 1 and 2 in Figure 6 are two hypothetical markets that are used as a benchmark for Qatar. Using this outcome, Qatar can set performance targets across the eight components and learn from countries that achieved relatively high maturities in such components compared to the others (e.g. noteworthy Publications form Country 2, Regulatory Framework from Country 1).

4. Conclusions

This research aimed to apply and compare two approaches for the analysis of market-wide BIM adoption: (a) the traditional survey based approach, and (b) specialised macro BIM adoption models. Both approaches were successfully implemented but the obtained results enable different understanding of market wide BIM adoption and have different practical implications.

Figure 4: Macro-Maturity Components model (Succar and Kassem, 2015)

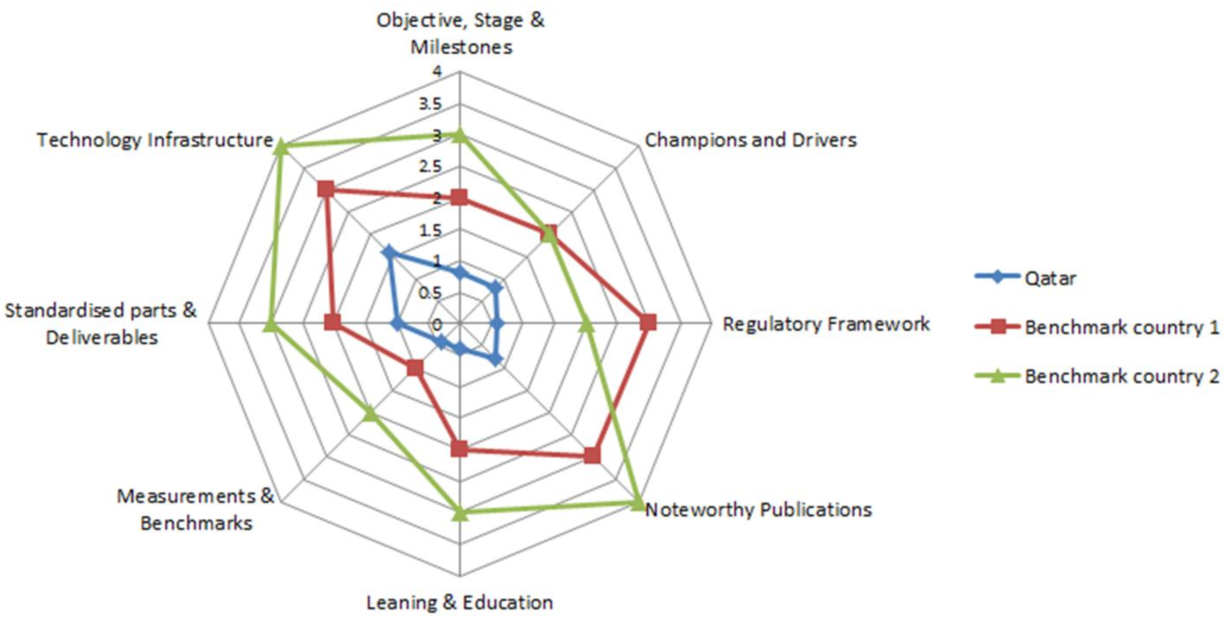

Figure 5: Rating of the eight maturity components in Qatar

The results from the survey/interview enabled an adequate general understanding of BIM adoption in Qatar. However, despite the improved structure (subdivision into topics: Technology, People, Process and Policy) and sampling methods (use of known sample of experts from key organisations operating in Qatar) of the survey/interview, the results remained descriptive and qualitative. For example, the results identified: the different BIM technologies used in Qatar; the key issues in policy domain such as the lack of country-specific standards and protocols; the limited BIM learning and training opportunities within Qatar, among others.

The application of two macro BIM adoption models – i.e. Diffusion Areas model and Macro-Maturity component model – both enabled a more informative assessment of BIM adoption in Qatar and provided results that could inform policy actions. This is the result of using specialised models, each with a specific purpose – one model to assess diffusion areas and another model to assess the macro-maturity components – and corresponding metrics. Using these models, the macro BIM adoption can be benchmarked between two or more markets. One market can set specific improvement targets corresponding to the high performance achieved within another market, hence, promoting the learning process in BIM policy development across markets.

Finally, the two approaches can be considered complementary. The results from the traditional BIM survey-based approach can be used to explain or justify the rating obtained from specialised macro BIM adoption models.

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