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BIM Maturity and its Influence on BIM Implementation Challenges: The Perspectives of UK Contractors

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Abstract

Building Information Modelling (BIM) offers a powerful means to enhance collaboration and efficiency in construction project delivery. However, many organizations still face persistent technical, organizational, and environmental challenges during implementation. BIM maturity has emerged as a key factor in addressing these issues, yet few studies have empirically examined how maturity influences the ability to manage such challenges. This study investigates how BIM maturity affects implementation challenges from the perspective of UK construction contractors. The research adopted a quantitative approach using a structured questionnaire administered to 65 professionals from UK contracting organizations. The survey measured BIM maturity across technology, process, and policy domains and examined how organizations manage common implementation challenges. The analysis employed descriptive statistics, Spearman's rank correlation, and independent-sample t-tests. Findings reveal that most organizations operate at Capability Stage 2, with moderate maturity across key BIM areas. Technological maturity, especially in software use, ranked highest. Organizations with higher BIM maturity managed challenges more effectively, though the correlation was moderate. These results underscore the value of assessing and developing BIM maturity as a strategic tool for overcoming barriers. Practically, construction firms can use maturity assessments to identify gaps, prioritize improvements, and enhance BIM implementation success across their projects.

Keywords: Digital, Maturity, Process, Construction, Implementation, BIM; Built Environment, Productivity, SDG 9.

1. Introduction

Building Information Modelling (BIM) has created new opportunities to maximize the collaboration between project teams (Adeniyi et al., 2024; Olivera et al., 2024). It is widely perceived as the "paradigm shift" that the construction industry needs to eliminate the silos within which it usually operates and improve productivity (Adeniyi et al., 2024; Eastman, 2011). However, as a relatively new and complex process, BIM has challenges that must be identified and successfully managed to harvest its benefits (Pavard et al., 2025; Azhar, 2011). The Computer Integrated Construction Research Programme (2013) underlines the need for systematic planning in order to effectively utilize BIM, which entails the maturity assessment of key organizational elements, the analysis of the results to identify areas of improvement, and the creation of a detailed plan to move forward based on the findings. Therefore, while successful BIM implementation connotes that the standard working procedures should be redefined and the necessary change in technologies, processes, and human behaviors should be effectively managed (Pavard et al., 2025; Hardin and McCool 2015), the assessment and advancement of organizational BIM maturity can be crucial in dealing with the associated challenges.

After the advent of BIM, much research has been conducted worldwide to track how the industry responds. The continuous increase in awareness regarding the value that BIM can bring to construction projects has created momentum in BIM adoption, which has significantly grown over the past few years and is expected to become an industry standard in the near future (Iqbal et al., 2025; Bernstein *et al.*, 2014; Malleson *et al.*, 2014; Smith, 2014). In the UK context, BIM was identified as a vital element of the construction industry's growth and was positioned as a "catalyst" in accomplishing the Government's ambitious strategic targets by 2025, including significant cost and time reductions during the overall project lifecycle (33% and 50% respectively) (HM Government, 2013). Following the BIM Level 2 mandate (Cabinet Office, 2011), BIM adoption in the UK construction industry has climbed from 13% in 2010 to 63% in 2016 (Waterhouse *et al.*, 2016). This indicates that UK organizations are steadily adopting BIM, and the interest moves now from deciding whether to adopt BIM to investigating ways of improving BIM capabilities and overall performance.

However, in order to achieve the BIM benefits, there is a significant number of underlying managerial, financial, training, technological, and legal issues (Olivera et al., 2024; Criminal and Langar, 2017; Bataw *et al.*, 2016; Liu *et al.*, 2015; Chien *et al.*, 2014). The various challenges can be generally classified into three broad categories: organizational, technological, and environmental, based on specific characteristics, but there is an inadequate exploration of discipline-specific BIM implementation challenges, which can enable different organizations and professionals to streamline their BIM processes and workflows (Navendren *et al.*, 2014).

Moreover, a significant amount of research has been conducted worldwide to underline the importance of BIM maturity and develop certain BIM maturity assessment models or investigate the applicability of the existing ones, with researchers concluding that there is no overarching solution yet, as the currently available maturity models have distinct advantages and disadvantages (Wu *et al.*, 2017). Morlhon *et al.* (2015) argue that evaluating BIM maturity can reduce the complex nature of BIM and is the first step that organizations should undertake towards establishing critical success factors that can assist in identifying and improving weaknesses in BIM implementation.

The critical role that BIM maturity plays in understanding and benchmarking the BIM implementation process is well recognized. At the same time, several barriers and challenges prevent organizations from developing their BIM capabilities and advancing through the maturity ladder (Pavard et al., 2025; Khosrowshahi and Arayici, 2012). BIM organizations operating at different maturity levels develop dissimilar BIM capabilities, meaning that different challenges must be addressed (Bataw and Kirkham, 2013). Achieving higher levels of BIM maturity leads to improved control, predictability, and effectiveness during BIM implementation, which means that BIM performance and productivity growth while targets are accomplished (Succar, 2009). This indicates that organizations with enhanced BIM maturity are more prepared to implement BIM effectively and cope with the various challenges. However, the researchers have predominantly focused on assessing BIM maturity without investigating how its status influences the BIM implementation process (Abdirad, 2017), and there needs to be an empirical study that directly links BIM maturity with the reported challenges of BIM implementation. This means that the impact of high maturity on the degree of effectiveness in dealing with implementation challenges has yet to be tested.

This study aims to address this research gap by focusing on UK contractors and investigating both BIM maturity and implementation challenges in a collective manner that is yet to be studied. For this to happen, a study is adopted that uses metrics from an already established maturity assessment tool to explore the implications of BIM maturity on time, quality, and cost performance of construction projects (Smits *et al.*, 2016). This study assesses the maturity of critical organizational BIM competencies, and the organizations' ability to deal with BIM implementation challenges is measured to test the association between the two elements.

2. Literature Review

2.1 BIM Implementation in the UK

The construction industry worldwide has acknowledged the importance of BIM, and its adoption is gaining significant momentum around the globe (Pavard et al., 2025; Cheng and Lu, 2015). The UK Government took the opportunity to lead globally by actively promoting BIM adoption. In the 2011-2016 Government Construction Strategy, BIM was identified as a vital element of the construction industry's growth, and Level 2 BIM was mandated for all publicly procured projects by 2016 (Cabinet Office, 2011). This bold statement was followed by a centralized Government BIM initiative, which incorporates detailed roadmaps published by the British Standards Institute (BSI) to guide successful and standardized BIM implementation to organizations and practitioners. BIM level 1 represents the non-collaborative standalone use of digital technologies for construction information sharing, while level 2 represents BIM model-based multidisciplinary collaboration (Cabinet Office, 2011). Level 3 represents a vision of full lifecycle, integrated, and seamless digital information processes (UK BIM Framework, 2021). Recently, the UK Government further expanded this endeavor by committing itself to supporting BIM adoption within the industry by presenting a Level 3 BIM Strategic Plan (Digital Built Britain, 2015).

2.2 Challenges to Implementing BIM

With BIM Level 3 targets in sight, interest has moved from pre-adoption challenges to post-adoption issues to improve BIM implementation success overall. Lately, substantial research on this subject has been conducted, with researchers identifying various challenges in several aspects of BIM implementation. Some studies initially classify BIM challenges into technical and non-technical. The report clarifies that BIM does not require the transformation of the whole work practice within an organization, but instead, it can be flexibly implemented to serve specific needs. Furthermore, BIM use and experience are growing, and challenges keep emerging in many new areas. A study argues that BIM challenges can be considered risk factors that hinder successful BIM implementation and identifies these five categories; technical, management, personnel, financial and legal (Olivera et al., 2024; Chien et al., 2014).

On the contrary, Poirier *et al.* (2015) classify challenges based on the organizational scales as industry-level, institutional-level, organizational-level, and project-level. However, although it is proved that BIM challenges can be explored by grouping them into distinct categories based on common characteristics, there needs to be a standard and widely adopted classification system in the literature. By combining the categories mentioned above, BIM challenges can be perceived either as internal, which refers to technical and organizational risks at the organizational or project level, or as external, which consists of environmental challenges at the industry and institutional levels. This accords with the technology, organizational, and environmental (TOE) framework, a theoretical model that explains adopting and implementing technological innovation (Olivera and Martins, 2011).

The technological challenges associated with BIM adoption contain issues that are related to technical aspects of how information is produced, exchanged, stored, and generally managed. Successful BIM implementation often necessitates increased workload and information needs during the early project stages, which can be challenging for teams with little or no previous BIM experience (Lu *et al.*, 2015; Navendren *et al.*, 2014). Kerosuo *et al.* (2015) report similar issues during the construction and maintenance stages, as the supply chain often needs to deliver the information requirements on-time and to the agreed standards. Possessing, maintaining, and delivering fit-for-purpose technological infrastructure is crucial to avoid data corruption and software and hardware failures that can restrain BIM performance (Pavard et al., 2025; Chien et al., 2014).

The organizational challenges to BIM adoption are enormous. The dominant themes identified under this group of challenges include the need to establish the necessary infrastructure and train personnel to adapt to the new process requirements, as there is a lack of skilled staff with the essential technical expertise, education, and BIM experience in the industry (Pavard et al., 2025; Olivera et al., 2024; Migilinskas *et al.*, 2013). Organizations should focus on dealing with the required cultural and process change to overcome the ingrained resistance to change within the business, promote collaborative working, and align new BIM roles and workflows with existing procedures (Navendren *et al.*, 2014). However, this can be inhibited by the parallel implementation of initiatives requiring considerable time, effort, and resources, such as high-quality health, safety, and environmental targets (Eadie *et al.*, 2014). Therefore, the absence of senior management support and commitment and the inability to measure BIM benefits and establish quantitative targets can seriously impede BIM uptake (Eadie *et al.*, 2014). Udom (2012) underlines the numerous legal issues concerning data ownership, intellectual property rights, risk allocation among project participants, and liability and insurance issues that pave the way for new collaborative BIM-focused contracts. In conjunction with the unaccommodating procurement routes, this implies the need for specific organizational measures (Porwal and Hewage, 2013).

Environmental challenges of BIM adoption mainly refer to institutional and industry-level external factors that affect BIM implementation. A recent study has identified that organizations need more guidance, which is critical to alleviating the challenges mentioned in the sections above (Building Cost Information Service, 2011). For example, the lack of comprehensive BIM standards, along with insufficient procurement and legal guidance, can create uncertainty for organizations, which will be forced either to implement BIM by following existing unsuitable methods of project delivery or spend extensive time and effort to establish their own workflows and regulatory frameworks (Navendren *et al.*, 2014b). This can also be impacted by the need for software vendors to promote BIM software and provide guidance (Navendren *et al.*, 2014a). Concerning interactions between organizations, the extent of the industry's BIM awareness and readiness is critical. The lack of client demand and supply chain adoption can result in "lonely BIM." In contrast, limited understanding by clients and low supply chain maturity can lead to inadequate BIM requirements, inability to meet BIM targets, and reluctance to share information openly (Poirier et al., 2015; Ku and Taiebat, 2011).

2.3 BIM Maturity

BIM is defined in this study as a set of interrelated policies, processes, and technologies that facilitate the digital management of building and project data throughout the entire life cycle of a facility (Succar et al., 2012). This definition reflects the multidimensional nature of BIM, going beyond mere software use to encompass the organizational, procedural, and strategic frameworks needed for effective implementation. To assess BIM maturity, this study draws directly from Succar's BIM Framework, which outlines five key components for evaluating BIM performance—namely, BIM capability stages, maturity levels, competency sets, organizational scales, and granularity levels. Specifically, this research focuses on the three core competency sets identified by Succar: technology (e.g., software use, hardware infrastructure), process (e.g., workflows, collaboration mechanisms), and policy (e.g., standards, guidelines, contractual arrangements). Succar and Kassem (2015) described BIM maturity as the extent to which organizations develop their BIM capabilities in a systematic, continuous, and consistent way to move from ad-hoc to optimized implementation of BIM tools, workflows, and protocols. This approach adopts the knowledge structures of a widely recognized BIM framework that introduces, among others, three Capability Stages and five Maturity Levels (Succar, 2009a; Succar, 2009b). BIM Stages act as major capability milestones and refer to minimum requirements in BIM deliverables that need to be achieved. Succar (2009a) espoused three key capability stages synonymous with UK strategic milestones (Levels 1, 2, and 3) as earlier discussed (Cabinet Office 2011). On the other hand, BIM Maturity Levels represent performance milestones that can be used as benchmarks for continuous improvement in several technologies, processes, and policy competencies, as well as future targets that organizations aspire to achieve. Succar (2009b) developed five maturity levels; initial, defined, managed, integrated, and optimized. Moving from initial to optimized maturity levels leads to better control, predictability, and effectiveness. Meaning that undefined and non-systematic procedures are abandoned while BIM competencies, performance, and costs become more consistent. Consequently, collaboration and productivity grow alongside achievements and the development of new goals (Succar, 2009b).

In the UK, BIM maturity is directly associated with the "BIM Wedge," which is a widespread maturity model created by Mark Bew and Mervyn Richards that consists of four distinct levels and forms the basis of the BSI committee's B555 Roadmap (Eynon, 2016). The four progressive maturity levels demonstrate different degrees of BIM experience in the UK context. However, the UK BIM Maturity model needs an in-depth analysis of BIM competencies in key capability areas and focuses more on the strategic milestone perspective (i.e., levels 0, 1, 2, 3). In this study, the BIM capability maturity model proposed by Succar (2009b) is relied on for determining key areas of capability in the following categories, Process, Policy, Technology, and Infrastructure (Succar, 2009a). These can be measured in five progressive maturity levels in consonance with widely used maturity models explained in the methodology section: initial, defined, managed, integrated, and optimized maturity (see Succar, 2009a; Succar, 2009b; CIC, 2013; Mahamadu 2019b).

2.4 Influence of BIM Maturity on BIM Implementation Challenges

BIM implementation can be perceived as an "input-process-output" model in which BIM users and tools act as inputs; the way that users utilize technological tools and interact with other users forms the process aspect of BIM, while BIM models and deliverables are the process outputs (Abdirad, 2017). However, BIM is not implemented at the same rate and success, mainly because of the different needs, goals, and expectations of the different organizations, as well as the various risks and challenges associated with each different level of implementation (Porwal and Hewage, 2013). BIM organizations operating at different maturity levels have been reported to possess varying BIM capabilities, thus influencing their ability to address different types of challenges (Bataw and Kirkham, 2013). It is, therefore, evident that successful BIM implementation requires a strategic approach that takes into consideration the different BIM dimensions in terms of technologies, processes, policies, and people associated with varying levels of maturity to overcome the implementation challenges and achieve the targeted BIM performance (Arayici et al., 2011). Therefore, BIM implementation needs to be "tailored" to the unique organizational and project requirements by following a planned procedure that reviews current practices; designs an action plan of how to adopt new technologies and processes; rolls out BIM implementation (by using pilot projects, training internal staff and project stakeholders, as well as documenting adopted processes); and finally evaluates the results and employs lessons learned for continuous improvement (Arayici *et al.*, 2012). This can be facilitated by a bottom-up approach in which organizations initially measure their BIM readiness and maturity in key competency areas to improve their BIM performance and alleviate the associated challenges.

3. Research Methodology

3.1 Research Approach/Strategy

A quantitative research approach was adopted to achieve this study's aim. It was deemed appropriate to adopt this approach because it offers room for questionnaire surveys to extract pertinent data from the respondents (Fellows and Liu, 2021). The authors opted for questionnaire surveys to generate a wide range of responses within a limited time frame (Naoum, 2013). Additionally, the quantitative approach provides logical and statistical findings, which is ideal for this study as it seeks to verify BIM maturity impacts on implementation challenges.

3.2 Research Instrument Design and Administration

A structured questionnaire with close-ended questions was utilized to ensure the data collection process's effectiveness. The questionnaire consisted of three (3) main sections. The first section, which had two parts, required respondents to give certain background information about themselves and their organization. This included respondents' professional roles, individual and organizational BIM experience, organization size, and personal involvement in BIM implementation. The second section was targeted to assess BIM maturity. Within the section, respondents were initially prompted to determine their organization's general capability stage (stages 1, 2, or 3) and assess several organizational BIM competencies regarding adopted technologies, processes, and policies. This assessment was based on the structure of the BIM Maturity Matrix (Succar, 2009b), while the assessed competencies were formed by combining the tool's measures/questions and Penn State's Organisational BIM Assessment Profile (CIC, 2013). The evaluation method adopted solicited professional respondents' opinions about maturity levels they believe their organizations have achieved. The last section required respondents to determine their level of agreement with the extent to which their organizations can alleviate several technological and organizational challenges and the extent to which they believe external (environmental) factors affect their BIM implementation. This was done using a Likert scale from 1-5, where 1= = strongly agrees, and 5= = strongly disagrees, with 3 being the neutral point among the ratings.

Before the questionnaires were distributed, piloting was undertaken to ascertain the suitability and validity of the questionnaire. The questionnaire was piloted among five (5) persons consisting of two (2) industry professionals and three (3) academics. The two industry professionals included a BIM manager and a senior project engineer from UK-based contracting firms, while the three academics specialized in construction management and digital construction. These individuals were purposefully selected to represent both practical and academic perspectives on BIM implementation. Since no definitive guidelines exist for determining sample size in questionnaire validation (Tsang et al., 2017), this study engaged five respondents for the pilot testing process. Also, a small, focused pilot group was adopted to ensure swift feedback and practical refinements without delaying survey deployment. The feedback received was used to improve the general layout, questions' clarity, and questionnaire length. With the necessary rectifications, the questionnaire was subsequently distributed through private *LinkedIn* messages to construction professionals currently working for UK contractors including BIM coordinators, BIM managers, BIM technicians, design managers, quantity surveyors, project managers, planners and engineers. Given the study's focus on assessing BIM maturity and its influence on implementation challenges, it was crucial to engage professionals with in-depth knowledge and practical experience in BIM processes. Therefore, a purposive sampling technique was adopted to deliberately select participants who held BIM-related roles such as BIM Managers, Digital Engineers, and Project Managers within UK contracting organizations. This approach ensured that the data collected would be both relevant and valid for the research objectives. To further enhance the reach of the study and identify additional qualified participants who might have been difficult to access directly, a snowball sampling strategy was also employed. Initial respondents were encouraged to recommend other professionals within their networks who had significant involvement in BIM implementation. This dual strategy improved access to a broader but still targeted pool of knowledgeable participants (Pittri et al., 2024). Of 180 distributed questionnaires, 65 complete ones were received, indicating a 36% response rate higher than the 30% average for online surveys and the 35% average for organizational research (Baruch and Holtom, 2008; Nulty, 2008). These responses, primarily from professionals with hands-on BIM experience, formed the basis for the empirical analysis.

3.3 Data Analyses

The data gathered was subjected to descriptive and inferential statistics methods. The descriptive statistical method was used to analyze the background information of respondents as well as examine the BIM maturity of UK construction organizations and BIM implementation challenges. The inferential statistical method was used to identify the association between BIM maturity and BIM implementation challenges. This involved the use of Spearman Ranked Correlation. Spearman's correlation is nonparametric, thus, more suitable for the categorical and ordinal nature of the collected data (Saunders et al., 2015).

Similarly, the independent-sample T-tests were performed to ascertain if organizational characteristics were more defining in organizational BIM maturity or ability to manage implementation challenges. The widely-adopted and user-friendly Statistical Package for the Social Sciences (SPSS) and Microsoft Excel were used to analyze the collected data. At the same time, all charts were extracted from Bristol Online Surveys (BOS).

4. Findings

4.1 Respondents Background

Respondents' demographics, as well as organizations' backgrounds, are presented in Table 1 below. The results indicated a dominance of BIM-related professionals. More specifically, 47.5% of the respondents hold either a BIM or digital engineering position, with BIM Manager being the predominant professional role (32.3%). The most significant proportion of the respondents had more than ten years of experience in the construction industry (46.2%). Most respondents (63.1%) came from larger organizations whose annual turnover exceeds £600 million, and a significant number of these companies (52.3%) had delivered more than ten BIM projects in the past. Regarding BIM capability, most respondents assessed their companies as level 2 compliant. This refers to Model-based collaboration capability, which is also the mandated level expected within the UK due to Government mandate since 2016.

[INSERT TABLE 1]

4.2 The Status of BIM Maturity Within the Organisations

For technology and infrastructure-related BIM maturity, respondents assessed their organizations' maturity levels in relation to software, hardware, and network systems, as well as physical spaces within their organizations for BIM activities. Following Succar (2009a) and Succar (2009b), the following scales were adopted for assessing each maturity level: initial, defined, managed, integrated, and optimized. The results (see Table 2) presented an overall trend towards "managed" and "integrated" levels for the first three categories, that is, software, hardware, and network systems. Unlike the others, physical spaces showed a more balanced distribution among the five identified levels. The combined percentage of these maturity levels was 63% for software systems, 60% for hardware systems, 58.5% for network systems, and 50.2% for physical spaces.

In addition, five sets of process-related BIM competencies were assessed, including BIM leadership and management. The maturity in most of the process-related organizational BIM competencies appeared to be distributed around a "managed" level of maturity. The highest percentages in BIM leadership and management were recorded in "managed" (30.8%) and "integrated" (29.2%) maturity levels, with BIM products and services reporting equivalent results with 30.8% and 26.2%, respectively. On the other hand, the highest results in change readiness were 30.8% in "defined" and 33.8% in "managed" maturity levels. In contrast, the maturity of BIM hierarchy, roles and responsibilities, and BIM activities and workflows appeared to be more balanced by spreading almost evenly between "initial," "defined," "managed," and "integrated" levels (all levels between 20% and 27.7%). Again, "optimized" maturity levels reported the lowest percentages among all process-related BIM competencies varying from 0% to 9.4%.

For policy-related BIM maturity, respondents were prompted to assess maturity in BIM training and education, Use of Codes, Regulations, Standards, Classifications, Guidelines and Benchmarks, and BIM contractual arrangements. BIM training and education, as well as BIM contractual arrangements, fluctuated from "initial" to "integrated" levels, with a slight superiority of "initial" maturity in both competency sets (27.7% and 29.2%, respectively). On the other hand, the use of BIM Codes, Regulations, Standards, Classifications, Guidelines, and Benchmarks reported the highest maturity in "managed" (33.8%) and "integrated" (24.6%) levels. In agreement with the previous sections, "optimized" levels did not exceed 4.6% in any of the examined competency sets.

[INSERT TABLE 2]

4.3 Managing Internal and External BIM Implementation Challenges

Respondents assessed the extent to which they agree that their organizations can alleviate a series of internal challenges mainly related to Technical and Organisational aspects of BIM implementation (as summarised in Table 3 below).

[INSERT TABLE 3]

The results suggest that, overall, the participating organizations possess a moderate to high capability in managing a range of technical BIM implementation challenges. Approximately 65% of respondents agreed that their organizations can effectively address issues such as software interoperability, communication and information exchange, quality control, and the increased workload and information requirements associated with BIM adoption. These findings imply that many UK contractors have invested in the necessary digital infrastructure and procedural adjustments to support core technical processes, consistent with the higher maturity reported in the technology dimension (e.g., software and hardware systems).

However, not all technical challenges are being managed with equal effectiveness. The inability of supply chain partners to meet agreed information requirements, the inaccuracy or unsuitability of BIM models, and inadequate technology infrastructure were among the least confidently managed challenges. These results suggest that while internal technical capacity may be improving, organizations remain hindered by inter-organizational dependencies, particularly when the maturity of supply chain actors lags behind. This aligns with prior studies (e.g., Mahamadu et al., 2017; Vrijhoef, 2011), which emphasize the difficulty of achieving consistent BIM implementation across fragmented project teams. Furthermore, data protection and cybersecurity emerged as a highly polarizing issue; nearly 30% of respondents expressed uncertainty about their organization’s ability to manage these risks, highlighting an area that requires clearer strategy and improved governance frameworks.

In terms of organizational challenges, the findings show a generally positive trend. A significant proportion of organizations reported being able to manage process change effectively, with 77% agreement. Additionally, over 60% indicated that they were not hindered by a lack of skilled personnel or the presence of competing internal initiatives, suggesting that internal organizational readiness has matured beyond earlier concerns highlighted in studies such as Navendren et al. (2014a) and Jones et al. (2015). However, persistent issues remain. Notably, many respondents expressed difficulty in addressing legal risks, including those associated with ownership, liability, and risk allocation, as well as challenges related to traditional procurement methods that fail to facilitate collaborative BIM workflows. These findings reinforce arguments made by Giel and Issa (2014) and Bataw et al. (2016), who stressed that legal and contractual systems continue to lag behind technological innovation, limiting the effectiveness of BIM in practice.

The picture is more complex when considering external (environmental) challenges as presented in Table 4, such as those stemming from clients, supply chains, and wider industry support. The results show that over 80% of respondents reported confidence in managing supply chain buy-in and client-related issues, including limited understanding and lack of BIM demand. However, this high agreement reflects respondents' perceived ability to manage—not necessarily the absence or insignificance—of these challenges. This distinction is crucial. These issues remain deeply embedded within the industry structure, and their frequent citation suggests that even capable organizations must constantly work to navigate external resistance and knowledge gaps. This insight aligns with macro-level maturity concerns raised by Kassem and Succar (2017), who argued that micro-level success often depends on enabling policy and education at the sectoral level. Conversely, lower agreement levels were recorded for challenges such as inadequate BIM standards and limited software vendor awareness, suggesting that these are less pressing barriers, or that the industry has made progress in resolving them (see Table 4).

The findings suggest that while internal technical and organizational capacity is strengthening, external alignment and legal frameworks remain substantial barriers to optimized BIM implementation. Organizations with higher maturity may be increasingly resilient, but structural industry-wide challenges—especially those related to fragmented procurement and inconsistent supply chain capability—continue to limit the transformative potential of BIM.

[INSERT TABLE 4]

4.4 The Influence of Organisational Background on BIM Challenges

The independent samples *t*-test was conducted to ascertain whether or not an organization's background or experience had a statistically significant influence on their perceptions about the external challenges that affect their organization and their ability to alleviate internal challenges. Generally, no significant differences existed except for two factors; number of BIM projects delivered in the past and annual turnover. More specifically, Organisations that have delivered over 5 projects through BIM were found as more capable of alleviating challenges when compared to those that have delivered up to 5 projects through BIM, especially when it comes to difficulties in measuring BIM benefits [$t(63) = 2.036$, $p = 0.046$]. Thus, more experienced firms found it easier to establish or ascertain the impact of BIM on their projects. The significant results are presented in Table 5.

It was also found that larger organizations (in terms of turnover) thought their BIM implementation needed to be improved due to the lack of availability of case studies that could follow. More specifically, Organisations with over £600 annual turnover (i.e., larger organizations) were impacted more by a general lack of case studies and lessons learned in the industry when compared to smaller organizations (under £600 annual turnover) [$t(20.638) = 2.383$, $p = 0.027$] as presented in Table 6. By implication, it means such companies may be placing more value on the lessons learned or may also be indicative of a lack of case studies for more wide-scale implementation.

[INSERT TABLE 5]

[INSERT TABLE 6]

4.5 The Influence of BIM Maturity on BIM Implementation Challenges

Spearman's rank correlation coefficient (ρ) was used to explore the relationship between organizations' reported BIM maturity and their ability to manage both internal and external implementation challenges (see Table 7). Due to the design of the Likert scale used in the survey, negative correlation coefficients indicate a greater ability to alleviate challenges with increasing BIM maturity, while positive coefficients (in the case of environmental challenges) imply that organizations are less affected by these external factors as maturity increases. The analysis as presented in Table 7 reveals that although most correlations were statistically significant, they were generally moderate in strength, suggesting that no single maturity area overwhelmingly influences challenge mitigation. Nonetheless, clear patterns emerged across the three maturity dimensions. Policy maturity—particularly the use of standards, codes, and regulations—showed the strongest relationship with reducing technical and environmental challenges, most notably in handling software interoperability issues ($\rho = -0.369^{**}$, $p < 0.01$). This highlights the value of standardization and formal frameworks in overcoming systemic barriers.

Process maturity demonstrated the strongest associations with technical challenges. For instance, change readiness was negatively correlated with several implementation issues, including model inaccuracy and interoperability. However, a noteworthy exception was its positive correlation with inadequate supply chain buy-in ($\rho = -0.376^{**}$, $p < 0.01$), an external factor. This suggests that even highly mature organizations may struggle with supply chain readiness—highlighting a lag between organizational and industry-wide maturity. This finding aligns with prior studies (e.g., Mahamadu et al., 2017), which emphasize persistent fragmentation across the construction supply chain.

Technological maturity showed a more balanced yet comparatively weaker relationship across all challenge categories. Among the competencies, hardware systems had the strongest correlation with improved model accuracy ($\rho = -0.392^{**}$, $p < 0.01$), indicating that robust infrastructure underpins reliable BIM delivery.

Overall, these results suggest that increased BIM maturity contributes meaningfully to challenge mitigation, though the effect varies by maturity dimension and challenge type.

[INSERT TABLE 7]

5. Discussion

This study provides empirical evidence on how BIM maturity influences the ability of UK construction contractors to manage implementation challenges. While earlier studies have examined BIM adoption barriers and enablers in general terms, this study extends the discourse by exploring the relationship between specific maturity dimensions—technology, process, and policy—and the degree to which organizations can alleviate internal and external challenges. Findings indicate that most organizations in the sample operate at Capability Stage 2, reflecting a model-based collaborative environment. However, maturity levels remain predominantly at the “managed” stage, indicating the presence of controlled and documented BIM processes, defined responsibilities, and established use of typical standards and tools, but without reaching full integration or optimization (Succar, 2009a; Succar et al., 2012). This suggests that while contractors have made substantial progress in BIM adoption, they are yet to achieve strategic alignment, performance measurement, and supply chain-wide integration characteristic of higher maturity levels.

The strongest relationships between maturity and challenge mitigation were found in the policy dimension, particularly in the use of BIM standards and contractual frameworks. Organizations with higher policy maturity were significantly better at addressing technical interoperability issues ($\rho = -0.369$, $p < 0.01$) and legal uncertainties, which reinforces the role of regulatory frameworks and standardized guidance in improving implementation outcomes (Kassem and Succar, 2017; Succar and Kassem, 2015). These findings also validate the importance of macro-level enablers in facilitating micro-level performance.

Process maturity demonstrated strong associations with the ability to manage technical and organizational barriers. For instance, increased change readiness was linked to improved model quality and data security. However, a notable exception was the positive correlation between change readiness and supply chain buy-in issues ($\rho = -0.376$, $p < 0.01$), suggesting that mature organizations may still struggle with external integration, particularly when operating in fragmented ecosystems. This echoes findings by Mahamadu et al. (2017) and Vrijhoef (2011), who highlight the need for cultural alignment and structural incentives across the supply chain to enable full BIM realization.

In contrast, technological maturity, although well-developed—especially in hardware and software systems—showed more moderate influence across challenge types. Organizations with advanced technical infrastructure were more capable of delivering accurate models and minimizing technical errors, aligning with findings from Mahamadu et al. (2019a), Prabhakaran et al. (2021), and Smits et al. (2016), who found that technological aspects of BIM tend to mature faster than process and policy elements.

Interestingly, perceived barriers differed from those typically emphasized in literature. Challenges such as increased time or workflow changes, commonly cited in prior studies (Criminal and Langar, 2017; Jones et al., 2015), were considered less significant by respondents. Instead, model inaccuracy and supply chain noncompliance were among the most pressing concerns. This suggests a shift in perception: organizations are increasingly confident in managing internal transitions but remain hindered by external dependencies, particularly inconsistent information delivery across project partners.

Furthermore, larger and more experienced organizations—often with a history of delivering multiple BIM projects—were more adept at managing both organizational and environmental challenges. This supports assertions by Smits et al. (2016) and Prabhakaran et al. (2021), who emphasized the enabling role of organizational size and accumulated BIM experience.

The findings also highlight that BIM implementation is not isolated to organizational readiness, but is also shaped by market dynamics and vendor ecosystems. As discussed earlier, the monopolization of BIM software in regions such as Australia/NZ presents a cautionary tale. While the UK context is more diverse, reliance on proprietary platforms still poses interoperability and cost-related limitations that affect maturity development beyond internal efforts.

This study affirms that BIM maturity is a critical factor in determining an organization’s ability to manage implementation challenges, but its effectiveness depends on balanced development across all dimensions and alignment with external collaborators. As BIM continues to evolve from isolated digital tools to integrated project delivery frameworks, maturity models must account not only for organizational capabilities but also for broader industry structures and policy environments (Succar, 2009a; Succar et al., 2012).

The influence of software vendors on BIM adoption presents a critical dimension in understanding BIM maturity development. In regions such as Australia and New Zealand, the dominance of a single commercial software provider has raised concerns about monopolistic influence, where BIM uptake may be guided more by product marketing and availability than by structured policy frameworks or capability-building initiatives. Although the UK construction sector currently exhibits a more diverse software environment, similar concerns regarding over-reliance on proprietary platforms remain. Such dependency may hinder interoperability efforts and restrict the advancement of maturity in process and policy dimensions, even when technological tools are in place. These observations suggest that BIM maturity should be considered not only as an outcome of internal organizational readiness but also as a reflection of external market forces and vendor ecosystems. A more holistic view of BIM performance must therefore account for how software ecosystems either enable or constrain the balanced development of BIM competencies across technology, process, and policy. This area warrants further investigation, particularly in cross-country comparative studies examining the interplay between software availability, industry policy, and maturity outcomes.

6. Conclusion

This study aimed to investigate the relationship between organizational BIM maturity and the challenges faced during BIM implementation, with a focus on UK construction contractors. Specifically, it sought to assess BIM maturity levels across core capability areas and examine how these influence an organization's ability to manage internal and external implementation challenges. The findings show that as BIM maturity increases, particularly in policy and process dimensions, organizations become more capable of mitigating technical and organizational challenges, and less affected by external barriers. Although the correlation strength was generally moderate, the results indicate a clear trend: maturity supports resilience in BIM implementation. From a practical standpoint, construction organizations can use BIM maturity assessments as strategic tools to identify competency gaps and tailor their improvement plans accordingly. Moreover, by understanding how different maturity dimensions influence challenge mitigation, industry stakeholders can prioritize capacity-building efforts in areas with the greatest impact such as change readiness, standards adoption, and leadership. Organizational challenges were found to be the most difficult to overcome, regardless of capability stage. External issues, such as client understanding and supply chain readiness, also remain significant. These insights reinforce the need for a coordinated, maturity-informed approach to BIM adoption across the construction ecosystem. The BIM maturity model employed thus captures both the extent (capability stage) and quality (maturity level) of BIM implementation across these dimensions. Although the study takes a high-level view, the survey items and analysis reflect key performance indicators derived from profession-relevant roles (e.g., BIM Managers, Digital Engineers, Project Managers), and are aligned with the knowledge areas proposed by Succar's BIM Competency Framework. While profession-specific and software-specific breakdowns are beyond the current scope, they are identified as important areas for future research and maturity benchmarking in the UK context.

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Table 1: Respondents' Background

Characteristics	Frequency	Percentage
Professional Role		
BIM Coordinator	4	6.2
BIM Manager	21	32.3
BIM Technician	1	1.5
Design Manager	7	10.8
Engineer	10	15.4
Planner	2	3.1
Project Manager	5	7.7
Quantity Surveyor	4	6.2
Other	11	16.9
Experience (Years)		
< 2	5	7.7
2-5	16	24.6
5-10	14	21.5
>10	30	46.2
BIM Experience (Years)		
< 2	22	33.8
2-5	20	30.8
5-10	15	23.1
>10	8	12.3
Annual Turnover		
Less £100 million	3	4.6
£100-£250 million	8	12.3
£251-£600 million	13	20.0
>£600 million	41	63.1
Number of projects delivered through BIM		
Only 1 project	4	6.2
2-5 projects	19	29.2
6-10 projects	8	12.3
>10 projects	34	52.3
BIM Capability		
Level 1 (Object-based modelling)	10	15.4
Level 2 (Model-based collaboration)	40	61.5
Level 3 (Network-based integration)	15	23.1

Table 2: Summary of Respondents' BIM Maturity Assessment

		Statistics – Central Tendency				Frequency (%) at each BIM Maturity Level				
Competency Category	BIM Competencies	Mean	Median	Mode	Rank by Mean	Defined	Initial	Managed	Integrated	Optimized
Technology and Infrastructure	Software Systems	3.03	3	4	1	12.30	18.50	29.20	33.80	6.20
	Hardware Systems	2.97	3	3	2	10.80	20.00	40.00	20.00	9.20
	Network Systems	2.88	3	3	5	12.30	24.60	30.80	27.70	4.60
	Physical Spaces	2.68	3	3	9	18.50	26.20	29.20	21.50	4.60
Process	Leadership and Management Change readiness BIM hierarch roles and responsibilities BIM activities and workflows	2.91	3	3	4	16.90	16.90	30.80	29.20	6.20
	Change readiness	2.49	3	3	12	18.50	30.80	33.80	16.90	0.00
	BIM hierarchy roles and responsibilities	2.7	3	2	7	21.90	25.00	23.40	20.30	9.40
	BIM activities and workflows	2.69	3	3	8	20.00	23.10	27.70	26.20	3.10
	BIM products and services	2.95	3	3	3	15.40	18.50	30.80	26.20	9.20
Policy	BIM training and services	2.57	3	1	10	27.70	21.50	21.50	24.60	4.60
	Use of BIM codes, standards, guidelines, and benchmarks	2.77	3	3	6	20.00	16.90	33.80	24.60	4.60
	BIM contractual arrangements	2.52	3	1	11	29.20	18.50	24.60	26.20	1.50

Table 3: Summary of Descriptive Statistics on Organisations' Ability to Manage Internal BIM Implementation Challenges

Challenges	Frequency				
	SA	A	NAD	D	SD
Organisation's Ability to Manage Technical Challenges					
Software Interoperability issues	16.9	49.2	23.1	9.2	1.5
Insufficient communication and information exchange between project teams	16.9	46.2	26.2	9.2	1.5
Inadequate quality control of data input (data inaccuracies, data integrity risks)	18.5	44.6	23.1	10.8	3.1
Inadequate technology infrastructure (low capacity, data loss, data corruption, software failures)	9.2	38.5	24.6	24.6	3.1
Data protection and security issues	18.5	29.2	29.2	16.9	6.2
Increased workload and information needed in the project	13.8	49.2	16.9	16.9	3.1
The BIM model is inaccurate/ not suitable for construction	10.8	38.5	23.1	20	7.7
BIM implemented by the supply chain without meeting the required/agreed information needs	10.8	35.4	26.2	23.1	4.6
Project meetings do not effectively take advantage of BIM's potential	23.1	35.4	16.9	21.5	3.1
Organisation's Ability to Manage Organizational Challenges					
High BIM implementation cost (technology, infrastructure, training, education)	12.3	44.6	20.0	15.4	7.7
Inadequate senior management support/commitment	12.3	49.2	15.4	18.5	4.6
Cultural change required (mindset, mentality, collaboration, resistance to change)	16.9	38.5	30.8	12.3	1.5
Process change required (new workflow, new roles, and responsibilities, alignment)	26.2	50.8	15.4	3.1	4.6
Other competitive initiatives that prevent complete focus on BIM (quality, health and safety, environmental targets)	9.2	53.8	20.0	13.8	3.1
Legal issues (ownership, intellectual property, liability, insurance, licensing, risk allocation, new contractual requirements)	15.4	26.2	33.8	20.0	4.6
Challenges caused by the existing procurement routes (limited involvement of critical stakeholders, cost distribution	12.3	43.1	13.8	26.2	4.6
Difficulties in BIM objectives/ Lack of quantitative objectives	15.4	41.5	21.5	20.0	1.5
Lack of personnel with adequate BIM skills (technical expertise, education, experience)	27.7	36.9	21.5	12.3	1.5
Significant time required for BIM implementation	26.2	35.4	18.5	18.5	1.5

SA - Strongly agree; A - Agree; NAD - Neither agree nor disagree; D – Disagree; SD – Strongly agree

NB: The Likert scale measures respondents' perceptions of their organization's ability to manage the listed challenges

Table 4: Summary of Descriptive Statistics on Organisations' Ability to Manage External BIM Implementation Challenges

Challenges	Frequency				
	SA	A	NAD	D	SD
Organisation's Ability to Manage Environmental (External) Challenges					
Inadequate wider industrial support and leadership (Government, authorities, industry association, educational institutions)	18.5	49.2	20.0	12.3	0.0
Inadequate supply chain buy-in/ Low BIM adoption and maturity in the industry	15.4	66.2	10.8	4.6	3.1
Inadequate BIM standards (data, software, and process standards)	10.8	24.6	29.2	33.8	1.5
Inadequate BIM-related procurement and legal guidance	13.8	40.0	26.2	20.0	0
Inadequate awareness or promotion of BIM software from software vendors	10.8	24.6	27.7	32.3	4.6
Lack of trust among supply chain/ reluctance to openly share information	18.5	46.2	26.2	7.7	1.5
Lack of client demand	46.2	36.9	9.2	4.6	3.1
Limited understanding by clients (confusing, not well-defined BIM requirements)	46.2	36.9	9.2	4.6	3.1
Lack of common language and definitions within the industry	21.5	36.9	21.5	18.5	1.5
Lack of BIM case studies and lessons learned	13.8	38.5	24.6	21.5	1.5

SA - Strongly agree; A - Agree; NAD - Neither agree nor disagree; D – Disagree; SD – Strongly agree

NB: The Likert scale measures respondents' perceptions of their organization's ability to manage the listed challenges

Table 5: Independent samples t-test for the capability of the organization to alleviate organizational BIM implementation challenges (by number of projects delivered through BIM)

Organizational challenge	Number of projects delivered through BIM	N	Mean	Std. Deviation	Std. Error Mean	Levene's Test for Equality of Variances			t-test for Equality of Means						
						Equality of variances	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
														Lower	Upper
Difficulties in measuring BIM benefits	up to 5 projects	22	2.864	0.990	0.211	Equal variances assumed	0.096	0.758	**2.036**	**63**	**0.046**	**0.538**	**0.264**	**0.010**	**1.066**
	over 5 projects	43	2.326	1.017	0.155	Equal variances not assumed			2.054	43.456	0.046	0.538	0.262	0.010	1.066

Note: Scale: 1 = strongly agree; 2 agree; 3 = Neither agree nor disagree; disagree; 5 = strongly disagree

Table 6: Independent samples t-test for the effect of external factors on BIM implementation by the company - by the size of the company (annual turnover)

External Bim implementation factor	Annual turnover (million)	N	Mean	Std. Deviation	Std. Error Mean	Levene's Test for Equality of Variances			t-test for Equality of Means						
						Equality of variances	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
														Lower	Upper
Lack of case studies and lessons learned	Up to £600	11	3.091	0.701	0.211	Equal variances assumed	5.461	0.023	1.822	63	0.073	0.609	0.334	-0.059	1.278
	Over £600	54	2.481	1.059	0.144	Equal variances not assumed			**2.383**	**20.638**	**0.027**	**0.609**	**0.256**	**0.077**	**1.142**

Note: Scale: 1 = strongly agree; 2 agree; 3 = Neither agree nor disagree; disagree; 5 = strongly disagree

Table 7: Influence of BIM maturity Ability to alleviate BIM implementation Challenges

Category	**BIM Maturity ↔ Impact of BIM Implementation Challenge**	**ρ**	**p-value**	**Colour Code**
Technology And Infrastructure Maturity	Software systems ↔ BIM model is inaccurate / not suitable for construction (T)	-0.345**	0.005	Green
	Software systems ↔ High BIM implementation costs (O)	-0.251*	0.043	Green
	Software systems ↔ Other competitive initiatives prevent complete focus on BIM (O)	-0.249*	0.048	Green
	Hardware systems ↔ BIM model is inaccurate / not suitable for construction (T)	-0.392**	0.001	Green
	Network systems ↔ BIM model is inaccurate / not suitable for construction (T)	-0.389	0.001	Green
	Network systems ↔ BIM is implemented by the supply chain to meet the required/agreed information needs (T)	-0.266*	0.032	Green
	Physical spaces ↔ BIM model is inaccurate / not suitable for construction (T)	-0.305*	0.013	Green
	Physical spaces ↔ Lack of common language and definitions within the industry (E)	-0.273*	0.028	Red
	Physical spaces ↔ Lack of BIM case studies and lessons learned (E)	0.263*	0.034	Green
Process Maturity	Change readiness ↔ Software interoperability issues (T)	-0.365**	0.003	Green
	Change readiness ↔ Software interoperability issues (T)	-0.255*	0.040	Green
	Change readiness ↔ Inadequate supply chain buy-in / BIM maturity (E)	-0.376**	0.002	Red
	Change readiness ↔ BIM model is inaccurate / not suitable for construction (T)	-0.302*	0.015	Green
	Change readiness ↔ BIM is implemented by the supply chain without meeting the required/agreed information needs (T)	-0.296*	0.017	Green
	BIM hierarchy, roles, and responsibilities ↔ Software interoperability issues (T)	-0.356*	0.004	Green
	BIM hierarchy, roles, and responsibilities ↔ Data Protection and security issues (T)	-0.306*	0.014	Green
	BIM hierarchy, roles, and responsibilities ↔ BIM model is inaccurate / not suitable for construction (T)	-0.289*	0.021	Green
	BIM activities and workflows ↔ Software interoperability issues (T)	-0.367**	0.003	Green
	BIM activities and workflows ↔ Data Protection and security issues (T)	-0.305	0.013	Green
	BIM activities and workflows ↔ BIM model is inaccurate / not suitable for construction (T)	-0.289*	0.031	Green
	BIM products and services ↔ BIM model is inaccurate / not suitable for construction (T)	0.341**	0.005	Red
	BIM products and services ↔ Data Protection and security issues (T)	-0.324*	0.008	Green
	BIM products and services ↔ Software interoperability issues (T)	0.305*	0.014	Red
Policy Maturity	BIM Training and Education ↔Legal issues (O)	-0.308*	0.013	Green
	BIM Training and Education ↔ Software interoperability issues (T)	-0.303*	0.014	Green
	BIM Training and Education ↔ Data protection and security issues (T)	-0.256*	0.04	Green
	Use of BIM standards, related codes, regulations, etc. ↔ Software interoperability issues (T)	-0.369**	0.003	Green
	Use of BIM standards, related codes, regulations, etc. ↔BIM Model is inaccurate/not suitable for construction (T)	-0.315*	0.011	Green
	Use of BIM standards, related codes, regulations, etc. ↔ Cultural change required (O)	-0.281*	0.024	Green
	BIM Contractual arrangements ↔ Increased workload and information needed early in the project (O)	-0.321**	0.009	Green
	BIM Contractual arrangements ↔ BIM is implemented by the supply chain without meeting the required/agreed information needs (T)	-0.283*	0.022	Green
	BIM Contractual arrangements ↔ Legal issues (O)	-0.286*	0.021	Green

Challenge category: T= Technical challenges; O= Organizational Challenges (negative ρ indicates increasing ability to deal with challenge);
E= Environmental Challenges (positive ρ indicates increasing ability to deal with challenge).

- Green = desirable correlation (indicates higher BIM maturity is associated with better ability to manage the challenge)
- Red = undesirable correlation (indicates higher BIM maturity is associated with more difficulty managing the challenge)

**, Correlation is significant at the 0.01 level (2-tailed); *, Correlation is significant at the 0.05 level (2-tailed)