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A Systematic Review of BIM Adoption and Implementation Challenges in Design & Build Contracts: Insights and Implications for Nepal

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ABSTRACT

The design & build (D&B) projects can be made efficient, cost-effective, and quality-assured through Building Information Modeling (BIM). Its adoption is limited in developing countries. The paper is a PRISMA-based systematic review of 21 empirical and conceptual studies on the topic published between 2000 and 2025. The review investigates obstacles to BIM adoption as far as Nepal is concerned. Each study was treated as a qualitative case and therefore, a thematic analysis was carried out. Codes were determined and sorted into major themes. There were five significant obstacles, namely technical, organizational, financial, contractual, and policy or cultural. All situations had common technical and organizational barriers. There were greater financial, contractual, and policy-related impediments in the developing countries. Low industry maturity, high cost, fragmented practices, unclear contracts, and less support for regulations are some of the reasons that limit BIM adoption in Nepal. The results demonstrate the necessity of national BIM standards, capacity building, financial incentives, contractual reforms, and increased awareness of the stakeholders. The presented research offers evidence-based information to help enhance the implementation of BIM and achieve better cost, time, and quality results in resource-limited situations.

KEYWORDS
Building Information Modeling (BIM), Design & Build (D&B), Barriers, Challenges, Nepalese AEC Industry, Construction Management, PRISMA.

INTRODUCTION

Building Information Modeling (BIM) is a digital technology that is used in enhancing the coordination and collaboration in a construction project. It is best applied in integrated procurements such as design & build (D&B). BIM supports universal digital data on the projects. The method allows designers to start working on projects from the beginning, which results in improved teamwork and minimizes project mistakes throughout the entire process (Järvenpää et al., 2019; Kalsaas et al., 2018). Previous research shows that BIM implementation in D&B projects leads to better cost management and shorter project durations and improved project results (Chamikara et al., 2023; Tam et al., 2023).

Regardless of these benefits, BIM application in D&B projects is scattered. This issue is more evident in the developing nations. The existing studies have a number of barriers. They are high implementation costs, skills deficiency, resistance to organizational change, ineffective contracting structures, and ineffective regulations (Bouhmoud & Loudyi, 2021; Langar & Criminate, 2017; Tudublin & Turner, 2019). The issue is increased in the setting where the degree of BIM maturity and institutional encouragement is minimal (Ariono et al., 2022; Habib et al., 2022).

Nepal is a nation that has initial stage of BIM implementation. It is mostly used during the design phase. No national standards of BIM exist, and there is minimal policy guidance (Niraula, 2020; Paneru et al., 2023a; Shah & Shrestha, 2023). In Nepal, empirical studies on the adoption of BIM in the D&B procurement sector are few. As a result, a step-by-step analysis of the world literature will be required in order to put the barriers to BIM adoption in the world into perspective. It is in this light that the current research relies on a PRISMA-facilitated systematic review to establish the key impediments to the use of

BIM in D&B projects and draw an inference on how the results of the study can be applied in the Nepalese construction industry.

Objectives

The general objective of this paper is to bring together available literature on the obstacles to BIM adoption in design-build procurement and explain the results within the framework of the Nepalese construction industry.

The specific objectives are as follows:

1. To determine and combine essential trends of BIM implementation obstacles in design & build procurement in various settings.
2. To investigate the effects of these obstacles on BIM application in the developing nations.
3. To elucidate the findings and come up with a context-based representation of the construction industry in Nepal.

METHODOLOGY

Review Design

This was a systematic literature review (SLR) study. The PRISMA framework was used as the guideline to the review. This was with the aim of summarizing secondary data on obstacles to Building Information Modeling (BIM) implementation in design-build (D&B) procurement. Transparency, methodological rigor and replicability in the review process were achieved by the PRISMA protocol.

Information Sources

The extensive search of the literature involved the key academic databases. These were Scopus, Web of Science, Science Direct ASCE Library and Google Scholar. A combination of Boolean keywords was used. The keywords included building information modeling (BIM), design-build, integrated procurement, adoption, implementation, barriers, or challenges. Only the English-language publications from 2000 to 2025 were searched to include the change in BIM adoption in the D&B setting.

Eligibility Criteria

The inclusion of the studies was done according to three criteria. To start with, the study was required to concentrate on BIM adoption or implementation in the construction industry. Second, it was required to deal with design-build or integrated procurement circumstances. Third, it had to report barriers, challenges or critical success factors with respect to BIM adoption. Empirical and conceptual research were taken into account. These were journal articles, conference papers and theses.

Research was filtered out when it was not related to BIM, in the case of non-construction industries, and when the research was about BIM as a technical tool without organizational and contractual implications. Included in the studies that did not touch on adoption barriers were also not excluded. Studies that only covered operation after construction or management of the facility were not catered.

Study Selection

The selection of the study was based on the PRISMA. This consisted of identification, screening, eligibility and inclusion phases.

At the identification stage, 450 records were identified by searching the database. A total of 210 records were excluded and 240 records were left to screen. These 240 records have titles and abstracts that

were screened in the screening stage. Twenty-one records were filtered out because they were irrelevant or did not focus on the topic of BIM adoption in design-build procurement. Consequently, out of this, 25 full-text articles were evaluated on the basis of their eligibility.

In the process of the eligibility assessment, four full-text articles were eliminated. These research works overlooked the barriers of BIM adoption and time, cost, and quality (TCQ) issues clearly. At last, 21 articles were included in the qualitative synthesis because they were all in accordance with the inclusion criteria.

PRISMA Flow Diagram

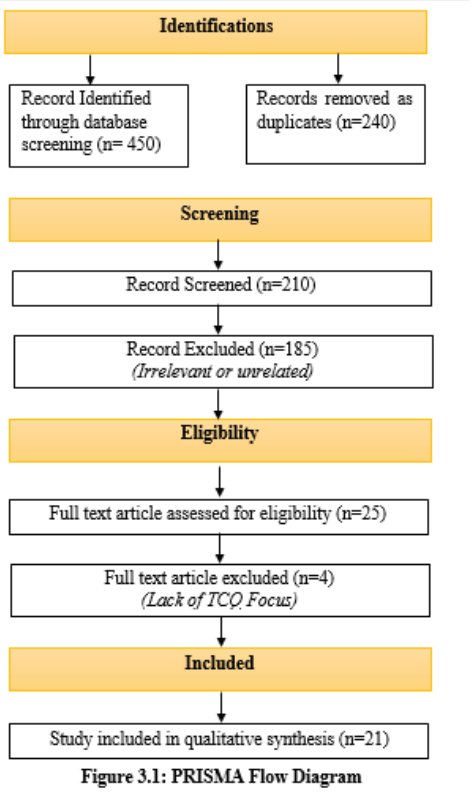

Figure 3.1: PRISMA Flow Diagram

Data Extraction

Suitable information was selected and coded out of the chosen study. The information that was extracted contained authors, year of publication, geographical context, research focus, identified barriers and implications to D&B procurement. Every research was regarded as a qualitative case. To aid in consistency and comparability, a systematic method of extracting data was applied.

Synthesis Method

The extracted data were analyzed using a thematic synthesis method. Similar patterns were found within the chosen studies. It was found that barriers can be classified into five primary categories, which include technical, organizational, financial, contractual and policy or cultural.

The findings that were synthesized were then applied to the construction industry of Nepal. This was achieved through the comparison of evidence across the world and developing countries with Nepal studies. The synthesis forms the basis on which context-specific implications of policy formulations, contractual reforms, capacity building, and stakeholder awareness could be developed to facilitate effective adoption of BIM in design-build procurement.

Table 1: Summary of Included Empirical Studies

Author(s)	Year	Country / Context	Project Type	Key BIM Adoption Barriers
Järvenpää et al.	2019	Finland (Developed)	D&B	Technical, Organizational
Chamikara et al.	2023	Sri Lanka (Developing)	Construction	Financial, Technical
Brahim et al.	2018	Algeria (Developing)	Construction	Financial, Technical
Kalsaas et al.	2018	Norway (Developed)	D&B	Technical
Tudublin & Turner	2019	UK (Developed)	D&B	Contractual, Policy
Keaveney et al.	2013	Ireland (Developed)	D&B	Contractual
Habib et al.	2022	Pakistan (Developing)	Construction	Organizational, Contractual
Langar & Criminate	2017	International	Construction	Technical, Cultural
Liu	2015	International	Construction	Technical, Organizational
Ariono et al.	2022	Southeast Asia	Construction	Technical, Cultural
Niraula	2020	Nepal	Construction	Technical, Financial
Shah & Shrestha	2023	Nepal	D&B	Organizational, Policy
Phuyal	2017	Nepal	Construction	Financial
Suwal & Karki	2024	Nepal	D&B	Organizational, Policy
Paneru et al.	2023	Nepal	Construction	Policy
Lama & Karki	2021	Nepal	Construction	Technical, Financial
Thapa & Khadayat	2020	Nepal	Construction	Policy
Bhattarai & Kisi	2022	Nepal	Construction	Technical, Policy
Olawumi & Chan	2018	Hong Kong (Developed)	Construction	Policy
Bouhmoud & Loudyi	2021	Morocco (Developing)	Construction	Policy, Cultural
Tam et al.	2023	Australia (Developed)	Construction	Technical, Financial, Organizational

RESULT AND EVIDENCE SYNTHESIS

Evidence Synthesis

The synthesized evidence shows that the barriers to the implementation of BIM in design-build procurement mostly belong to such categories as technical, organizational, financial, contractual, policy and cultural. The research on developed countries investigates two main technical and organizational barriers which stem from system integration problems and missing operational guidelines and staff

resistance to organizational changes (Järvenpää et al., 2019; Kalsaas et al., 2018; Tam et al., 2023). The research findings from developing nations focus on financial and technological barriers because BIM implementation faces three major obstacles which include high implementation costs insufficient skilled personnel and insufficient technological infrastructure (Brahim et al., 2018; Chamikara et al., 2023).

Contractual and policy barriers are also present in a range of settings, particularly in Design-Build where the contractual requirements are not clear and no regulations are established that would support the collaboration in terms of BIM (Keaveney et al., 2013; Olawumi & Chan, 2018; Tudublin & Turner, 2019). It is further revealed in the literature that these challenges are further enhanced by the limits of organizational capacity and fragmented systems of governance in developing economies (Habib et al., 2022). Other restrictions are the cultural resistance and unawareness of the advantages of BIM, especially in the Asian construction sector (Ariono et al., 2022; Langar & Criminate, 2017; S. Liu et al., 2015).

The Nepal-specific research demonstrates that the hindrances to the implementation of BIM are even worse due to the inability of technical capacity, finances, and inefficient policy support (Lama & Karki, 2021; Niraula, 2020). Other obstacles to successful implementation in Design & Build procurement are failure to adopt national BIM standards and lack of reliability in the enforcement of regulations (Shah & Shrestha, 2023; Suwal Sunil & Karki Mahesh, 2024). In spite of the significance of the BIM that is recognized in recent policy discussions, it cannot be practiced in a broad way (Bhattarai & Kisi, 2022; Paneru et al., 2023b; Thapa & Khadayat, 2020). The research findings show that BIM implementation in Nepal will succeed through three critical factors which consist of policy adjustments that match local conditions and workforce development and funding assistance.

Result

The thematic review of the 21 research articles identified some common obstacles to Building Information Modeling (BIM) adoption in the design-build (D&B) procurement process. All research was considered a qualitative case. The obtained results were coded and divided into bigger themes. There were five main categories of barriers. These were technical, organizational, financial, contractual and policy or cultural barriers.

Frequency of BIM Adoption Barriers

The 21 reviewed studies showed technical barriers as the leading challenge which appeared in 14 studies while organizational barriers appeared in 12 studies. The research found financial barriers in nine studies but eight studies showed contractual barriers and ten studies demonstrated policy-related barriers. Research conducted in Nepal showed that financial and policy and contractual barriers exist at higher levels than what developed countries experience according to their studies which suggest non-technical obstacles play a more significant role in Nepal.

BIM Implementation impediments in design-build Procurement

Most of the reviewed studies had reported technical barriers. The most frequent ones were the complexity of the software, incompatibility of the systems, and inadequate information technology infrastructure (Ariono et al., 2022; Langar & Criminate, 2017; Niraula, 2020). These disruptions were seen in the global and Nepal-specific studies.

Another problem that received much discussion was organization barriers. Their resistance to change, ambiguity of roles and responsibilities, and the lack of BIM-related skills and training were their resistance (Habib et al., 2022; Järvenpää et al., 2019; L. Liu, 2023). It is not only that Nepalese researches emphasized their organizational practice being disjointed, but also lack systematic capacity-building initiatives (Shah & Shrestha, 2023; Suwal Sunil & Karki Mahesh, 2024).

The financial barriers were also mostly associated with the high cost of BIM implementation. The research study included software and hardware expenses together with training expenses which proved essential for developing and resource-constrained settings including Nepal (Brahim et al., 2018; Chamikara et al., 2023; Phuyal, 2017).

The contractual barriers were associated with the conventional contract designs. The research findings showed that BIM-related provisions were missing from various studies because the allocation process became unclear because of outdated contractual systems (Habib et al., 2022; Keaveney et al., 2013; Tudublin & Turner, 2019). There are also other issues with the contract that were found in the Nepalese literature(Paneru et al., 2023b; Shah & Shrestha, 2023).

Such barriers included policy and culture in relation to the absence of governmental interference, the absence of incentives, and the inadequate knowledge of BIM among the industry players (Ariono et al., 2022; Bouhmoud & Loudyi, 2021). There were no policies and regulatory guidance of national BIM in Nepal (Suwal Sunil & Karki Mahesh, 2024).

The government-run training programs and BIM adoption step-by-step requirements which Sri Lanka and Morocco implemented as developing nations led to improved readiness for BIM adoption according to (Chomikara et al. 2023; Bouhmoud & Loudyi, 2021). The Malaysian government established cost-sharing initiatives to let small businesses obtain BIM technology access when they began implementing this technology (Brahim et al.,2018). The experiences show that Nepal needs to establish policy enforcement through sequential steps which should receive financial support and institutional help instead of beginning with mandatory rules.

Cross-Context trends of barriers to BIM adoption

The analysis trends depicted some general patterns and some historical differences. Such organizational and technical barriers were experienced in the developed and developing nations. Quite to the contrary, the barriers of financial, contractual and policy nature proved worse in creating situations.

In the developed countries, the studies were more concerned with the streamlining of the workflow and project productivity (Järvenpää et al., 2019; Kalsaas et al., 2018). The Nepalese population along with other groups concentrate their efforts on non-essential matters which include public awareness program, and making healthcare services affordable, ensuring medical staff have proper skills and obtaining necessary regulatory support for promotion.

BIM adoption obstacles in Nepal.

According to the literature that is evaluated, BIM use in D&B projects in Nepal is not widespread. It is associated with the immaturity of the industry, the lack of a properly functioning technological infrastructure, high costs of implementation, incoherent operations of the organizations, lack of clarity in the relations between the contracts, and weak policy environment(Niraula, 2020; Paneru et al., 2023b; Shah & Shrestha, 2023; Suwal Sunil & Karki Mahesh, 2024).

DISCUSSION

This paper has systematically reviewed 21 peer-reviewed articles to understand the barriers and challenges to the adoption of BIM in design-build procurement and summarized the trends in contexts, as well as discussed implications in the context of Nepal. These findings are interpreted in the discussion and put into the context of the global and local.

Organizational and Technical Obstacles.

Similar to the previous research (Järvenpää et al., 2019; Langar & Criminate, 2017; L. Liu, 2023), technical and organizational problems were pointed out as the most common in developed and developing countries. The issue of technicalities, including software complexity, non-interoperability and lack of adequate IT infrastructure, remains one major negative issue to the success of BIM implementation. In the world, the obstacles to change, role definition, and the absence of training were also identified in organizational cases (Habib et al., 2022); in Nepal, it was reported in (Shah & Shrestha, 2023; Suwal Sunil & Karki Mahesh, 2024). These findings suggest that in spite of the presence of technological capability,

organizational readiness and human capacity are also the determinant facts to the success of BIM integration.

Financial, Contractual and Policy Problems.

The prohibitive price of software and hardware and the lack of access to training proved to be one of the key factors in the resource-constrained environment(Brahim et al., 2018; Chamikara et al., 2023; Phuyal, 2017). On a global (Keaveney et al., 2013; Tudublin & Turner, 2019) and Nepal (Shah & Shrestha, 2023) level, such obstacles as contractual and legal, such as out-of-date D&B contracts and blurred responsibilities. It was particularly acute in Nepal where the governmental support was weak, and the advantages of BIM were not well-understood (Paneru et al., 2023b; Suwal Sunil & Karki Mahesh, 2024). All these points to the fact that the adoption of BIM cannot be regarded as a technological problem but instead a multi-dimensional one that demands all interventions are implemented on financial, contractual, and policy levels.

Nepal Cross-Context Patterns and Lessons.

The comparative synthesis reveals that the barriers are technical and organizational, though those that are founded on the financial, contracts, and policies are particular to the situations and are more drastic in the developing countries. These barriers are often resolved in developed countries through robust standards and training possibilities and the contractual conditions(Järvenpää et al., 2019; Kalsaas et al., 2018). In Nepal, the level of BIM maturity is small, the management of projects is decentralized and the policy is implemented irregularly, and this also contributes to the problems of adoption. These trends indicate that the international best practices such as the early use of BIM and the involvement of stakeholders and clarity of contracts can be translated to Nepal-specific strategies but must be modified to the local socio-economic and institutional realities.

Implications for Practice and Policy

The findings have implications to the project managers, policymakers and practitioners of Nepal. To manage the organizational and technical barriers, first, capacity-building exercises and organized training programs should be present. Second, the implication of cost-sharing or incentives would mean the reduction in the cost of software, hardware, and training. Third, the requirements of the BIM, roles and responsibilities may be included in the contractual reform to take projects in D&B more responsible. Finally, policy development like national BIM standards, regulatory support, etc. may help in achieving a culture of adoption which is fundamental in the establishment of a culture of implementation that is sustainable.

Theoretical and Research Contributions.

The research also contributes to the literature by providing a global and Nepal-based PRISMA-directed synthesis of BIM adoption barriers of the D&B projects. It extends the earlier research with an emphasis on the contextual peculiarities of the country Nepal and bridges the gap between the knowledge on BIM in the rest of the world and the problems associated with its application in Mr. Nepal. The thematic coding and correspondence to the research objectives also offer an all-encompassing framework that can be utilized in the future study to validate quantitatively or conduct a policy analysis.

CONCLUSION

A systemic review of 21 empirical and theoretical studies that were undertaken by the research aimed at identifying and summarizing the challenges confronting the adoption of BIM in design-build contracts, and implications to Nepal. The thematic analysis has revealed that there exist five broad categories of barriers, which are, technical, organizational, financial, contractual, and policy/cultural. The global setups had a common technical and organizational setback, and the financial, contractual and policy setbacks were high in developing economies and Nepal was not an exception. The other challenges cited in Nepalese research

were low BIM maturity, high costs, lack of proper policy support and poor organization structures. These findings reveal that the implementation of the solutions in the form of capacity-building, contractual reforms, national BIM standards, and stakeholder awareness programs are required to support the successful implementation of BIM in D&B projects in Nepal. Overall, the study provides evidence-based information that can inform policymakers, project managers, and other practitioners who would like to improve the results of BIM implementation and construction projects on constrained environments in terms of resources.

LIMITATIONS

Despite this paper providing a systematic and comprehensive evidence synthesis, several weaknesses should be identified. To begin with, there is a scarcity of empirical researches on Nepal as such, and this aspect could restrict the overall contextualization of the issues of BIM adoption in the multitude of Nepal-based construction projects. Second, the search did not cover any peer-reviewed journal articles published before 2000 and, therefore, possibly, any relevant conference papers, professional reports, and grey literature. Third, the thematic synthesis approach involved interpretive coding of the literature available thus may introduce some degree of subjectivity in the process of identifying and categorizing types of barriers. Finally, due to the differences between the magnitude of the projects, procurement system and regulatory environment, the studies taken may belong to various national and institutional contexts, which will not be directly applicable in the Nepalese Design-Build context. These are the limitations that should be considered during the interpretation of the results, as well as during drawing policy or practice oriented conclusions.

RECOMMENDATIONS

Based on the summarized evidence, several recommendations are provided that help in the effective implementation of BIM in Design & Build procurement. Firstly, BIM national standards and regulatory frameworks need to be made in a bid to create some sense of direction and uniformity among the projects. Second, closer attention should be paid to capacity-building because of the deficiency of technical and organizational competency: the program of specific training of project managers, engineers, and contractors should be organized. Third, a financial subsidy system, such as subsidies, tax credits or cost-sharing systems, could be employed to reduce the high start-up cost of using BIM tools, particularly with small and medium-sized companies. In addition, the reforms on contractual issues are necessary in specifying BIM-related roles, responsibilities, and deliverables in Design-Build contracts, which will make it more accountable and collaborative. Finally, sensitization and advocacy programs to both the government and non-government stakeholders should be promoted to raise awareness on the benefits of BIM and the inculcation of cultural acceptance. These measures can be employed to facilitate the introduction of BIM in Nepal.

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