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A Strategic Roadmap for BIM Adoption in Design-Build Projects in Nepal.

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ABSTRACT - Building Information Modeling (BIM) has emerged as a significant digital innovation for increasing collaboration, project coordination, and overall construction performance. However, BIM adoption in developing countries such as Nepal remains limited due to institutional, technical, and organizational challenges. In this research, a modified Delphi method is used to generate a strategy for implementing Building Information Modeling (BIM) in design-build projects of Nepal. Two rounds of consultation were conducted with experts using a mix of qualitative thematic analysis (Round 1) and quantitative validation (Round 2).

In the first phase, expert opinions were collected to identify the major barriers, enabling factors, and strategic priorities influencing BIM adoption The qualitative findings show the key barriers to be the lack of government policy, the lack of BIM standards, technical skills, and software cost. In the second phase, the identified factors were quantitatively validated and prioritized using expert consensus analysis. The findings confirmed that the lack of government policy was the highest rated (Mean = 4.75), followed by the lack of BIM standards, technical skills, and software cost (Mean = 4.67). The results also reveal that institutional factors are the enablers of BIM. Government Policy, BIM guidelines and education were considered as the most significant. The strategic plan highlights the need for a national BIM policy, guidelines, training, and approach for digital transformation.

Based on the integrated findings, the study proposes a strategic roadmap emphasizing policy development, capacity building, standardization, training programs, digital transformation initiatives, and pilot implementation projects. The findings reveal that the implementation of BIM in Nepal is heavily reliant on the institutional readiness and complemented by human resource development and technology infrastructure. The study has insights for policy development and digital transformation in the construction industry.

Keywords: - Building Information Modeling (BIM), Delphi Method, Nepalese Construction Industry, Design-Build, Digital Technology

1. INTRODUCTION

Nepal is undergoing a shift in the construction industry, but there are problems such as budget and time overruns, and poor coordination among the stakeholders. They are common in complex projects where the traditional project delivery method has restricted communication and collaboration in design and construction. There are problems with design consistency, clashes, and quality issues. Building Information Modeling (BIM) is a digital approach to collaboration, better design, and project management in the project delivery phase (Mazzucca et al., 2018). BIM, which integrates spatial and other non-spatial data in a digital format, enables real-time access and sharing of data with project partners and saves costs by eliminating potential for mistakes and allowing better decision-making.

BIM's advantages are relevant to design-build projects as they involve collaboration between design and construction Design-build is a construction project delivery system that places emphasis on integration, overlap, and interdisciplinary responsibility, which BIM can support to optimize processes and products. Previous research has demonstrated that the application of BIM in design-build practice improves communication, eliminates design clashes, and improves productivity (Azhar et al., 2024; Bryde et al., 2013). However, the use of BIM in developing countries such as Nepal is limited due to a lack of awareness, skills, high set-up costs, and policies and regulatory frameworks (Niraula, 2020).

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In recent years, there has been a growing interest in the Nepalese construction industry and academia in applying digital technologies for improved project performance. However, without a structured and contextualized method for the implementation of BIM, its adoption has been limited. A handful of literature and frameworks have been proposed in developed countries and may not account for socio-economic and institutional contexts in Nepal. Therefore, there is a need for a strategic model that considers Technological, Organizational, and Environmental (TOE) factors affecting the adoption of BIM in the construction industry in Nepal.

This study addresses this need with a conceptual and strategic model for BIM adoption for design-build projects in Nepal. It integrates the Technology-Organization-Environment (TOE) model, the Diffusion of Innovation (DOI) theory, Institutional Theory, and the Resource-Based View (RBV) to understand the BIM adoption process. Technological, organizational and environmental factors affect the BIM adoption process - which include awareness, acceptance, implementation and integration. Institutional pressures, including regulatory, normative, and mimetic, also influence the adoption process. When BIM is successfully adopted, this results in improved project performance, which will feed into the development of a strategic plan for the Nepalese construction industry.

2. LITERATURE REVIEW

Building Information Modeling (BIM) has been recognized as a technological breakthrough for integrating project data during the project life cycle (planning, design, construction, and operation). The technology provides a coordinated environment to collaborate on project data, supporting visualization, coordination, and decision making (Bouhmoud & Loudyi, 2021; Rae et al., 2019). BIM helps visualize a three-dimensional representation of project elements to support the coordination of project information and avoid clashes where traditional design is two-dimensional. This makes it possible to minimize waste and enhance the project's efficiency and is a critical component of project management.

BIM has been essential to fulfilling the integration requirements of design-build projects. Design-build promotes and facilitates the overlap of project phases; there is a greater need for communication and cooperation. BIM supports this integration by sharing information and cooperating. Several studies report the application of BIM in design-build projects to improve project outcomes, reduce design conflicts, and improve cost and time performance (Azhar et al., 2024; Bryde et al., 2013). BIM also aids risk management and resource allocation, resulting in project success.

There are, however, barriers to the uptake of BIM, particularly in developing countries. These include: the initial cost, lack of skilled professionals, resistance to change, and awareness (Bhatti et al., 2018). Additionally, technology problems (lack of infrastructure and interoperability) are also constraining BIM adoption. There are also organizational barriers, such as a lack of management support and training (Eadie et al., 2013). These issues are more evident in the developing world, where traditional construction practices are still dominant, and institutional mechanisms are inadequate (Olawumi & Chan, 2018).

In developing countries, BIM adoption is influenced by not only organizational issues but also environmental issues. Research has been done on policies, markets, and standards for BIM (Datta et al., 2023; Yılmaz et al., 2024). Uncertainties and fear of BIM can be present in the absence of policies and national standards. Conversely, favorable policies and government mandates have driven the rapid adoption of BIM in developed countries.

At present, BIM is very new to Nepal, with limited use in construction. The lack of awareness, technical know-how of practitioners, and training programs are found as major factors impeding the adoption of BIM (Shrestha et al., 2024). And the lack of national policy and standard also affects its uptake. However, there is a growing interest among practitioners and academic institutions in adopting BIM, which could lead to its potential adoption in the future (Reddy et al., 2025).

Theories have been applied to understand the factors that influence BIM adoption. The Technology-Organization-Environment (TOE) model offers a big-picture view of the technological, organizational and environmental factors (Sanhudo et al., 2021). Using the Diffusion of Innovation (DOI) model, characteristics such as relative advantage, compatibility, and complexity can be seen to influence the pattern of innovation adoption over time (Maceika et al., 2024). In contrast, Institutional Theory highlights how organizational practices are driven by coercive, normative, and mimetic pressures

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(Borrmann et al., 2018), and the Resource-Based View (RBV) argues that it is an organization's internal resources that provide the basis for competitive advantage (Ismail et al., 2017).

This study draws on these theories to combine these perspectives to create a conceptual framework, as shown in Figure 2.1. The model displays the interaction of technology, environment, and organization, which affects BIM adoption, and its further effect on project performance. The pressures from institutions are external adoption and readiness drivers. Similarly, BIM adoption would assist in formulating a strategy to address policy, capacity, and implementation challenges in the Nepalese construction industry.

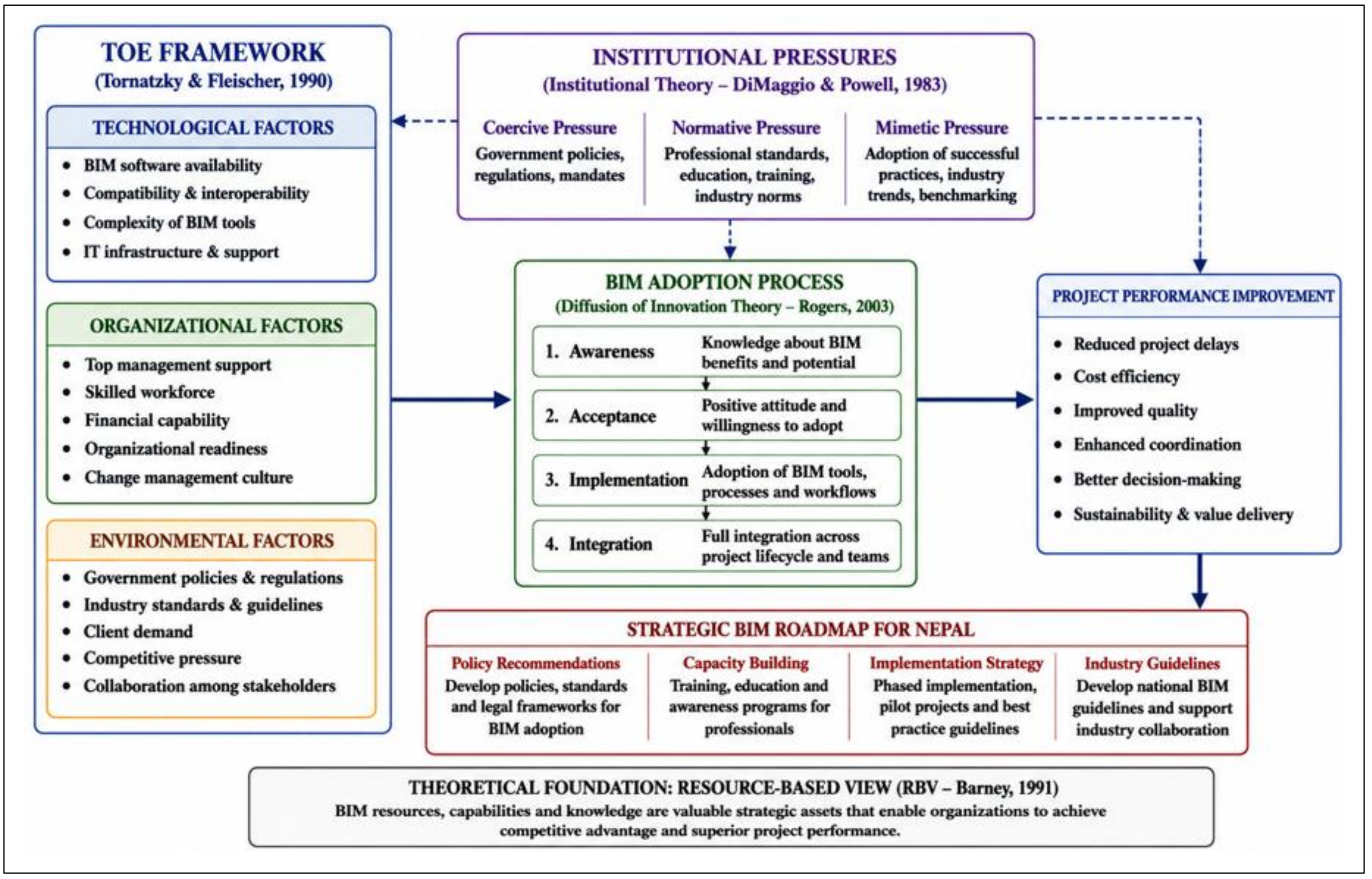

Figure 2.1: Conceptual Framework for BIM Adoption in Design & Built Projects in Nepal

3. Aim and Objectives of the Study

This research aims to build a contextual strategic plan for Building Information Modeling (BIM) implementation in design-build projects in Nepal. To do this, this research aims to:

1. To identify the key factors and challenges of the use of Building Information Modeling (BIM) in design-build projects in Nepal.
2. To identify the technological, management, and environmental factors enabling the successful implementation of BIM in the Nepalese construction industry.
3. To devise a viable and practical strategy for the implementation of BIM in design-build projects in Nepal through expert opinion.

4. METHODOLOGY

This study adopts a modified Delphi method to develop a strategic plan for adopting Building Information Modeling (BIM) in design-build projects in Nepal. This has been used to gather opinions from experts and reach a consensus on factors that affect BIM adoption. The Delphi method is ideal for studies that seek to elicit structured expert judgement and produce valid

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findings through feedback and opinion pooling (Tiza, 2024). The study methodology aligns with its conceptual underpinning, which considers technological, organizational, and environmental factors for BIM adoption.

The study follows a two-phased sequential exploratory design. The first phase is exploratory (qualitative) to identify dominant barriers, enablers, and strategic factors to consider, and the second phase is inferential (quantitative) to verify the factors and rank their importance. The modified Delphi method is used as it provides an open-ended and structured approach that is appropriate for the development of a framework and roadmap for construction management research.

Experts in the field of construction projects and digital technologies were selected using purposive sampling. The experts included engineers, architects, project managers, and academics with BIM and design-build experience. The experts were selected based on experience, involvement in construction projects and knowledge of new digital technologies. A total of 24 experts participated in the study, with 12 experts in each round of the Delphi process.

In the first round (qualitative round), 12 experts were asked to respond to a questionnaire to express their opinions about implementing BIM in Nepal. These questions requested to identify the problems, opportunities and approaches to implement BIM. The first round allowed experts to provide feedback based on their knowledge and experience. The responses were analyzed using thematic analysis, in which themes, sub-themes and codes were identified. This was then used to create the items for the subsequent round.

The second round represented the quantitative phase of the study, where another 12 experts were engaged via a structured questionnaire developed from the first round. The factors were transformed into variables that were measured using a Likert scale. The respondents ranked the factors, and the study confirmed and prioritized the main factors of BIM adoption. This ensured consensus among experts and enhanced research validity.

In the phase 1 round, descriptive analysis and rankings were used to analyses the qualitative data. During the second round, descriptive analyses (mean score and rank) and statistics were used for the quantitative data. This allowed the identification of the issues and consensus among experts, which was further used for developing a roadmap.

The results of both rounds helped to create a BIM roadmap. This roadmap will help to focus on the key issues, approaches, and actions in the context of the Nepalese construction industry. This will enable policy makers, practitioners, and stakeholders to implement BIM in design-build projects.

This research is based on research ethics. The research purpose was explained to participants, and they gave their consent. The confidentiality of the participants was maintained, and the data collected was used only for learning and research purposes.

5. RESULTS AND ANALYSIS

5.1 Respondent's Demographic

The study involved a group of experts purposely selected based on their expertise in construction and digital technologies. All the participants were males. This shows the gender imbalance of the construction sector of Nepal, where only males have been involved in the research. The age range of the participants varied between 40 and 60 years of age.

Out of the total panel members, most of panel members held a master's degree, and the remaining panel members held a PhD. They are based in different cities of the Kathmandu Valley. These are the centers of knowledge and construction in Nepal, and the results are likely to have been from the most active part of the industry.

5.2 Round 1 Thematic Analysis

5.2.1 Barriers to BIM in Nepal (Objective 1)

While the qualitative findings reveal the set of challenges facing the country to effectively implement BIM, there are a set of technical, financial, institutional, and organizational barriers that need to be addressed to effectively implement BIM in Nepal. Survey results indicate a lack of training on BIM and limited hands-on experience with BIM tools. Also, poor

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hardware availability and weak internet systems were identified as additional issues, particularly in the case of handling large data sizes.

Financial constraints also play a key role in limiting BIM adoption. BIM software licenses and training expenses are major concerns, particularly for small to medium-sized companies. Further, BIM investments are tempered by uncertainty about the return on investment (ROI). Survey participants cited a lack of awareness of BIM benefits and uncertainty about long-term financial gains as barriers to BIM implementation.

Institutional issues were identified as a major problem in adopting BIM. The lack of government support, the absence of national BIM policies, and the lack of standards and guidelines all contribute to this. According to the respondents, without clear regulations, mandates, and regulatory frameworks, organizations have little motivation to transition from traditional practices to BIM-based approaches.

Organizational resistance and a lack of adoption of innovations are often attributed to a desire to hold on to 'traditional' methods of construction that are known and familiar. However, poor collaboration and coordination of key project stakeholders is seen as a major barrier to innovation adoption. This can stem from the communication structures within projects and the wider cultural and structural issues affecting the industry.

In summary, BIM adoption in Nepal is not simple or unidirectional. It is influenced by several technical, economic, institutional, and organizational factors as shown in Figure 5.1.

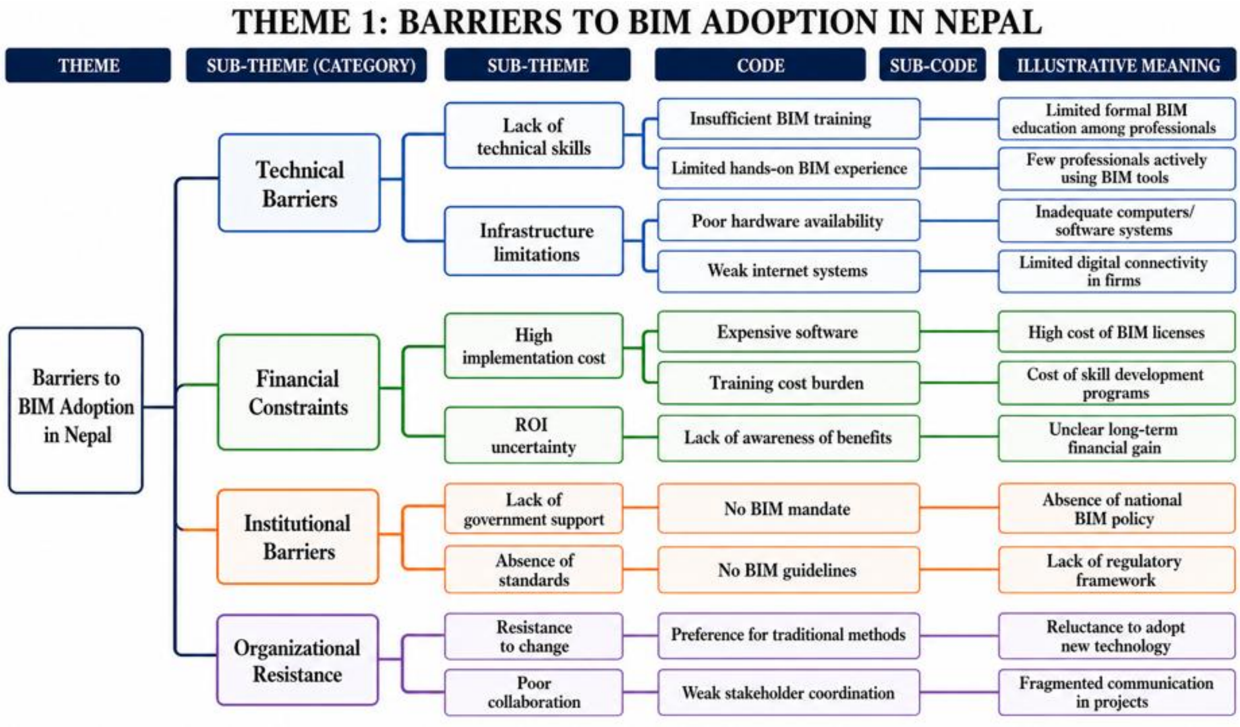

Figure 5.1: BIM Adoption Barriers
Source: Author's field study (Delphi analysis, 2026)

5.2.2 Critical Factors for BIM Implementation (Objective 2)

The critical factors analysis for BIM implementation shows that human resource development, institutional support, and technological readiness are critical factors in Figure 5.2. Human resource development is the most critical. The participants identified a need for BIM training and experience, and for embedding BIM in academic courses. In particular, the need to integrate BIM in the academic sector was emphasized as a longer-term approach to increasing the talent pool to support the digital transformation of the construction industry.

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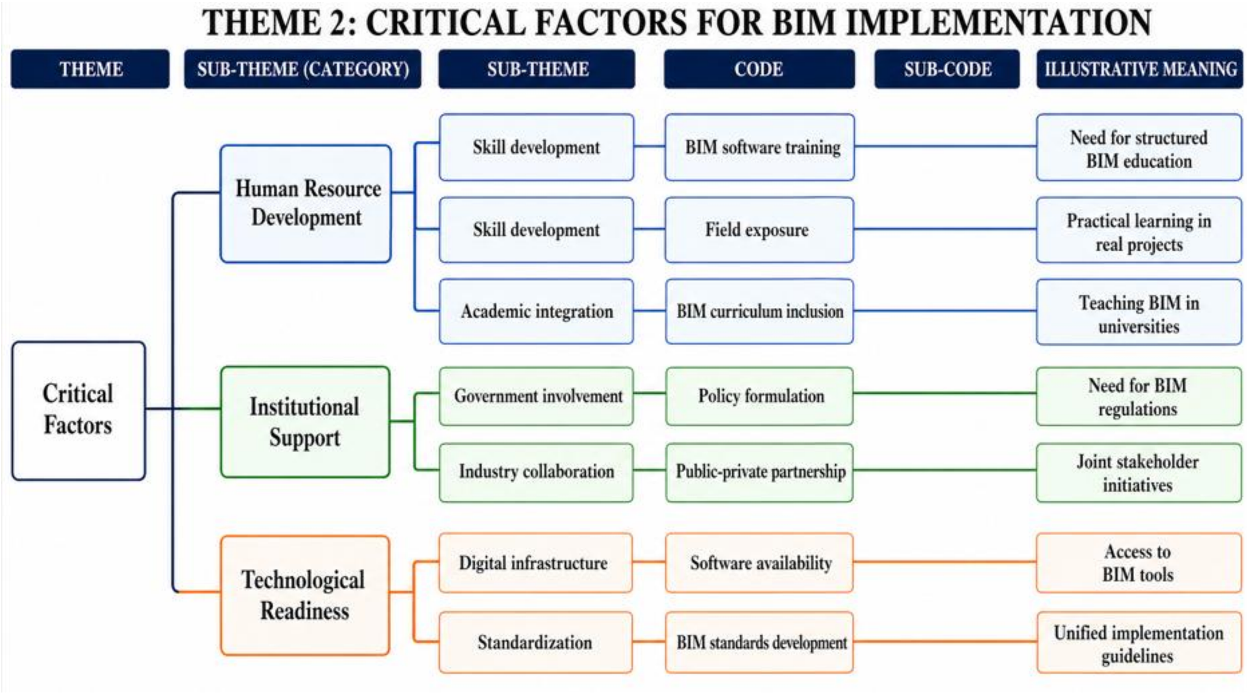

Figure 5.2: Critical Factors for BIM Implementation
Source: Author's field study (Delphi analysis, 2026)

A further driver of BIM was found to be institutional support. The importance of the government developing policies and regulations was stressed. This has been a significant barrier but is considered a key driver for BIM adoption. They also identified public-private partnerships as an important factor to help raise awareness and adoption of BIM through partnership and knowledge dissemination.

They also mentioned technology readiness as vital for BIM. The survey identified the need to have access to appropriate software and to set up BIM standards and guidelines, to ensure consistency and effectiveness in implementation. They also referred to the availability of digital tools and standards for interoperability as an integration factor.

This suggests that factors needed for successful integration of BIM are a mix of capacity building, institutional, and technological readiness. The lack of any one of these factors could present a barrier.

5.2.3 BIM Adoption Roadmap (Objective 3)

The synthesis of factors and challenges allows for a roadmap of BIM adoption in Nepal to be developed, as illustrated in Figure 5.3. The roadmap can be divided into three areas: capacity building, policy, and industry.

The stakeholders identified capacity building, training, and awareness programs as the main areas where managers and practitioners must focus. The dissemination of knowledge and skills through workshops and BIM seminars was identified to enhance skills. This helps to close the gap and build a digital culture.

The development of a robust policy framework was also seen as a key component of the roadmap. The need for national policies, guidelines, and evaluation for successful BIM implementation was identified. The need for monitoring systems to track BIM implementation was also recognized, to ensure that the progress of BIM could be measured.

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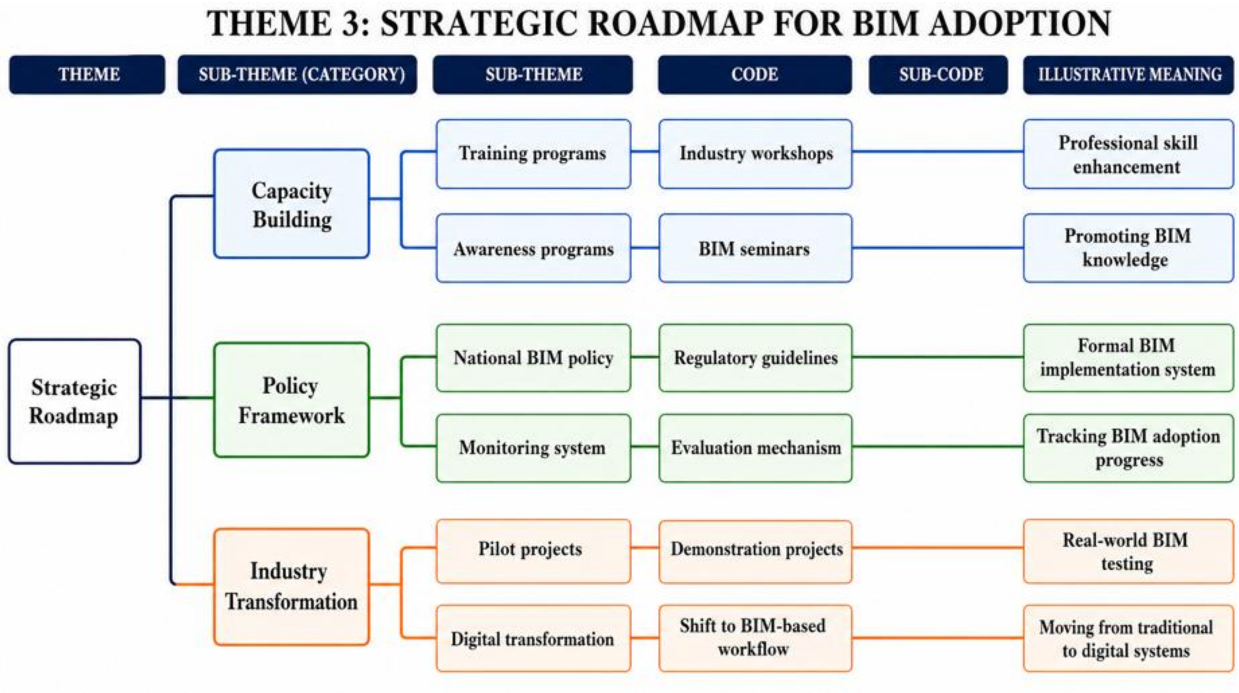

Figure 5.3: Roadmap for BIM Adoption

Source: Author’s field study (Delphi analysis, 2026)

The aim of the roadmap is industry transformation. Participants suggested the piloting and demonstration projects show the benefits of BIM. These projects can be used as demonstration projects to encourage industry adoption. Moreover, the transformation from traditional construction to BIM implementation was identified as an important element of digital transformation.

Our roadmap is a progressive approach to the adoption of BIM that is sensitive to the issues the industry is currently facing and prepares the industry for transformation. It is in line with the conceptual model of this study by linking technological, organizational, and environmental factors to strategic implementation actions.

5.3 Qualitative Results

This study's qualitative findings offer an understanding of the impact of technological, organizational, financial, and institutional factors in BIM adoption in Nepal. The research identifies that the major obstacles to the adoption of BIM are the lack of technical expertise, inadequate infrastructure, investment in implementation, and regulatory framework. These challenges are further compounded by an unwillingness to change the current system and resistance.

On the other hand, the study identifies some critical factors to support BIM. The factors are capacity building (training and education), institutional processes (industry and government), and technological readiness (BIM tools and standards).

This is then used to create a strategy to support the adoption of BIM in Nepal. The roadmap outlines capacity building, policy and planning, and industry transformation through pilot projects and digital transformation plans. Finally, the findings are in alignment with the conceptual framework, as the outcomes demonstrate that the uptake of BIM is a product of interaction between the technological, organizational, and environmental factors, and is supported by institutional mechanisms and planning.

5.4 Round 2 Results: Quantitative Validation and Consensus Analysis

The modified Delphi round 2 was used to rank the issues identified in the qualitative round. The experts were requested to participate in a questionnaire that used a Likert scale. The mean was used to calculate the level of importance, standard

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deviation (SD) to calculate variability, and interquartile range (IQR) to calculate the consensus of the respondents. An IQR of 0 suggests high agreement, and an IQR of 1 suggests good agreement.

5.4.1 Barriers to BIM Adoption (Section A)

Table 5.1: Barriers to BIM Adoption (Round 2 Results)

SN	Statement	Mean	SD	IQR	Rank
A7	Lack of government policy	4.75	0.45	1	1
A8	Lack of BIM standards	4.67	0.49	1	2
A1	Lack of technical skills	4.67	0.49	1	2
A4	High software cost	4.67	0.49	1	2
A2	Limited hands-on experience	4.50	0.52	1	5
A5	High training cost	4.33	0.49	1	6
A3	Poor IT infrastructure	4.25	0.45	1	7
A10	Poor collaboration	4.00	0.00	0	8
A9	Resistance to change	3.75	0.45	1	9
A6	ROI uncertainty	3.67	0.49	1	10

The findings show that institutional barriers are the most significant in constraining BIM adoption in Nepal, with the lack of government policy being the most significant (Mean = 4.75), followed by the lack of BIM standards (Mean = 4.67). This suggests that policy and regulatory issues are the key barriers and validates the qualitative findings that a lack of institutional support is a major constraint.

Technical and financial aspects also rank high. Lack of technical skills and high software cost are ranked equally (Mean = 4.67), suggesting that skills and financial costs are still significant constraints. Lack of experience and high training cost also reinforces the lack of skilled professionals and the cost of BIM training.

Notably, the lack of collaboration shows perfect consensus (IQR = 0), indicating unanimous consensus of experts about its significance, while it holds a lower rank. Conversely, the uncertainty of ROI and change resistance are ranked the lowest, suggesting that though present, these factors are not as important as organizational and institutional factors.

In general, the results indicate that in the context of Nepal, the adoption of BIM is constrained by a lack of policies and standards, and limited technical expertise, rather than merely organizational resistance.

5.4.2 Critical Factors for BIM Implementation (Section B)

Table 5.2: Critical Factors for BIM Implementation (Round 2 Results)

SN	Statement	Mean	SD	IQR	Rank
B4	Government policy support	4.92	0.29	0	1
B8	BIM standards development	4.83	0.39	0	2
B1	BIM training programs	4.83	0.39	0	2
B3	BIM in curriculum	4.67	0.49	1	4
B6	BIM software availability	4.67	0.49	1	4
B2	Continuous development	4.58	0.51	1	6
B5	Stakeholder collaboration	4.58	0.51	1	6
B7	IT infrastructure	4.25	0.45	1	8

The findings suggest institutional support is the most important factor for successful BIM implementation, with government policy support rated highest (Mean = 4.92, IQR = 0), having the highest agreement. This emphasizes the role of regulatory policy and supports the results in Section A.

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Also rated highly are BIM standards development and training opportunities (Mean = 4.83, IQR = 0), indicating the importance of both standardization and capacity building in implementing BIM. The fact that IQR = 0 for these factors suggests high agreement among the respondents.

Other factors related to education and technology (BIM in the curriculum and availability of software) are also ranked highly, which indicates the need for ongoing skills development and the provision of digital tools. Stakeholder collaboration and continuous professional development show that there is a need for collaboration within the industry.

While IT Infrastructure is the least important factor, its high mean score (4.25) indicates that it is still an essential supporting factor.

These results show that to successfully implement BIM, a mix of policy, standards, and human resource development is needed, complemented by a sufficient technology infrastructure.

5.4.3 Strategic Roadmap for BIM Adoption (Section C)

Table 5.3: Strategic Roadmap Priorities (Round 2 Results)

SN	Statement	Mean	SD	IQR	Rank
C3	National BIM policy	5.00	0.00	0	1
C4	BIM guidelines	4.83	0.39	0	2
C8	Digital transformation	4.83	0.39	0	2
C1	Training workshops	4.83	0.39	0	2
C2	Awareness programs	4.67	0.49	1	5
C6	Pilot projects	4.58	0.51	1	6
C7	Public-private partnership	4.58	0.51	1	6
C5	Monitoring system	4.00	0.00	0	8

The result of the strategic roadmap shows that policy development is the highest priority for BIM adoption in Nepal, with a national BIM policy receiving a maximum score (Mean = 5.00, IQR = 0), which indicates full agreement of experts. The findings are well supported by qualitative analysis and the conceptual framework of the importance of institutional mechanisms.

The next priority is the development of BIM guidelines, digital transformation and training workshops; these are also important in terms of operational mechanisms and capacity building. These relate to the organizational and human resource problems identified in earlier stages of the project.

Training and pilot projects are also in the top two, suggesting that training and demonstration of the benefit of BIM are important in driving its adoption. Finally, public-private partnerships are seen as important vehicles for enabling communication and information exchange.

The lower ranking of monitoring mechanisms shows that although evaluation mechanisms are important, they are not as important as policy and implementation mechanisms.
The roadmap highlights a policy-led, top-down approach, which is supported by capacity-building and industry transformation programs.

5.5 Integrated Findings from Delphi Rounds (Objectives 1–3)

Objective 1: Challenges of BIM Adoption in Nepal

The synthesis of qualitative and quantitative results shows that institutional, technical, financial, and organizational aspects are the key barriers to BIM adoption in Nepal, with institutional being the most dominant. Qualitative study (Round 1)

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revealed a lack of government policy and regulation, a lack of BIM standards, a lack of technical skills, a high cost of BIM adoption, and a lack of change readiness as major constraints. These barriers were well supported in Round 2: lack of government policy (Mean = 4.75) was rated as the most critical, followed by lack of BIM standards, lack of technical skills, and high software cost (Mean = 4.67).

The overlap of the two rounds clearly shows that the greatest challenges are policy and regulatory related, rather than technical or operational. Although technical constraints like lack of skills and infrastructure are important, they are not as critical as institutional constraints. Budget constraints, especially costs associated with software and training, also play a crucial role in preventing access to BIM.

But organizational factors such as lack of change management and collaboration were mentioned in the qualitative stage but were not seen as important in Round 2. However, a lack of collaboration had a high level of agreement (IQR = 0), which implies that while not the most important factor, it is acknowledged. In summary, the overall results indicate that in Nepal, BIM implementation is constrained by a systemic gap resulting from poor institutional support, complemented by technical and financial support.

Objective 2: Critical Factors for BIM Implementation

The overall findings from both rounds suggest that institutional support, human resource readiness, and technological readiness are the key factors for successful implementation of BIM in Nepal, with institutional support being the most critical factor.

Round 1 identified the key factors to be training/education, integration in education, government support, industry support, and technological readiness. This was confirmed in Round 2, where government policy support was rated as the highest (Mean = 4.92, IQR = 0), followed by BIM standards development and training programs (Mean = 4.83). The high level of agreement (IQR = 0) among experts about these factors is reflected in the strong consensus on their importance.

Human resource training, particularly training and curriculum integration, was recognized as an important long-term enabler for BIM. This is in line with the qualitative study that refers to a lack of skills/knowledge. Technology factors (e.g., software, IT) were also identified as important, but less important than institutional and human resource factors, suggesting that technology will not be adopted without these factors.

This dual round analysis shows that adopting BIM is more than a technology adoption, but it requires a multifaceted approach with policy for guidance, human resource development for skills and training, and technology for readiness. This revelation is in line with the TOE framework, in which organizational and environmental factors are more important than technological factors.

Objective 3: Strategic Roadmap for BIM Adoption

A BIM adoption strategy results from the integration of the qualitative and quantitative rounds, describing a logical, step-wise approach to adopting BIM through policy and institution development, capacity building, and industry transformation.

The qualitative round first determined the key aspects of the strategy, training, raising awareness, policy development, pilot projects, and digital transformation. These have been confirmed in Round 2, in which the creation of national BIM policy has been rated as the highest (Mean = 5.00, IQR = 0) and unanimously agreed upon by the experts. This indicates that policy development is the most important strategy to adopt BIM in Nepal.

The next set of strategies is the preparation of BIM guidelines, the conduct of training workshops, and the encouragement of digital transformation, which all scored highly with consensus. Education and pilot projects were also identified as significant bridging strategies, which can ease adaptation and showcase benefits.

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The holistic results indicate that BIM adoption in Nepal should be initiated in a top-down manner, commencing with government-driven policy and standardization, evolving into capacity-building programs, and finally resulting in industry-wide digital transformation. This is aligned with the conceptual model of this study, where institutional forces are the primary drivers for BIM adoption, and are supported by organizational and technological preparedness.

6. DISCUSSION

This research investigated the barriers, enablers, and strategies for Building Information Modeling (BIM) adoption in the design-build industry in Nepal, drawing from the results of two rounds of Delphi. The findings suggest institutional factors are the most important for BIM adoption. The absence of government policy and lack of BIM standards were the top barriers, and government support and BIM standardization were the top enablers. This finding is consistent with Institutional Theory, which highlights the influence of regulatory and normative factors on organizational practices (DiMaggio & Powell, 1983). Nepal's lack of strong policies represents low coercive pressure, reducing industry incentives to adopt BIM, as reflected in evidence from developing nations (Olawumi & Chan, 2019).

In terms of Technology-Organization-Environment (TOE) aspects, the study confirms that environment and organization trump technology. Having basic access to software and infrastructure is important, but not the key factor. Rather, human resource management, including training and curriculum development, is more important. This finding aligns with earlier research that indicates the readiness and support of organizations is more important than the technology itself (Succar & Kassem, 2015).

The study also suggests the need to focus on capacity building to implement BIM. The lack of technical knowledge and experience found in Round 1 and confirmed in Round 2 is indicative of the complexity of the innovation identified in the Diffusion of Innovation (DOI) model (Rogers, 2003). Better training and integration in the education sector can reduce complexity and hasten adoption.

While financial factors - such as the costs of software and training - were identified, they were not rated as the most significant. This indicates that institutional and systemic barriers are more important than financial constraints, contrary to some other research (Eadie et al., 2013). Further, change resistance seems to be rooted in other problems, rather than standing in isolation.

Our roadmap prioritizes a policy-led approach to BIM adoption, starting with national BIM policies and standards, then capacity building and industry transformation. This is in line with global experiences and places BIM as a resource capability within the Resource-Based View (Barney, 1991). In summary, BIM adoption in Nepal is determined by the institutional environment, coupled with organizational and technical infrastructure.

7. CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

The challenges, drivers and strategies for Building Information Modeling (BIM) in design-build projects have been explored in this study. The research adopted a modified Delphi technique to mix quantitative and qualitative data to build a comprehensive understanding of the adoption of BIM from a contextual view. The study shows that BIM adoption in Nepal is a process affected by the interaction of institutional, organizational, and technological factors, with the former being most important.

The findings show that a lack of government policy and BIM standards is the key barrier to adoption. Although technical barriers such as skills and infrastructure play a crucial role, they are less important than governance and regulatory issues. Indirect barriers, such as budget constraints (high software and training costs), also limit the adoption of BIM but are not the key factors. From these results, we can see that institutional readiness is the major factor limiting the adoption of BIM in Nepal.

The research also reveals significant factors in BIM adoption. The enabling factors are government policy, BIM standards and training. Developing human resources through education and training for digital innovation is integral. Technology availability and related infrastructure are facilitating factors.

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Informed by these insights, a roadmap for the adoption of BIM is proposed, with a focus on incrementalism and policy. The roadmap emphasizes the need to develop national policies and standards for BIM, build capabilities through education and training, and transform industry through pilot projects and digital transformation. The synthesis of the two rounds of Delphi shows that successful adoption of BIM in Nepal requires holistic efforts in the institutional, organizational, and technological aspects.

In terms of theory, the research adds value by adopting the Technology-Organization-Environment (TOE) framework, Diffusion of Innovation (DOI) theory, Institutional Theory, and Resource-Based View (RBV) to explain the adoption of BIM in a developing country. The results confirm the significance of both the environment and institutional factors in technology adoption, in addition to the role of organizational capabilities and resources.

In summary, the research is aimed at providing an insightful understanding of how BIM could be promoted in Nepal's construction industry and making relevance between the global BIM issues and Nepal's construction industry. It contributes theoretically and practically to the current practice of BIM implementation.

7.2 Recommendations

This study has identified several recommendations to achieve successful BIM adoption in Nepal:

First, the government can help to establish a national BIM policy. Similarly, the incorporation of BIM protocols in public projects can help drive the demand for BIM usage.

Second, BIM protocols and guidelines should be created for consistency and interoperability. Local standards should be developed in line with global standards but considering industry-specific circumstances.

Third, capacity development should be focused on providing training programs and incorporating BIM in education. Universities and professional groups should work together to train and certify in BIM.

Fourth, grants, subsidies, or other incentives should be given to offset the cost of BIM software and training.

Lastly, there is a need to promote public-private partnerships to foster knowledge and innovation and promote the adoption of BIM practices.

7.3. Practical Implications and Policy Recommendations

The study has important implications for practitioners and managers in industry, for policymakers, and for educators and trainees in business informatics and software development.

The study recommends to policy makers in government the adoption of a BIM national strategy, which comprises policy, regulations, and monitoring/metrics at a national level. The government should act to create an enabling regulatory framework for BIM implementation, bringing the construction industry up to the global digital age.
The study suggests the industry should focus on its people and organizations. BIM should be widely adopted by the industry in terms of training staff and embracing collaborative work and progressive transition from conventional work to BIM workflow. BIM should be recognized as a technology upgrade and a change management tool that improves project delivery and competitiveness.

For educators, the study calls for higher education institutions to integrate BIM in engineering and construction management courses. Courses should be developed to provide both theoretical and practical insights to equip students with skills for digital construction.

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In terms of policy, the research proposes a national BIM roadmap with short-term, medium-term, and long-term planning. In the short term, information programs and demonstration projects should be implemented. In the medium term, capacity building and standardization should be promoted. Long-term, full-scale digital transformation of the construction industry should be facilitated through the enforcement of policies and integration with technology.

The study offers practical recommendations for stakeholders to promote BIM and enhance project performance in the construction industry in Nepal.

DECLARATION

The corresponding authors of this article guarantee that this article has been written independently. In the following article, the corresponding authors of this article declare that in this article, no AI-based applications, tools, software etc. have been used to generate any part of this manuscript. Hence, no AI-based technology has been used for data analysis, tables, diagrams, figures, flowcharts etc. in this article.

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