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Enabling BIM Adoption in Nepal's Construction Industry: Barriers and Strategic Interventions

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Abstract

Building Information Modeling (BIM) has emerged as a transformative digital approach in the global construction industry, enabling improved collaboration, information management, and project performance throughout the project lifecycle. Nevertheless, its use in Nepal is still in its infancy, and it is predominantly used in basic applications like the visualization of designs and the calculation of quantities. This study aims to investigate the level of adoption of BIM in the construction sector of Nepal. This study also identifies the barriers to the implementation of BIM in the construction industry in Nepal. The survey was systematic and applied to a sample of 45 professionals in the areas of architecture, engineering and construction. The major factors that prevent adoption of BIM were found to be lack of clear government regulations and national standards, inaccessibility of professional training, high costs of software and implementation and organizational resistance to change. Meanwhile, stakeholders in the industry were at a clear consensus on the necessity to establish national BIM guidelines, to incorporate BIM education in university courses, and offer strategic incentives to use it. Overall, the study concludes that the need to adopt a coordinated and collaborative strategy by the government, in conjunction with industry and academic institutions, to enable BIM to be implemented and the long-term modernization and digital transformation in the construction industry in Nepal.

Keywords : *Building Information Modeling (BIM), BIM Adoption, Construction Industry in Nepal, BIM Implementation Barriers, BIM Framework, Digital Transformation*

1. Introduction

The construction industry is a vital part of the economy of a country and a principal contributor to infrastructure development. It offers enormous opportunities for employment and development in a country. Despite the numerous benefits that the construction industry can offer a project, it faces numerous problems that affect its performance negatively. Delays, cost overruns, and poor coordination/communication, among other issues, negatively impact construction projects, often stemming from the project stakeholders.

For decades, the construction industry has experienced inefficiencies, inaccuracy, and poor communication, among other problems. Building Information Modeling (BIM) is changing this process by providing building information and creating and managing digital building models. BIM data improves communication, increases coordination, and facilitates better decision-making among individuals and organizations that design, build, and maintain capital projects (Datta et al., 2023). BIM also reduces the incidence of design errors and minimizes the need for rework, therefore increasing the quality of project outcomes (Olawumi & Chan, 2018).

Globally, numerous nations have managed to embrace BIM in their construction work. The role of governments has been paramount in introducing policies, standards, and guidelines to help in BIM implementation. These programs have yielded increased efficiency, cost management, and project quality (Gurung, 2020).

But in Nepal, things are very different. The use of BIM is in its infancy. Most of the construction companies are still utilizing conventional techniques. Less advanced tools, such as 3D visualization and quantity calculation, predominantly restrict BIM utilization. It has several obstacles that restrain its further implementation (Olawumi & Chan, 2018). They lack government clarity of policies, the costliness of software and implementation, training, and technical skills. Moreover, organizational resistance to change also decreases the pace of adoption (Bhattarai & Kisi, 2022).

Irrespective of these obstacles, the BIM is attracting interest among professionals in Nepal. Thus, the present study is evaluating the extent of BIM adoption and the main obstacles, examine their effects, and propose strategic demands to enhance the use of BIM in Nepal's construction sector.

2. Literature Review

2.1 BIM Concept

Building Information Modeling (BIM) is a modern method of digital construction and information management for construction projects. It is a shared virtual data model that contains all building- and application-related information. In contrast to traditional CAD data, this information is stored in one data set that can be accessed and edited by all parties involved in the project, including architects, engineers, builders, and the facility manager. BIM is a digital tool. It is also an organizational process and a form of collaboration and data-driven communication. The BIM model is used for enhanced 3D modeling, details, coordination, and decision-making. Integrating project information across different stages of the construction process is what BIM aims to achieve in reducing the fragmentation within the sector. (Abbasnejad et al., 2016) argued that BIM makes data integral across various phases of a project, and this approach prevents fragmentation in the construction process.

2.2 Benefits of BIM

BIM has several advantages for the construction business. Minimization of errors and rework is one of the chief benefits. A digital model helps in identifying the design conflicts at an early stage. This assists in preventing expensive errors in construction. BIM is also effective in improving the efficiency of the project by increasing the coordination of the stakeholders. It aids in the proper estimation of the cost and schedule, resulting in improved project control. Besides this, BIM also leads to quality improvement and high productivity. (Azhar et al., 2024) pointed out that BIM has the potential to boost the project's cost and time and enhance its overall performance.

2.3 Global BIM Adoption

The world has intensely embraced the use of BIM. Many developed nations have applied BIM in both governmental and private construction. Governments encourage BIM through policies and regulations. As an example, the United Kingdom has made BIM binding to undertake projects in the public sector. In the same vein, Singapore has also put in place powerful strikes aimed at promoting the use of BIM. These nations have also come up with standard practices in the country and training opportunities to improve the use of BIM. Consequently, BIM has become a necessary phenomenon in construction practice today. Research indicates that one of the factors contributing to successful adoption of BIM is government support (Paneru et al., 2023).

2.4 Barriers in Developing Countries

There has been minimal use of BIM even in developing countries, although there are its advantages. The process has various obstacles to its implementation. The high cost of BIM software and the associated technologies is one of the greatest challenges. Most small and medium-sized firms are unable to afford such investments. Another problem is ignorance and knowledge of BIM. Its benefits might not be appreciated by the professionals. Besides this, access to training and technical expertise is limited. Organizational resistance to change also lowers the rate of adoption. As (Olawumi & Chan, 2018) have pointed out, these barriers introduce a lot of challenges to BIM implementation in emerging economies.

2.5 BIM Adoption in Nepal

The adoption of BIM in Nepal is undeveloped (Paneru et al., 2023). It has only been applied to a couple of projects and organizations. Traditionally oriented construction companies dominate the industry. No national standards or guidelines on BIM are evident (Niraula, 2020). This generates doubt and restriction of adoption. The opportunities to train are also limited, which influences the training of competent professionals. But it can be noticed that engineers, architects, and students are increasingly interested in BIM. This shows that it is possible for Nepal to adopt BIM in the years to come. BIM can be used to enhance the construction sector in Nepal with the aid of proper policy support and training, as well as industry collaboration (Prahan, 2018).

2.6 Research Gap

Despite extensive research on the implementation of BIM in developed countries, little research exists in the context of the Nepalese construction sector. Most existing studies have concentrated on BIM awareness, benefits and general implementation challenges. However, there is limited empirical evidence on the relative influence of policy, cost, training, organizational resistance, and awareness on BIM adoption in Nepal. Therefore, this study aims to fill this gap through looking at the critical barriers to the implementation of BIM and identifying strategies to promote the broader adoption of BIM in the construction industry of Nepal.

3. Materials and Methods

3.1 Research Methodology

The research method used for this study is shown in Figure 1. The flow diagram shows the chronological steps taken to understand the challenges of BIM implementation and to find possible solutions to overcome these challenges for greater integration of BIM in the construction industry in Nepal. The methodology adopted is the systematic approach of Quantitative Research, which aims to collect, analyze, and interpret empirical data in a systematic manner.

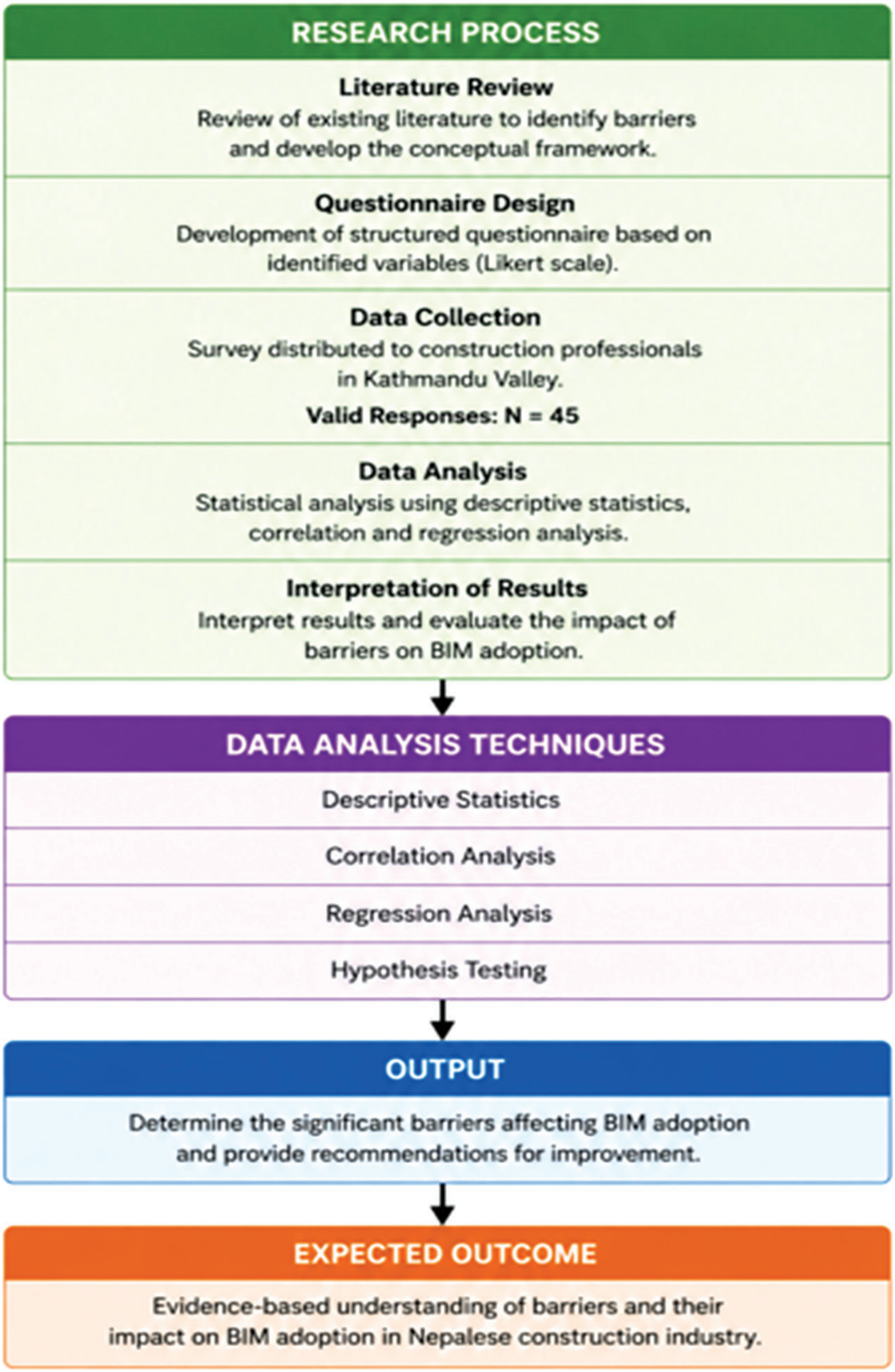

Figure 1: Flow Diagram of Research Methodology

The study commenced with an in-depth literature review on BIM. The literature review was focused on key constraints facing BIM implementation. The study conceptualized an approach to study, and the structured questionnaire was designed based on the literature review. All constructs were validated, and the questionnaires were distributed amongst various stakeholders of the construction industry, i.e., architects, engineers, BIM consultants, construction companies, and project managers based in Kathmandu Valley. Responses from 45 participants were analyzed by using various statistical tools.

Data collected were analyzed descriptively to find out the characteristics of the respondents and the distribution of the variables. To investigate the relationships between the study variables, correlation analysis was conducted, and the influence of these barriers on the BIM adoption was examined through regression analysis. To test the proposed relationships and to determine their statistical significance, hypothesis testing was subsequently conducted. Lastly, findings were analyzed to identify the most important barriers and propose strategic interventions to help achieve effective BIM implementation in Nepal. The flow diagram summarizes the research methodology and creates an improvement in the transparency, logical sequence and reproducibility of the study.

3.2 Research Design

The research was conducted in the form of a quantitative research study to investigate the use of BIM in the Nepalese construction industry through Kathmandu Valley as a study area. To meet this goal, a survey method was selected, as it allowed acquiring structured information with a sample of professionals in a limited amount of time. There are several barriers that were used to support research design, and their effects were evaluated on BIM adoption. The conceptual framework was constructed where BIM adoption was the dependent variable and where the identified barriers were the independent variables. The technique was helpful to grasp cause-and-effect relationships procedurally.

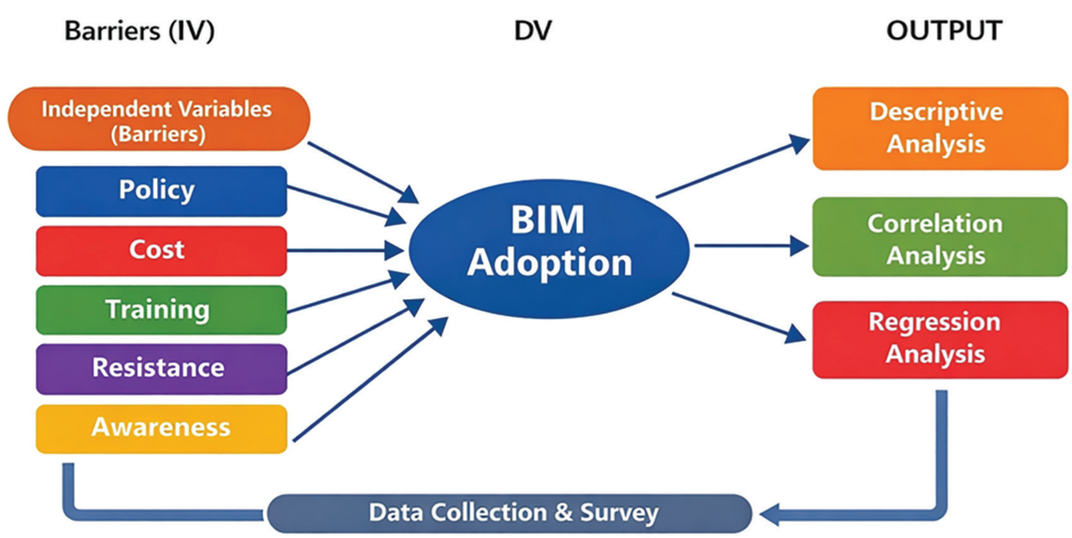

Figure 2: Research Design

The research process was carried out in several steps. To begin with, different variables were determined according to the existing literature. Second, a design questionnaire was created. Third, researchers sampled professionals from the construction industry in the Kathmandu Valley to gather data. Lastly, the results were interpreted by statistical analysis. This research design made sure that the process was clear, consistent, and reliable.

3.3 Study Area and Sample Size

The study was conducted in Kathmandu Valley, Nepal as it has the highest concentration of construction projects and professional organizations. A total of 45 valid questionnaire responses were received. The respondents are various engineers, architects, consultants, and project managers who are closely engaged in construction projects.

The sample also portrays people who have experience in the industry. This enhances the validity of the results. Even though the sample is tiny, it is enough to conduct preliminary statistical analysis, such as correlation analysis and regression analysis. It focused on obtaining quality responses from experienced industry practitioners rather than achieving a larger sample size.

3.4 Research Variables

Both independent and dependent variables are involved in the study. These variables were assessed according to the literature and the BIM adoption situation in developing countries.

Independent Variables:

- Government policy and regulations
- Implementation cost
- Professional training
- Organizational resistance to change
- BIM awareness

Dependent Variable:

- BIM Adoption

The variables assist in evaluating the effects of various barriers on the adoption of BIM in the construction industry in Nepal.

3.5 Data Analysis

The data collected was analyzed statistically. This analysis was conducted in three key phases.

To be more exact, data were summarized with the help of descriptive statistics. To obtain general trends, the BIM usage level, awareness, frequency, and percentage were computed.

Second, the correlation analysis was used to investigate the relationship between independent variables and BIM adoption. This method was used to determine whether there is a positive or a negative relationship between the variables.

Third, the regression analysis was conducted to see how different barriers influenced BIM adoption. The approach can be used to determine the most influential factors that affect adoption.

The universal interpretation of all results was simple. These statistical methods are used to ensure that the results are objective and reliable.

4. Results

This part consists of the study findings, founded on the answers to the questions obtained through the interviews of 45 professionals in construction. Descriptive statistics, correlation analysis, and regression analysis are used to analyze results. All findings are submitted in a tabular manner and then interpreted.

4.1 BIM Usage

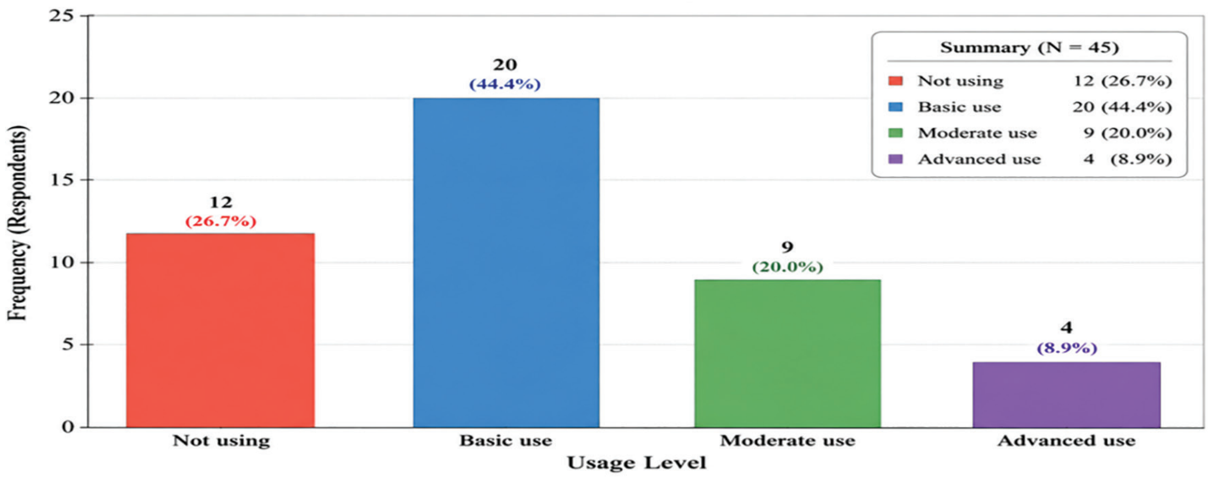

Figure 3: Technology Uses Level

The findings reveal that adoption of BIM in Nepal is undeveloped. A considerable percentage of the answers downloaded was credited to basic usages of BIM (44.4%) in 3D modeling and visualization. About 26.7% of the participants reported that they do not use BIM in their projects. This implies that much of the industry is still conventional.

The percentage of moderate level of BIM use is only 20.0%, with a very low percentage (8.9) of brokering with BIM at an advanced level. This means that the construction companies do not use advanced BIM applications such as clash detection, integration and coordination of the project. In general, the results demonstrate that the adoption of BIM in Nepal is weak and confined to simplistic functions.

4.2 Awareness Level

The findings have pointed out that the majority of the respondents (48.9%) are moderately aware of BIM. This implies that although professionals are relatively aware of BIM, they might lack adequate knowledge of the same to apply effectively.

A high level of awareness was involved, and approximately 28.9% respondents said that they were well informed about the use of BIM concepts and applications. This shows that a few professionals possess the best knowledge of BIM concepts and applications. Nevertheless, there are 22.2% of low awareness level among the respondents, and it is an important gap in knowledge in the industry.

Such results demonstrate that the level of awareness is improving but it is still inadequate. The need has been identified for the strengthening of awareness on BIM among construction professionals in Nepal through training and education.

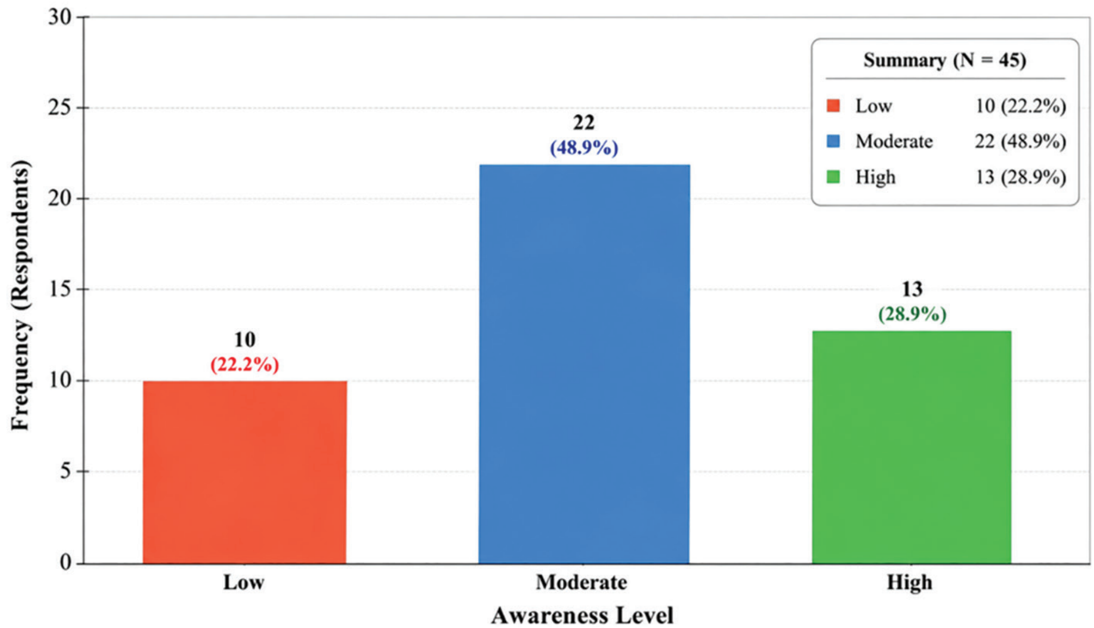

Figure 4: Awareness Level of BIM

4.3 Barriers to BIM Adoption

Table 1: Major Barriers to BIM Adoption

Barrier	Frequency	Percentage (%)
Lack of policy	36	80.0%
High cost	34	75.6%
Lack of training	33	73.3%
Resistance to change	29	64.4%
Lack of awareness	25	55.6%

The results explicitly reveal that there are a few key obstacles to the use of BIM in Nepal. Lack of government policy is reported and found to be the greatest barrier, 80.0% among the respondents. This shows that the lack of national standards and guidelines brings ambiguity and a lack of motivation towards using BIM among organizations.

Another significant barrier is high software and implementation costs; 75.6% of the respondents reported this. Understanding the efforts of many firms, particularly small and medium enterprises, they are unable to adapt to BIM technology due to financial constraints.

Another important problem is the lack of training (73.3%). Professionals cannot operate BIM without training. Resistance to change (64.4%): It shares the same opinion that organizations are not always eager to move towards digital practices instead of traditional ones.

Lastly, low adoption is also related to a lack of awareness (55.6%). These results show that BIM implementation is facing both technical and organizational challenges.

4.4 Strategic Requirements

Table 2: Strategic Requirements for BIM Adoption

Strategy	Frequency	Percentage (%)
National guidelines	38	84.4%
Curriculum integration	36	80.0%
Training programs	35	77.8%
Government incentives	33	73.3%
Industry collaboration	31	68.9%

The findings shed light on the major strategies that are needed to enhance the adoption of BIM in Nepal. Most of the respondents (84.4%) are very keen on developing national BIM guidelines. This demonstrates the significance of government intervention in marketing BIM.

It is also highly recommended that BIM be integrated into university curriculum (80.0%) and be introduced in universities. This will assist in producing competent professionals in the future. Improvement of practical knowledge and skills is necessary through training programs (77.8%).

Financial barriers can be decreased with the aid of government incentives (73.3%). Collaboration (68.9%) within the industry is also essential due to the need to share knowledge and for other stakeholders to coordinate.

These measures are a good guide to the enhancement of BIM in Nepal.

4.5 Correlation Analysis

Table 3: Correlation Matrix (n = 45)

Variables	Policy	Cost	Training	Resistance	Awareness	BIM Adoption
Policy	1	.522**	.498**	.471**	.455**	.681**
Cost	.522**	1	.563**	.502**	.468**	.645**
Training	.498**	.563**	1	.488**	.520**	.702**
Resistance	.471**	.502**	.488**	1	.462**	.621**
Awareness	.455**	.468**	.520**	.462**	1	.658**
BIM Adoption	.681**	.645**	.702**	.621**	.658**	1

Note: Correlation is significant at 0.01 level

The correlation analysis indicates that the relationship between all the independent variables and BIM adoption is a positive and statistically significant association. This implies that the more these factors are enhanced, the better the use of BIM is.

Training is the most correlated variable with BIM adoption ($r = 0.702$). This implies that training is an essential requirement for enhancing BIM usage. There are also strong relationships between policy ($r = 0.681$) and awareness ($r = 0.658$).

Moderate relationships are found between resistance ($r = 0.621$) and cost ($r = 0.645$). Altogether, the findings prove that all the barriers provided are significant determinants of BIM adoption.

4.6 Regression Analysis

Table 4: Model Summary

Model Summary			**ANOVA**	
R	**R²**	**Adjusted R²**	**F**	**Significance**
0.802	0.643	0.601	29.84	0.000

The summary of the model reveals that the independent variables explain 64.3% of the variation in the adoption of BIM. This shows a high explanatory ability of the model.

The outcome of the ANOVA indicates that the regression model is significant ($p < 0.001$). This validates the fact that this model is appropriate when it comes to forecasting the adoption of BIM.

Table 5: Coefficients

Variable	**Beta**	**Significance**
Policy	0.285	0.005
Cost	0.214	0.021
Training	0.331	0.002
Resistance	0.198	0.034
Awareness	0.247	0.012

Based on the regression outcomes, all the variables have a strong positive impact on BIM adoption ($p < 0.05$). The most influential one is training ($\beta = 0.331$), followed by policy ($\beta = 0.285$) and awareness ($\beta = 0.247$).

The effects of cost and resistance are also highly influential, but their impact is not dramatic. The above findings propose that the most effective measures of increasing BIM adoption are to improve training opportunities and the development of clear policies.

4.7 Hypothesis Testing

The results of the regression analysis were used to test the hypothesis of this study. All the hypotheses focus on how a certain barrier affects the adoption of BIM in the Nepalese construction industry. The significance value ($p < 0.05$) is used to decide whether to accept or reject each hypothesis.

Table 6: Hypothesis Testing Results

Hypothesis	**Statement**	**Result**
H1	Government policy significantly influences BIM adoption	Accepted
H2	Software cost significantly influences BIM adoption	Accepted
H3	Training significantly influences BIM adoption	Accepted
H4	Resistance to change significantly influences BIM adoption	Accepted
H5	Awareness positively influences BIM adoption	Accepted

The hypothesis testing results indicate that all hypotheses are accepted. This implies that all the perceived barriers are statistically significant in affecting BIM adoption in the construction sector in Nepal.

Hypothesis H1 is a valid one that government policy is a significant factor in the adoption of BIM. The lack of clarity and national standards regarding regulations leaves uncertainty, which restricts implementation. This shows the necessity of powerful policy-backing.

Hypothesis H2 demonstrates that the level of software price has a strong influence on BIM adoption. The high cost of initial investment and the cost of running BIM have scared away many organizations, including small and medium-sized firms.

Hypothesis H3 implies that BIM adoption is strongly influenced and significant because of training. This is congruent with the regression analysis, in which training was found to have the greatest impact. Absence of qualified experts restricts successful implementation.

Hypothesis H4 establishes the fact that the resistance to change in organizations is a significant factor that influences BIM adoption. Several companies are reluctant to abandon the traditional ways, and this reduces the pace at which the process is adopted.

Hypothesis H5 demonstrates that awareness is a major causative factor. Lack of information about BIM advantages lowers the adoption intentions of professionals.

In general, it is obvious that the identified barriers are all significant predictors of BIM adoption. These results question the necessity to develop policies, cost-cutting measures, training, and awareness creation to encourage the installation of BIM in Nepal.

5. Discussion

This study explains the findings regarding the current literature and justifies the implications of the findings to the BIM use in Nepal.

5.1 BIM Adoption and Awareness

These findings indicate that BIM use in Nepal is in its initial phase. Most of the respondents apply BIM to simple functions, such as 3D visualization. Only a small number of them utilize advanced features. This suggests that BIM was not well integrated into the process of construction.

It aligns with the literature on developing nations, where BIM use initially begins at a simple level due to inadequate technical capacity (Olawumi & Chan, 2018). Regarding awareness, most of the respondents are moderately aware with some having little awareness. This indicates the presence of knowledge gaps that require filling. (Shah & Shrestha, 2023) introduced similar results, emphasizing the importance of awareness for the successful implementation of BIM.

5.2 Barriers to BIM Adoption

The survey found that the main barriers to change were lack of policy, high cost, need for training, resistance to change, lack of awareness and the lack of public policy.

This finding is in line with (Azhar et al., 2024), who emphasized the relevance of government regulations in BIM adoption. Another significant challenge, particularly to small firms, is the high cost and lack of training.

Additional barriers to change and awareness further hinder adoption. Companies are generally favoring the traditional ways which are delaying digital transformation.

5.3 Strategic Requirements

The analysis points out some of the key strategies such as national BIM standards, incorporation of education, training programs and government incentives.

These findings are in line with the best global practices where the role of policy support and education is significant in BIM adoption. Training is a must, as it directly increases the capacity to implement and the level of skills.

5.4 Relationship Between Barriers and BIM Adoption

The statistical results indicate that the variables have significant effects on BIM adoption. The best ones are training, policy and awareness.

Such results have been consistent with other previous research, highlighting the importance of skills and institutional support. The results indicate that the use of BIM can be improved significantly with training and policy.

6. Conclusion, Recommendations and Future Research

6.1 Conclusion

This study examined the adoption of BIM in the Nepalese construction industry, highlighting the major challenges and strategic needs. The results reveal that the applications of BIM are still at their infancy and mainly limited to simple applications.

The study identified major obstacles such as lack of government policy, cost, lack of training, change resistance and lack of awareness. Of these, training and policy were identified as the most influential concepts.

Results of correlation and regression analysis point out that all barriers identified have a significant impact on BIM adoption. The study also strongly supports other aspects such as national BIM guidelines, integration of education and training programs.

In summary, the research concludes that the government, industry and academia should share the responsibility of using BIM in Nepal.

1.2 Recommendations

Based on the findings, it is recommended as follows:

1. The government should formulate the national BIM policies and standards to provide clear directions.
2. BIM should be included in the syllabus of universities and academic institutions.
3. Professional skills should be improved through training programs and workshops.
4. There should be monetary incentives and resources to create cost breaks.
5. Awareness campaigns need to be conducted to promote the benefits of BIM.
6. Promote collaboration with industries for knowledge and experience sharing.

6.3 Future Research

There are certain limitations to this study. The sample size is not so big as it contains 45 respondents. Future research may involve a larger sample size for better generalizations.

There is still some scope for further research on BIM application in Nepal through case studies. It may also study impact of BIM on project performance, cost and time.

Additionally, future research can use more sophisticated tools like structural equation modelling (SEM) to examine the relationship between variables in greater depth.

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