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# Navigating BIM Transformation: Implementing Building Information Modeling in Selected Bataan Firms

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**Abstract**

Building Information Modeling (BIM) has emerged as a transformative innovation in the Architecture, Engineering, and Construction (AEC) industry, enabling improved coordination, accuracy, and decision-making across the project lifecycle. By integrating design, construction, and operational information into a unified digital environment, BIM supports more efficient project delivery and enhances collaboration among project stakeholders. As the global construction industry moves toward digitalization, BIM adoption has become increasingly essential for improving productivity, cost control, and overall project performance. However, despite its recognized benefits, many firms, particularly small companies, continue to experience challenges in fully implementing BIM. This study examined the level of BIM awareness, organizational readiness, and adoption potential among selected architectural and construction firms in Bataan, Philippines. It also identified the key barriers and challenges that affect BIM implementation within these organizations. A quantitative research design was employed using survey questionnaires distributed to industry professionals to assess current practices, perceptions, and implementation constraints. The findings revealed that while firms demonstrate moderate awareness of BIM, actual adoption remains at an early stage. Major challenges include high software and training costs, limited technical skills, and organizational resistance to change. In response to these challenges, the study developed a strategic BIM implementation framework tailored to the needs of small and medium-sized firms. The proposed plan emphasizes phased adoption, skills development, pilot project application, and internal process standardization to support gradual and sustainable BIM integration. The results of this research provide practical insights for industry practitioners, professional organizations, and policymakers in promoting effective digital transformation and strengthening BIM adoption within the local construction sector.

**Keywords:** Building Information Modeling (BIM), implementation, firms, awareness, challenges, Bataan, Philippines



## INTRODUCTION

In the Architecture, Engineering, and Construction (AEC) sector, Building Information Modeling (BIM) has become a transformative tool that enables the creation of digital project representations, coordination, and accuracy throughout a project. BIM is defined as a collaborative, interdisciplinary, model-centric approach focused on enhancing the design and construction of a building throughout the project lifecycle. Due to BIM's capacity to combine design, construction, and operational data into a unified, coordinated digital model, the construction sector's digitization is considered a competitive need on a global scale (Darko, 2019). Cost and time overruns characterize major capital programs and projects globally. Worldwide, capital project failure rates have risen to 60–75%, with cost overruns of 30–50% and schedule overruns of up to 100% being common (Collins, 2021; Das et al., 2025). BIM implementation must transform the traditional ways in which project participants work.

BIM adoption in the Philippine AEC industry is generally still in its early stages. The usage of BIM software started around 2005 with a few architectural design companies. However, the study found that BIM concepts have not been widely implemented, with only one-third identified as current BIM users (Rodriguez et al., 2019). Small architectural and construction firms face significant barriers to BIM adoption. The BIM implementation process in the Philippines is often seen as having a medium-low maturity level, where firms acknowledge the availability of more efficient digital workflows but continue to rely on traditional practices due to the high costs of upgrading software and hardware, training skilled personnel, and coordinating with others. The industry needs implementation strategies that are tailored to the organization's culture to successfully overcome barriers to implementing new initiatives. The single most significant barrier identified by respondents is the high cost of BIM software. A core barrier is the lack of skilled BIM operators and qualified professionals to use BIM tools and software.

According to Rodriguez et al. (2019), few professionals possess BIM skills and knowledge. Mostly, companies are satisfied with the use of current software, specifically Computer-Aided Drawing (CAD) tools, believing they are sufficient to sustain the firm. This situation indicates BIM is often treated as an "add-on" to the existing 2D CAD system, which is used primarily for coordination and developing construction drawings.

These studies emphasize practical strategies for promoting BIM adoption, including the provision of financial support, the development of training programs, and the delivery of hands-on guidance for implementation. This perspective was further reinforced by Ahmed R. S. (2022), who underscored the critical role of well-structured implementation plans when introducing BIM in contexts such as those in the province of Bataan.

**Theoretical Framework.** This study is grounded in the theoretical framework of the Technology Acceptance Model (TAM), which offers valuable insights into the adoption of Building Information Modeling (BIM) in selected firms. Applying the Technology Acceptance Model to the local contexts offers insights into organizational readiness for BIM adoption. A recent study by Vitente et al. (2024) in Qatar's construction industry utilized TAM to assess BIM implementation and acceptance within firms. Within this study, TAM's core constructs Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) were used to explain BIM adoption behavior. Perceived Usefulness refers to the extent to which professionals believe that BIM improves project efficiency, coordination, cost control, and overall performance. Perceived Ease of Use reflects the degree to which BIM is perceived as user-friendly, learnable, and compatible with existing workflows. These constructs were mapped to study variables such as BIM awareness, adoption level, perceived benefits, and implementation challenges. By examining PU and PEOU, the study assessed how user perceptions influence organizational willingness to adopt BIM technologies and integrate them into routine professional practice.

The study examined how staff within architectural and construction firms in Bataan view BIM's practicality and user-friendliness. It demonstrated a connection between the individual ideas measured by TAM. Understanding these insights helped them evaluate their willingness to adopt BIM technology into their workflow.

**Conceptual Framework.** The firm's willingness to embrace digital transformation is crucial for the successful implementation of BIM, particularly in a local context where factors such as existing technological capabilities, employee skill levels, and organizational culture must be carefully assessed. In evaluating readiness for BIM adoption, the firm must develop an implementation strategy that aligns with its organizational characteristics, including firm size, workforce demographics, and the types of projects typically undertaken in the local sector.

The conceptual framework of this study is presented through the research paradigm, based on the Input–Process–Output (IPO) model. The expected output was a Strategic BIM Implementation Plan designed to enhance coordination within the firm and streamline project workflows.

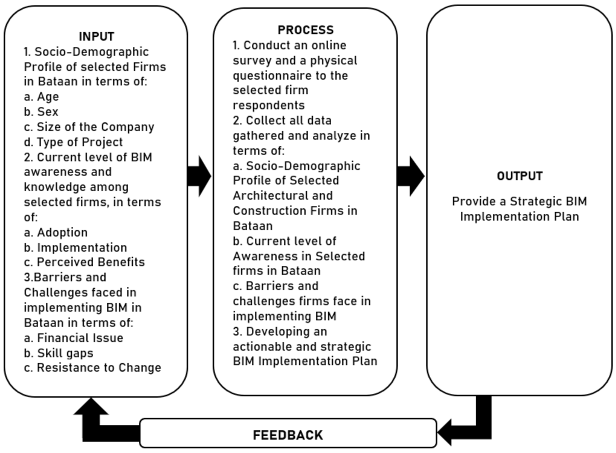


**Figure 1**
*Conceptual Framework of the Study (Input-Process-Output Model)*

As shown in Figure 1, the framework presents the relationship between the input variables, the research processes undertaken, and the expected output of the study.

The input component consists of the socio-demographic profile of selected architectural and construction firms in Bataan, including age, sex, company size, and type of project, as well as the current level of BIM awareness and knowledge in terms of adoption, implementation, and perceived benefits. It also includes barriers and challenges encountered in BIM implementation, specifically financial constraints, skill gaps, and resistance to change.

The process component involves the conduct of an online survey and physical questionnaire, data collection, and analysis of respondents' profiles, BIM awareness levels, and implementation challenges. Based on the analyzed data, the study proceeded with the development of an actionable and strategic BIM implementation plan tailored to the needs of firms in Bataan.

The output of the framework was the proposed Strategic BIM Implementation Plan, which served as a guide to support BIM adoption and improve workflow efficiency within selected architectural and construction firms. A feedback mechanism was incorporated in the framework to emphasize the continuous evaluation and refinement of BIM implementation practices.

**Statement of the Problem.** The purpose of the study was to implement a strategic plan for Building Information Modeling (BIM) in selected architectural and construction firms in Bataan for future adoption. To address this, the study examined the following questions:

1. What is the socio-demographic profile of the respondents in terms of:
   1.1 Age;
   1.2 Sex;
   1.3 Size of the Company; and,
   1.4 Type of Project?

2. What is the current level of BIM awareness and knowledge among selected firms in terms of:
   2.1 Adoption;
   2.2 Implementation; and,
   2.3 Perceived Benefits?

3. What are the barriers and challenges faced in implementing BIM in Bataan in terms of:
   3.1 Financial Issues;
   3.2 Skill gaps; and,
   3.3 Resistance to Change?

4. What strategic BIM implementation plan can be proposed to support the selected firms' BIM adoption, address implementation challenges, and improve overall project efficiency?

**Scope and Limitations of the Study.** The scope was to evaluate the current level of BIM awareness, adoption, and impact on project workflows and results in selected architectural and construction firms in Bataan.

It also highlighted some recommendations that these firms could use to overcome these barriers and improve BIM use in their projects. This study examined selected firms that focus on residential and commercial projects. The study collected data through survey questions and an online Google form from selected professionals and practicing architects in the province. The results revealed the current state of BIM adoption in Bataan, as well as recommendations for increasing BIM integration and collaboration in the local construction industry.

This study also acknowledges several limitations, such as the absence of a nationally mandated BIM standard and standard BIM-based contract forms in the Philippines. This absence limited the ability of firms to fully implement BIM practices. Second, the lack of formal BIM requirements in local government project submissions limited external motivation for BIM adoption. Lastly, the study focused only on selected small and medium firms in Bataan.

**Significance of the Study.** The results of this study contribute meaningfully to the growing body of knowledge on Building Information Modeling (BIM) implementation and serve as a valuable resource for diverse programs and sectors. For architectural and construction firms in Bataan, the study offers practical insights and a strategic BIM implementation plan that can help overcome barriers to adoption, thereby enhancing operational efficiency and improving project outcomes.

Educational institutions in the province, particularly universities and colleges, may also benefit from the findings. The results can inform the development of standards, guidelines, and training modules that promote BIM adoption, especially among smaller firms that often face challenges in embracing digital transformation. In this way, the academe can play a pivotal role in preparing future professionals to integrate BIM into their practice.

Professional organizations such as the United Architects of the Philippines (UAP) can likewise draw on the study's recommendations. By providing resources and training programs, UAP can support small firms in their transition toward BIM, ensuring that provincial practices are included in the broader digital transformation of the architecture and construction sector.

Local government units in Bataan may also find the study useful, as it provides a clearer picture of the current BIM capabilities and limitations of local firms. These insights can guide the development of BIM-related requirements for project submissions, fostering transparency and improving coordination between government agencies and private firms.

Finally, the study serves as a reference point for future researchers. The data and findings presented here can inspire new investigations into BIM implementation, offering fresh perspectives and identifying additional factors that may influence adoption. In this way, subsequent studies can build upon the present work to advance more informed decisions and strategies for BIM integration in the construction industry.

## LITERATURE REVIEW

This chapter reviews both local and international literature relevant to Building Information Modeling (BIM) implementation. Firm characteristics play a significant role in adoption, with company size, years of operation, and workforce capacity influencing the use of digital technologies. Alreshidi (2019) observed that small and medium-sized firms in developing countries face distinct challenges in BIM implementation, while Chileshe et al. (2022) noted that SMEs often operate with limited manpower, requiring employees to assume multiple roles that hinder specialization in BIM tasks. Saka and Chan (2023) further highlighted that newer firms are more likely to adopt BIM workflows, whereas established firms may struggle to transition from traditional practices. Globally, BIM adoption varies due to differences in awareness and training availability. Alasmari et al. (2022) found that firms in developed economies demonstrate higher BIM awareness and adoption compared to those in countries constrained by limited technical knowledge and financial resources. In the Philippines, local firms generally exhibit mid-level BIM maturity, while foreign firms outsourcing in the country demonstrate higher maturity levels through integrated workflows and standardized practices.

BIM implementation has been shown to improve project coordination, design accuracy, workflow efficiency, cost management, and interdisciplinary collaboration. Ahmed (2022) reported that countries with structured BIM policies, such as the UK where over 75% of firms use BIM, achieve substantial improvements in project coordination. Malaysia has also set a target of 80% BIM utilization by 2025 under the Construction Industry Transformation Programme (CITP) 2021–2025, supported by certification programs from the Construction Industry Development Board (CIDB) (Rahman et al., 2023; CIDB, 2021). In the Philippines, Dimaculangan (2023) documented varied approaches to BIM adoption, while Rodriguez et al. (2019) highlighted persistent barriers among local firms. Saka and Chan (2023) emphasized that BIM investments yield significant benefits, suggesting that wider adoption in the Philippines could enhance collaboration and accelerate workflows across the design and construction sector.

**Local Government Influence on BIM Implementation.** Local government units (LGUs) also play a crucial role in implementing BIM, especially in the construction industry. A study by Ahmed (2022) showed that public-sector BIM requirements aligned with ISO 19650 significantly accelerated BIM adoption and standardization among firms.

A study by Rahman et al. (2023) in Southeast Asia found that government-led initiatives encouraged the private sector to improve BIM maturity in public projects. As a result, some firms invested in training and adopted more BIM workflows. In countries like Singapore, the construction and design industries are required to invest in BIM to facilitate required digital submissions.

In contrast, BIM implementation within the Philippine government remains limited. According to Rodriguez et al. (2019), public sectors continue to rely on traditional 2D manual documentation and submissions. Furthermore, Dimaculangan (2023) noted that local government units (LGUs) face critical hurdles, specifically a shortage of BIM-literate personnel and the absence of standardized guidelines, both of which stifle effective adoption.

**Level of Development in BIM Implementation.** De Guzman et al. (2023) found that some local design and construction companies, especially here in the Philippines, operate BIM at LOD 200–300, whereas higher LOD applications like LOD 400–500 are more prevalent in projects that involve foreign consultants or international collaboration. Dimaculangan (2023) observed that some firms engaged in BIM outsourcing had adopted higher LOD practices, especially for tender drawings and construction coordination, which demonstrated improvement in BIM maturity. (De Guzman et al., 2023).

**Challenges Faced by Firms in Adopting BIM Financial Constraints.** Financial constraints should be considered in BIM implementation. Zhang and Gao (2021) identified that investing in BIM software and the requirement for specialist computer hardware posed substantial obstacles in the construction sector. Many companies faced challenges in procuring software and providing training due to their limited financial resources, especially small firms. The expenses related to enhancing technology might be excessive compared to traditional methods. A study by Saka and Chan (2023) identified this cost challenges associated with system improvements as a major barrier to BIM implementation.

**Skill Gaps.** A study by Alreshidi (2019) found that one hindrance *to* BIM implementation was the shortage of educated BIM users in the sector, especially in design and construction firms. Many companies lack the internal expertise and execution strategies necessary to integrate BIM into their workflows, often necessitating the recruitment of external consultants. Chileshe et al. (2022) validated this, noting that a lack of BIM capabilities among professionals remains a primary barrier to efficient implementation.

**Resistance to Change.** Research has shown that resistance to change is one of the main barriers, especially in small firms with mostly senior employees and managers who were accustomed to the traditional 2D method, such as tools like AutoCAD. A study pointed out that companies were reluctant to invest in new software because of the limited experience of both management and personnel. The shift to BIM could cause possible delays in current projects, and staff voiced concerns about the significant learning curve. Thompson and Bryant (2023) raised a critical issue due to the lack of guidelines for interoperability between BIM and other software; this also poses a significant barrier to the implementation of new technology in the architecture and construction sector.

## METHODS

**Research Design.** This study employed a cross-sectional survey design using a quantitative approach, which is commonly used to obtain the numerical statistics of the respondents' opinions as representatives of a whole population. This research methodology was designed to collect data from a specific population. The quantitative method was employed for a more numerical approach, grounded in statistical analysis of the collected data. Wang and Cheng (2022) used a statistical method to examine the adoption rates of BIM in small construction firms, with data collected from firm management and personnel. Ruan et al. (2020) used factor analysis to explore the key factors influencing BIM adoption.

**Population, Sample Size, and Sampling Technique.** In research on BIM implementation, purposive sampling was employed to target firm owners and industry professionals who were capable of providing in-depth insights into the research problem. Given that BIM is a specialized and technical domain, purposive sampling enabled the deliberate selection of firms at different stages of adoption, including those that had implemented BIM, those in the process of implementation, and those with no prior experience. This approach allowed the study to capture a range of perspectives on BIM's perceived benefits, challenges, and implementation barriers, such as organizational limitations and resistance to change. By focusing on firms that were directly relevant to the research questions, purposive sampling strengthened the study's ability to generate meaningful and context-specific findings on BIM implementation.

The population for this study included firms located in Bataan, Philippines that were involved in design, planning, and construction activities. These firms represented varying levels of BIM adoption maturity and mostly operated residential and commercial projects. The survey included a total of 97 professionals from design and construction firms in Bataan. There were 78 respondents in this survey calculated using Cochran's formula at a 0.05 level of significance.

Cochran's formula is expressed as:

$n_0 = (Z^2 * p * q) / e^2$

where:

$n_0$ = initial sample size

Z = Z-value corresponding to a 95% confidence level (1.96)

p = estimated proportion of the population with the attribute (0.5)

q = 1 — p (0.5)

e = margin of error (0.05)

$n_0 = (1.96^2 \times 0.5 \times 0.5) / (0.05^2)$

$n_0 = (3.8416 \times 0.25) / 0.0025$

$n_0 = 384.16$

Since the population size is finite (N = 97), the adjusted sample size was computed using the finite population correction formula:

$n = n_0 / [1 + (n_0 - 1) / N]$

Substituting the values:
$n = 384.16 / [1 + (384.16 - 1) / 97]$
$n = 384.16 / [1 + 3.95]$
$n = 384.16 / 4.95$
$n \approx 77.6$

Thus, the computed minimum sample size was rounded to 78 respondents, which constitutes the final number of survey participants included in this study. The data collected covered BIM awareness, current technology usage, workflow challenges, and factors influencing the firms' decision-making regarding BIM implementation in their firms.

Upon completion, the data were synthesized and interpreted to identify prevailing trends in BIM adoption. These findings served to evaluate the organizational readiness of firms in Bataan to successfully integrate BIM into their operational workflows.

**Description of the Respondents.** The respondents for this study consisted of individuals directly involved in the implementation and use of Building Information Modeling (BIM). The inclusion criteria for respondent selection were as follows:

1. Respondents had to be business owners or active employees of architectural, or construction firms physically located in Bataan.

2. Participants needed to have experience managing or executing small-scale projects, specifically within the residential and commercial sectors.

3. Respondents were required to voluntarily express their willingness to participate and provide informed consent; and,

4. Participants had to possess sufficient proficiency in English to comprehend the survey instruments.

While the exclusion criteria were as follows:

1. Individuals not currently employed within the province of Bataan were excluded.

2. Professionals whose primary experience was limited to large-scale or industrial projects, rather than small-scale residential or commercial works, were ineligible.

3. Individuals employed by outsourcing companies or offshore service providers were excluded to maintain a focus on local firm workflows.

4. Any potential respondent who declined to participate or provide informed consent was excluded.

**Research Instrument.** The research instrument used for data collection consisted of a structured questionnaire administered through an online survey platform and a printed version for selected respondents. The questionnaire was designed to gather quantitative data related to BIM awareness, adoption level, perceived benefits, and implementation challenges among architectural and construction firms in Bataan. To ensure content validity, the questionnaire underwent expert validation prior to distribution. The instrument was reviewed by professionals with expertise in BIM implementation, construction management, and research methodology to evaluate the clarity, relevance, and alignment of the items with the study objectives. Minor revisions were incorporated based on the experts' recommendations to improve item wording and consistency. A pilot test was conducted with a small group of respondents who were not included in the final sample to assess the reliability and comprehensibility of the instrument. The results of the pilot test indicated that the questionnaire items were clear and suitable for the target respondents.

On the other hand, the scale measurement used in this study was a Likert scale. According to Encyclopaedia Britannica (2024), Likert scales are rating systems used in questionnaires that are designed to measure people's attitudes, opinions, or perceptions. They distinguish the positive and negative attributes of the study. A 5-point Likert scale was employed across the questionnaire; however, the instrument consisted of multiple subscales rather than a single unified scale. Separate Likert scale anchors were used to accurately measure different constructs. For BIM familiarity, the scale ranged from "Not Familiar" (1) to "Expert Level" (5). For BIM adoption, the scale ranged from "Not Adopted" (1) to "Fully Implementing BIM" (5). For frequency of use, the scale ranged from "Not Applicable" (1) to "Always" (5). Each subscale was treated as an independent construct, and reliability was assessed separately to ensure measurement accuracy.

**Data Collection Procedure.** The survey was conducted using an online data collection method, with the questionnaire distributed via Google Forms. Prior to data collection, the researcher sought and obtained approval from the relevant authorities of the selected firms. The online survey remained open for responses for a period of two (2) weeks. This study adhered to ethical research standards involving human respondents. Participation in the survey was strictly voluntary, and all respondents were informed of the purpose of the study prior to data collection. Informed consent was obtained from each participant before they were allowed to proceed with the questionnaire. To ensure data confidentiality and anonymity, no personally identifiable information was collected. Responses were treated with strict confidentiality and were used solely for academic and research purposes. All collected data were securely stored and accessed only by the researcher. Approval to conduct the survey was sought and obtained from the relevant authorities of the selected architectural and construction firms in Bataan. As the study posed minimal risk to participants and involved no sensitive personal data, formal institutional ethics board approval was not required. In addition to primary data, secondary data were obtained from various sources, including journals, books, articles, theses, dissertations, conference papers, and online resources. These materials were used to inform the literature review and to provide comparative insights into BIM adoption practices across different regions.

***Weighted Mean.*** This was employed to describe the verbal interpretation of data. If all the weights were equal, then the weighted mean equaled the arithmetic mean (the regular "average" you're used to). For the level of awareness, barriers, and implementation, the weighted mean was applied. The present study primarily used descriptive statistical techniques, including weighted mean, frequency, and percentage to address the research objectives. This approach was deemed appropriate given the exploratory nature of the study, which focused on assessing the current level of BIM awareness, adoption, and implementation challenges among selected architectural and construction firms in Bataan. Although inferential statistical methods such as chi-square tests or correlation analysis could have further examined relationships between firm characteristics and BIM adoption levels, these techniques were beyond the scope of the present research. The study was designed to establish baseline data and provide an overview of existing BIM practices rather than to test causal relationships. Future studies may build upon these findings by incorporating inferential statistical analyses to examine connections between demographic variables, implementation barriers, and BIM adoption outcomes.

***Frequency.*** The frequency of a particular data value refers to the number of times it occurs. It is one of the values of a variable that divides the distribution of the variable into 100 groups having equal frequencies.

For the socio-demographic profile of the respondents, frequency and percentage were used.

**Data-Gathering Procedure.** The researcher *distributed and collected* the survey responses in this study. From this, the researcher *categorized, tallied, and tabulated* the data based on the responses.

***Categorization.*** The collected data were organized according to the sections of the questionnaire. Part I presented the organizational and socio-demographic profiles of the selected firms. Part II examined the extent of BIM implementation within the respondents' firms. Part III focused on the barriers and challenges to BIM implementation, including factors such as cost, limited expertise, and resistance to change. The final section discussed the perceived benefits and impacts of BIM implementation.

***Tallying.*** To organize and quantify the responses, the data were tallied using Microsoft Excel. The responses were coded and compiled to provide a clear picture of the extent of BIM implementation within selected firms in Bataan.

***Tabulation.*** After the tallying process, the data were tabulated in Microsoft Excel to summarize the findings. The results were presented in tables that clearly showed the frequency and percentage of responses for each item, such as the extent of BIM use in various aspects of the firms' operations and the perceived effectiveness of BIM adoption. These tables served as a foundation for the analysis, providing a detailed examination of the factors that influence BIM implementation and how they were connected with firm characteristics, such as size and practices.

## RESULTS

The following tables present the analyzed and interpreted data obtained from the selected firms in Bataan, providing a structured account of the respondents' perspectives on BIM implementation.

**Profile of the Respondents.** Table 1 shows the frequency and percentage distribution of respondents by age. This clearly indicates that most of the respondents were young to mid-career professionals. The workforce was generally within an age group expected to be more interested in digital technologies such as BIM. This suggested a positive impact, as BIM implementation could be easier, given that the middle-aged group had more interest in the advancement of technology.

**Table 1**
*Frequency and Percentage Distribution of the Respondents in Terms of Age*

| Age | Frequency | Percentage (%) |
|---|---|---|
| 25 years old and below | 7 | 9.0 |
| 26-35 years old | 37 | 47.4 |
| 36-45 years old | 30 | 38.5 |
| 46-55 years old | 3 | 3.8 |
| 56 years old and above | 1 | 1.3 |
| Total: | 78 | 100.0 |

The distribution of respondents in Table 2 reveals a female majority (66.7%), with males comprising 33.3% of the sample. This finding underscores the significant participation of women in architectural and construction firms in Bataan, reflecting a shift from the traditionally male-dominated composition of the construction sector. The predominance of female professionals may suggest evolving workforce dynamics, where women increasingly contribute to technical and managerial roles. This demographic characteristic has implications for BIM adoption, as diverse perspectives and inclusive participation can foster broader acceptance of digital innovations within the industry.

**Table 2**
*Frequency and Percentage Distribution of the Respondents in Terms of Sex*

| Sex | Frequency | Percentage (%) |
|---|---|---|
| Male | 26 | 33.3 |
| Female | 52 | 66.7 |
| Total: | 78 | 100.0 |

The data in Table 3 indicate that most firms represented in the study are small-sized enterprises, with 55.1% employing between 1–5 workers and 23.1% employing 6–10 workers. Only 12.8% of firms reported having more than 20 employees. This profile highlights the predominance of micro and small enterprises in the provincial construction sector. Such firm characteristics are critical in understanding BIM adoption, as smaller firms often encounter financial and manpower constraints that limit their ability to invest in advanced technologies. Consequently, BIM implementation strategies must account for resource limitations, emphasizing cost-effective solutions, scalable training programs, and simplified workflows tailored to the operational realities of small firms.

**Table 3**
*Frequency and Percentage Distribution of the Respondents in Terms of Number of Employees*

| Number of Employees | Frequency | Percentage (%) |
|---|---|---|
| 1-5 employees | 43 | 55.1 |
| 6-10 employees | 18 | 23.1 |
| 11-20 employees | 7 | 9.0 |
| More than 20 employees | 10 | 12.8 |
| **Total** | **78** | **100.0** |

As shown in Table 4, the majority of firms reported engagement in residential (98.7%) and commercial (67.9%) projects, with fewer involved in institutional projects (9.0%) and none in industrial developments. This distribution reflects the localized and small-scale nature of construction activities in Bataan, where firms primarily focus on repetitive, fast-turnaround projects rather than large-scale infrastructure.

**Table 4**
*Frequency and Percentage Distribution of the Projects Undertaken by the Firms of the Respondents*

| Type of Project | Frequency | Percentage (%) |
|---|---|---|
| Residential | 77 | 98.7 |
| Institutional | 7 | 9.0 |
| Commercial | 53 | 67.9 |
| Industrial | 0 | 0.0 |
| Others | 1 | 1.3 |

The dominance of residential and commercial projects suggests that BIM adoption in the region must be contextualized to the needs of small-scale construction, where efficiency, cost management, and streamlined documentation are paramount. Moreover, the absence of industrial projects highlights the limited exposure of local firms to complex BIM applications, reinforcing the need for capacity-building initiatives that gradually introduce advanced BIM practices aligned with the scale and scope of their operations.

**Current Level of BIM Awareness and Knowledge in Selected Bataan Firms.** The results in Table 5 indicate that firms are moderately familiar with BIM (mean = 2.86), yet adoption remains in its early stages (mean = 1.81), with usage reported as rare (mean = 2.26). This disparity highlights a critical gap between awareness and practical application. While knowledge of BIM exists, firms lack structured implementation strategies, suggesting that familiarity alone does not guarantee integration into workflows without organizational commitment and resource investment.

**Table 5**
*Respondent's Assessment of the Level of BIM Awareness and Knowledge of the Firm in Terms of Adoption Rate*

| Familiarity | Mean | Verbal Interpretation |
|---|---|---|
| How familiar is your firm with Building Information Modeling (BIM)? | 2.86 | Moderately Familiar |
| *Legend: "Not Familiar (1.00 – 1.50)," "Somewhat Familiar (1.51 – 2.50)," "Moderately Familiar (2.51 – 3.50)," "Very Familiar (3.51 – 4.50)," "Expert Level (4.51 – 5.00)."* | | |
| Adoption Rate | Mean | Verbal Interpretation |
| What is the current adoption rate of BIM in your firm? | 1.81 | Early Stages in Adoption |
| *Legend: "Not Adopted (1.00 – 1.50)," "Early Stages in Adoption (1.51 – 2.50)," "Partially Implementing BIM (2.51 – 3.50)," "Fully Implementing BIM (3.51 – 4.00)."* | | |
| Frequency of Use | Mean | Verbal Interpretation |
| If your firm has implemented BIM, how frequently is it used in projects? | 2.26 | Rarely |
| *Legend: "Not Applicable (1.00 – 1.50)", "Rarely (1.51 – 2.50)", "Occasionally (2.51 – 3.50)", "Often (3.51 – 4.00)", and "Always (4.51 – 5.00)".* | | |

**Table 6**
*Frequency and Percentage Distribution of the Implementation Strategies Followed by the Respondent's Firm*

| Implementation Strategies | Frequency | Percentage (%) |
|---|---|---|
| Conducting BIM training and workshops | 26 | 33.3 |
| Hiring BIM-skilled professionals | 16 | 20.5 |
| Investing in BIM software and technology | 13 | 16.7 |
| Partnering with BIM consultants | 5 | 6.4 |
| Establishing BIM guidelines | 10 | 12.8 |
| Others | 29 | 37.2 |

While the most common strategies adopted by firms (Table 6) include conducting BIM training and workshops (33.3%) and hiring BIM-skilled professionals (20.5%). Investment in BIM software and technology (16.7%) and establishing guidelines (12.8%) are less frequent, while 37.2% reported other approaches. This distribution suggests that firms prioritize human capital development over technological investment, reflecting resource constraints. The reliance on training underscores the importance of capacity-building as a precursor to sustainable BIM adoption.

**Table 7**
*Frequency and Percentage Distribution of the Method of BIM Training Provided by the Respondent's Firm*

| Method of BIM Training | Frequency | Percentage (%) |
|---|---|---|
| On-the-job training/learning by doing | 29 | 37.2 |
| External training or certification process | 14 | 17.9 |
| In-house training program | 14 | 17.9 |
| No formal training provided | 9 | 11.5 |
| Others | 29 | 37.2 |

In Table 7, on-the-job training (37.2%) emerged as the dominant method, followed by external certification (17.9%) and in-house programs (17.9%). Notably, 11.5% of firms provided no formal training, while 37.2% reported other approaches. The prevalence of experiential learning indicates a pragmatic reliance on informal skill acquisition rather than structured programs. This reliance may limit the depth of BIM expertise, underscoring the need for standardized training frameworks to ensure consistent competency across firms.

**Table 8**
*Frequency and Percentage Distribution of the Perceived Benefits of BIM to the Respondent's Firm*

| Perceived Benefits | Frequency | Percentage (%) |
|---|---|---|
| Positive impact on cost reduction | 46 | 59.0 |
| Positive impact on time management | 49 | 62.8 |
| Positive impact on quality control | 34 | 43.6 |
| Negative impact on cost | 0 | 0.0 |
| Negative impact on time management | 1 | 1.3 |
| Negative impact on quality control | 3 | 3.8 |
| No significant impact | 18 | 23.1 |

Respondents overwhelmingly perceived BIM as beneficial, particularly in time management (62.8%) and cost reduction (59.0%), with 43.6% citing improvements in quality control. This evident in the data presented in Table 8. Negative impacts were minimal, and 23.1% reported no significant effect.

These findings suggest that firms recognize BIM's potential to enhance efficiency and project outcomes. The strong positive perception provides a favorable environment for adoption, though translating these perceived benefits into consistent practice remains a challenge.

**Table 9**
*Frequency and Percentage Distribution of the Benefits Experienced by the Respondents' Firms by Adoption of BIM*

| Benefits Experienced | Frequency | Percentage (%) |
|---|---|---|
| Improved project delivery time | 31 | 39.7 |
| Enhanced design accuracy | 32 | 41.0 |
| Better collaboration between teams | 23 | 29.5 |
| Reduced errors and rework | 23 | 29.5 |
| Others | 2 | 2.6 |
| No BIM experience | 35 | 44.9 |

Among the firms with BIM experience, as presented in Table 9, enhanced design accuracy (41.0%) and improved project delivery time (39.7%) were the most frequently cited benefits, followed by better collaboration and reduced errors (29.5% each).

However, 44.9% of respondents reported no BIM experience, highlighting limited exposure to its advantages. This suggests that while BIM demonstrates tangible benefits, its diffusion across firms remains uneven, necessitating broader adoption initiatives to ensure industry-wide gains in efficiency and quality.

**Barriers and Challenges Faced in Implementing BIM in Selected Bataan Firms.** In Table 10, respondents assessed financial barriers to BIM adoption as a moderate challenge (mean = 2.72). This suggests that while firms recognize cost as a limiting factor, it is not insurmountable. Financial considerations remain central to adoption decisions, particularly for resource-constrained small enterprises.

**Table 10**
*Respondent's Assessment on the Barriers and Challenges in the Implementation of BIM in Terms of Financial Constraints*

| Financial Constraint | Mean | Verbal Interpretation |
|---|---|---|
| How much of a financial barrier does BIM adoption present to your firm? | **2.72** | Moderate Barrier |

*Legend: "Not a Barrier (1.00 – 1.50)," "Minor Barrier (1.51 – 2.50)," "Moderate Barrier (2.51 – 3.50)," "Major Barrier (3.51 – 4.50)," "Critical Barrier (4.51 – 5.00)."*

**Table 11**
*Frequency and Percentage Distribution of Financial Challenges Preventing Full Adoption of BIM*

| Benefits Experienced | Frequency | Percentage (%) |
|---|---|---|
| High cost of BIM software | 64 | 82.1 |
| High cost of hardware upgrade | 37 | 47.4 |
| Expensive training programs for employees | 32 | 41.0 |
| Additional cost for hiring BIM specialists | 34 | 43.6 |
| Others | 3 | 3.8 |

The high cost of BIM software (82.1%) emerged as the most significant barrier presented in Table 11, followed by hardware upgrades (47.4%), training programs (41.0%), and hiring specialists (43.6%). These findings highlight the cumulative financial burden firms face, underscoring the need for cost-effective solutions to support wider BIM adoption.

**Table 12**
*Frequency and Percentage Distribution of the Financial Support to Encourage the Respondent's Firm to Adopt BIM*

| Financial Support | Frequency | Percentage (%) |
|---|---|---|
| Lower-cost BIM software options | 67 | 85.9 |
| More affordable BIM training programs | 60 | 76.9 |
| Others | 0 | 0.0 |

Respondents strongly favored lower-cost BIM software (85.9%) and affordable training programs (76.9%) as key incentives for adoption (Table 12). This indicates that firms prioritize reducing upfront costs and training expenses over other forms of support, emphasizing affordability as a critical enabler of BIM integration.

**Table 13**
*Respondent's Assessment of the Overall BIM Skill Level*

| Skill Level | Mean | Verbal Interpretation |
|---|---|---|
| How would you assess your firm's overall BIM skill level? | 2.21 | Basic Understanding of BIM Concepts |

*Legend: "No Knowledge of BIM (1.00 – 1.50)," "Basic Understanding of BIM Concepts (1.51 – 2.50)," "Moderate Knowledge with Limited Application (2.51 – 3.50)," "Advanced Knowledge with Regular BIM Usage (3.51 – 4.50)," "Expert-Level BIM Implementation (4.51 – 5.00)."*

The mean score of 2.21 in Table 13 indicates that firms generally possess only a basic understanding of BIM concepts. This limited skill base constrains effective implementation, suggesting that knowledge gaps remain a significant barrier to advancing BIM maturity within the local construction sector.

**Table 14**
*Frequency and Percentage Distribution of the Skill-Related Challenges Respondent's Firm Face in BIM Adoption*

| Skill-Related Challenges | Frequency | Percentage (%) |
|---|---|---|
| Lack of employees trained in BIM software | 37 | 47.4 |
| No internal BIM training programs | 25 | 32.1 |
| Limited access to BIM training or certification programs | 21 | 26.9 |
| Difficulty in hiring experienced BIM professionals | 11 | 14.1 |
| Others | 3 | 3.8 |

The most pressing challenge, as indicated in Table 14, is the lack of employees trained in BIM software (47.4%), followed by absence of internal training programs (32.1%) and limited access to certification opportunities (26.9%). These findings highlight systemic skill shortages that hinder firms' ability to integrate BIM effectively.

**Table 15**
*Frequency and Percentage Distribution of the Measures Needed to Bridge the BIM Skill Gap in the Respondent's Firm*

| Measures Needed | Frequency | Percentage (%) |
|---|---|---|
| Company-sponsored BIM training programs | 59 | 75.6 |
| University/Technical school partnership for BIM education | 54 | 69.2 |
| Hiring external BIM consultants | 25 | 32.1 |
| Others | 1 | 1.3 |

The data in Table 15 reveals that respondents emphasized company-sponsored training (75.6%) and partnerships with universities or technical schools (69.2%) as the most effective measures. This underscores the importance of institutional collaboration and long-term capacity-building, rather than reliance on external consultants, to strengthen BIM expertise.

**Table 16**
*Respondent's Assessment of the Resistance to BIM Adoption in Their Firm*

| Resistance to BIM Adoption | Mean | Verbal Interpretation |
|---|---|---|
| How would you describe the level of resistance to BIM adoption in your firm? | 2.27 | Minimal Resistance |

*Legend: "No Resistance (1.00 – 1.50)," "Minimal Resistance (1.51 – 2.50)," "Moderate Resistance (2.51 – 3.50)," "High Resistance (3.51 – 4.00)."*

Resistance was rated minimal (mean = 2.27), as shown in Table 16, suggesting that firms are generally open to technological change. This finding indicates that barriers to BIM adoption are more structural than attitudinal, with limited cultural opposition to digital transformation.

In Table 17, preference for traditional 2D drafting (53.8%) and lack of management support (43.6%) were the primary sources of resistance, followed by lack of confidence in new technology (33.3%). These factors reveal entrenched practices and leadership hesitancy as key obstacles to BIM adoption.

**Table 17**
*Frequency and Percentage Distribution of the Primary Reasons for Resistance to BIM in the Respondent's Firm*

| Measures | Frequency | Percentage (%) |
|---|---|---|
| Preference for traditional 2D drafting methods | 42 | 53.8 |
| Lack of confidence in new technology | 26 | 33.3 |
| Lack of management support for BIM implementation | 34 | 43.6 |
| Others | 9 | 11.5 |

**Table 18**
*Frequency and Percentage Distribution of the Strategies that Would Overcome Resistance to BIM Implementation in the Respondent's Firm*

| Strategies | Frequency | Percentage (%) |
|---|---|---|
| Step-by-step implementation rather than sudden transition | 69 | 88.5 |
| Case studies from firms successfully using BIM | 26 | 33.3 |
| Hiring external BIM consultants | 19 | 24.4 |
| Providing hands-on training and workshops for employees | 38 | 48.7 |
| Collaboration with universities and professional organizations for training | 35 | 44.9 |
| Offering incentives for employees who complete BIM training | 15 | 19.2 |
| Conducting an awareness campaign on BIM benefits | 17 | 21.8 |
| Others | 0 | 0.0 |

Step-by-step implementation (88.5%) was identified as the most effective strategy (Table 18), complemented by hands-on training (48.7%) and collaboration with universities (44.9%). These approaches highlight the importance of gradual transition and capacity-building initiatives to foster acceptance and reduce resistance to BIM integration.

**Strategic BIM Implementation Plan to Support Adoption, Address Challenges, and Enhance Project Efficiency.** The proposed BIM implementation plan in this study adopts a phased strategic framework intended to guide firms from initial awareness toward consistent BIM utilization. This approach directly addresses findings that firms demonstrate moderate awareness yet encounter substantial financial barriers, particularly software and training costs. The plan emphasizes incremental adaptation rather than immediate full-scale implementation. Standardized pilot-based learning is recommended to align with emerging BIM policies and LGU readiness. This strategic design ensures feasibility for resource-limited firms while positioning them for sustainable long-term BIM maturity.

**Phased BIM Implementation Plan.** The proposed phased BIM implementation plan provides a structured roadmap for guiding firms from initial awareness to institutional integration. Table 19 emphasizes organizational readiness through orientation seminars and case studies to reduce resistance. Table 20 highlights human capital development via company-sponsored training and academic partnerships. Table 21 advances pilot implementation on small projects to demonstrate tangible benefits. Table 22 focuses on internal standardization, ensuring consistency through LOD targets and templates. Finally, Table 23 underscores institutional alignment with LGUs and ISO 19650, positioning firms for regulatory compliance and sustainable BIM maturity within the Philippine construction sector.

**Table 19**
*Phase 1: BIM Awareness and Organizational Readiness*

| Aspect | Description |
|---|---|
| Strategic Focus | The organizational alignment and readiness |
| Key Issues Addressed | Firms with moderate awareness and preference for 2D drafting |
| Key Actions | To conduct BIM orientation seminars for firm owners and their staff. Also, present case studies showing cost, time, and quality benefits of the BIM |
| Responsible Parties | The firm owners and architects, professional organizations like UAP and other BIM Team Organizations |
| Expected Outputs | To reduce the resistance of firms to BIM adoption, |
| Timeframe | Short-term (0–3 months) |

**Table 20**
*Phase 2: Skills Development*

| Aspect | Description |
|---|---|
| Strategic Focus | Human capital development |
| Key Issues Addressed | Firms with basic BIM skill level and a lack of trained personnel |
| Key Actions | A company-sponsored BIM training program and on-the-job BIM learning using real projects. Furthermore, partnerships with other universities and training institutions to introduce BIM concepts and workflows. |
| Responsible Parties | Firms, academics, universities, and training providers |
| Expected Outputs | To improve BIM competency |
| Timeframe | Short- to mid-term (3–9 months) |

**Table 21**
*Phase 3: Pilot BIM Implementation*

| Aspect | Description |
|---|---|
| Strategic Focus | Controlled application of BIM |
| Key Issues Addressed | Companies in the early-stage adoption of BIM with limited experience |
| Key Actions | Select small residential projects and apply BIM for 3D modeling. From this, it will evaluate the impacts on time, cost, and quality. |
| Responsible Parties | Project teams in selected firms |
| Expected Outputs | Demonstrated BIM benefits and reduced modeling errors and rework |
| Timeframe | Mid-term (6–12 months) |

**Table 22**
*Phase 4: Internal BIM Standardization*

| Aspect | Description |
|---|---|
| Strategic Focus | The process of consistency and quality control |
| Key Issues Addressed | Because of Lack of internal BIM guidelines |
| Key Actions | To establish minimum Level of Development (LOD) targets and standardize templates and naming conventions |
| Responsible Parties | The firm's management and BIM coordinators |
| Expected Outputs | Consistent BIM delivery and improved collaboration and coordination |
| Timeframe | Mid- to long-term (9–15 months) |

**Table 23**
*Phase 5: Integration with LGUs*

| Aspect | Description |
|---|---|
| Strategic Focus | Institutional alignment |
| Key Issues Addressed | The absence of national BIM standards and LGU mandates |
| Key Actions | To coordinate with LGUs on BIM-ready submission and align internal practices with ISO 19650 concepts and participate in professional BIM initiatives |
| Responsible Parties | Firms, Professionals, and LGU's |
| Expected Outputs | BIM-ready firms and improved regulatory coordination |
| Timeframe | Long-term (12–24 months) |

## DISCUSSION

The findings reveal that the majority of respondents were within the 26–45 age bracket, representing a relatively young to middle-aged demographic more receptive to digital technologies, consistent with Saka and Chan (2023). Female respondents comprised the majority, underscoring the growing participation of women in provincial architectural and construction firms. Most surveyed firms were small in scale, with more than half employing between one and five personnel, reflecting the SME profile common in developing regions (Chileshe et al., 2022). Project types were predominantly residential and commercial, with limited institutional involvement and no industrial projects, aligning with Dimaculangan (2023). This dominance of small-scale, fast-turnaround projects helps explain the cautious approach toward BIM adoption, as firms may perceive limited immediate returns from advanced applications.

Although firms demonstrated moderate familiarity with BIM, adoption and consistent use remained at an early stage. This gap between awareness and implementation mirrors Rodriguez et al. (2019), who noted that Philippine firms recognize BIM's potential but hesitate to integrate it fully. Even among adopters, usage was infrequent, often limited to specific projects rather than organization-wide standards. The Technology Acceptance Model (TAM) provides a theoretical lens: while perceived usefulness (PU) of BIM is acknowledged—particularly in time management, cost control, and quality assurance—perceived ease of use (PEOU) remains low. Technical complexity, training requirements, and workflow compatibility hinder adoption, echoing Vitente et al. (2024). Benefits such as improved project delivery and design accuracy were reported, yet reliance on informal training methods constrains comprehensive rollout, highlighting the gap between conceptual awareness and organizational integration.

Barriers to BIM adoption were primarily financial, with high costs of software, hardware upgrades, and employee training posing significant challenges, consistent with Alreshidi (2019) and Zhang and Gao (2021). Firms often relied on traditional CAD tools to minimize costs, though respondents overwhelmingly perceived BIM's benefits positively, particularly in time management and coordination. Resistance to change, especially among senior personnel accustomed to conventional practices, remains a secondary barrier, as noted by Ahmed (2022) and Thompson and Bryant (2023). These findings suggest that phased adoption strategies, targeted training, and pilot projects are essential to improve ease of use and normalize BIM workflows. Furthermore, industry organizations and local government units can play a critical role by offering subsidized training, shared resources, and clearer guidelines, thereby bridging the gap between awareness and full implementation in provincial SMEs.

**Conclusions.** The study reveals that respondents were largely young professionals working in small firms, primarily engaged in residential and commercial projects. This demographic profile suggests openness to digital technologies, yet findings highlight a clear disparity between recognition of BIM's strategic advantages and its actual operationalization. While awareness of BIM's benefits in cost, time, and quality management is evident, adoption remains constrained by financial limitations, skill gaps, and reliance on traditional practices. High software costs, hardware upgrades, and training expenses emerged as primary deterrents, consistent with challenges faced by SMEs in developing contexts. Despite these barriers, respondents expressed overwhelmingly positive perceptions of BIM, indicating that once initial constraints are addressed, firms are likely to experience tangible improvements in project efficiency and collaboration. Overall, BIM adoption in Bataan is gradually improving in terms of technical readiness, but skill development remains the most pressing challenge requiring targeted interventions.

**Recommendations.** To advance BIM maturity, firms should adopt phased implementation strategies that begin with basic modeling and coordination tools, supported by pilot projects to demonstrate tangible benefits. Negotiating flexible licensing arrangements, utilizing educational or trial versions, and collaborating with firms already using BIM can help mitigate high software costs. Industry organizations should facilitate shared resources and subsidized training programs to reduce financial burdens and promote sustainable adoption. Strengthening human capital through internal training programs, partnerships with universities, and structured certification initiatives is essential to address skill gaps. Firms are further encouraged to adopt gradual transition plans, supported by awareness campaigns and incentives, to reduce resistance and normalize BIM workflows. Local government units (LGUs) can play a pivotal role by establishing BIM readiness guidelines, designating focal persons, and integrating BIM and Level of Detail (LOD) awareness into long-term policy frameworks, including continuing professional development (CPD) requirements. Collectively, these measures will bridge the gap between awareness and implementation, ensuring that small and medium-sized firms in provincial contexts achieve sustainable BIM integration and improved project efficiency.

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