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BIM Awareness Assessment among Hydropower Professionals in Nepal

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Abstract: Building Information Modelling (BIM) has evolved into a comprehensive, collaborative method in construction project delivery. Most industrialized and developed countries have made BIM mandatory in the government and public projects, whereas developing countries are embracing and catching up BIM technologies to improve their professional's abilities and reduce claims in the construction projects. However, BIM awareness and professional's competence have become critical in implementing BIM in infrastructure projects in Nepal, particularly hydropower projects. The objectives of this study are to find the BIM awareness among hydropower professionals in Nepal and assess their response. The study used a questionnaire survey to assess the awareness. The results showed that only few professionals (12 percentage in this study) are aware of BIM and its application in Hydropower infrastructures. Majority of the respondents (more than 50%) were interested in BIM trainings and believed BIM implementation in future projects. The study indicated that lack of BIM training and lack of BIM awareness were the top factors affecting BIM implementation in hydropower projects in Nepal. The findings showed that about 66 percent of the respondents who used BIM in their projects mainly used during construction phase. More than 80 percent believed that BIM should be mandated for the hydropower projects in Nepal. The findings presented in this study could promote awareness among different professionals, organization, and construction team and encourage BIM implementation in Hydropower projects. The findings could raise awareness of BIM in Nepal's infrastructure sectors and its invaluable benefits in construction.

Key words: Awareness, BIM, Developed Country, Developing Country, Hydropower

1. INTRODUCTION

Building Information Modelling (BIM) is evolving as a novel approach, an advanced information technology tool, or a collaborative digital platform for digitally designing, managing, and integrating the roles of all project stakeholders. BIM is relatively an innovation in infrastructure projects that assists the traditional methods of designing, constructing, and operating. The goal of the BIM approach highlights a need to be able to examine and retrieve information about the construction project digitally from a single-source model [1]. The extent to which BIM is being used around the world, particularly in industrialized countries, is well documented. In developed countries, BIM adoption and utilization have been aggressively advocated and implemented. Smith [2] emphasizes that the report prepared by McGraw Hill [3] has been following BIM adoption in the construction sector through a global survey since 2007, and their survey results demonstration indicating that BIM adoption has changed the construction industries considerably in North America since 2007.

Developing countries are aware of the BIM wave of progress and the technology's gradual development. The developing countries in the Middle East region is rapidly adopting BIM to manage the design and construction phases of large and complex projects, since it provides a framework for communication among various disciplines and stakeholders [4]. In contrast, Ismail, Chiozzi, and Drogemuller [5] finds that most of the developing nations in Asia have a low degree of BIM implementation in their areas, however the benefits of adopting BIM have been acknowledged so far.

Nepal, one of the Asia's developing countries, lacks awareness or implementation of BIM in Architecture, Engineering, and Construction (AEC) sectors. One of the flourishing AEC sectors with both domestic and foreign investments in Nepal is the hydropower infrastructure due to an abundant amount of water resources available in the country and the high variation of elevation [6]. In fact, Nepal is considered as one of the richest countries in the world in terms of water resources [7]. With the decade-long peace and constitutional process established, the Government of Nepal is keen to accelerate economic growth and become a middle-income country by 2030. The lack of adequate electricity was a barrier to higher economic growth. That's why, at present time, Nepal's vast hydropower potential creates an opportunity for the country to earn revenues by exporting power to the South Asia region and will pay significant economic dividends [8]. The domestic as well as foreign financial sectors are continuing to take the lead in the development of hydropower projects with the involvement of international contractors and consultants. Apparently, most of the engineering professionals are involved in this sector as Nepal has seen hydropower infrastructure development at a rapid pace. These hydropower projects, however, are experiencing delays and cost overruns due to various reasons such as lack of adequate coordination and collaboration amongst them. Since BIM technologies have been used worldwide as a new construction technology trend in assisting constructors and minimising the cost of conflicts during the construction phases, this paper focuses on identifying and assessing the awareness of BIM uses in hydropower projects in Nepal.

2. LITERATURE REVIEW

Solid modelling applications first appeared in the 1970s and 1980s, while the notion of BIM can be traced back to the early days of computing in the 1960s. Many consider the invention of the ArchiCAD software program in Hungary in 1982 to be the true start of BIM, while the introduction of the Revit software program in 2000 marked a significant move toward effective BIM deployment [9]. Even though BIM deployment and adoption in the construction industry has been delayed for the past two decades, BIM technology and adoption in later stages provide major benefits for the industry [10]. Succar [11,12] iterates that BIM generates concurrent evolutionary and revolutionary changes at multiple scales within the organizational hierarchy, ranging from individuals and groups to organizations and project teams, and finally industries and entire markets.

Gu and London [13] believe that BIM has piqued the interest of academics and, as a result, the literature during the last decade. Most publications on BIM adoption, according to Bui, Merschbrock, and Munkvold [14], come from vendors of BIM packages, guidelines, and official institution reports, and there are just a few examples of adoption in real projects. According to a report issued by McGraw Hill [3], BIM adoption has been led by nations such as the United States, the United Kingdom, Germany, Canada, and France, while relative new adopters like as Australia, Brazil, Japan, Korea, and New Zealand are rapidly gaining pace and even exceeding the more established countries in certain areas.

Smith [2] investigated global BIM adoption trends as well as detailed implementation strategies created in international locations such as North America, Scandinavia, the United Kingdom, Singapore, China, Hong Kong, and Australia. According to his research, North America, the United Kingdom, and the Scandavian region are leading the way in BIM adoption. In addition, his research highlights the importance of BIM education, training, and establishing the business case for BIM deployment. Charef et al. [15] examine the differences in BIM adoption between 28 EU nations and the challenges to BIM implementation. According to the findings, 25% of Europe has mandated BIM, 25% has planned to mandate BIM, and nearly a quarter of Europe has no plan in place for BIM implementation. It demonstrates that there is a significant disparity between early adopters, late adopters, and very late adopters even in Europe.

With the popularity of BIM in the building industry, governments in developed countries have been enacting necessary rules. Since BIM has become widely accepted in the construction sector, researchers have focused on how it is used in developed countries and how it is comprehended in developing countries, resulting in a body of literature. Based on case studies in Malaysia and Sri Lanka, Lim et al. [16] conducted study into the philosophies, applications, and trends of BIM for improved adoption in developing countries. The study was recognized as one of the earliest studies on BIM scenarios in developing countries. Similarly, Bui, Merschbrock, and Munkvold [17] provided an overview of BIM research in emerging nations, with work focused on China, India, and Malaysia. They find out that limited attention is given to BIM implementation in infrastructure projects. Gerges et al. [18] investigate the status of BIM in the Middle East region by examining the extent of BIM adoption among AEC stakeholders in that region. The research reveals that BIM implementation and adoption has gradually increased in the Middle East, with the United Arab Emirates having the most BIM projects and Lebanon and Jordan having the fewest BIM projects.

Further, Ismail, Chiozzi, and Drogemuller [5] examine BIM adoption and constraints in Asian emerging countries, including China, India, Indonesia, Malaysia, Mongolia, Myanmar, Pakistan, Sri Lanka, Thailand, and Vietnam. Although most developing countries in Asia noted the low level of BIM adoption in their individual regions, the study concluded that the technology's benefits have also been recognized. More importantly, the barriers to implementing BIM must be addressed if its potential need to be effectively utilized to enhance the low level of its use. Diverse Asian countries have taken both diverse and similar ways to improving the use of BIM technology in their respective regions.

3. METHODOLOGY

Several research have been published in the awareness and implication of BIM in different regions and country around the globe. However, the authors are unaware of any research published in awareness of BIM in Nepal. To acknowledge the generic view of the BIM awareness and competence of engineering professional involved in hydropower project in Nepal, survey approach was selected. Survey is a system of data collection with the purpose to describe, compare and explain knowledge, attitude, and behaviour of a specific group of individuals [19]. The survey enabled exploration of any associations between BIM competencies possessed by professionals who work in hydropower projects. An online questionnaire (hosted by Qualtrics Texas State University) was designed for conducting the survey. The questionnaire was structured into two sections: first section related with the demographic information of the professionals; and second section related with the awareness with the BIM. The second section is further sub-divided to acknowledge the different perspective view from experienced professionals who were aware with BIM and professionals who are unaware of BIM.

The researcher selected professionals from the hydropower sector for survey administration. A questionnaire weblink (Qualtrics) was distributed through Email and LinkedIn with request note to 90 professionals.

4. RESULTS

The survey's findings are presented as descriptive statistics on demographic responses and the BIM awareness responses. The researcher received 68 responses out of 90 surveys sent, of which 58 responses were complete and used in this study for data analysis and outcomes.

4.1.Section 1: Demographic responses

Among the valid responses, 51.72 percent of respondents (30) were involved in the owner's organization, 41.38 percent (24) were involved in engineering consulting firm, and 6.90 percent (4) were professionals who worked for contractors. Table 1 shows the participant's years of experience in construction project and years of experience in hydropower projects. The result shows that 43.1 percent of respondents had more than 10 years of experience in hydropower projects, 31.03 percent had 5 to 10 years of experience, and 25.86 percent had less than 5 years of experience. Most respondents (91%) were either unaware of BIM or had no experience with it whereas only 9 percent of respondents had knowledge about BIM and had implemented BIM in their hydropower projects.

Table 9. Years of Experience among Professionals

S.N.	Years of Experience	Construction Projects (%)	Hydropower Projects (%)
1	Less than 5 years	18.97	25.86
2	5-10 years	34.48	31.03
3	10 years and above	46.55	43.10

4.2.Section 2: BIM awareness responses

4.2.1.Professionals who were unaware with BIM

As discussed in methodology different questionnaire were prepared for experienced professionals who were unaware with BIM and professionals who were aware with BIM. This section mainly presents about the professional who were unaware of the BIM. Respondents, who had never heard of BIM were inquired if they would be ready to take part in any BIM-related training and implement in future projects. Table 2 shows that 55 % of the respondents, who were not aware of the BIM, showed willingness to participate in BIM training, whereas 20.41% of respondents were undecided about whether to engage in the training or not. About quarter of the respondents (24.49%) thought that they would like to participate sometime in the future but no rush. Similarly, the respondents who had no prior BIM knowledge were given short infographics outlining the benefits of BIM and its features. Then they were inquired about the frequency of its adoption in future projects. Table 2 shows that one-fourth of respondents (24.49%) were unsure about BIM implementation in future projects. However, more than half (53.06%) of the respondents believed the possibility of implementation of BIM in future projects.

Table 2. Participant's response to BIM training and its implementation in future projects

S.N.	Frequency	Willingness to Participate in BIM Training (%)	Implementation in Future Projects (%)
1	Always	55.10	53.06
3	May Be	20.41	24.49
2	Sometimes	24.49	22.45
4	Never	0.00	0.00

4.2.2.Professionals who were aware with BIM

The respondents, who have prior experience of BIM, were inquired about their years of experience in BIM. The years of experience level were divided into two years differences such as

0 to 2 years, 2 to 4 years, and 4 to 6 years as shown in Table 3. Table 3 shows professional's duration of involvement in project by implementing BIM. For example, 20 percent had more than 6 years of experience, 40 percent had 4 to 6 years of experience, whereas 40 percent had less than 2 years of experience. The result shows more than 50 percent of respondent had implemented BIM for more than four years.

Table 3. Years of BIM Implementation

S.N.	Years	Percentage
1	less than 2 years	40
2	2-4 years	0
3	4-6 years	40
4	More than 6 years	20

Similarly, respondents were inquired about phases of project where they have implemented BIM. The questionnaire was divided into design phase, construction phase, and operation and maintenance phase. Table 4 shows the percentage of phases when they implemented BIM such as about sixty six percent of the respondent said they implemented BIM in construction phase whereas 33 percent said they implemented BIM during the design phase. There was no response for the operation and maintenance phase.

Table 4. BIM Implemented Phases in Projects

S.N.	Phases	Percentage
1	Design phase	33.33
2	Construction phase	66.67
3	Operation and maintenance phase	0

Respondent were also asked about how important it is to mandate BIM in hydropower project. Table 5 shows that 80 percent of respondent chose it was very important to mandate BIM in hydropower project in Nepal whereas 20 percent of respondent chose it was extremely important. Table 5 indicates every respondent were positive towards mandating BIM in Hydropower project in Nepal.

Table 5. Importance of Mandating BIM in hydropower Projects in Nepal

S.N.	Significance	Percentage
1	Not at all important	0
2	Moderately important	0
3	Very important	80
4	Extremely important	20

5. ANALYSIS AND DISCUSSION

The responses from those, who had experience with BIM regarding benefits and challenges behind the adoption of BIM, could provide great impact for further research. Hence, those respondents who had experience with BIM knowledge were inquired about the factors affecting the implementation of BIM in hydropower projects of Nepal. The factors were assessed on a four-point Likert scale of 1 to 4, a weight of 1 for "strongly disagree", 2 for "disagree", 3 for "agree" and 4 for “strongly agree”. The frequencies of each factors affecting BIM implementation are tabulated in Table 6. The Relative Important Index (RII) based on the formula shown in equation (1) [20,21] is used to determine the relative ranking.

$$RII = \frac{\sum W}{AN} \tag{1}$$

Table 6. Factors affecting BIM implementation in Hydropower Projects of Nepal

Factors Affecting BIM	Frequency				Overall	
	1	2	3	4	RII	Rank
Lack of BIM training	0	0	1	4	0.95	1
Lack of BIM awareness	0	0	2	3	0.9	2*
Lack of national standard, procedure, and guidelines	0	0	2	3	0.9	2*
Lack of guidance on BIM implementation and utilization	0	0	3	2	0.85	4
Resistance to adopt new technology (BIM)	0	1	2	2	0.8	5*
Perception of BIM: a difficult tool to learn	0	1	2	2	0.8	5*
High cost towards BIM application (Technology cost and training cost)	0	2	2	1	0.7	7
Lack of trust towards new technology	2	1	1	1	0.55	8

Note: * represent the co-rank

Where W is the weight given to each factor by the respondent on 1 to 4 scale, A is the highest weight, 4 in the study and N is the total number of samples. The RII ranges from 0 to 1, closer to 1 being the significant [20]. RII value is calculated for the challenges to Implement BIM. For example, 0 respondents strongly disagreed the lack of BIM training, 0 disagreed, 1 agreed, and 4 strongly agreed. Therefore, the RII for the factor is = (0x1+0x2+1x3+4x4) / 4x5) = 0.95. Table 6 shows factor affecting BIM implementation in hydropower projects in Nepal, response frequency, relative important index, and their rank. RII was calculated for each factor and ranked from 1 to 8, 1 as the top ranking. The analysis show that the lack of BIM training was the top factor. Due to the same response result “lack of BIM awareness” and “lack of national standard, procedure, and guidelines” shared co-rank of second top factor. Similarly, ”resistance to adopt new technology (BIM)” and “perception of BIM: a difficult tool to learn” shared co-rank of fifth position. Factors such as “high cost towards BIM application (technology cost and training cost)” and “lack of trust towards new technology” were ranked the least and showed they were not the major factor affecting the implementation of BIM in hydropower projects in Nepal.

6. CONCLUSIONS AND RECOMMENDATIONS

This study assessed the awareness and experience of BIM with those professionals who had been involved in hydropower projects of Nepal. The survey results clearly indicate that only few professionals (9 percentage in this study) are aware of BIM and its application in Hydropower infrastructures. Majority of the respondents (more than 50%) were willing to take trainings related with the BIM. Besides, more than 50 percent believed that they were interested in implementing BIM in future projects. The study also indicates that lack of BIM training and lack of BIM awareness were the top factors affecting BIM implementation in hydropower projects in Nepal. Similarly, the study also showed that the cost of BIM application (technology cost and training cost) and the lack of trust towards new technology were not the factors that affected in BIM implementation. The findings showed that about 66 percent of the respondents who used BIM in their projects mainly used during construction phase. More than 80 percent believed that BIM should be mandated for the hydropower projects in Nepal. These findings indicate that BIM awareness in Nepal is increasing and the professionals who are working in the hydropower projects believe that BIM should be mandatory in hydropower projects in Nepal. The findings presented in this study could promote awareness among different professionals, organization, and construction team and encourage BIM implementation in Hydropower projects. This study highlighted the necessity of more BIM awareness in hydropower projects in Nepal. The study findings recommend policy makers and vendors to increase more BIM tools and its usage in Hydropower projects that could benefit the professionals in the hydropower industry in effective project management and reduce claims by taking advantage of the BIM usage. The limitations of this study are that the professionals surveyed are from Nepal and mainly involved in hydropower projects and therefore the findings from this study may not be generalized for other infrastructure projects. Moreover, although the paper highlighted that there is a need of BIM awareness among professionals who are working in Hydropower industry, the survey result from five professionals who are aware of BIM limits the findings on the factors affecting BIM implementation in hydropower projects in Nepal.

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