Barrier Analysis to Implement Building Information Modeling (BIM) Execution Plan in Sri Lankan Construction Industry

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Abstract: *Building Information Modeling (BIM) can bring the project team significant advantages. BIM can be used to improve the project's delivery and usage throughout its life cycle. The concept of BIM is currently being used in the construction industry worldwide. Currently, technologies such as 3D 4D 5D BIM are being used in the construction industry. And, lot of countries are using a BEP.*

A well-conceived BEP on your BIM-enabled project, make sure the advanced design technologies are successfully deployed. In contrast, the BEP focuses on improving work and model flow throughout the project to promoting specialized interests for each individual stakeholder. Currently, BEP In light of the benefits BEP offers, it is practiced all over the world, but due to numerous obstacles, it is less common in Sri Lanka.

This study examined current BIM techniques in SL, BIM adoption in Sri Lanka, BIM awareness in the country's construction industry, how an execution plan can help with BIM implementation, The challenges to modifying an implementation strategy for the Sri Lankan construction industry, suggestions for overcome the identified barriers.

Through this study, suggestions for removing the identified barriers are also acknowledged. Less understanding of the idea and its advantages, government support for traditional practices documentation approach and problems in lack of knowledge were identified as foremost barriers for successful implementation o were determined to be the main obstacles to the successful implementation of BEP. Additionally, findings suggested that Sri Lankans must undergo cultural changes BIM practices, difficulties, and raising awareness among those involved in the construction industry.

Keywords: *BIM, BEP, SRI LANKA*

1. Introduction

The growth of the nation's economy is significantly influenced by the construction sector. The industry is currently facing a number of difficulties that have an impact on project goals and steady growth (Holmes & Troy, 2022). According to the Rameezdeen (2006), Sri Lanka's construction industry creates a wide range of goods, from single homes to significant infrastructures like roads, power plants, and petrochemical complexes.

Nayanthara De Silva (2008), stated that the main issues in Sri Lanka were the varying workload in the construction industry, unfair competition from foreign contractors, skills drain, shortages, and the high cost of skill development.

Raufdeen Rameezdeen (2002), has analyzed because of its extensive nature, involvement of a large number of stakeholders, and complex newer projects, contractual relationships distribution of responsibilities and authorities between parties, scope of assigned duties, and uniqueness of the construction products, the construction industry gradually becomes more complex. Therefore, implementing cutting-edge

software like BIM has many advantages for a construction project.

Hence, adopting an advance software like BIM gives many benefits to a construction project. BIM provides a common data environment for all the participants to exchange their data. The paradigm that will help create a shared working space for all stakeholders is revolutionary. (Epasinghe, Jayasena, Kolugala, & Wijewickrama, 2018). In addition, benefits of BIM include cost and resource savings, increased efficiency and shorter project lifecycles, improved communications, more opportunities for prefabrication and modular construction, and higher quality results (Reyes, et al., 2020).

But it's important to comprehend the state of BIM roles now and what the sector's needs will be in the future. There may be barriers in the construction industries that need to be identified and removed before BIM can be implemented. Cost, law, experts, interoperability, awareness, culture, processes, management, demand, project scale, technology, skills, training, contract, and standard are some of the 15 categories of barriers. The study provides important information for future research to remove obstacles to BIM adoption. (Z. Sriyolja, 2021)

On your BIM-enabled project, the BIM Execution Plan (BEP) aims to create a fundamental framework for the successful application of advanced design technologies. The BEP focuses on streamlining work and model flow throughout the project as opposed to siloed interest optimization. (GERCEK, TOKDEMIR, ILAL, & GUNAYDIN, 2017). In addition, Kelly (2016), stated that BEP benefits such as Communications, Collaboration, saving time Sharing data and stronger execution. Thus, in light of the advantages BEP offers, it is used widely around the world, whereas Sri Lanka uses it less frequently due to numerous obstacles.

The study presented here investigates the barriers of the implementation BEP in construction industry and the gravity of them.

The literature review investigates the barriers to implement the BIM and execution plan of BIM. Applicability of the suggestions to the Sri Lankan construction industry was analyzed.

2. Literature Review

A. Building Information Model (BIM)

In 1982, Autodesk was the first to introduce 2D computer aided design (2D CAD). Better documentation, accurate drafting, and time savings are all benefits of 2D CAD. BIM has an advantage over traditional CAD 2D models in that tasks associated with project planning, design, construction can all be successfully carried out using the BIM model (Anil Sawhney, 2017). Moreover, the collection, creation, and also exchange of shared structured data, 3D models and intelligent was also involved by BIM. Jian Li (2014) pointed out that pre-handling with BIM software further simplifies the clash detection process.

B. SL and global Level of BIM using

In the present BIM is using all across the globe. Jung and Lee (2015) pointed out, the global BIM uses among the nations that use BIM extensively on a global scale are the United States of America (USA), Canada, France, the United Kingdom (UK), Russia, Republic of Korea, the Philippines, Taiwan, Singapore, Taiwan, the Netherlands, Thailand, Saudi Arabia, Lebanon, Jordan, Iran, , India the United Arab Emirates (UAE), South Africa, Argentina, Mexico, Egypt, Italy, Qatar, Brazil, and Chile. And also, the governments in a few of the nations have taken the lead in implementing and growing BIM within their own national borders. University of Westminster (2019) explained that the implementation of BIM has received a prompt response from the UK construction sector. Since their customers might not be familiar with BIM, small and medium-sized businesses (SMEs) are less likely to have adopted it.

According to M.S. Siriwardhana (2018), the government should be the first to initiate this journey. BIM is necessary for consumers to

deliver a smooth project by cost, achieving time, and quality targets. When considering about BIM implementation in Sri Lanka, 55.55% of construction company owners do not interest in BIM in to the projects.

And also, they are responsive on the essentiality of BIM for the local context.

C. BEP

X. Sun & J. J. McArthur (2015) stated that to a specific project or set of projects, a BEP is a useful ool that offers a systematized workflow and general pathway for strategic BIM execution. In addition, Sun (2015) directs the overall vision of project, outlines the uses of BEP, and acts as a record of the understandings of the stakeholders. And also, it is known as a "living document" which needs to be reviewed continuously across the course of the project.

D. Importance of BEP

Implementing BEP gives many advantages. (JOHN MESSNER, 2019) define that information which included in a BEP as BIM objectives, model quality control procedures, collaboration process, technology infrastructure requirements, project deliverables, model structure and delivery strategy.

plans. (Sun J. J., 2015) Because a BEP is a living document, the project members should cooperate in real time to ensure accepted attention is offered to each project. Apart from that, BEP concentrate on the benefits of the project, no one is going to be delayed with analyzed data which very often cause damaging delays to project outcomes. And also, sharing information of project group should have straight access to BIM operation data in a way that is simply shareable and can be updated repeatedly. Well-built implementation composing a BEP contribute to keep items accountable and moving to make sure a strong finish on budget and on time. Furthermore, Ahmad Ridzuan Abu Bakar (2020) demonstrate a review of the Building and Environment (Protection Plans (BEPPs) stated that the BEP framework was a main reason for the project's evolution. The framework of document should include the process, strategy, data, infrastructure, personal and ethics to improve the understanding of the members in project team.

Ramage(2022) stated that there are two models of BIM, such as pre-contract BIM plan and post-contract plans. Precontract plans are made available to potential bid design suppliers during the tendering process. The

During the project planning, design construction, and operational phase identify high value BIM uses | Using process maps, design the BIM execution process | Specify the information exchanges the BIM deliverables | Create the framework for implementation, including the contracts, communication protocol technology, and quality control
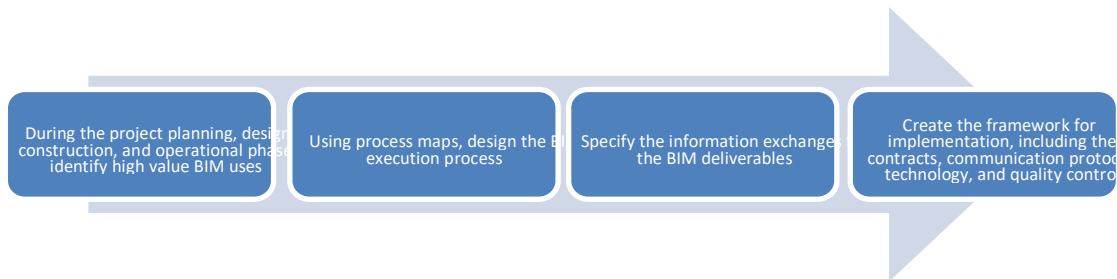
Figure 1. BIM Project Execution Planning Guide

(Chimay Anumba, 2010) identified the advantages of BEP such as helping to supervise prospects and responsibilities and also communication with teams at the very beginning of the construction projects, each construction project have various requirements depend on, and internal standards and regulations. To achieve project goals easily it's better to have an execution

supplier will implement their suggested strategy, and other information, available capacity. There is also post-contract award BEP created after the contract is awarded to the selected contractor or contractors. Post BEP important chapters are about planning, management documentation, standards

and technical solutions. Further, (Chimay Anumba, 2010) identified the information which are included in a BEP such as, Information about the BEP, the project, and important project contacts , Project objectives and BIM goals include organizational roles and staffing, design BIM process, exchanges of BIM information, requirements for BIM and facility data, collaboration processes, model quality control processes, infrastructure requirements for technology, project deliverables ,model structure and delivery strategy and contracts.

The BEP will present for the protocol establishment for the improvement, transmission, and exchange of digital information. It interprets expectations of LOD for model elements at different stages of the project. And also issues a detailed design of the process for implementing BIM throughout the lifecycle of project. (BIM Project Execution Plan, 2018). According to Otmar Hrdina (2016), BEP provides a history of documents and outlines the goals for a BIM project. The plan should specify define appropriate BIM applications, such as design authoring, design reviews, cost estimation, etc.

(Chimay Anumba, 2010) stated each potential supplier to the BIM project generates a pre-contact award that details the abilities) of their digitalization infrastructure. The designer and the contractor team develop the post-contract BEP, which includes operational details about administration and creation of the project.

E. BIM Project Execution Planning Procedure

Four-step structured procedure for creating and implementing a BEP

F. Global usage of BIM execution plan

To confirm BIM implementation runs productively, various reference documents have been improved, such as guidelines, modelling techniques, standards and work process manuals, with BEPs. The examples of the documents are NATSPEC national BIM guide, AEC (CAN) BIM Protocol, national BIM model protocol, design guidelines BIM manual rail Baltic, the New Zealand BIM handbook, CIC building information modelling standards, the guide to building information modelling, application guide BIM Luxembourg CRTI.B, AEC (UK) BIM protocol
(Ahmad Ridzuan Abu Bakar, 2021)

Not only that, the New Zealand BIM Handbook (2019) has described the definition of BEP production as to issue a framework that will ensure all parties know the benifits and responsibilities of projects that execute BIM. It sets goals and people's responsibilities and outlines how the process will be implemented in the project's life cycle. (Ahmad Ridzuan Abu Bakar, 2021). Anyhow, some of the BEP's structure outlines were different depending on its priority. Moreover, some BEP's include additional chapters to give good knowledge. Hence, further investigates and contrasts of the guidelines will demonstrate) available patterns that found in BEP frameworks. (Ahmad Ridzuan Abu Bakar, 2021). Despite, Otmar Hrdina (2016) has researched that there is requirement to create common guideline or template which will be legally supported and used in contracting.

G. Barriers

When considering the barriers to implement BIM, (Salman Azhar, 2011) stated that the rights of the BIM data should be determined as the very first legal risk. Inhibitions or incentives that protect stakeholders from fully realizing the potential of the model are to be avoided. The question of who will oversee data access into the model is another problem that needs to be addressed. According to (National Business School (NBS) statistics 2017), lack of internal BIM modeling expertise results in higher cost of training, Cyber security can create from external and internal, or system failures are other sets of issues to implement BIM. 65% of clients do not understand the

advantages of BIM. Thus, BIM adoption in small businesses are less.

Implementing a performance-based system effectively is hampered by conventional procurement practices. Collaboration may be disadvantaged by resistance to change "human factor". (University of Westminster, 2019).

Gayathri Nagalingam (2013) defined unlike many other practices of construction, there are not having any document or treatise on BIM that instructs on its application or usage. Sri Lankan construction industry has an issue on lack of technology is not a huge obstacle for BIM implementation and also technology can be adopted. Decision on whether to acquire BIM would be on the balance of costs and benefits. In absence of knowledge and experience, it is difficult to know the benefits.

Shijing Liu (2015) explained that to the issues on AEC Industry such as, national standards are less and Incomplete, High application cost, implementation process, Lack of skilled workers, Lack of professionals, Organizational and Legal barriers. (George Kekana, 2015) exposed that the barriers to implement BIM in South Africa duty of care of using BIM, Intellectual property Design delegation, Data translation and professional responsibility,

Insurability. And also Shijing Liu (2015) specified the researchers and practitioners have to develop suitable solutions to overcome these challenges and other associated risks. As a number of practitioners, researchers, software vendors and professional organizations are taking actions to overcome these challenges, it is expected that in the AEC industry the adoption of BIM will continue to increase.

3. Methodology

A. Research Approach

The goal of this study is to find ways to get around obstacles in the way of BEP implementation in Sri Lanka's construction sector. To learn more about the value of and obstacles to implementing BEP, a literature review was conducted. The mixed approach used in this study's research involves combining quantitative and qualitative data collection and analysis methods.

B. Data Collection

This study first used a questionnaire survey to collect primary data, and then it used the questionnaire survey results to guide semi-structured interviews.
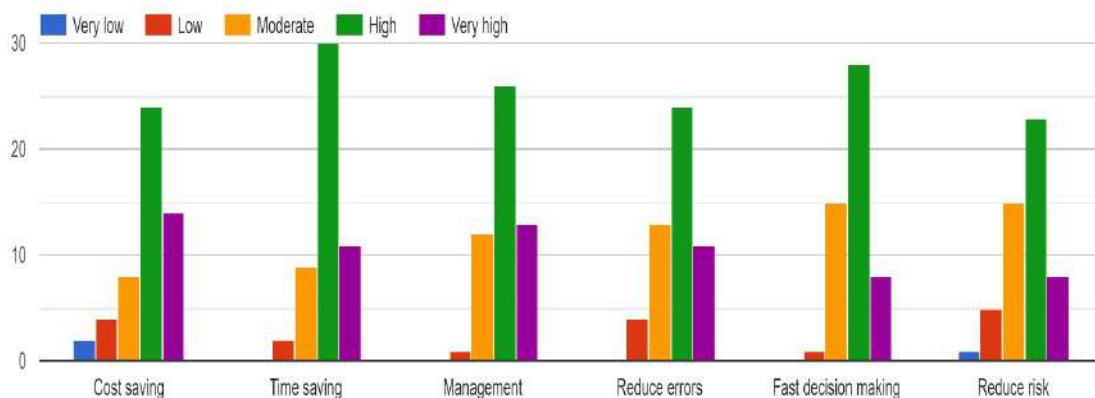

Figure 2. Significance of BIM

The questionnaire was sent out to experts in order to get a useful response.The questionnaire was developed using the information gathered during the literature review. A Likerttype scale with a maximum of five points was used in the questionnaires. This scale was used to determine how much the respondents agreed or disagreed with the factors that were presented to them.65 randomly chosen professionals were given the questionnaire, and 50 of them responded. Quantity surveyors accounted for 46% of the responses, followed by engineers (16%), architects (12%), academic professionals (8%) and others (18%).

C. Data Analysis

The frequency distribution method was used to analyze and present the data from the questionnaire survey in graphs, tables, and figures. Interview data was recorded, and content analysis was used to examine it.

4. Discussion

The questionnaire was circulated among sixty-five (65) numbers of selected professionals and received fifty-two (52) responses. Out of the responses, forty six percent (46%) was quantity surveyors, fifteen percent (15%) was engineers, twelve percent (12%) was architects, ten percent (10%) was Academia
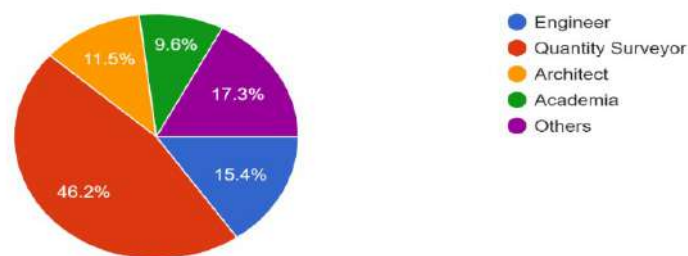

Figure 3. Percentage of professional responses

Gathered data was analyzed through the frequency distribution method under descriptive statistics. Figure 2 shows the significance of implementing Building Information Model in Construction Industry in Sri Lanka.

Findings proved that Implementing BIM would improve many factors which can be helpful to increase the productivity of construction industry in Sri Lanka such as cost saving, time saving, management, reduce errors, fast decision making and reduce risk. Figure 3 shows the level of impact of implementing BIM and to which extent the experience and knowledge of the professionals would impact in Sri Lankan construction context.

Even though there are plenty of advantages and significances of implementing BIM, number of limitations and barriers for implementing BEP in Sri Lanka were found. According to findings, Professionals have suggested number of ways to overcome the barriers to implementation of BEP. Survey results for this is denoted in figure 4.

Furthermore, from the survey circulated, provided strong recommendations to improve the use of BIM to improve efficiency, effectiveness and productivity of Construction projects and the products in Construction Industry in Sri Lanka. Increase the awareness of the BIM identified through literature was surveyed and illustrate in figure 4.
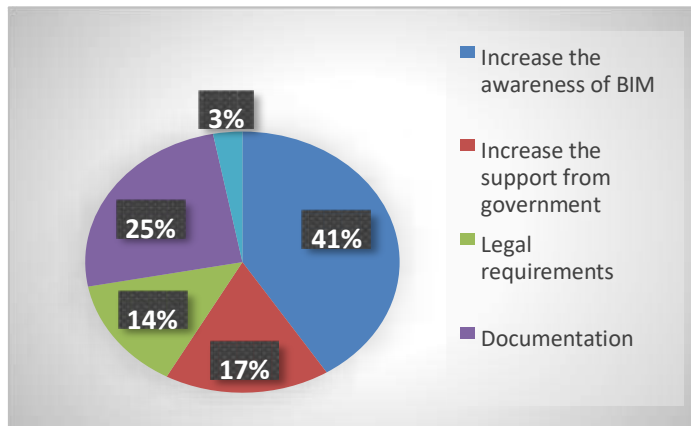
Figure 4: Barriers to BIM execution plan implementation

The pie chart shows the frequent and most suggestions which identified through the questionnaire survey. Further they confirmed the proper documentation and improved government support with satisfying legal requirements will improve this technology barrier which take place in Sri Lanka when implementing BEP.

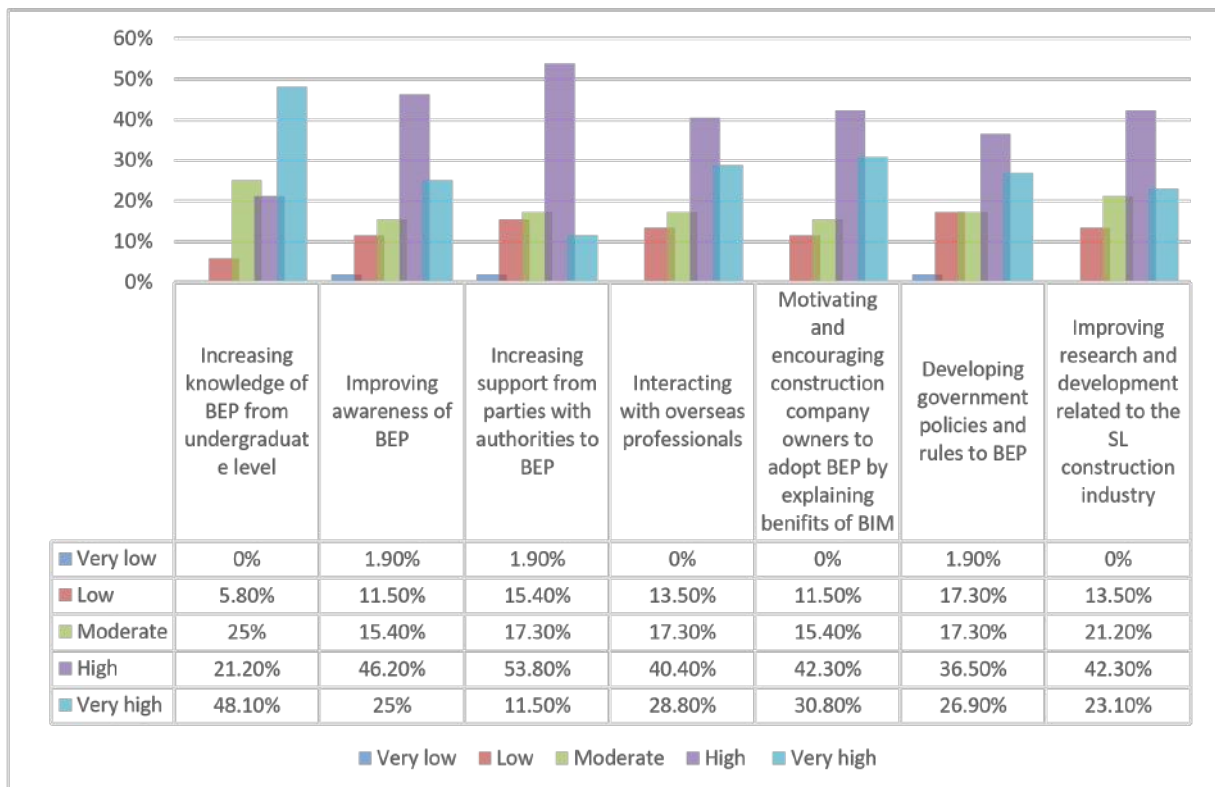|	Increasing knowledge of BEP from undergraduate level	Improving awareness of BEP	Increasing support from parties with authorities to BEP	Interacting with overseas professionals	Motivating and encouraging construction company owners to adopt BEP by explaining benifits of BIM	Developing government policies and rules to BEP	Improving research and development related to the SL construction industry
Very low	0%	1.90%	1.90%	0%	0%	1.90%	0%
Low	5.80%	11.50%	15.40%	13.50%	11.50%	17.30%	13.50%
Moderate	25%	15.40%	17.30%	17.30%	15.40%	17.30%	21.20%
High	21.20%	46.20%	53.80%	40.40%	42.30%	36.50%	42.30%
Very high	48.10%	25%	11.50%	28.80%	30.80%	26.90%	23.10%

Figure 5: Strategies to Implement BIM execution plan in SL

It was suggested as strategies to overcome barriers to Implement BEP in Sri Lanka, including training programs,

workshops which can give practical knowledge to construction professionals, establishing clear legal procedure following proper documentation, and adopting necessary changes to legal arrangements in documentation from pre contract to post contract stage, and encourage professionals and new comers to the industry to use BIM with having BEP in Sri Lankan Construction Context, and enhancing the trust among stake holders about BEP.

Subsequently, five semi structured expertise interviews were conducted. Data collected through interviews were analyzed using content analysis method. Table displays interviewers' demographic profile. Forty percent (40%) had 0 – 10 years of experiences in construction industry while sixty percent (60%) had over 10 years' experience. Eighty percent (80%) of them had engaged with local BIM implementing projects whereas rest had foreign experience.

Table 1. Years of experience

Category	Type	Response	Percentage
Years of experience	0 – 10 years	02	40%
	Over 10 years	03	60%

In addition to findings of quantitative analysis, several other barriers of implementing execution plan of BIM in Sri Lanka found by semi structured interviews which conducted. Further interviewees confirmed that most of the ongoing and completed projects have been using BIM for the different stages in their projects, but they have not adopted with the execution plan of BIM in their projects. Further most of the major projects executing in Sri Lanka get the consultancy by foreign professionals and they are not adopting to the documentation of BIM execution plan in

projects in Industry. Interviewees suggested the required prospects to improve the BEP in Sri Lankan Construction Industry, including the aspiration of providing awareness and practical knowledge from the basics of the undergraduate's level. With the acknowledgement of the industry professionals to use BIM in industry the CDPs and Seminars were conducted in the necessity of reaching the outcome. The support given by the professional bodies such as IQSSL, IESL, RICS to the Industry about the BIM and BEP is suggested to be increased as well. The implementation of a BIM hub which provides support and knowledge for local industry professionals is proposed to come into fruition by incorporating with foreign professionals. Getting support from government authorities to have legal policies and regulations to do documentation and give legal advice about the BEP is an essential requirement too. Providing background to improve the use of BIM software in the life span of construction projects while doing researches and developing to improve the use of BIM in Construction Industry of Sri Lanka, basically the sum up the essence of the entire dissertation.

5. Conclusion

BIM is a process as well as a technology. BEP play a significant role in the BIM concept. Moreover, an execution plan offers a framework or a direction for a building project. Despite the advantages, there are numerous obstacles to BEP adoption in the construction sector. The results showed that the primary obstacles to the adoption and implementation of BEP were Lack of documentation, legal barriers, professionals are lack of knowledge of BIM in SL, not enough support from SL government financial crisis in SL, lack of interconnected relationships between construction professionals & IT professionals

in SL and resistance to change. It is advised for that increasing knowledge of BEP from undergraduate level, improving awareness of BEP, increasing support from parties with authorities to BEP, interacting with overseas professionals, motivating and encouraging construction company owners to adopt BEP by explaining benefits of BIM, developing government policies and rules to BEP, improving research and development related to the SL construction industry, attract investors from foreign countries to the construction industry and maintain proper documents.

Additionally, results showed that the effective use of BEP applications helps to alleviate the restrictions and that the significant BIM application capabilities previously mentioned contribute to improving the effectiveness and efficiency of the Sri Lankan construction industry. By accomplishing all project objectives, it will result in the completion of the building construction project. Finally, implementing these suggestions should result in higherquality, more effective, and efficient project delivery in Sri Lanka's construction industry.

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