The Impact of BIM Software Application on the Quality of the Construction Project Success: Special Reference to the Post Pandemic Situation in Sri Lanka

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Abstract—*The COVID-19 pandemic significantly impacted Sri Lanka's construction sector, even in the post-pandemic situation. As a response, project stakeholders embraced remote work practices. This presents an opportunity for stakeholders in the construction industry to leverage Building Information Modelling (BIM) software applications for enhanced the quality of the project success. BIM's integration throughout the construction project life cycle positions it to become the standard, including procurement processes. The widespread adoption of BIM tools has transformed the global construction industry, automating service delivery and revolutionizing practices of the construction professionals. This research offers insights into using BIM software applications to overcome challenges associated with traditional methods. Findings indicate a positive impact of using BIM software applications by the construction professionals on the quality of project success in the post-pandemic situation of Sri Lanka and a positive relationship is observed between the BIM software applications by the construction professionals and the quality of project success. These findings can inform improvements for better preparing future professionals for upcoming challenges. In conclusion, this research emphasizes the importance of leveraging BIM software applications for enhanced the quality of the project success. It provides valuable insights to the construction professionals for empowering them to navigate the changing landscape and capitalize on the benefits of BIM. By embracing the advancements and recommendations outlined in this study, construction professionals can proactively adapt to future challenges and deliver improved project outcomes.*

Keywords: BIM Software, Project Success, Post Ppandemic Situation, Sri Lanka

I.INTRODUCTION

The COVID-19 pandemic situation has also increased the number of quantity surveyors, architects, engineers, and main contractors using BIM. In the post-pandemic situation, the stakeholders got used to working from home. They had a good opportunity to practice BIM software to succeed in their projects(L.P.D.S, 2020). BIM may be used in many ways, and it is becoming more common in post-pandemic situations(G. H. A. H. N. De Silva & Sandanayake, 2022). There are Autodesk Revit, Bentley Architecture, Graphisoft ArchiCAD, Tekla Structures, Innovaya Visual BIM, Vico Estimator, Exactal CostX, Autodesk Navisworks, Solibri IFC Model Checker, Synchro and Cubi cost(Jayasena & Weddikkara, 2014). BIM is very important for construction professionals for construction project quality in Sri Lanka. But after the COVID-19 period (post-pandemic situation) construction professionals have practiced the work-from-home concept to work in the construction industry. The project is considered an overall success if it not only meets the technical performance specifications and/or missions to be performed but also demonstrates a high level of quality in terms of construction standards, adherence to industry best practices, and the satisfaction of key stakeholders, including key individuals in the parent organization, members of the project team, and the intended users or clientele of the project effort (Alzahrani & Emsley, 2013).This research focuses on finding out whether construction professionals are using BIM for the quality of the project success. In the Sri Lankan construction industry, technology-based approaches to service delivery were not extensively adopted. As a result, when evaluating the construction sector in Sri Lanka, various writers discovered that traditional manual processing methods were being employed for service delivery(Abeywardhana, 2016). In the absence of a national effort, Sri Lanka can benefit from a bottom-up approach to BIM implementation. There is currently not much documentation of attempts by any Sri Lankan organization to implement BIM in a post-pandemic situation(Diaz et al., 2022).

The main objective of this research is to identify the impact of BIM software application on the quality of the construction project success in the post-pandemic situation in Sri Lanka. Further the following sub objectives were identified.

i. To find the relationship between the BIM software application and the quality of the construction project success in the post-pandemic situation in Sri Lanka

ii. To identify the implementation issues relating to the use of BIM software application for the quality of the construction project success in the post-pandemic situation in Sri Lanka.
iii. To give some practical strategies to improve the quality of project success using BIM software applications in the pandemic situation in Sri Lanka.

II.LITERATURE REVIEW

BIM Software is computer software used to automate or support managing, modelling or visualising of BIM data. However, it is often the software used for modelling that is talked about under BIM Software(Jayasena & Weddikkara, 2014). Construction professionals are in charges of making construction projects run more efficiently. Because of changes in information technology (IT), they also must adapt to how their jobs are changing(Diaz et al., 2022). The success of a construction project can be defined as the perceived level of accomplishment in meeting predetermined performance objectives, as well as the extent to which the execution of a construction facility or service aligns with the expectations of the involved participants(G. A. S. K. Silva & Warnakulasooriya, 2017).

A. The quality of Project success of using BIM software

BIM is the successor of computer-aided drafting (CAD), which has been based on two-dimensional designs and is now focused on three-dimensional perspectives. These drawings, however, lacked interactivity, and changes in one viewpoint were not immediately reflected in others. Since the advent of BIM at the beginning of the twenty-first century, this approach has begun to shift gradually. BIM-based architectural software has allowed the automatic updating of views whenever a change is made to one view by developing intelligent 3D and 4D models(Nagalingam et al., 2013). A BIM system may automate the measurement of quantities from construction plans. This will enable construction professionals to access design documents in a digital form that contains precise figures and material specifications. With a correctly designed building information model, a BOQ may be generated automatically. The BOQ is used to create reports in the specified format. This is carried out at each phase of QS dispatches, including estimating, bidding, and construction control(Fan et al., 2014).

As an example, QS technique was straightforward to administer using BIM throughout the bidding process. Competitive tendering and bidding that makes use of BIM models has the potential to remove the potentially dangerous gap that may develop between project partners as a result of the openness and usability of project documentation and information First, at the bidding stage of the procurement process, the traditional tendering techniques might be applied. In comparison to conventional working drawings, the information that was provided by BIM for the construction project was of much better quality, and the resulting bill of materials was also more precise. The BIM software also provides education in the processes of quantity extraction and measurement for prospective builders. Bidders may find flaws in the model throughout the course of the auction and correct them, which will result in more precise offers. Potential purchasers were able to have a comprehensive understanding of the structure and the dangers associated with it, which resulted in reduced tender return costs(Date et al., 2020).

BIM is the opportunity to avoid obstacles that Sri Lankan construction professionals can continue their work very accurately by using BIM software (Fan et al., 2014). There are some issues with the use of BIM software by practicing construction professionals in post-pandemic Sri Lanka (Diaz et al., 2022).

B. Organizational barriers

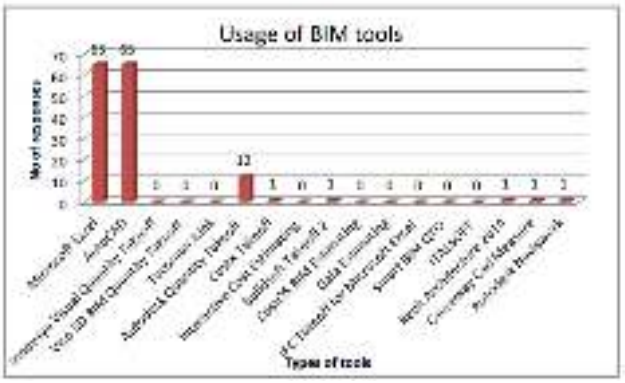

Figure 1 Usage of BIM tools

Figure 2 Shows The majority of Sri Lankan QSs rely on traditional manual processing techniques for service delivery. Most of the Sri Lankan construction professionals use traditional programs such as AutoCAD and Microsoft Excel for quantity take-off. As one of the categories of construction professionals, quantity surveyors have said that the existing methodologies used in Sri Lanka are insufficient to satisfy project objectives (cost, quality, schedule, and sustainability) in an efficient manner(Abeywardhana, 2016).

C. Technological barriers

Poor knowledge management is a key barrier regarding technological barriers. Automated BIM quantity take-off that was compared to regional BIM standards (NRM 2, SLS 573, etc.) The conclusion is that the BIM-related BOQ is achievable, although with a few problems, in the context of Sri Lanka. Concerns have been raised over the possibility that the BIM implementation might begin with QS-related activities. This raises additional questions that need to be addressed(Diaz et al., 2022).

D. Psychological barriers

The implementation of BIM has an impact on both the technological environment and the social context. The social aspect of building projects must be aligned with the usefulness of technology. Ignoring social considerations during the implementation stage may result in failure or mismatched usage. However, there are a limited amount of people who properly understand complex BIM systems(Ismail et al., 2016).

E. Financial barriers

According to a report, overall expenses associated with BIM software are often under 2% of total net income. The first expenditure in applying BIM methods includes the acquisition of BIM-based software, the necessary hardware to operate it, and enough training for the project team to adapt to and execute the technology. The cost of creating the BIM depends on the level of detail, the project's degree of complexity, and the modelling team's proficiency. If the on-site architect does not use BIM software, the contractor must outsource the whole model. This is time-consuming and expensive. In addition, the architect's modelling may not include all the necessary information for the contractor, resulting in a more expensive build. These expenses incurred by the contractor in the use of building information modelling are classified as overhead costs and may determine the contractor's contract success(Date, 2014).

III.METHODOLOGY

The research approach is the mix method. Because quantitative and qualitative data were used in this research. Basically, the primary data collection method was used to collect data. Main objectives and sub objective i are justified by the questionnaire survey. A questionnaire was developed and distributed among the professionals who are involved in the construction sector in Sri Lanka. 35 construction professionals were selected as a sample by using the stratified random sampling technique. The professional in the construction field as engineers, architects, quantity surveyors, surveyors, project managers and other executives were selected for the sample.

The expert interview method is used to justify sub objectives ii and iii. Purposive sampling A technique was used for the expert interview. These interviews were conducted by selective five experts in the construction field considering their professional experience. A civil engineer, a chartered architect, a chartered quantity surveyor, a licenced surveyor and a project manager were selected who have more than 10 years of senior level experience.

The questions were formed based on the research problem, research objectives, and variables. The relationship between the dependent and independent variables are illustrated through the following conceptual framework.

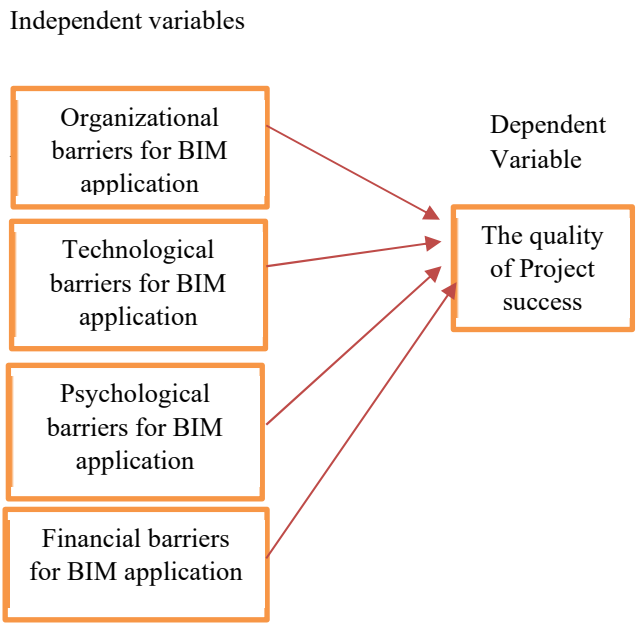

Figure 2 Conceptual framework

IV.DATA ANALYSIS

The collected data was analysed through Correlation analysis, Regression analysis, and Content analysis methods. Statistical Package for Social Sciences software used for Correlation analysis and Regression analysis.

A. Correlation analysis

Correlation analysis was used to find the relationship between independent variables and dependent variables. A questionnaire survey's outcomes were used for the correlation analysis. Sub objective i was justified using correlation analysis. Hypotheses were made using the conceptual framework and correlation analysis was used for testing hypotheses.

Hypotheses are as follows.

H1: There is a relationship between the organizational barriers of BIM implementation and the quality of the project success.

H2: There is a relationship between the technological barriers of BIM implementation and the quality of the project success.

H3: There is a relationship between the psychological barriers of BIM implementation and the quality of the project success.

H4: There is a relationship between the financial barriers of BIM implementation and the quality of the project success.

Table 1 Correlation analysis

Correlations

		AOR	AFI	ATO	APS	APR
AOR	Pearson Correlation	1	.512**	.625**	.324	.460**
	Sig. (2-tailed)		.000	.000	.000	.000
	Sum of Squares and Cross-products	16.730	13.825	13.111	4.540	7.984
	Covariance	.492	.407	.386	.134	.235
	N	35	35	35	35	35
AFI	Pearson Correlation	.512**	1	.827**	.565**	.100
	Sig. (2-tailed)	.000		.000	.000	.000
	Sum of Squares and Cross-products	13.825	43.619	28.000	12.794	2.794
	Covariance	.407	1.283	.824	.376	.082
	N	35	35	35	35	35
ATO	Pearson Correlation	.625**	.827**	1	.633**	.216
	Sig. (2-tailed)	.000	.000		.000	.000
	Sum of Squares and Cross-products	13.111	28.000	26.267	11.133	4.689
	Covariance	.386	.824	.773	.327	.138
	N	35	35	35	35	35
APS	Pearson Correlation	.324	.565**	.633**	1	.244
	Sig. (2-tailed)	.000	.000	.000		.000
	Sum of Squares and Cross-products	4.540	12.794	11.133	11.765	3.543
	Covariance	.134	.376	.327	.346	.104
	N	35	35	35	35	35
APR	Pearson Correlation	.460**	.100	.216	.244	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	Sum of Squares and Cross-products	7.984	2.794	4.689	3.543	17.987
	Covariance	.235	.082	.138	.104	.529
	N	35	35	35	35	35

**. Correlation is significant at the 0.01 level (2-tailed).

Number of responses = 35

AOR =Organizational barrier (Independent variable)

AFI =Financial barrier (Independent variable)

ATO =Technical barrier (Independent variable)

APS =Psychological barrier (Independent variable)

APR =The quality of Project success (dependent variable)

As above, there is a symbolic link between all of the dependent variables and the dependent variable, Table 1. Based on the table findings, all the independent variables' significance levels are listed at 0.000. Aside from that, the table shows the positive relationship between variables. All the alternative hypotheses are accepted.

B. Regression analysis

Regression analysis was used to find the impact of the independent variable on the dependent variables. Typically, the independent variable(s) vary with the dependent variable(s), and the regression analysis aims to determine which elements are most important to that change. A questionnaire survey's outcomes were also used for regression analysis. Regression analysis is used to justify main objective.

Table 2 Regression analysis

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.368	.561		.655	.030
	AOR	.584	.207	.563	2.817	.008
	AFI	.176	.178	.274	.988	.012
	ATO	.065	.271	.078	.240	.034
	APS	.328	.250	.265	1.310	.017

a. Dependent Variable: APR

According to Table 2, the quality of project success can be explained through a linear relationship among the issues regarding the usage of BIM software, such as organizational barriers, technological barriers, psychological barriers, and financial barriers.

The above regression model's relationship may be defined as follows:

$Y = \alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + S.E$

$Y = 0.368 + (0.584*AOR) + (0.176*AFI) + (0.065*ATO) + (0.328*APS) + S.E$

(X1 = AOR, X2 = AFI, X3 = ATO, X3=APS), α = Constant)

According to Table 2, all the variables' B (beta) values are positive numeric values. Thus, regression analysis with independent and dependent variables has a positive impact.

C. Content Analysis

Content analysis is an approach for establishing reproducible or accurate conclusions from texts, which can include both text and visual media and items(Creamer & Ghoston, 2013). Sub objectives ii and iii are justified by content analysis. The data gathered through expert interviews were used for the content analysis.

1. *What are the main issues of BIM implementation in post-pandemic situation?*

This question is based on the sub objective ii. Four of the five respondents said the initial cost of purchasing BIM software was high. Three of the five respondents stated a lack of understanding of BIM software applications. Out of five respondents, one interviewee stated that organizational culture is a barrier to the implementation of BIM software in a post-pandemic situation.

2. *What are the practical strategies to improve project success using BIM applications?*

This question is based on the sub objective iii. Four respondents said that contractors and consulting firms should have a thorough understanding of the BIM execution plan (BEP). Four of the five respondents said they were aware of the BIM protocol. Three of the five respondents said the government should use BIM software to manage construction projects.

V. CONCLUSION AND RECOMMENDATIONS

A. Main objective- To identify the impact of issues of BIM software application of construction professionals on the quality of the project success in the post-pandemic situation in Sri Lanka.

Following data collection, the researcher uses the regression analysis method (using SPSS software) to determine the impact of issues with the BIM software application on the quality of project success. Regression analysis illustrates that there is a positive impact of the issues of BIM software application of construction professionals on the quality of the project success in the post-pandemic situation in Sri Lanka.

B. Sub objective i- To find the relationship between the issues of BIM software application of construction professional and the quality project success in the post-pandemic situation in Sri Lanka.

According to correlation analysis, high relationships define organization barriers and the quality of project success, medium relationships define psychological barriers and the quality of project success, considerable relationships define technical barriers and the quality of project success, and minimum relationships define financial barriers and the quality of project success. The level was defined by correlation analysis using Pearson correlation values.

C. Sub objective ii- To identify the implementation issues relating to the use of BIM software application for QS professionals in the post-pandemic situation in Sri Lanka.

According to the content analysis, the majority of interviewees responded that the 'initial cost of purchasing BIM software was high'. This comment illustrates how financial issues have become a threat for the Sri Lankan construction industry's BIM implementation. Therefore, Sri Lanka's construction sector has less opportunity for BIM implementation. As a result, construction professionals have less experience with BIM software in large-scale projects.

D. Sub objective iii- To give some practical strategies to improve the quality of project success by using BIM software applications in post pandemic situation in Sri Lanka.

According to the content analysis, majority of interviewees responded to ‘contractors and consulting firms should have a thorough understanding of the BIM execution plan (BEP). It is needed to have a clear communication among project stakeholders, project team members collaborate in real time on different project phases, preventing conflicts among project tasks and allowing proper attention to the significant tasks, save money, and help to finish the construction within budget, Identifying that different regions may have distinct norms, standards, or regulations are especially significant for large or international projects, contractors, owners, and others should get the direct access to BIM data like file formats, dimensions, and other details in a way that could be easily shared and updated.

E. Recommendations

Short term,

- Based on the key conclusions discussed above, it is suggested that the implementation of BIM software application is a necessary requirement for the construction sector to quality of the project success rather than relying on traditional manual conventional processing methods. In the short run, it is recommended to get support from the consultancy organization with regard to BIM application until the construction industry will have a sufficient number of experts with BIM knowledge.

Long term,

- Based on the results of the questionnaire survey and interviews, the authors of this study propose that "Conducting seminars, workshops, and short courses" be implemented as the most important tactics to encourage the implementation of BIM software applications in the construction industry in Sri Lanka. Continuous awareness is needed.
- It is further recommended that the construction professionals should "Recognize the benefits and significance of using BIM" and "BIM is considered necessary to be added as a required module to the relevant educational programmes.
- Finally, it was suggested that “The authorized bodies should develop BIM taskforce or BIM supervisory board to support BIM adoption” as for promoting the implementation of BIM software to the construction industry in Sri Lanka.

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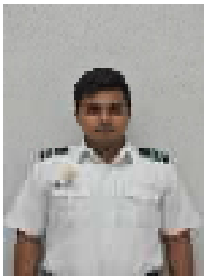

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