Importance of BIM Usage in Proposal Setting Strategies - A Comprehensive Survey

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Abstract
The construction industry is one of the largest sectors around the world. It is vital to job markets and is important to keep economies thriving. This industry has struggled over the years to avoid cost overruns, as they occur on over half of the projects constructed. Cost overrun leads to low productivity and can compromise the overall completion of a project. Understanding how to overcome this must begin with understanding the issues that cause costs to exceed the budget. There were many causes of cost overrun determined throughout research with primary and secondary data. Two of the main causes that this paper focuses on are design errors and schedule delays. Both causes were confirmed to be highly important, as a questionnaire survey result suggested. Also, a survey conducted by a secondary source showed that these two causes were a problem that drove up costs. By researching secondary data, it was found that the Building Information Model (BIM) is a successful strategy to help construction companies avoid design errors, schedule properly, and ultimately help control the budget so that costs do not overrun. A case study implemented BIM on one project and used the conventional method on another. It can be concluded that BIM not only reduces the overall construction cost but also provides other benefits.

Keywords
Building Information Modeling, Construction, Proposal, Cost Overrun

1. Introduction

Cost overrun is a global problem in the construction industry and is a popular issue as nine out of ten construction projects exceed their budget by about 50-100 % (Shibani & Arumugam, 2015). Overrunning the budget has damaged the industry by sparking major concern among investors and resulting in low productivity and quality. This is largely harmful to the industry, which provides job opportunities and keeps economies thriving (Ahmed et al., 2016). With this industry growing, more research is crucial. The construction industry is pivotal in a country's economic growth. The building structure industry has emerged as one of the world's leading sectors. The growing complexity of construction projects indicates an increased demand for construction managers to complete projects on schedule, within budget, and to a high standard of quality. The main challenge is to finish the project within the allocated budget and time (Gupta & Kumar, 2020). In situations when there is a lack of clarity regarding the ground conditions, it is impossible to perform proper project costing (Afzal et al., 2021). Construction projects vary in size, location, and diverse constituents etc. So, this industry is the riskiest due to weather, multiple parties involved, inaccurate designs, inadequate scope, and much more (Shrestha et al., 2013). This makes it hard for the industry to gauge when it comes to pricing. Putting together a proposal to ensure that the company does not overrun the cost of the project, so a profit can be made, is the goal, along with delivering a satisfactory product. However, the lowest bid typically wins. The low bid method is a common method for contractor selection in the U.S. and is described as the winner's curse. If a contractor is awarded a project based on their proposal price, then they must stick to the agreed price, schedule, and required level of quality, which puts him/her at risk if certain measures are not taken while constructing the bid. Once construction begins, the contractor will face high levels of uncertainty events, inevitable and unforeseen increases in costs, and labour issues, which can all lead to cost overrun (Ahmed et al., 2016).

This research is being conducted to promote awareness regarding the issue of cost overrun in construction and the need for strategies to be implemented to eliminate cost overrun. Contractors need proposal solutions to avoid cost overruns to keep the economy and job market thriving. The purpose of this study is to determine how effective BIM is when it comes to scheduling. Secondly, it also focused on investigating how the BIM software can assist in reducing design errors. Started with a questionnaire survey containing different questions regarding proposal making and issues, which will eventually map the current scenario of technology adoption and practices of the construction industry. After a survey, some interviews were also conducted to see in-depth the adoption of BIM and other technologies, if used. Finally, the study used some past literature that has been done in the same area. The findings of this study and previous research were compared to determine the validity of the findings.

2. Literature Review

The basic goal in the construction industry is to complete projects successfully within a specific time frame and budget. Unfortunately, this is not the reality of the industry as "cost overrun in construction is a worldwide phenomenon, and its effects are normally a source of friction between owners, project managers, and contractors" (Subramani et al., 2014). The construction industry exhibits inadequate cost performance regarding the completion of projects within budgetary constraints (Haron et al., 2018), also it does not perform well in the scheduled time as well (Gupta & Kumar, 2020). Construction projects have consistently faced a range of cost overrun issues due to their complex and dynamic nature. The cost failure arises from the complexity and uncertainty inherent in a project system (Pehlivan & Öztemir, 2018). Over the years, the construction industry has grown into a global market that sustains economies and provides jobs. The market will grow as economies grow and more development is needed. The emergence of this industry calls for more research to move the industry forward and keep up with demands. Construction is one of the largest industries, but it produces a low productivity rate as updated methods have not been developed. To improve productivity, performance needs to be enhanced (Yates, 2014). To achieve higher performance and productivity, schedules and costs should not be overrun. Costs in construction are determined in many ways; however, there is usually an estimator appointed to specific projects who examines all documents to formally prepare a bid. Construction documents will be solicited by construction companies with project information and a bid due date. There are different costs that the estimator must examine, such as labour, material, machinery, administration, management, temporary construction, etc. (Subramani et al., 2014).

2.1. Cost and Time Overrun:

Several factors can cause cost overrun, which need to be examined further for the construction industry to move forward. Ashrafi et al., (2022) have identified exactly 40 risk factors linked to cost overrun. These include site conditions, poor management, environmental conditions, labor security, market conditions, including price increases, estimating mistakes, poor acts of subcontractors, improper scheduling, and design errors. The purpose of this study is to investigate two issues that lead to cost overrun: improper scheduling and design errors. The schedule and budget of a construction project are directly related, so a strategy is needed to coordinate them. Time overrun is an issue in construction that directly affects the budget of the project. It is an unanticipated delay in projects due to the unavailability of adequate resources, administrative problems, improper scheduling, and weather conditions (Raykar & Ghadge, 2016).

An example of a time delay that is unavoidable is a global pandemic. During 2020, a global pandemic shut down many construction suppliers. Not having adequate supplies of resources caused many construction projects to shut down, which prolonged their schedules. However, sometimes delays are avoidable, such as improper scheduling. The need for a proper schedule that is kept true throughout the project is necessary to avoid cost overrun. Design errors coincide with time overrun issues, as design changes are the main contributor to schedule delays. Rework because of design errors contributes to 52% of total cost overrun and causes schedule delays of 22% (Han et al., 2013). There is no set plan in construction, as architectural mistakes and human error occur.

2.2. Traditional Proposal Strategies:

There is not much research published on traditional methods to put together proposal strategies for construction projects, as the process was clear-cut and done by hand. A construction company would be provided with a bid

invitation, instructions for bidders, bid forms, blueprints, project specifications, and a bid date. Construction Cost Estimating Process and Practices (CCEPP), written by Holm et al., (2005), does a great job explaining a traditional ten-step strategy to put together proposals that can be used today.

2.3. BIM

The emergence of the Building Information Modeling BIM software has elevated proposal strategies and become common in putting together project proposals. BIM is software that can virtually build a structure before physically constructing it and allows project management to analyze and explore the project through a digital environment (Hardin & McCool, 2015). Building Information Models (BIMs) are increasingly employed as they enhance design planning, reduce disagreements, and diminish risks throughout a project (Zhou et al., 2020). Tahir et al., (2017) did a good job explaining the issue between cost and time in construction and how BIM can be incorporated to solve this. When a project is in design, there are many factors to consider, such as square footage, market conditions, the type of building being constructed, site conditions, permitting requirements, size of construction, etc., as they play a role in the contractor's bid. BIM technology is effective in saving time and money, so cost overrun does not occur, and this article states that costs were saved by about 7% per square foot for construction projects (Tahir et al., 2017). There is no perfect set of blueprints for a construction project, so design errors are inevitable. RFI's must be sent out before mobilization for clarification and for project management to identify all errors in plans. Design errors that need to be reworked are the primary contributors to cost overruns (Han et al., 2013).

2.4. Traditional vs. Contemporary Proposal Strategy Methods

The traditional methods of putting together proposals are used in current practices, as the newer practices have not been implemented well. This could be due to limited research, additional company costs, and a lack of awareness or education. Throughout research for this thesis, most articles displayed concern about the need for more research for the construction industry to be updated and avoid cost overruns. The application of the BIM model for progress measurement offers numerous advantages over traditional methods. In addition to automatic calculations and volume measurements, a BIM model can synchronize information from other software applications, such as Microsoft Excel and Microsoft Project (Nguyen et al., 2020). Using a traditional method can be time-consuming, and it is estimated that out of the time spent on doing a quantity takeoff, 50-80% is spent on quantification. KV et al., (2016) did a study that entailed them doing a takeoff in Planswift as well as the traditional way. They found the same results; however, Planswift was more accurate and took almost half the time. The traditional and Planswift takeoffs took 15 and 7 hours, respectively. Reduced time and higher accuracy are the benefits of using contemporary methods. BIM can detect elements that will clash before construction begins, which saves time and money. Typically, engineers and contractors will check all drawings for inaccuracies, as any design errors can cause costs to overrun, but checking pages manually can be time-consuming. BIM can detect design errors through its analytical systems.

3. Methodology

This research aims to determine if BIM is an effective proposal strategy to avoid cost overrun in construction. As discussed above, the questionnaire survey contains sixteen different questions related to proposal strategies in construction. The survey was conducted with different contracting firms in North Carolina, USA. The respondents need to answer only "yes" or "no" for their response. A total of 150 firms' contractors were contacted, and 134 responded. The total response percentage can be seen in Fig. 1, and the questions that were asked can be seen in Table 1.

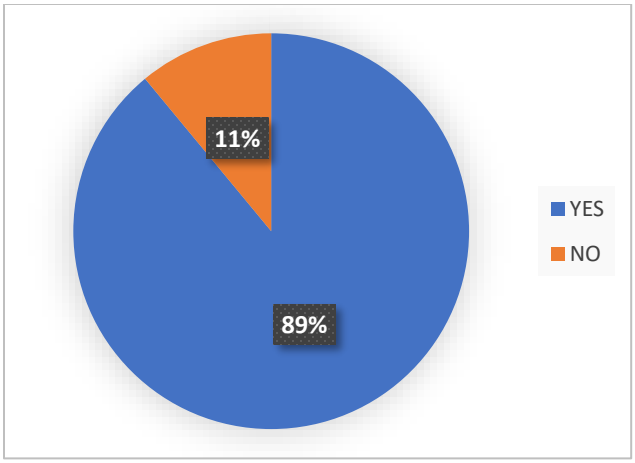

Fig. 1. Survey Responses Percentage

Questions have been categorized into different forms. The first is a general inquiry related while the second category is for time.

Table 1. Questions asked in the Survey.

Question
Inquiry Related Questions
Do you set meetings with the subcontractors to go over their scope of work to determine if their bid is as accurate as possible?
Does your team have an estimator on staff who looks over every aspect of the project, or just specific aspects?
Do you think that time and scheduling are the main factors that directly contribute to cost overrun?
Do you think design errors are the main factor that directly contributes to the overrun cost?
Do you think that cost overrun is a significant risk factor in construction?
Do you base an allowance for any unforeseen circumstances that could occur on the project so that it does not cut into profit?
Do you think that preparing to avoid cost overrun is possible in construction?
Do you use BIM to assist with scheduling your projects?
Do you use a certain calculation to determine what the markup for profit is on your company's proposal?
Does your team use estimating software?
Do you set meetings with the client to discuss the scope of work for the project?
Do you implement certain clauses in your contract to assist with overrun costs regarding scheduling delays?
Do you implement certain clauses in your contract to assist with overrun costs related to design errors?
Schedule Related Questions
What is an acceptable time to construct a good proposal for a construction project? 0-2 months? 3-6 months?
How long do you give subcontractors to turn in a bid? 0-2 months? 3-6 months?
Once their bid is turned in, how long do you take to look over it? 0-2 months? 3-6 months?

4. Results and Discussion

The results of the survey can be seen in Fig. 2, which shows 130 responses against 16 different questions, and it can be concluded that most people said yes to every question; only question eight got more "no" than yes. Interviews were conducted, consisting of nine questions with ten firms' contractors, to gather more information about strategies or implementations of tasks that the companies enforce while constructing a project proposal. Question domains and responses can be seen in Table 2. Contractors also provided some tips, which are in the same table.

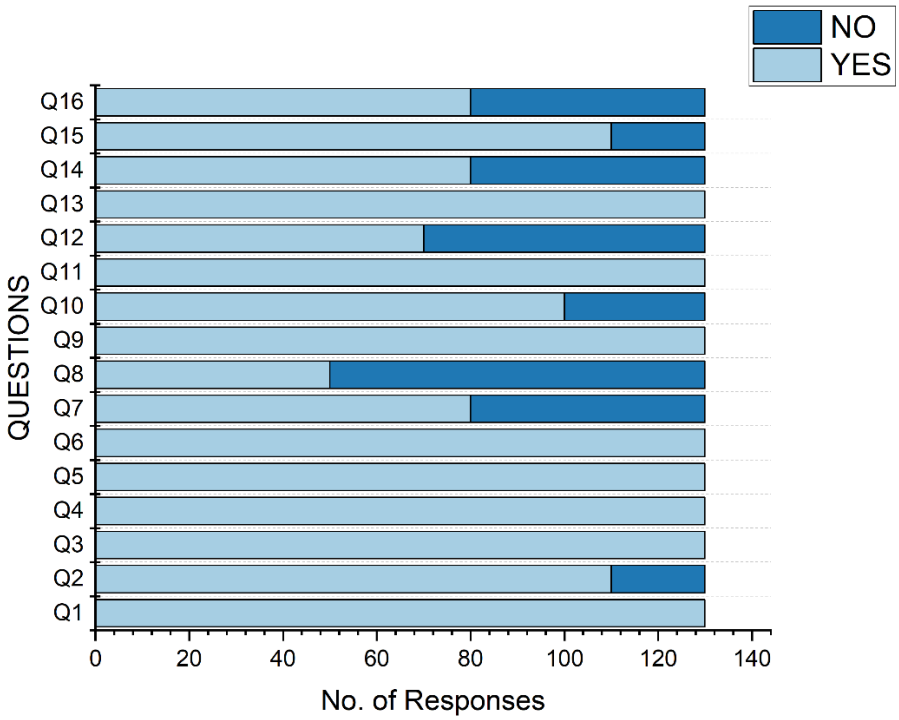

Fig. 2 Result of Responses

Table 2. Interview Results

Questions	Responses
Current Proposal Strategies	Double-check their proposal or have someone look over it before sending it to the client. Putting an estimating team together to collaborate on the proposed budget Using Planswift to do takeoffs of the project and comparing them with the subcontractor proposals to ensure accuracy Using historical or similar data from other projects and comparing the budget Planswift
Software use for Proposal Making	STACK Takeoff & Estimating Software Benchmark Estimation Software Esticom
Calculation of Profit	A percentage is added to the overall cost of the project.
Scope of Work	Frequent meetings with clients Client opinion Discussion on Geotechnical Reports Sorting design errors
Value Engineering	Every firm includes value engineering to meet a client's budget and quality.
Estimation Team	Some firms have an estimation team to review proposals before submission. Some have an estimator that works on the budget, and they double-check it to prevent errors.
Accuracy	Double-checking the proposal before submission can ensure accuracy. All firms stated that estimating software is reliable and helpful since technology will continue to grow. Some of the firms responded that the inclusion of technology increases accuracy, but at a cost.

Tips	Firm No.	Tip#1	Tip#2	Tip#3
	1	Double-check the plans	Have someone review the final budget	Qualify all subcontractor pricing

	2	Have a team review the final budget	Correlate the bid with the construction. schedule	Look over the plans for any inconsistencies and errors
	3	Have someone look over the final budget	VE when possible	Make a site visit
	4	Implement an estimating software	Make a site visit	Confirm the project scope with the client or management firm
	5	Make a site visit	Send RFI's for plan clarification	Implement software for estimating and accurate take-offs
	6	Qualify subcontractor pricing	Draft a well. constructed schedule	Put together an estimating team
	7	Use an estimating software	Double-check the proposal	Assess all risks with the project
	8	Look for any plan's errors and sort them out before submitting the bid	Do not rush the bid	Use software to put the budget together
	9	Factor in extra costs for overtime or to account for risks	Use construction software	Have someone double-check the math
	10	Thoroughly review all bid documents	Use an estimating software	Use a team to put the budget together
Inclusion of BIM	Only one firm has specialized people for BIM in proposal making. They eliminated design errors using BIM and indicated that it is useful in all pre-construction aspects and provides accurate schedules and designs. The remaining firms indicated that they did not use BIM as they found it costly and considered its design software, and they were not design-build firms.			

Conducting this research provided a clear solution to the problem of cost overrun in the construction industry. The primary data provided specific information about the overall study, and the secondary data filled in deficiencies. The results of this research have given construction companies an outlook on the variety of causes of cost overrun. The focused causes in this project were design errors and scheduling delays. The primary data received through the postal questionnaire distributed to 150 construction companies showed that overrun cost is an issue, and it directly correlates with design errors and schedule issues. Secondary data results supported this. This calls for a strategy to avoid overrun costs, which can help boost the economy and produce more jobs. Design errors were found to be common in construction, as architectural and human errors occur. The postal questionnaire proved design error to be the main factor that directly contributes to cost overrun, as all 134 participants answered "yes" to this question. To address this issue, a proposal strategy is needed. Research found that BIM can be an effective strategy if implemented in the design phase. BIM contains technology that can assist the design team and highlight errors. The interview conducted found that a good proposal strategy is to double-check plans to find any issues with the design. Also, the contractor may find items that are unclear and issue an RFI to resolve them before the final bid is submitted to improve the accuracy of the final bid. Another strategy is to make site visits, as this can help identify issues with plans or the site beforehand. Schedule delays were another contributing factor in the overrun cost. Some causes are inevitable, and the contractor must identify any delays and account for them in his/her construction schedule. In the survey, all participants answered "yes" when asked if time and scheduling are the main factors contributing to cost overrun. In the interview, a strategy was provided to correlate the bid with the construction schedule to draft a well-constructed/accurate schedule. Another strategy would be to implement BIM, as it can assist with scheduling. The secondary data sources also showed that BIM is an acceptable proposal strategy to avoid cost overrun.

Cost overrun is a primary issue in construction, as projects rarely get completed within the original costs. Subramani et al., (2014), examined this issue in their article and focused on the leading causes, which were ranked based on importance. They aimed to get opinions from major personnel in the industry, assess the frequency and impact of causes, and find which causes should be prioritized to avoid cost overrun. They have concluded that inadequate project information is the leading cause of project cost overruns, followed by poor planning and lack of management before the execution and during execution. The inadequate project formulation pertains to issues including poor field

investigation, inaccurate cost estimates, and a lack of experience. Poor planning for implementation and a lack of project management are directly correlated to the project schedule. Cost overrun occurs if the estimated time for activities or the overall schedule is not planned correctly. The lack of proper contract planning and management comes into play at the beginning of a project, as the contract must be signed before construction work can commence. Similarly, Haron et al., (2018) discuss how to improve cost overrun and scheduling in their research. The purpose was to discuss how BIM is applied and how it can assist in cost overrun elimination. The causes of cost overrun are directly correlated with the findings in this paper and other source cited. For example, slow decision-making, poor planning and design, poor project management, and inaccurate schedules. They have compared BIM implementation on one project and conventional methods used in another project. BIM saved costs by 7% per square foot (Haron et al., 2018). This shows that BIM can be an effective strategy to avoid cost overrun in construction.
BIM can be applied in many ways throughout construction. Latiffi et al., (2016) discussed this in their research, and they provide some ways that show how BIM can be applied in separate phases of construction. They also suggested various benefits of implementing BIM on construction projects, some of which are:

- BIM can save 10% of the contract value due to its ability to detect clashes.
- BIM can achieve 3% accuracy for cost estimating.
- BIM reduces design conflict issues.

The construction industry is broad, as every project is different. Research happens worldwide, and the secondary data sources used here were based in India and Malaysia, so this may not align with construction in the US. It can, however, help provide a new perspective and possibly a solution. One study conducted in India found BIM effective in cutting costs and analyzing issues in the design phase. These results were generalized as they discussed numerous issues of cost overrun and primary construction language. Additional research can serve as a foundation to benefit the construction industry by outlining how dominant this issue is, why it is an issue, and a strategy to overcome it. Further analysis of BIM can look at its pros and cons and promote it to companies. The typical clientele for the implementation of BIM would be construction companies and design firms. Many can put together a proposal with an accurate schedule and set of blueprints; however, this is rare as there are several risks. A simple-worded research paper will be effective for the clientele to analyze and will help show the advantages of using BIM software throughout construction as a proposal strategy. The results from primary and secondary data presented show cost overrun as an issue and a need for proposal strategies. It is due diligence to provide accurate costs to clients to ensure that costs do not exceed their budget. The strategies proposed in this research include the implementation of BIM, double-checking the plans, putting together an accurate schedule, assessing all risks when estimating, and sending RFI's for clarification.

4. Conclusion

In conclusion, cost overrun is a significant issue in the construction industry, as 60% of projects overrun on costs. The main contributing issues were design errors and schedule issues. These were seen in all data collected, including the questionnaire, interviews, and secondary sources. BIM is a strategy that could be implemented to avoid cost overrun, as determined by secondary research articles. BIM is digital software that has tools to assist a construction project in all phases. Its benefits are innovative, can eliminate many issues beforehand through clash elimination tools, and can detect issues within the design and during scheduling. While BIM is a great strategy to implement, more research needs to be conducted on its effectiveness. There is also an issue with construction companies being educated in BIM. As demonstrated in the interview, one participant used BIM, while others thought that it was just design software and found it costly. The cost and education aspects should be researched to provide a solution for it to dominate the industry and eventually eliminate cost overrun. The construction industry is one of the largest industries around the world and is important for thriving economies and the job market. Clients are also an important aspect, as they need to feel secure about their budget and quality of services with contractors and design professionals. There is due diligence for members of the industry to provide services within the estimated time frame and budget. Lastly, the construction industry will continue to grow as populations grow, and there will always be a need for more residential, commercial, and industrial buildings. It is important to overcome the challenges of overrun costs as this will improve productivity. Proposal strategies, research, and education across the industry can help improve construction.

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