Comparing the Effects of ABC and BIM in Construction Projects and Choose the Best Solution to Minimise the Delay and Cost Overrun Using MADMA[1, 2]

Justin Johnson

ABSTRACT

The importance of construction projects is increasing day by day, but the efficiency of the projects is not up to the level considering the statistics of delay and cost overrun in projects. "31% of projects came within +/-10% of budgets meaning a whopping 69% exceeded their budgets by more than 10% and as only 25% of the projects finished on time, means that 75% finished late"[3]. This paper aims to identify and analyse the problems causing delay and cost overrun in construction projects and alternative solutions for the problem. In this paper, we analyse the 5 alternative solutions with 14 attributes. For the analysis we use Multi-Attribute Decision Making analysis and with the additive weighting technique to determine the most suitable alternative solution. Based on the analysis, implementing Activity Based Costing with Building Information Modelling in projects improves efficiency and can minimize delay and cost overrun in constructions projects.

Keywords: Building Information Modelling, Cost Estimation, Delay and Cost overrun, Construction, Activity Based Costing

INTRODUCTION

The world economy is growing in very fast rate "The world economy could more than double in size by 2050"[4]. Projects have a major role to play in this booming situation. Projects involve a set of specific complex tasks with a particular scope and limited time in allocated budget. "Accurate

[1] Editor's note: This paper was prepared for the course "International Contract Management" facilitated by Dr Paul D. Giammalvo of PT Mitratata Citragraha, Jakarta, Indonesia as an Adjunct Professor under contract to SKEMA Business School for the program Master of Science in Project and Programme Management and Business Development. http://www.skema.edu/programmes/masters-of-science. For more information on this global program (Lille and Paris in France; Belo Horizonte in Brazil), contact Dr Paul Gardiner, Global Programme Director, at paul.gardiner@skema.edu.

[2] How to cite this paper: Johnson, J. (2019). Comparing the Effects of ABC and BIM in Construction Projects and Choose the Best Solution to Minimise the Delay and Cost Overrun Using MADMA, *PM World Journal*, Vol. VIII, Issue VII, August.

[3] GUILD OF PROJECT CONTROLS COMPENDIUM and REFERENCE (CaR) | Project Controls - planning, scheduling, cost management and forensic analysis (Planning Planet). (n.d.). Retrieved from http://www.planningplanet.com/guild/gpccar/introduction-to-managing-cost-estimating-budgeting

[4] IPMA. (2017, February 17). The World in 2050 - and some implications for project management - IPMA International Project Management Association. Retrieved from https://www.ipma.world/world-2050-implications-project-management/

cost estimate and effective cost monitoring and control are essential elements to construction project success"[5]. Unfortunately, the current project management is not efficient "The average cost overrun of all projects is 27%"[6] this is a major problem in projects and will increase if not properly managed. The examples cost overrun projects are international space station (68bn$ over budget) and Sochi Olympics (32 bn $ over budget)[7].

"Pre-construction and design services contribute 15% of the budget of that can successfully identify potential issues before construction actually begins. This percentage is very less compared to the money saved on the project construction phase"[8]. Preconstruction planning and estimation have a major role in deciding the project success. "The factors that were studied make it difficult to control cost overruns during the construction stage alone. Instead, there should be sufficient planning of the project at the inception stage. Drawings and other tender documents should be well detailed before going out to tender"[9]. Efficient planning and estimation can prevent delay and cost overrun in construction projects. Current cost estimation system is not accurate as activity-based cost estimation system.

"Activity-Based Costing traces indirect costs or known as overhead to products and services identifying resource and their costs, the consumption of these resources by activities and performance of activities to produce output" [10]. This efficient cost estimation system improves the performance of cost estimation and it results in the performance of project management. The challenge for ABC is huge and complex data input is needed. "BIM (Building Information Modeling) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure"[11]. BIM can provide adequate data for ABC the combined utilization of both activity-based costing and building information modeling will significantly minimize the problems in projects. "although delay and cost overrun may seem very inherent in most projects, the good news is that it can be reduced or totally eliminated using a

[5] Elbeltagi, E., Dawood, M., Hosny, O., & Elhakeem, A. (2014, August). BIM-Based Cost Estimation/ Monitoring For Building Construction. Retrieved from https://www.researchgate.net/publication/264195542_Cost_Estimation_in_Building_Information_Model
[6] Seven Shocking Project Management Statistics. (2018, November 16). Retrieved from https://www.teamgantt.com/blog/seven-shocking-project-management-statistics-and-lessons-we-should-learn
[7] McCarthy, N. (2014, December 10). Major International Construction Projects That Went Billions Over-Budget [Infographic]. Retrieved from https://www.forbes.com/sites/niallmccarthy/2014/12/10/major-international-construction-projects-that-went-billions-over-budget-infographic/#1bcd927d376a
[8] 5 Common Causes of Cost Overruns in Construction Projects - PlanGrid Construction Productivity Blog. (2018, June 4). Retrieved from https://blog.plangrid.com/2017/11/5-common-causes-of-cost-overruns-in-construction-projects/
[9] Ramabodu, M. S., & Verster, J. P. (n.d.). Factors Contributing to Cost Overruns of Construction Projects. Retrieved from https://www.irbnet.de/daten/iconda/CIB_DC22746.pdf
[10] Implementing Activity-Based Costing | IMA - The association of accountants and financial professionals working in the business. (n.d.). Retrieved from https://www.imanet.org/insights-and-trends/strategic-cost-management/implementing-activity-based-costing?ssopc=1
[11] What Is BIM | Building Information Modeling | Autodesk. (n.d.). Retrieved from https://www.autodesk.com/solutions/bim

proper project performance monitoring and control system that will integrate all the key activities of each phase of the project"[12].

The primary causes of delay and cost overrun in the project are analyzed through the fishbone diagram. The primary category can be divided into 4 namely project category, human category, environment category, and management category.

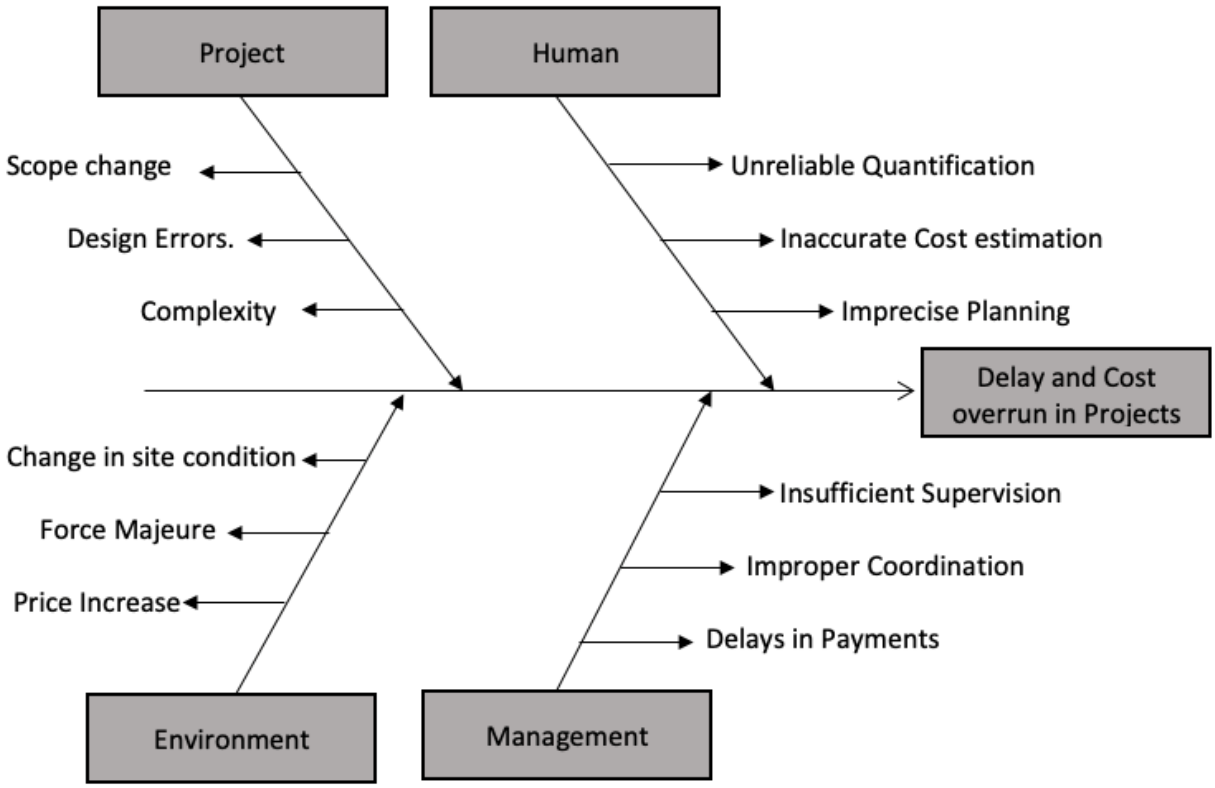


FIG:01 FISHBONE DIAGRAM [13]

By analyzing the fishbone diagram, it is clear that Implementing Activity-Based costing using Building Information modeling can eliminate most of the problems. By the end of the paper, we would able to understand the advantages of using Activity Based Costing and Building Information Modeling Together.

[12] Buys, F. (2015, September). FIVE CAUSES OF PROJECT DELAY AND COST OVERRUN, AND THEIR MITIGATION MEASURES. Retrieved from https://www.linkedin.com/pulse/five-causes-project-delay-cost-overrun-mitigation-measures-buys/
[13] FISHBONE DIAGRAM (BY AUTHOR)

METHODOLOGY

Step 1 – Summarize

"Construction delays are more likely to happen in almost all projects due to the miscommunication between contractors, subcontractors, property owners or any other reasons. In many cases, construction projects are delayed because of the inaccurate estimate of time and project cost that was initially presented to the clients or project owners"[14]. Miscommunication and inaccurate estimation are the major reasons for delay and cost overrun in projects. Thereby understanding the different options to minimize or eliminate this problem. So, what are those alternatives that can be implemented to avoid delay and cost overrun in projects?

Step 2 -Feasible alternatives

Below is the feasible alternative solution to be implemented to minimize the delay and cost overrun in construction projects.

1. **Traditional Costing**

"Traditional costing systems can be inaccurate because it has a tendency to assign indirect costs based on something easy to identify such as direct labor hours. Actually, there is no actual relationship between the cost pool and the cost driver. This can make indirect costs allocation inaccurate" [15]. Cost estimation has an important role in projects for taking major decisions. Unrealistic cost estimation leads to cost overrun in projects.

2. **Traditional CAD**

Computer Aided Designing was a breakthrough in the field of construction. CAD helped to reduce the time and effort to make accurate drawings even though CAD have some drawbacks like if a change in drawing in the section we need to manually change it into every other connected drawing. "In CAD each line is independent and need to adjust manually that means each sheet is separate. The database is not interconnected and for maintaining and update extra work is required"[16].

[14] Nor Razinah Mohd Zain. (2018, October 5). (PDF) An Exploration of Causes for Delay and Cost Overruns In Construction Projects: Case Study of Australia, Malaysia & Ghana. Retrieved from https://www.researchgate.net/publication/305770518_An_Exploration_of_Causes_for_Delay_and_Cost_Overruns_In_Construction_Projects_Case_Study_of_Australia_Malaysia_Ghana
[15] Kumar, N., & Mahto, D. (n.d.). A Comparative Analysis and Implementation of Activity Based Costing (ABC) and Traditional Cost Accounting (TCA) Methods in an Automobile Parts Manufacturing Company: A Case Study. Retrieved from https://globaljournals.org/GJMBR_Volume13/3-A-Comparative-Analysis.pdf
[16] Jurgens, C. (18, October 23). BIM vs. CAD... What's the difference? Retrieved from https://home.akitabox.com/blog/bim-vs-cad-what-is-the-difference

3. Building Information Modelling

"Building Information Modeling (BIM) technology allows you to digitally create very precise virtual building models. These models facilitate design and improve analysis and control over manual procedures. Once completed, these digital mockups contain precise geometric information and data needed for construction, manufacturing, and supply"[17]. BIM is a computer-aided designing software allow architects, engineers, designers, and other departments can work together and virtually stimulate the model of target project. This stimulation helps to improve communication between different stakeholders. The change orders can be automatically ripples to all connected models. "BIM is software for modeling and information input but also incorporates project management tools and processes. BIM can, therefore, be used in construction projects by project professionals, for example, to improve stakeholder collaboration"[18]. BIM also helps the project management team to get a better understanding of the project and improve planning to avoid delays.

4. Activity-based costing

Activity Based costing is most accurate and suitable for projects. In ABC indirect cost is allocated according to the resource utilized by specific activity. By this method, we can precisely calculate how resources are used and make decisions to maximize efficiency and resource allocation. "A method that can measure the cost and performance of activities, cost objects, and resources. Resources are assigned to activities, then activities are assigned to cost objects based on their use. Activity-based costing recognizes the causal relationships of cost drivers to activities"[19]." Activity Based Costing discloses the links between execution particular activities and the demands those activities make on the organization's reserves, so it can give managers a clear image of how parts, customers, brands, facilities, regions, or distribution channels both generate revenues and consume resources. The profitability picture that emerges from the Activity Based Costing study helps managers focus their consideration and energy on refining activities"[20]. The major drawback of ABC is it is complex and needs accurate quantifications. The errors in quantification will drastically decrease the accuracy of Activity Based Costing.

[17] Qu'est ce que le BIM? (2018, August 28). Retrieved from https://www.tekla.com/fr/a-propos/quest-ce-que-le-bim
[18] Bryde, D., & Marc volm, J. (2013, June 31). the project benefits of building information modeling (bim). Retrieved from https://www.apm.org.uk/media/7571/building-information-modelling.pdf
[19] Wideman Comparative Glossary of Project Management Terms v5.5. (n.d.). Retrieved from http://www.maxwideman.com/pmglossary/PMG_A02.htm#Activity%20Based%20Costing
[20] Kumar, N., & Mahto, D. (n.d.). A Comparative Analysis and Implementation of Activity Based Costing (ABC) and Traditional Cost Accounting (TCA) Methods in an Automobile Parts Manufacturing Company: A Case Study. Retrieved from https://globaljournals.org/GJMBR_Volume13/3-A-Comparative-Analysis.pdf

5. Activity-based costing with BIM

This is the method of utilizing BIM for getting accurate resource requirement and based on this data cost is estimated using Activity Based Costing. "The main aspects of BIM including clash detection, constructability, analysis, time and cost estimation (4D and 5D), integration, quantity take-off, element-based models, collaboration and team building, and communication on construction projects"[21]. Building Information Modelling is very effective in communicating different stakeholders, so we can rectify design errors in initial stages. "Using building information model drawing and quantifications can be generated directly from the underlying model. So, the info is always reliable with the design. When an alteration is made in design is continuously automatically waves to all connected documents and schedules that can be used by estimator"[22]. Every change order implemented into BIM section automatically modify all other sections. Resource requirement also changes according to change order is transferred to cost estimation software, so cost estimation will be always updated. Realistic cost estimation helps project management team to take effective decisions and eliminate cost overruns and delay in projects.

Step 3 - Development of Attributes

To assess the different alternatives, we need some attributes that will enable to rank the best solution to least. The attributes are selected as per the influence of factors that can cause delay and cost overrun on projects.

1 Coordination

Coordination between different stakeholders in the aspect of data sharing is a significant factor in the success of projects. "Coordination can be seen as a process of managing resources in an organized manner so that a higher degree of operational efficiency can be achieved for a given project."[23]

2 Version Control

In the construction site, it is very important that the current version of documents is used. The capability of the alternative solution to handle this problem is analyzed by this

[21] Rokooei, S. (2015, December). Building Information Modeling in Project Management: Necessities, Challenges, and Outcomes. Retrieved from https://www.researchgate.net/publication/286541567_Building_Information_Modeling_in_Project_Management_Necessities_Challenges_and_Outcomes
[22] Autodesk. (n.d.). BIM and Cost Estimating. Retrieved from http://images.autodesk.com/apac_grtrchina_main/files/aec_customer_story_en_v9.pdf
[23] Hossain, L. (2009, January). (PDF) Communications and coordination in construction projects. Retrieved from https://www.researchgate.net/publication/46529107_Communications_and_coordination_in_construction_projects

attribute. "Version control is important when documents are being created, and for any records that undergo a lot of revision and redrafting. It helps us to track changes and identify when key decisions were made along the way"[24].

3 Accuracy

This attribute regards the quality of the alternative method to generate output close to original estimate to eliminate the delay and cost overrun in projects. Accuracy leads to the elimination of difference between planned and actual situation. In fact, this is an important attribute to consider how realistic is the alternative solution. "Inaccurate cost estimation is detrimental for construction projects. Both overestimation and underestimation have negative consequences"[25].

4 Change Acceptance

The change orders are one of the major reasons for project delays and cost overruns in the project. The alternative solution should have the ability to accept the change orders. "When owner or contractor realizes that a design isn't working or want to introduce new supplies after early model and budget have been finished a change order occurs. Additional requirements will result in a higher cost than the original project budget. The extra time, manpower required to complete the new initiative also classified as a cost overrun"[26].

5 Precision

This attribute considers how precise is the output of the alternative solution. "precision is defined as the measure of exactness"[27]. For a precise output accurate and reliable data is essential.

6 Complexity Management

This attribute considers the complexity management of the alternative solution, the complexity level of the solution is important for Applying in small projects. "The complexity of the project could also be a contributing factor to delay and cost overrun. Complexity could be defined in terms of the size of the project, most mega-projects tend to have relatively long implementation

[24] The University of Nottingham. – 404. (n.d.). Retrieved from https://www.nottingham.ac.uk/governance/records-and-information-management/documents/guidance-documents
[25] Bipat, C. (2018, July 11). Why Accuracy Is Important in Construction Cost Estimation. Retrieved from https://www.ny-engineers.com/blog/construction-cost-estimation
[26] 5 Common Causes of Cost Overruns in Construction Projects - PlanGrid Construction Productivity Blog. (2018, June 4). Retrieved from https://blog.plangrid.com/2017/11/5-common-causes-of-cost-overruns-in-construction-projects/
[27] Precision. (2017, December 19). Retrieved from https://project-management-knowledge.com/definitions/p/precision/

period when compared to small project"[28]. The alternative solution should have the ability to handle the complexity of the project.

7 Reliability

This attribute regards to the reliability of the output of alternative solution. For producing good output for cost estimation reliable quantification is required. Estimation based on unreliable data is a risk to decision making in projects. Reliability is "Consistency and validity of test results determined through statistical methods after repeated trials"[29].

8 Errors Handling

Error handling attribute considers the capacity of the alternate solution to react with errors in cost estimation. "One major factor that has been identified as reasons for cost overrun in most projects is design errors"[30]. The best alternative method has minimum errors in cost estimation leads to realistic cost estimation. The perfect error elimination ability is desired for the alternative solution.

9 Skill level required

This attribute analyzes the skill level required for the user to handle different alternative solution. The alternative solution with computer-aided calculation support needed less skill than manual calculations.

10 Scalability

This attribute considers the ability of the alternative solution to accommodate new options and increase the output. The alternate solution that has the capacity to work with future developing technologies. "Facility, plant, or unit whose size, performance, or the number of users can be increased on demand without a penalty in cost or functionality"[31].

[28] Buys, F. (2015, September). FIVE CAUSES OF PROJECT DELAY AND COST OVERRUN, AND THEIR MITIGATION MEASURES. Retrieved from https://www.linkedin.com/pulse/five-causes-project-delay-cost-overrun-mitigation-measures-buys/
[29] What is reliability? definition and meaning. (n.d.). Retrieved from http://www.businessdictionary.com/definition/reliability.html
[30] Buys, F. (2015, September). FIVE CAUSES OF PROJECT DELAY AND COST OVERRUN, AND THEIR MITIGATION MEASURES. Retrieved from https://www.linkedin.com/pulse/five-causes-project-delay-cost-overrun-mitigation-measures-buys/
[31] What is scalable? definition and meaning. (n.d.). Retrieved from http://www.businessdictionary.com/definition/scalable.html

11 Confidentiality

It is important when the client is from defense or government projects. The alternative solution has enough document control to who can access the document. Documents are uncontrolled if it in hard copy and more secure if the document is in softcopy. The softcopy with access control is most desired. "Failure to properly secure and protect confidential business information can lead to the loss of business/clients"[32].

12 Duration

Duration is "Period required to complete an activity, job, or task"[33].This attribute regards the time required for the alternative solution to make output in initial or after a change order. The alternative solution with minimum processing time is most desired.

13 Traceability

This attribute analyzes the ability of the alternative solution to trace back the previous revisions and review the changes according to the time. This important in construction documents with many revisions. By this feature, the user can find what changes applied in each revision and who approved the modifications. "Ability to trace the application, location, and/or history of an activity or item by means of recorded data"[34].

14 Reusability

This attribute considers the capacity of the alternative solution to using in future projects. Customizing the already designed solution to similar projects rather than reinventing the wheel.

Step 4 – Selection Criteria

In this paper, we are now going to use a **multi-attribute decision-making model** based on a qualitative analysis to compare the attributes to the alternative's solution[35]. Here the alternative solution is ranked on 5 stages namely very high, high, neutral, low and very low. Each color

[32] The Importance of Confidentiality in the Workplace. (2017, October 18). Retrieved from https://www.halpernadvisors.com/why-is-confidentiality-important/
[33] What is duration? definition and meaning. (n.d.). Retrieved from http://www.businessdictionary.com/definition/duration.html
[34] What is traceability? definition and meaning. (n.d.). Retrieved from http://www.businessdictionary.com/definition/traceability.html
[35] Sullivan, Wickes & Kroelling (2014) Engineering Economics 15th EditionThen the second step is to calculate the relative weighting of each attribute. Retrieved from: http://www.planningplanet.com/guild/gpccar/managing-change-the-owners-perspective

indicates each stage varies from green for very high, light green for high, yellow for neutral, orange for low and red for very low.

Table 1- Multi Attribute Decision Matrix[36]

Alternative solutions / Attributes	Traditional costing	Traditional CAD	Building information modeling	Activity Based Costing	ABC with BIM
coordination	low	low	high	neutral	Very high
Version control	very low	low	high	neutral	very high
Accuracy	Very low	neutral	high	high	Very high
change acceptance	Very low	low	high	neutral	Very high
Precision	Low	high	very high	high	very high
complexity management	Very low	low	high	high	Very high
Reliability	low	high	very high	high	very high
Errors handling	very low	low	neutral	neutral	Very high
Skill level Required	low	neutral	high	low	high
scalability	low	high	very high	neutral	very high
confidentiality	low	very low	high	neutral	high
Duration	low	low	high	very low	very high
Traceability	very low	low	high	high	very high
Reuseability	very low	low	high	low	high

To quantitatively analyze the alternative solution represented in the table we need to convert the table into scorings.

Table 2- Quantitative representation of attributes[37]:

Alternative solutions / Attributes	Coordination	Version control	Accurcy	Change acceptance	Precision	Complexity Management	Reliability	Errors handling	Skill level	Scalability	confidentality	Duration	Traceability	Reuseability
very high	1	1	1	1	1	1	1	1	1	1	1	1	1	1
high	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
neutal	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
low	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
very low	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Now we can use the above table 2 to weight the attributes in table 1.

[36] Multi Attribute Decision Matrix (BY AUTHOR)
[37] By Author

FINDINGS

Step 5 – Analysis and Selection of Best Alternative Solutions

Table 3- Relative Weighting[38]

Alternative solutions / Attributes	Traditional costing	Traditional CAD	Building information modeling	Activity Based Costing	ABC with BIM
coordination	0.25	0.25	0.75	0.50	1
Version control	0	0.25	0.75	0.50	1
Accuracy	0	0.50	0.75	0.75	1
change acceptance	0	0.25	0.75	0.50	1
Precision	0.25	0.75	1	0.75	1
complexity management	0	0.25	0.75	0.75	1
Reliability	0.25	0.75	1	0.75	1
Errors handling	0	0.25	0.50	0.50	1
Skill level Required	0.25	0.50	0.75	0.25	0.75
scalability	0.25	0.75	1	0.50	1
confidentiality	0.25	0	0.75	0.50	0.75
Duration	0.25	0.25	0.75	0	1
Traceability	0	0.25	0.75	0.75	1
Reuseability	0	0.25	0.75	0.25	0.75
Total	1.75	5.25	11	7.25	13.25

We will use "additive weighting technique"[39] by ranking each of attributes by their importance. The sum of each solution can be compared to the normalized weight of 1.50, which is the maximum. The attributes are ranked from most important to least in the following order. Coordination > Change acceptance > Complexity management > Error handling > Accuracy > Precision > Reliability > Confidentiality > Version control > Skill level required > Scalability > Duration > Reusability > Traceability.

[38] By Author
[39] Sullivan, Wickes& Kroelling (2014). Engineering Economics 15th Edition Then the second step is to calculate the relative weighting of each attribute. Retrieved from http://www.planningplanet.com/guild/gpccar/managing-change-the-owners-perspective

Table 4- Additive weighting technique[40]

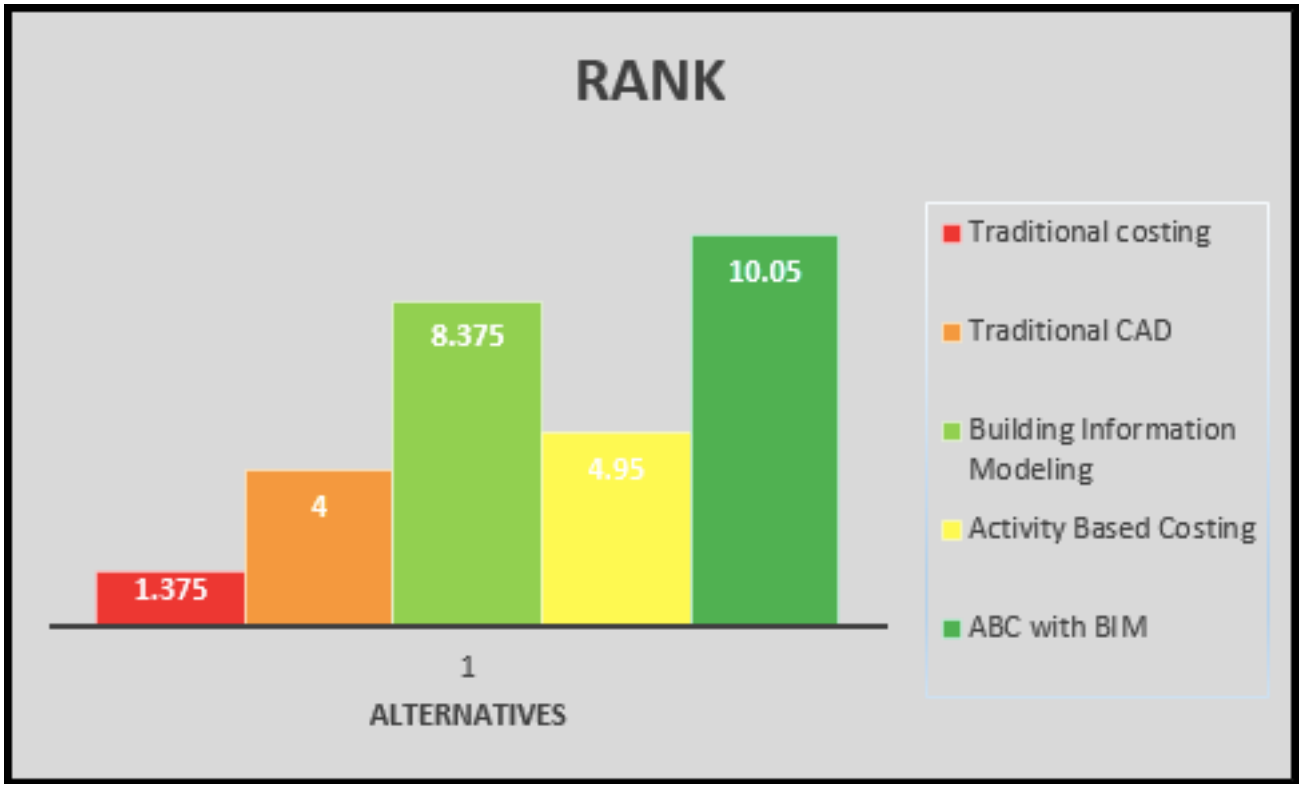
Alternative solutions / Attributes	Relative Rank/ Weight	Normalised Weight	Traditional costing		Traditional CAD		Building information modeling		Activity Based Costing		ABC with BIM	
coordination	1	0.10	0.25	0.025	0.25	0.025	0.75	0.075	0.50	0.05	1	0.10
Version control	9	0.90	0	0	0.25	0.225	0.75	0.675	0.50	0.45	1	0.90
Accuracy	5	0.50	0	0	0.50	0.25	0.75	0.375	0.75	0.375	1	0.50
change acceptance	2	0.20	0	0	0.25	0.05	0.75	0.15	0.50	0.10	1	0.20
Precision	6	0.60	0.25	0.15	0.75	0.45	1	0.60	0.75	0.45	1	0.60
complexity management	3	0.30	0	0	0.25	0.075	0.75	0.225	0.75	0.225	1	0.30
Reliability	7	0.70	0.25	0.175	0.75	0.525	1	0.70	0.75	0.525	1	0.70
Errors handling	4	0.40	0	0	0.25	0.10	0.50	0.20	0.50	0.20	1	0.40
Skill level Required	10	1.00	0.25	0.25	0.50	0.50	0.75	0.75	0.25	0.25	0.75	0.75
scalability	11	1.10	0.25	0.275	0.75	0.825	1	1.10	0.50	0.55	1	1.10
confidentiality	8	0.80	0.25	0.2	0	0	0.75	0.60	0.50	0.40	0.75	0.60
Duration	12	1.20	0.25	0.30	0.25	0.30	0.75	0.90	0	0	1	1.20
Traceability	14	1.40	0	0	0.25	0.35	0.75	1.05	0.75	1.05	1	1.40
Reuseability	13	1.30	0	0	0.25	0.325	0.75	0.975	0.25	0.325	0.75	1.30
Total	10.5	10.50	Total	1.375	Total	4	Total	8.375	Total	4.95	Total	10.05

Step 6 – Selecting and Re-Arranging the Best Alternative Solutions

After ranking the attributes according to their importance for solving the problem of delay and cost overrun in projects by use of "additive weighting technique" , now we can clearly identify which alternative solution is most suitable to solve the problems. From table 4 it is clear that traditional costing is the least total of 1.375 out of 10.50 and a less fit choice. Traditional CAD and Activity-based costing have a similar total from different attributes. Traditional CAD has a total of 4 out of 10.5 and Activity-based costing has a total of 4.95 out of 10.5. comparing to the other alternatives this is less so Traditional CAD and Activity-based costing is not a suitable solution for the problem. BIM has a total of 8.375 out of 10.50 and a good solution but the combined ABC and BIM are almost perfect have a total of 10.05 out of 10.50 is the most suitable solution for the problem.

[40] By Author

Chart 1- Rank of alternative solution[41]



Thus, the best alternative solution is ABC with BIM, followed by Building information modelling, Activity-based costing, Traditional CAD and Traditional costing.

The ABC with BIM alternative is a better choice by 95% (10.05/10.50*100) suitable to solve the problems causing delay and cost overrun in projects.

Step 7 – Performance Monitoring and Post-Evaluation of Results

The analysis is performed to find the best solution among the chosen alternatives, which confirms how we can eliminate delay and cost overrun in construction projects. Implementing ABC with BIM can help in formulating realistic cost estimation and improved coordination from different stakeholders that helps to eliminate problems in construction projects like delay and cost overrun. The ABC with BIM has the advantages of both Activity-based costing and Building information modelling. Thus, the best alternative solution is ABC with BIM followed by Building information modelling and Activity-based costing. These solutions must be managed by the project management team to overcome the delay and cost overrun in construction projects.

[41] By Author

CONCLUSIONS

The goal of this paper is to answer the following question: What is the solution to the problems in construction projects that cause delay and cost overrun? And what are the best alternative solution to be implemented to eliminate delay and cost overrun in construction projects?

Through this paper, we have highlighted the different alternatives to solve the delay and cost overrun in construction projects as being: Traditional costing, Traditional CAD, Building Information Modelling, Activity Based Costing and Activity Based Costing with Building Information Modelling. We have explained each alternative and assessed the impact of each regarding our specific topic. Through the studies, it is clear that ABC with BIM is the best solution to solve the problems that can be caused delay and cost overrun in construction projects. It is very important that delay and cost overrun should be eliminated from future projects. "The importance of BIM model especially in design-build projects and implement them in the design phase and in during the construction for scheduling "[42]. As explained in the paper ABC with BIM enables companies to minimize delay and cost overrun in construction projects.

BIBLIOGRAPHY

1. Shen, X., Tang, L., & Kecheng, L. (2013, October). Cost Estimation in Building Information Model. Retrieved from https://www.researchgate.net/publication/264195542_Cost_Estimation_in_Building_Information_Model

2 Elbeltagi, E., Dawood, M., Hosny, O., & Elhakeem, A. (2014, August). BIM-Based Cost Estimation/ Monitoring For Building Construction. Retrieved from https://www.researchgate.net/publication/264195542_Cost_Estimation_in_Building_Information_Model

3 Giammalvo, P. D. (2018, April). Mapping ERP "Chart of Accounts" to Building Information Modeling Software Using Omniclass Coding Structures and Activity Based Costing/Management- A CONTRACTOR'S perspective. Retrieved from https://pmworldjournal.net/article/mapping-erp-chart-of-accounts-to-building-information-modeling-software/

4 Al hajj, A., & Hussein al zaher, T. (2012, August). Effectiveness of implementing Activity Based Costing technique on cost function and performance of construction project. Retrieved from https://www.researchgate.net/publication/281439488_Effectiveness_of_implementing_Activity_Based_Costing_technique_on_cost_control_function_and_performance_of_construction_project

[42] Franco, J., Mahdi, F., & Abaza, H. (2015, October). Using Building Information Modeling (BIM) for Estimating and Scheduling, Adoption Barriers. Retrieved from http://www.hrpub.org/download/20150930/UJM5-12104533.pdf

5 Ayachit, A., Attarde, P. M., & Kulkarni, S. (2014, December). Activity Based Costing in Construction Projects. Retrieved from http://www.technicaljournalsonline.com/ijaers/VOL IV/IJAERS VOL IV ISSUE I OCTBER DECEMBER 2014/514.pdf

6 Baoping, C. (2011). BIM and its Effects on Project Managers. Retrieved from https://www.pucsp.br/icim/ingles/downloads/papers_2011/part_4/part_4_proc_71.pdf

7 Buys, F. (2015, September). FIVE CAUSES OF PROJECT DELAY AND COST OVERRUN, AND THEIR MITIGATION MEASURES. Retrieved from https://www.linkedin.com/pulse/five-causes-project-delay-cost-overrun-mitigation-measures-buys/

8 Rokooei, S. (2015, December). Building Information Modeling in Project Management: Necessities, Challenges and Outcomes. Retrieved from https://www.researchgate.net/publication/286541567_Building_Information_Modeling_in_Project_Management_Necessities_Challenges_and_Outcomes

9 Subramani, T., Sruthi, P. S., & Kavitha, M. (2014, June). Causes of Cost Overrun In Construction. Retrieved fromhttp://iosrjen.org/Papers/vol4_issue6 (part-4)/A04640107.pdf

10 Travaglini, A., Radujkovic, M., & Mancini, M. (2014, October). Building Information Modelling (BIM) and Project Management: a Stakeholders Perspective. Retrieved from https://www.researchgate.net/publication/276805598_Building_Information_Modelling_BIM_and_Project_Management_a_Stakeholders_Perspective

11 Autodesk. (n.d.). BIM and Cost Estimating. Retrieved from http://images.autodesk.com/apac_grtrchina_main/files/aec_customer_story_en_v9.pdf

12 Ramabodu, M. S., & Verster, J. P. (n.d.). Factors Contributing to Cost Overruns of Construction Projects. Retrieved from https://www.irbnet.de/daten/iconda/CIB_DC22746.pdf

13 IPMA. (2017, February 17). The World in 2050 - and some implications for project management - IPMA International Project Management Association. Retrieved from https://www.ipma.world/world-2050-implications-project-management/

14 Seven Shocking Project Management Statistics. (2018, November 16). Retrieved from https://www.teamgantt.com/blog/seven-shocking-project-management-statistics-and-lessons-we-should-learn

15 McCarthy, N. (2014, December 10). Major International Construction Projects That Went Billions Over-Budget [Infographic]. Retrieved from https://www.forbes.com/sites/niallmccarthy/2014/12/10/major-international-construction-projects-that-went-billions-over-budget-infographic/#1bcd927d376a

16 Nor Razinah Mohd Zain. (2018, October 5). (PDF) An Exploration of Causes for Delay and Cost Overruns In Construction Projects: Case Study of Australia, Malaysia & Ghana. Retrieved from https://www.researchgate.net/publication/305770518_An_Exploration_of_Causes_for_Delay_and_Cost_Overruns_In_Construction_Projects_Case_Study_of_Australia_Malaysia_Ghana

17 Kumar, N., & Mahto, D. (n.d.). A Comparative Analysis and Implementation of Activity Based Costing (ABC) and Traditional Cost Accounting (TCA) Methods in an Automobile Parts Manufacturing Company: A Case Study. Retrieved from https://globaljournals.org/GJMBR_Volume13/3-A-Comparative-Analysis.pdf

18 Precision. (2017, December 19). Retrieved from https://project-management-knowledge.com/definitions/p/precision/

19 Jurgens, C. (18, October 23). BIM vs. CAD... What's the difference? Retrieved from https://home.akitabox.com/blog/bim-vs-cad-what-is-the-difference

20 Hossain, L. (2009, January). (PDF) Communications and coordination in construction projects. Retrieved from https://www.researchgate.net/publication/46529107_Communications_and_coordination_in_construction_projects

21 Autodesk. (n.d.). BIM and Cost Estimating. Retrieved from http://images.autodesk.com/apac_grtrchina_main/files/aec_customer_story_en_v9.pdf

22 GUILD OF PROJECT CONTROLS COMPENDIUM and REFERENCE (CaR) | Project Controls - planning, scheduling, cost management and forensic analysis (Planning Planet). (n.d.). Retrieved from http://www.planningplanet.com/guild/gpccar/developing-the-contractors-cost-estimate-bottom-up

23 Bryde, D., & Marc volm, J. (2013, June 31). the project benefits of building information modeling (bim). Retrieved from https://www.apm.org.uk/media/7571/building-information-modelling.pdf

24 Qu'est ce que le BIM ? (2018, August 28). Retrieved from https://www.tekla.com/fr/a-propos/quest-ce-que-le-bim

25 Implementing Activity-Based Costing | IMA - The association of accountants and financial professionals working in business. (n.d.). Retrieved from https://www.imanet.org/insights-and-trends/strategic-cost-management/implementing-activity-based-costing?ssopc=1

26 Wideman Comparative Glossary of Project Management Terms v5.5. (n.d.). Retrieved from http://www.maxwideman.com/pmglossary/PMG_A02.htm#Activity%20Based%20Costing

27 Bipat, C. (2018, July 11). Why Accuracy Is Important in Construction Cost Estimation. Retrieved from https://www.ny-engineers.com/blog/construction-cost-estimation

28 San Cristóbal, J. R. (2017, November). Complexity in Project Management. Retrieved from https://www.sciencedirect.com/science/article/pii/S1877050917323001

29 What Is BIM | Building Information Modeling | Autodesk. (n.d.). Retrieved from https://www.autodesk.com/solutions/bim

30 BIM Software | Project Controls - planning, scheduling, cost management and forensic analysis (Planning Planet). (n.d.). Retrieved from http://www.planningplanet.com/wiki/507764/bim-software

31 The University of Nottingham. – 404. (n.d.). Retrieved from https://www.nottingham.ac.uk/governance/records-and-information-management/documents/guidance-documents

32 The Importance of Confidentiality in the Workplace. (2017, October 18). Retrieved from https://www.halpernadvisors.com/why-is-confidentiality-important/

33 5 Common Causes of Cost Overruns in Construction Projects - PlanGrid Construction Productivity Blog. (2018, June 4). Retrieved from https://blog.plangrid.com/2017/11/5-common-causes-of-cost-overruns-in-construction-projects/

34 Max Wideman comparative glossary. Projectnet Glossary, April 1997, on the website of the UK publication Project Manager Today, Nordic Project Management Terminology, NORDNET, Reistad Offset, Oslo, 1985. Retrieved from http://www.maxwideman.com/pmglossary/PMG_P20.html

35 The Importance of Confidentiality in the Workplace. (2017, October 18). Retrieved from https://www.halpernadvisors.com/why-is-confidentiality-important/

36 GUILD OF PROJECT CONTROLS COMPENDIUM and REFERENCE (CaR) | Project Controls - planning, scheduling, cost management and forensic analysis (Planning Planet). (n.d.). Retrieved from http://www.planningplanet.com/guild/gpccar/introduction-to-managing-cost-estimating-budgeting

37 What is reliability? definition and meaning. (n.d.). Retrieved from http://www.businessdictionary.com/definition/reliability.html

38 Robles, G., Jose, L., Stifi, A., & Gentes, S. (2014, October). Labor Productivity in the Construction Industry -Factors Influencing the Spanish Construction Labor Productivity. Retrieved from http://waset.org/publications/9999560

39 Franco, J., Mahdi, F., & Abaza, H. (2015, October). Using Building Information Modeling (BIM) for Estimating and Scheduling, Adoption Barriers. Retrieved from http://www.hrpub.org/download/20150930/UJM5-12104533.pdf

40 Sullivan, Wickes& Kroelling (2014). Engineering Economics 15th Edition Then the second step is to calculate the relative weighting of each attribute. Retrieved from http://www.planningplanet.com/guild/gpccar/managing-change-the-owners-perspective

About the Author

Justin Johnson

India and France

Justin Johnson is an Engineer with 4+ years of experience in Oil and Gas Projects, Construction management and Occupational health and safety. Born in UAE, raised in India and recently relocated to France. He holds a bachelor's degree in Electronics and Communication Engineering from Calicut university, India and MBA Project management from Bharathiar University, India. He certified in Occupational Health and Safety by NEBOSH(UK). He has experience in LNG and LPG Gas plants construction in India and Middle east as Project Engineer and Health and Safety professional. Currently student of Skema Business School, France for MSc Project & Programme Management and Business Development. He speaks fluent English, Hindi, Malayalam, Tamil and basic French.

Justin lives in Lille, France and can be contacted at justin.johnson@skema.edu or LinkedIn: www.linkedin.com/in/justin-johnson-36360556