

Review Article

Identifying the Factor of Cost Overrun Affected BY Inflation in Construction Project: A Review

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Abstract - The rise of inflation affects the Gross Domestic Product (GDP), which indicates unstable economic growth. Inflation is becoming a major obstacle, which has a negative impact on the construction industry. The inflation rate has spiked in recent years due to market influence and industry demand. This review explores the role and limitations of inflation in the construction industry. In addition, it elaborates on the impact of inflation and how to optimize material cost, resources, and cost overruns affected by inflation, which have been discussed in detail. The conclusion indicates that cost overrun can be tackled using multi-objective scheduling, an optimization model, and some inventory methods. Automation in the construction industry cuts the time-cost overruns and increases the project's profit.

Keywords - Inflation, Material cost, Construction budget, Cost overruns, Labor wages.

1. Introduction

Inflation is a significant factor that plays a serious role in sustainable economic growth. It has been known in the construction industry for a long time, since 1945. Inflation research has been persistent in improving economic growth and in knowing the effects of industries till today [1]. In the construction economy, cost overrun is a widespread issue worldwide, but it provides particular difficulties for underdeveloped nations, which is called inflation.[2] Inflation affects the changes in material prices, and labor wages are the three common risk variables that are classified as follows: economic, construction, and design. [3] The inflation rate impacts the construction sector and the project's estimated budget, which causes a revision and results in cost overruns.

The annual modification of building material prices, labor pay, and machinery hire rates is to blame for this effect, which is causing major distress among the stakeholders [1]. The primary issue of clients is the construction industry's inability to finish projects on schedule and within budget.[2] We must also consider how scheduling and cost uncertainty affect a project's overall success [4]. Overall, inflation has increased during the last 30 years. In general, the inflation in the construction industry affects the estimated budget and ends up at cost overrun. However, the most significant increase in inflation occurred between the years 2000 and

2017, when the inflation rate increased from 1500 to 3700.[1] To identify the factors of cost overrun, time delay and schedule management in the construction industry by rectifying them using improved automation, software approach and mathematical model.

2. Role of Inflation in the Construction Industry

Windapo and Cattell state a conceptual model for the reason for inflation in the construction industry. The two major causes of inflation are the market and rising costs in construction sites. The reasons for the market include demand, supply, market conditions, transport costs, exchange rates, import duties, and raw materials. [1] The cost impact of a structure can be easily calculated by specialization values in the price of materials. [5] Also, rising construction site costs include labour, brick and cement, electrical material, paint, aggregates, reinforcing steel, wood and plumbing materials [1].

Building materials account for 35% to 60% of the total cost of building. [6] The cash flow term is regarded as a comprehensive record of all entering and exiting financial flows. This indicates that it incorporates all expenses and income when implementing a project. [7] The primary factors determining and forecasting the correlation of macroeconomic data on credit risk were the unemployment rate, GDP and inflation. [8]



3. Role of Inflation in Resource Management

Resource management is a challenging yet essential step in building projects, but a number of things prohibit projects from allocating resources effectively, which is called inflation. [9] The issues with resource scheduling are studied closely in construction management due to their significance. Given its complexity, resource levelling within resource scheduling is one of the main issues. [10] Uniform resource levels and resource requirements are needed to be achieved by reducing variations. The interaction between the activities, the need for resources, and the duration of the activities must all be considered in

the model. [10] Cost, workers, supplies, and machinery are important assets that greatly impact construction projects. It is essential in construction project scheduling to evaluate how resources affect cost. [11] But here, the inflation rate is not always in control of material costs; alternatively, prices may vary due to other unknown factors like market demand. But in the year 2017–2018, the biggest negative deviation was found in the categories of "Ordinary Portland Cement in Bulk" and "Ready Mix Concrete – Normal Mix", with percentages of 32.82% and 26.20%, respectively, indicating a correlation with the inflation rate by following the same decreasing pattern as inflation. [6]

Table 1. Factors of Cost-overrun in the construction industry

S. No	Name	Year	Area	Factor affects Cost overrun	Remarks
1.	Aminbakhsh and Sonmez [35]	2016	Turkey	Labour& Material	Solving the discrete time-cost tradeoff problem using Particle Swarm Optimization (PSO) in large projects.
2.	Kazaz <i>et al.</i> [30]	2016	Turkey	Material	Time, Cost and Quality (TCQ) are the triple constrain in construction projects.
3.	Prayogo <i>et al.</i> [10]	2018	Indonesia	Material	Using the MSOS algorithm, we can control resource fluctuations during the project.
4.	Musarat <i>et al.</i> [6]	2020	Malaysia	Material	To forecast the building material prize and revise the initial bill of quantities to cut the cost overrun.
5.	Alaloul <i>et al.</i> [25]	2021	Malaysia	Labour	Replacing labor with automation in machineries will reduce the cost-overrun.
6.	Ildarabadi and Alamatian [20]	2021	Iran	Material	The Monte Carlo simulation technique has been used to reduce the financial risks in construction projects.
7.	Sarvari <i>et al.</i> [19]	2021	Iran	Labour& Material	To develop Small and Medium-sized Enterprises (SMEs) by focusing on human resources, organizational management and Health Safety Environment (HSE).
8.	Peng <i>et al.</i> [14]	2022	China	Labour	To use a PSO-based algorithm to balance the labor force in the extremely short construction period of the project.
9.	Shapovalov <i>et al.</i> [22]	2023	Russia	Machinery	Designing the machine with reliable indicators, minimal metal consumption, and dynamic calculation will optimize the automation of the machinery.
10.	Basheer <i>et al.</i> [29]	2024	United Kingdom	Material	The blockchain-based material management is used to reduce material purchasing costs, improve decision-making, and reduce disputes between project parties on the construction site.

4. Project Cost Management in Construction

Project cost management includes the processes required to ensure the project is completed within the approved budget. In order to manage costs, there are three essential components. They are cost estimating, cost budgeting and cost control so that the project can be completed within the allocated budget. [12] Cost performance is evaluated using the Cost Performance Index (CPI), which measures how cost-effectively the project is being carried out. [12] However, cost overrun has a negative impact on cash flow, variances, and construction project schedules, among other things. A change in the cost of project resources or, occasionally, a change order causes a cost overrun. [11] So, clients continue to pay excessive project costs that increase because of the inflation rate effect, which first affects the construction sector. [13] So CPI is the function of cumulative earned value, and the cumulative actual cost management process involves different stages such as the Initial stage, Planning stage, Execution stage, Controlling stage and Completion stage. [12] The author evolved an optimization model to focus on minimizing the construction duration and successfully solved the problem by using Particle Swarm Optimization (PSO) based on priority and arrangement to determine the shortest duration of a single construction project under resource constraints. [14] The resource leveling of the project has been focused on both time and cost by using the method of multi-model resource constraint, which optimizes the project with a non-dominated sorting genetic algorithm. [15], [16] The author in the paper was gathered and analyzed using the mean item score ranking, percentages, and descriptive statistics. Cost overrun contributors were graded in terms of percentage using the severity index. [17]

A most important component of construction supply chains is material inventory management, which lowers the risks involved with running out of material (stock out costs), particularly for the contractor. These risks may end up in not only financial losses but also delays in the project's schedule. [18] The stakeholders of the construction project consider factors like time management, communication, cooperation, and consultation as the overall project's objectives, which have been briefly explained in the Critical Success Factors (CSFs). [19] For the process of project cost management, these three design variables were used to identify all financial features and effective economic considerations to achieve this goal. Final Cost (FC), Material Cost (MC), and Cost List (CL) were the three main economic variables that were determined in this case. The following information may help to clarify why these characteristics were selected. First, the annual update of the Cost List is dependent on the rate of inflation. Limits on access, supply and demand, and internal or external manufacturing also impact Material costs. The Final cost is determined by the analysis of Material cost and Cost List. [20] By coordinating inventory management responsibilities with material purchasing, monitoring, and

real-time status updates, this solution addressed material management's planning, sourcing, and management components. [21]

5. Resolving Issues in Labor Wages

In order to resolve the issue successfully, the dynamic indicators of the machine that are reflected in such a scheme must be similar to the qualitative indicators of its actual design. [22, 23] It is expected that demand for workers in the construction sector will grow at a consistent rate of 8% to 9%, but it is equally important to recognize that the sector is plagued by cost and time overruns as well as poor quality in resource management. [24] So, using machines instead of labor will cut both direct and indirect costs, allowing the project to be completed on schedule and within the allocated budget. The problem of labor costs exceeding budget can be remedied by implementing automation systems. Machines can minimize worker costs, allowing projects to easily fulfill their goals. [25] Focusing on the areas of specialization has changed industrial processes, creating favorable economic possibilities by using automation in construction sites. Taking tactical, operational, and strategic aspects into the project's cost is crucial. [26, 27] The improvement certainly was brought on by the pandemic's significant temporary unemployment. Therefore, it is likely that the increase in safety performance would only be temporary and not be directly attributed to the safety regulations or policies implemented during the pandemic. [28] The solution's inventory management component was created to strike a compromise between the certainty of human judgment and the scientific method when used with automation for material ordering. [29]

The effects of building materials on a project's time, cost, and estimative quality indicators should be compared in the beginning using the same crew formation and crew policy. In reality, in addition to building supplies, the expected grade of a project will be determined at the conclusion of the initial stage. [30] The time, cost, resource and environmental impact objectives of a building project are simultaneously optimized and balanced using a multi-objective scheduling optimization model. [4] The quality should not be included in the following stage. The planning engineer should only begin the next stage if they wish to alter the cost and timing of the best schedule they were able to establish in the initial stages; the only things that should be optimized simultaneously are project time and cost, considering various employee sizes and regulations for each work. [30]

6. Rectifying Time-Cost Constraints

According to government and business sector data, up to 65% of projects currently suffer from schedule and financial limitations violations, which subsequently cause significant disagreements. It should be noted that the research trends of

construction projects have thoroughly examined key elements influencing the timing, cost, and level of quality of building projects. [24] Additionally, the majority of these companies ignore critical financial issues of construction projects in favor of make-span optimization even when addressing time cost tradeoffs. [31] The Company protects its long-term organizational interests through the industries it serves at the same time, adds more value to the organization by expanding its service areas, in case the company has the financial strength and advance payment ability according to the actual needs of the project. [32]

This conceptual framework represents that the construction industry and inflation on the market are simultaneously interrelated to economic growth and Gross Domestic Product. The three main factors determining construction cost overrun in the construction industry are building material prices, labour wages and machinery costs. [1] The project cost includes both direct and indirect expenses. This study focuses on some cases of small- and large-scale problems. [33] Construction time–cost tradeoff problems are viewed as one of the most important aspects of construction decision-making. In a project, the duration and cost of an activity depend on the method to be used and the assigned crew and equipment. Determining the best combinations of possible durations and costs for the activities is the goal of time–cost tradeoff problems. [34] The objective control over determining the price of building items is directly responsible for the decrease in the expected

construction cost. [12] So, using the combined integer-based programming approach, the majority of the instances are solved using the cost optimization problem's optimal solution.

The large-scale discrete time-cost tradeoff cost optimization issue may be evaluated for performance using heuristic and meta-heuristic approaches. [35, 36] To illustrate how to utilize the model, show its optimization process and design a minimal financial construction with scheduling, a small case study and application example were examined. [37] Also, these two financial indicators are commonly strongly connected to material inventory management: acquisition costs (or ordering costs) and holding costs. [29] Acquisition costs or ordering costs will cover all expenses related to obtaining the item, such as creating requisitions, identifying suppliers, managing the supply chain, speeding the commodity's delivery, handling, inspecting, and processing payments. Then again, the holding costs play a role in the total cost of keeping the items in the stores, which is included in the holding expenses. This cost comprises insurance, value loss, expiration, storage space, lighting, heating, power supply, and storage documentation costs. [29]

This solution addressed material management's planning, sourcing, and management components by coordinating inventory management responsibilities with material purchasing, monitoring, and real-time status updates. [29]

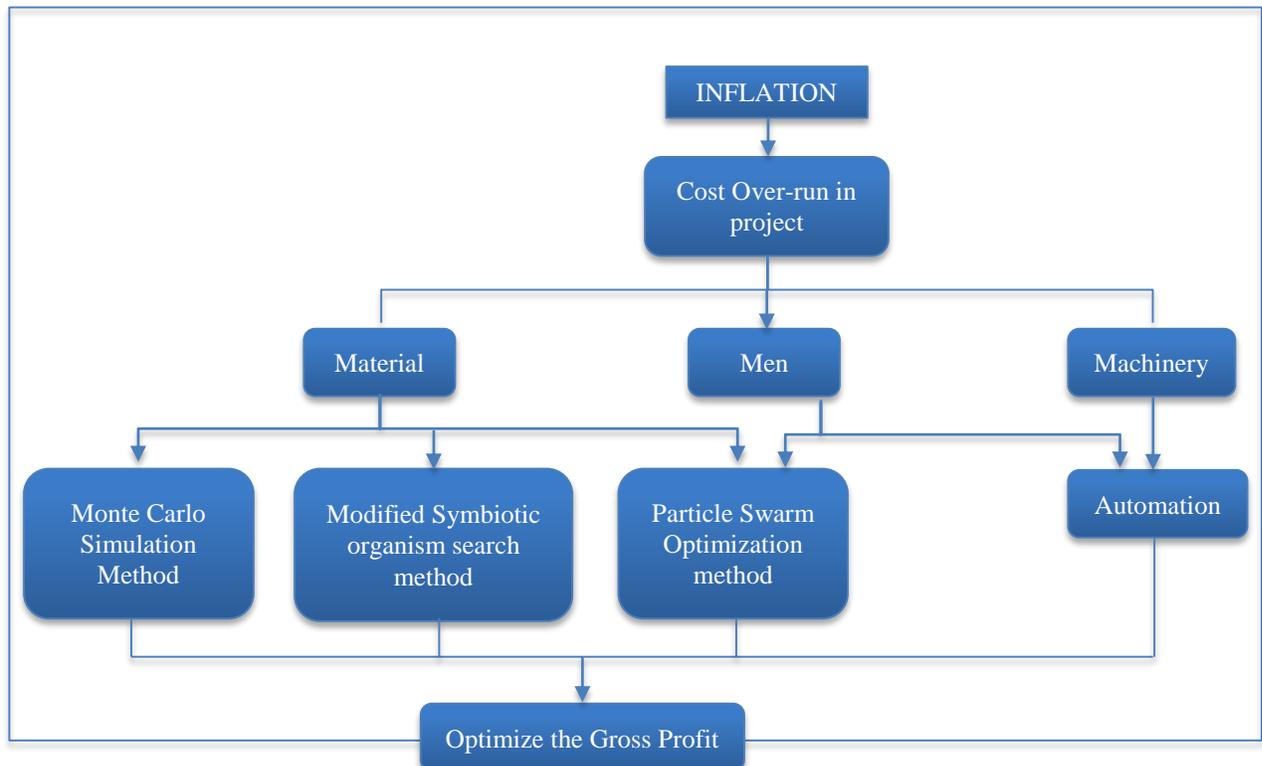


Fig. 1 Optimization method for gross profit affected by inflation

7. Resource in Construction

Construction time is ultimately determined by the quality, cost and productivity of each resource used in the process. [38] According to the basis of "resource reduction, reuse, and utilization," the circular economy is an economic growth model based on resource efficiency and reuse, with the resource-based city's fundamental characteristics being low consumption, low emission, and high efficiency. [39] Commonly, the increasing world oil price induces higher business costs. On the other hand, depreciating exchange rates encourage increased import prices and raise exports. However, both these factors lead to cost-push inflation risk. [1]

In this rising property price ignites the increased customer wealth. Meanwhile, the rapid expansion of money and credits from banks has led to the rise of consumer spending on finance by loan. Overall, these factors cause the demand-pull inflation risk. [1] In the same way, using alternative building materials will have an impact on both the direct and indirect costs of an undertaking as well as maintenance costs. Lastly, there are differences in various building material's qualities like strength, durability, comfort, insulation, and appearance. As a result, every material will satisfy project requirements at different quality levels. [30]

8. Enhance the Automation to Control Cost Overrun

To build a hybrid building information modelling IOT, integrated design and BIM software were used as a collaborative platform for automation systems in smart construction in China was involved. Based on the construction cost management operations system, the relationship between automatic transmission and emerging evaluation, and comparison between data operation and dynamic flow and error rate. Using artificial intelligence, the construction cost management operating system is solely based on the integrated application of emerging information technology, excluding safety and quality management technology, which needs improvement and improvement. Other complications in network environments, such as complex and huge construction environments, lead to data diversification for sale and secure smart construction. [40] BIM has played a major role in construction management and automation in the construction industry. The factors influencing time and cost overrun in South Korea on free-from-construction project questionnaire surveys were taken to determine cost overrun using the significance, likelihood, and acuteness indexes. The respondents of this survey are BIM consultants, clients, contractors, architects, project managers, structural consultants and fabricators. The clients should provide sufficient resources to complete the project to avoid time and cost overruns. Better care during the project preparation stage will rectify the cost and time overrun. [41] Automation plays a major role in predicting cost-overrun in construction projects. In Saudi Arabia, a questionnaire

survey was taken with the respondents, including project directors, cost accountants, project engineers, project managers, and design consultants. The data was tested using the Mamdani Fuzzy Interference System (FIS) technique. This model doesn't exclude diverse infrastructure with cultural dimensions. Thus, the Mamdani FIS Technique was used to predict the cost overrun in construction projects. [42] The cost optimization and prediction of Intelligent Building construction using BIM and Elman Neural Network in China. The data was tested using prediction accuracy, RMSE, R2 and AUC. The PSO with the ENN algorithm manages the times series information more accurately and takes in different trends in cost variations. It predicts accurately compared to real construction projects. [43] Also, a severe and repeatable method for building a Bayesian Network (BN) will be used to explain the performance of cost overrun risk due to the lack of a Project Management Maturity Model (PMMM). [44]

9. Mathematical approach for Cost Control

To ensure the safety and productivity of the construction site by using a Data Preprocessing Fusion Single shot Multi-Box Detector (DPS-SSD) in China. For a better improvement in construction management, a DIKW knowledge management framework was constructed. The variables were tested by parameters of the confusion matrix for individual object classes and mean average precision. This assures site managers to find the complexities of construction in a skillful manner and provides advanced and secure management of construction sites. [45] To investigate the critical factors affecting cost overrun and delay in Egyptian mega-construction projects. A five-point Likert scale questionnaire was distributed to the contractors. Based on the questionnaire survey, the factors affecting cost-overrun were tested by frequency model using rank of factors. The top factors, such as the low experience of the design team, delay in finishing works, and lack of good supervision, can be sorted out by decision-making trial and evaluation laboratory, structural equational modelling and Global sensibility analysis such as sobol indices and artificial intelligence algorithms. [46] The assessment of the impact of cost overrun causes on the transmission lines construction project was held in Vietnam. Based on the questionnaire survey, the variables were tested using Bartlett's sphericity test and Kaiser-Meyer-Olkin (KMO). The respondents were the contractor, owner, project manager, supplier and contractor. In results, the regression model states that there were only four major factors which caused cost overrun in Transmission line construction project. Risks, resources, components of transportation and machinery, and incompetence of parties were significant. On the other hand, project policies, poor collaboration of parties, and firm policies were insignificant in terms of cost overrun. [47, 48] The PLS-SEM approach was used in Malaysia to examine the factors affecting the budget overrun of construction projects undertaken using the management procurement method.

Table 2. Resolving cost-overflow by using software approach on automation

S.No	Title (Area -Year)	Software & Responders	Test	Benefits
1.	SSD-based innovations for improved construction management (China -2025) [45]	Data Preprocessing's Fusion Single Shot MultiBox Detector (DPS-SSD)	Parameters of the confusion matrix, yielding Mean Average Precision (mAP) and Average Precision (AP) for individual object classes DIKW knowledge management framework	Ensures safety and productivity of the construction site. Assures site managers to find the complexities of construction in a skilful manner and provides advanced and secure management of construction sites.
2.	A hybrid building information modeling and collaboration platform for automation systems in smart construction (China-2024) [40]	BIM and the Internet of Things (IoTs), and integrated design.	Relationship between emergency evacuation and automatic transmission, comparison between dynamic flow and data operation, Error rate and construction efficiency of the working mechanism of automation system based on BIM technology and collaboration platform	The construction of AI construction cost management operation system is only based on the integrated application of emerging information technology, without considering other aspects such as quality and safety management, which needs to be further improved and expanded. Network environment, huge, complex construction environment and other characteristics lead to data diversification. So, it is necessary to guide the smart construction industry to ensure safety and security.
3.	Factors Influencing Time and Cost Overruns on Freeform Construction Projects (South Korea -2019) [41]	Consultants, 6 clients, 5 contractors, 5 architects, 2 project managers, 2 construction managers, 1 structural consultant and 1 fabricator by using BIM	Significance Index, Likelihood Index and Acuteness Index	The client should provide sufficient resources to complete the project. Good care in the preparation stage will avoid the cost and time overrun.
4.	Modified Mamdani-fuzzy inference system for predicting the cost overrun of construction projects (Saudi Arabia 2024) [42]	Mamdani-type fuzzy inference system Automation project directors, project managers, cost accountants, project engineers, and designers/consultants.	Mamdani FIS technique	This model also includes data from diverse infrastructure projects within the cultural dimension. This Mamdani FIS technique has predicted the cost overrun of the construction project.
5.	An Approach Based on Bayesian Network for Improving Project Management Maturity: An Application to Reduce Cost Overrun Risks in Engineering Projects 2020 [44]	Project Management Maturity Model (PMMM) in Bayesian Network	Bayesian Network (BN)	This paper proposes a rigorous and repeatable method for building BNs that explains performance failures (cost overrun risk) due to a lack of maturity in PMM.

Contractors, consultants, and clients were the respondents to the questionnaire, and the data was tested by Cronbach Alpha. Individual item reliability, composite reliability, and average variance were extracted using the PLS-SEM approach. This model was tested into two stages, namely, the inner model and the outer model. In the outer model, it is reliable and valid. On the other hand, the inner model is significant in terms of cost overrun. Therefore, by identifying these factors it helps to develop the construction industry. [49] A questionnaire survey was conducted with clients, consultants, and contractors to identify factors that affect time and cost overrun in the Malaysian construction industry. The collected data was tested by Kruskal Wallis,

Normality mean Rank, and Cronbach Alpha using SPSS. The highest affecting factor is the cash flow problems faced by contractors. On the other hand, poor supervision by clients and less storage in construction sites were the lowest factors that caused time-cost overrun in the construction industry. [50] In Iran, a mathematical model is used to optimize cash flow in construction projects. This metaheuristic approach was taken from the organization's perspective. The data was tested using Teaching-Learning Based Optimization (TLBO), Particle Swarm Optimization (PSO), Differential Evolution (DE), Water Cycle Algorithm (WCA) and Genetic Algorithm (GA). Therefore, this metaheuristic approach to optimize the cash flow was hugely successful in Tehran. [51]

Table 3. Predicting cost-overrun by using the mathematical model

S.No	Title (Area- Year)	Software & Responders	Test	Benefits
1.	Investigation of critical factors affecting cost overruns and delays in Egyptian mega-construction projects (Egypt-2023) [46]	Contractors	Frequency index model was tested by Rank of Factors	The top factors, such as the low experience of the design team, delay in finishing work, and lack of good supervision, can be sort-out by decision-making trial and evaluation laboratory, structural Equation Modelling and Global sensitivity analysis (such as sobol indices and Artificial Intelligence Algorithms)
2.	Assessing the Impact of Cost Overrun Causes in Transmission Lines Construction Projects (Vietnam-2020) [47]	Owner, contractor, project manager, consultant, and supplier	Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity	The result of the regression model shows that only 4 factors they are risks, resources, incompetence of parties, and components, transportation and machinery costs are found to be significant, but firm policies, project policies, and poor collaboration of parties are insignificant to cost escalation
3.	Examining factors affecting budget overrun of construction projects undertaken through management procurement method using the PLS-SEM approach (Malaysia-2013) [49]	PLS-SEM approach contractors, consultants and clients	<i>Individual Item Reliability, Cronbach's Alpha, Composite Reliability, Average Variance Extracted.</i>	This model was tested into two stages, namely, the inner model and the outer model. The inner model is significant to the budget overrun, and the outer model is reliable and valid. Therefore, identifying these factors helps to develop the construction industry.
4.	Optimizing cash flow in construction portfolios: A metaheuristic approach from the organization's perspective (Iran-2025) [51]	Metaheuristic approach	Differential Evolution (DE), Particle Swarm Optimization (PSO), and Genetic Algorithm (GA),	This mathematical model of cash flow has been hugely successful in Tehran.
5.	Predicting construction cost under uncertainty using grey-fuzzy earned value analysis (Ethiopia-2024) [48]	Earned Value Analysis (EVA) and its modifications: fuzzy EVA and grey EVA.	triangular fuzzy numbers, linguistic terms, and degree of greyness	In this integrated grey and fuzzy theory, the probability theory was excluded, giving a more accurate prediction.
6.	Intelligent building	BIM and	prediction	It accurately predicts compared to real

	construction cost optimization and prediction by integrating BIM and Elman neural network (China-2024) [43]	Elman neural network	accuracy, RMSE, R2, and AUC.	construction projects. ENN with PSO algorithm handles the time series data more accurately and absorbs different trends in cost variations.
7.	Factors contributing to the project time and hence cost overrun in the Malaysian construction industry (Malaysia-2014) [50]	Questionnaire survey with clients, contractors and consultants	Kruskal Wallis, normality mean rank, Cronbach alpha	Contractors' cash flow problems are the highest factor; less storage in construction sites and poor supervision by clients is the lowest factor causing cost overrun in the Malaysian construction industry.

10. Conclusion

There is a clear conclusion regarding how the impact of inflation affects the overall project, which offers how profit margins vary in project duration. It's frequently more beneficial to make enormous profits on short-term projects than on long-term ones. Identified factors such as GDP, capital goods prices, Producer Price Index (PPI), Consumer Price Index (CPI), productivity in the construction industry, labor costs, net migration, employment rate, housing prices, building consents, energy prices, exchange rate, monetary policies, investor confidence, and fiscal policies that affect the cost of building development.

After reviewing the research, the conclusion was that the majority of researchers thought that the primary success factors for construction projects were time, money, quality, customer satisfaction, project management techniques, safety, organization of project implementation methods, and external factors like contractors, human resources, employers, and the project's physical and environmental

conditions. As per the project stakeholders, the Critical Success Factors (CSFs) of the projects include things like communication, cooperation, consultation, time management, and accomplishing project objectives and strategic advantages.

10.1. Further Research

Future research shall focus on the significant increase in material price by proceeding with the statistical approach of comparing material price and quality in various countries to identify the relationship between inflation rates. Research should be conducted on the shortage of skilled labor, pay growth and worker productivity to know the relationship between labour wages and the inflation rate. Most authors only focus on project total cost minimization and ignore other useful considerations and indicators crucial for contractors, such as net present value or maximum monthly cash demand. So, the further consideration for the construction budget has been to focus on automation instead of labor, which was effective for good results.

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