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Research Article

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The frequency and significance of the primary cause of cost overruns in infrastructure projects

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Highlights

- Managing the delay and cost overrun.
- Identify the causes of road project delays and cost overruns.
- Minimizing the effects of project overrun in developing nations.

Abstract

Many road construction projects often go over budget. Take longer than expected. This research focuses on pinpointing the reasons, for delays and cost increases in road construction ventures in Libya. A survey was conducted with owners, consultants and contractors involved in road projects in Libya resulting in 163 completed questionnaires being analyzed. The study examined 55 factors identified through literature review. Improper planning emerged as the factor leading to project delays and cost overruns in road projects. Respondents ranked factors based on their impact with the top five issues being lack of experience with contracts, political instability, unrealistic contract durations and insufficient details and specifications. The insights gained from this study can aid all parties involved in construction projects to better handle delays and cost overruns. Researchers focusing on delay causes and cost escalations, in developing countries within the realm of road construction can also benefit from these findings.

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1. Introduction

Most construction projects exceed their budgets due to communication issues among the various parties involved. Clients and project owners frequently receive estimates at the outset leading to cost overruns. This trend is observed in both developing countries with a number of projects facing such challenges globally. Research spanning 20 countries and five continents revealed that 90% of sampled companies encountered cost overruns in their projects [1]. The construction sectors susceptibility to budget deviations is well known with costs varying widely across projects and regions [2]. The construction industry plays a role in the economy [3]. Olawale's research given its employment rates and resource consumption compared to sectors it significantly influences GDP growth and job creation in many nations. Consequently, it is considered a driver of progress [4]. Addressing concerns about cost overruns requires examination and analysis to streamline project timelines and manage discrepancies, for future endeavors. The consequences of exceeding the budget can sometimes have implications and amount, to as much as 100% of the initial project estimate in certain affluent countries [5]. The construction industry plays a role in supporting and providing the components for a nation's economic advancement. Hence it is widely believed that the construction sector is closely linked to and significantly contributes to the growth or rejuvenation of all countries.

Given the scale and intricate nature of the projects being executed a significant number of both international companies in Libya along with various developing nations have faced challenges in fulfilling their commitments. This has resulted in project delays. Exceeding the designated budget over the three decades [6]. The industry management often receives criticism due, to projects failing to meet their deadlines, budgets and quality standards [7]. The Libyan Construction Industry (LCI) has struggled with managing delays and cost overruns since the 1970s. Research conducted by the Public has highlighted the prevalence of schedule and cost overruns

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in Libya [8]. The Public Committee, for Project Monitoring and Follow up conducted a study in Libya in 2004 uncovering a problem of delays and exceeding budgets in construction projects. In Libya the government frequently serves as the client, for building endeavors with legal matters involving both project owners and contractors as indicated by the Directorate of Projects and Contract Management [8]. Currently the sector is grappling with a challenge of escalating cost overruns that are adversely affecting the economy at large.

2. Literature Review

Since 2011 ongoing unrest, in Libya has led to pauses in projects. Security issues notably play a role in this situation. Particularly affected are projects in areas where security conditions worsen. The political turmoil in Libya has had an impact on multinational projects across the country leading to challenges such as payment delays, cash flow problems and weakened determination [9]. Many of these projects have been left unfinished due to constraints [10]. Construction project setbacks, including delays and cost overruns are issues faced globally in developing countries. Libya is no exception, to this trend as highlighted by studies [11-13]. A similar scenario can be observed in Saudi Arabia well [14, 15].

Earlier research [16, 17] has shown a link, between delays in schedules and exceeding project budgets. Nevertheless, of the socioeconomic position of the country concerned [18], delays have a negative impact on the production planning and control component of operations [19], especiallt in construction projects [20]. Regardless of the situation of a country delays can have impacts on the planning and control aspects of operations especially in construction projects. These delays can lead to issues such as disagreements, over contracts increased construction costs decreased productivity and even contract terminations [21-23]. Alsuliman [15] highlights that contractors who overlook opportunity costs may experience reduced profitability and productivity. Studies have indicated that in Nigeria delays frequently result in exceeding costs and schedules [24]. In South Africa schedule delays can lead to time extensions, cost overruns, profit loss, disputes and lower quality work due, to rushing to projects [25]. The pressure of scheduling could adversely impact the quality and efficiency of work by causing tasks to be completed out of sequence resorting to cost saving measures and reducing staff involvement [26, 27].

Over the five years Larsen et al. [28] Highlighted how issues related to consultants have significantly impacted project scheduling, in Denmark. They demonstrated that delays not affect project quality but lead to increased costs. A study in Vietnam conducted by Nguyen and Chileshe [29] identified planning and staff incompetence as the reasons for project failures. Similarly research carried out in Burkina Faso [30] revealed that contractor incompetence, lack of expertise and funding shortages were the obstacles to completing projects on time. In Egypt delays in road construction projects are primarily caused by constraints, inadequate resources, incompetent contractors and material shortages [11]. In the United Arab Emirates delays can be attributed to strategies inherited from parties [13]. Bajjou and Chafi noted that Moroccos challenges stemmed from waste management plans, lack of training and competence among project staff and delayed payment processes [31]. Delays in China are commonly due to variations in project requirements slow progress payments, competition during bidding processes, subcontractor underperformance and breakdowns, in communication channels [32]. Zidane and Andersen [33] found 10 factors that caused delays, in Norway in the year. The primary reasons for delays included planning and scheduling design changes during construction and delayed payments to contractors.

The literature review aimed to identify and evaluate the factors contributing to cost overruns requiring consideration, for understanding and resolution. A detailed examination of 55 variables linked to cost overruns was conducted for this study. These variables were classified into six categories; construction material related factors, labor related factors project finance related factors, project management related factors, external influence related factors and political factors. Existing literature guided the selection of these variables.

3. Methodology

In the construction industry a study found that there are 55 factors contributing to delays and increased costs, in projects. These factors were compiled into a questionnaire after research and interviews with figures. The questionnaire consists of two parts; Part I includes details about the organization and the individual being surveyed while Part II lists the known reasons for cost overruns and schedule delays in road construction projects. The goal of the questionnaire is to assess how much these identified causes are impacting project delays using a five point rating system ranging from high to little. Each category is rated on a scale from 5 to 1. An average index of components was calculated using Formula (1) to analyze the collected data helping project stakeholders rank these causes based on their perceived impact levels, on schedule delays and cost overruns. Each response, in this scenario is given a weight represented by the ai," which ranges from 1 (indicating importance) to 5 (reflecting significant importance).

$$\text{Average index} = \frac{\sum_{i=0}^{n}(ai \times xi)}{\sum(xi)} \quad (1)$$

The variable "x_i" signifies the weight assigned to each response and its frequency. The significance indices of all factors were. The average values within each group were

used to determine the group index. An ordinal scale was utilized to measure the extent of each of the 55 identified attributes with a sample of 95 contractors completing the questionnaire. A total of 79 contractors responded to the survey. For surveys an email invitation was sent to remaining respondents in the database encouraging them to participate in a survey. Table 1 shows that out of 227 questionnaires sent 163 (72%) were completed and returned. These included responses, from 36 owners/clients, 48 project management consultants and 79 contractors.

Table 1. Distribution of questionair

Description	Percentage (%)
Owner/Clients	22.0
PM consultants	29.5
Contractors	48.5

4. Results and discussion

For the purpose of to determine the components' relevance, the respondents (owners/clients, contractors, and project management) evaluated the components' respective degrees of significance during the questionnaire survey phase.

4.1. Effect of construction material

The materials category in Figure 1 encompasses several aspects. Participants assessed their level of agreement using a 10-point scale. The graphic illustrates that the inflation rate and currency rate volatility had the greatest levels, namely 3.31 and 2.99, respectively.

4.2. Effect of workforce

Infrastructure projects rely heavily on both manpower and machinery. Employee involvement, in the procurement process plays a role. According to the findings illustrated in Figure 2 individuals involved in infrastructure projects attribute cost overruns to factors related to the workforce the increased expenses linked to having a skilled and knowledgeable labor force. This conclusion is supported by research conducted by authors [34,35] indicating that one of the contributors to project cost overruns is the scarcity of qualified individuals and their associated high costs. It is deemed reasonable as the high cost of labor helps mitigate issues such as rework, time and cost delays well as non performance from suppliers and subcontractors. Within the realm of workforce considerations these factors were identified as being second, in importance.

4.3. Effect of finance

In Figure 3 it's evident that longer and expensive contracts are the concerns. This is mainly due, to how market conditions influence construction expenses. The next factor discussed pertains to government regulations suggesting that implementing policies could help reduce financial challenges causing cost overruns in road construction ventures in Libya. Addressing issues effectively such, as financial planning and management can also prevent cost overruns.

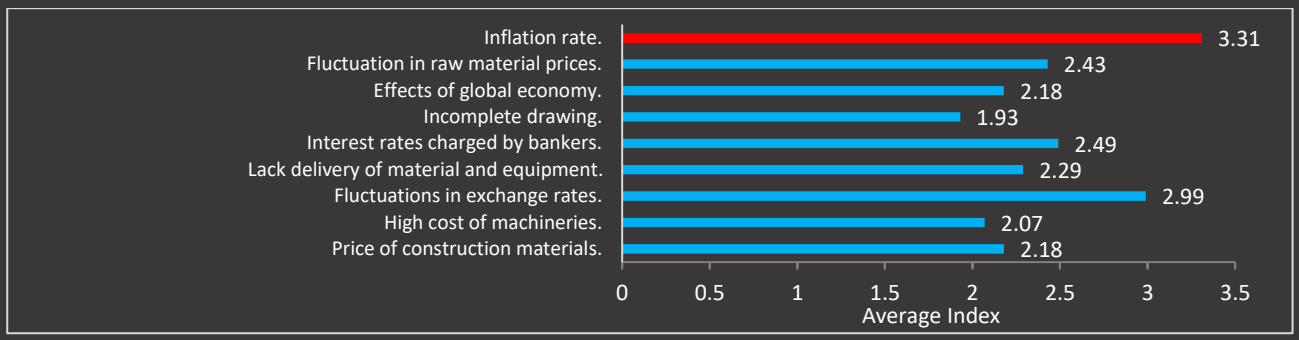

Figure 1. The effects of construction material on projects cost overrun.

Figure 2. The effect of the workforce on project coost overrun.

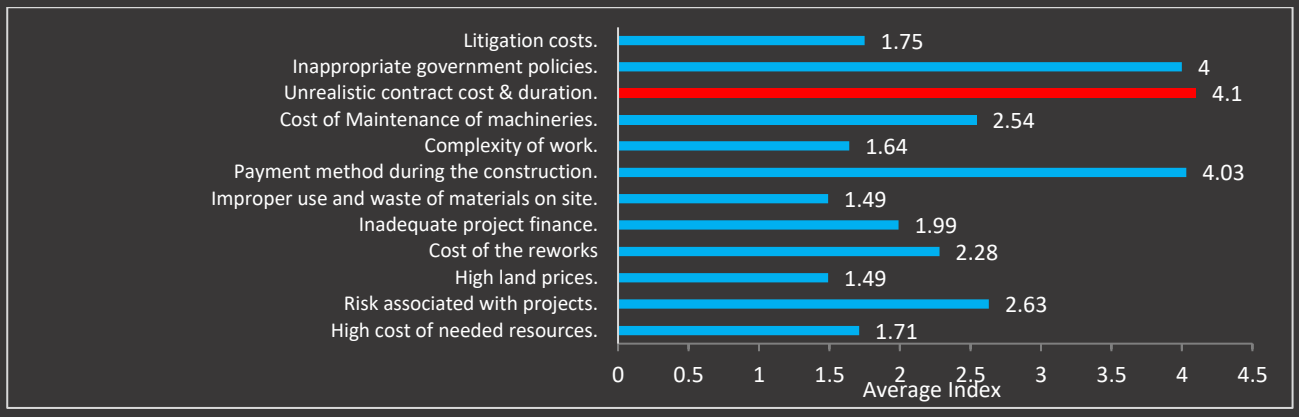

Figure 3. The effects of finance on projects cost overrun.

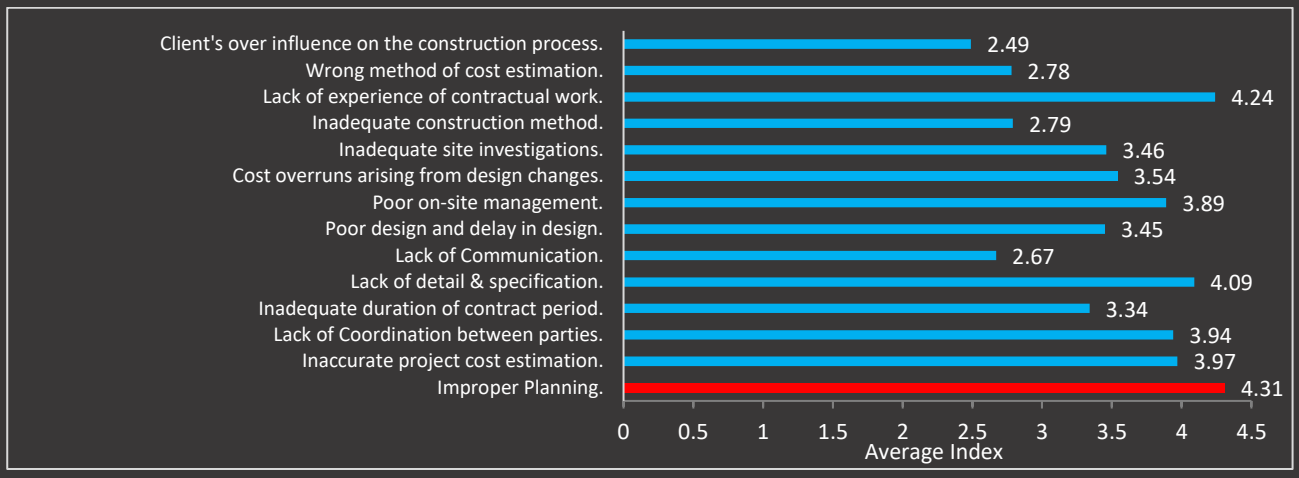

Figure 4. The effects of management on project cost overrun.

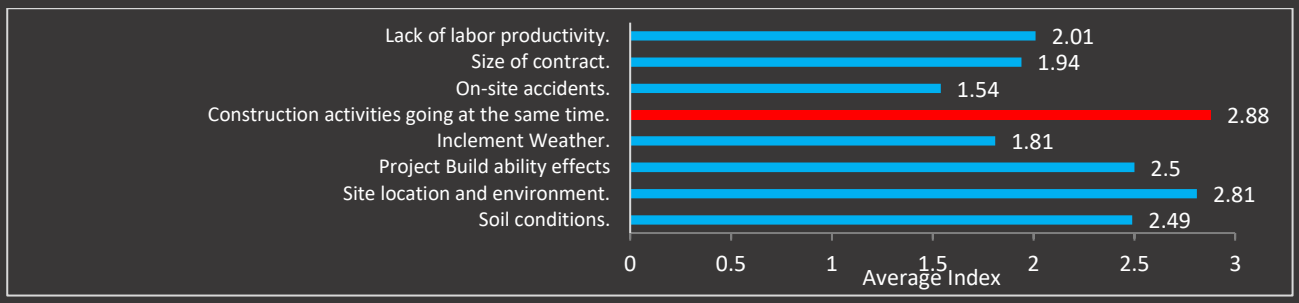

Figure 5. The effects of external factors on projects cost overrun.

4.4. Effect of management

Figure 4 examines how aspects, within the project management category impact road projects in Libya. Among the 55 sub factors studied it was found that inadequate planning emerged as the factor leading to cost overruns. This finding is consistent with studies highlighting the effects of poor planning on construction costs. The importance of cost construction planning in achieving project goals is emphasized as a key justification for this outcome. Additionally specifications and lack of specificity were identified as the influential factors contributing to cost overruns in road projects. Proper cost analysis, during the construction phase is crucial to avoid exceeding project budgets considering various cost factors involved in estimating processes to mitigate potential overruns.

4.5. Effect of external factor

The different elements, within the category that contribute to exceeding costs are displayed in Figure 5. Concurrent construction activities emerged as the element. Following in the external variables ranking, site location and environment stand out as significant factors leading to cost overruns in projects in Libya. Several researchers [36,37] delved into the effects of weather, on project expenses. Found it to be notably influential. Nevertheless according to Figure 5 adverse weather conditions were positioned sixth in terms of impact.

4.6. Effect of political

Politicians, in emerging countries such as Africa significantly impact contract costs as shown in the data from Figure 6 where the political climate is identified as

the factor. Following closely is the control over resources and suppliers which plays a role in causing budget overruns in projects within Libya. Other challenges mentioned involve obstacles related to importing materials and equipment highlighting the need, for enhanced infrastructure to streamline imports. Consequently escalating supplier rates contribute to project cost escalations.

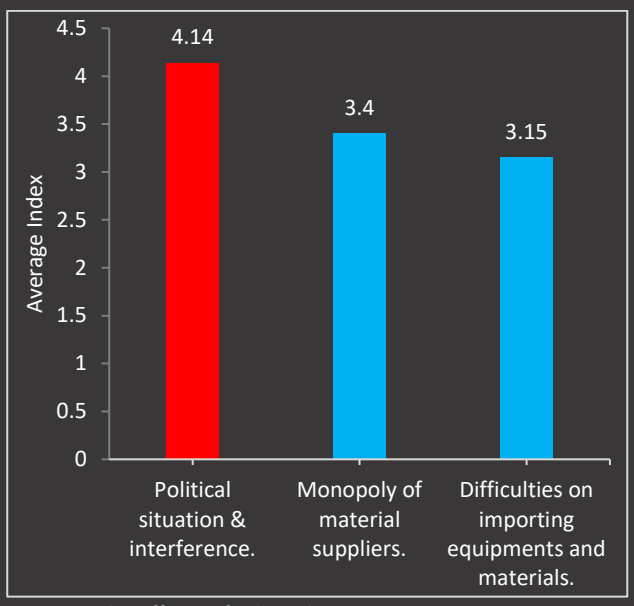

Figure 6. The effects of political on project cost overrun.

4.7. Identifying the "Root Causes" of a project's cost variation

Root cause analysis also known as RCA is a method, for comprehending and resolving issues. One recognized process that assists individuals in addressing the core reasons behind a problem is called Root Cause Analysis (RCA). The objective is to pinpoint the factor contributing to an issue through the application of defined techniques and relevant tools to uncover the root cause of the problem. Root cause analysis (RCA) serves as a management tool that can be easily adopted by both supervisors and frontline personnel. These strategies offer value providing insights and a holistic view. They enable the assessment of systems, identification of measures monitoring trends and detecting patterns. Managers can ascertain the frequency of errors compared to prevailing trends. This analysis may prove beneficial than its predecessor. The approach extends beyond engineering applications, into academic domains [38]. It represents a problem solving methodology focused on identifying the cause of deviations or issues. Its purpose is to address or mitigate these root causes to prevent recurrence of problems [39]. "Root cause analysis often referred to as RCA involves following established protocols, in an detailed manner to identify and solve issues. It is an structured process integrated into quality management practices, not a term used randomly." [40].

In root cause analysis methods a range of techniques are employed to boost the thinking process. These methods include Fishbone diagrams, Mind mapping, Pareto analysis, causal tree analysis, brainstorming, nominal group technique, metaphorical thinking and 5 Why analysis. The focus of the study will primarily be, on Fishbone diagrams, Pareto diagrams and the 5 Why method. The fishbone diagram was created by Professor Kaoru Ishikawa in the 1960s as part of quality management practices. The concept was further elaborated in a paper titled "Introduction to Quality Control" in 1990. Known as Ishikawa diagrams or cause and effect analysis charts due to their resemblance to a fishs structure [41] these tools aid in sparking ideas through discussions similar to collaborative brainstorming sessions but with a more impartial approach [42]. The cause and effect diagram provides a way to identify factors contributing to a specific problem. It helps organize problem solving efforts by categorizing factors that could be linked to challenges systematically. This method is commonly applied following Pareto or brainstorming sessions, for arrangement of ideas [42]. This chart shows an analysis of all factors that could play a role in a problem. Utilizing a fishbone diagram to capture and illustrate details can help in pinpointing solutions [39]. Figure 7 offers a representation of this approach.

The reasons, behind exceeding project budgets in Libya are depicted in Figure 7. They stem from project planning, limited understanding of contractual arrangements, political conditions, extended contract durations, lack of clear specifications inadequate construction payment methods, inappropriate government policies, inaccurate cost estimations, lack of coordination, among stakeholders and ineffective site management.

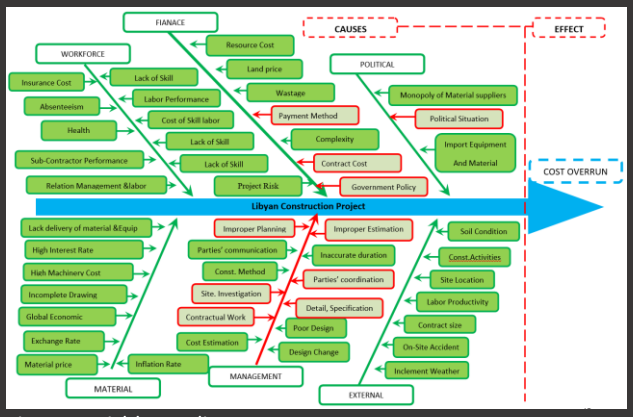

Figure 7. Fishbone diagram.

4.8. Ranking group' effect on the project

The factors that have the impact, on exceeding project budgets are indicated in Table 2. Management plays a role in steering efforts affecting decision makers and potentially leading to project delays and increased costs. With a rating of 4.31 it's clear that the management had an impact on the projects advancement. The political and

finance teams also wields influence with average index 4.1 each. Then followed by workforce, material and external with average index 3.47, 3,31 and 2,88, respectively.

Table 2. Ranking group' effect on the project

Groups	Average Index	Rank
Management	4.31	1
Political	4.10	2
Finance	4.10	2
Workforce	3.47	3
Material	3.31	4
External	2.88	5

5. Conclusions

The success of a project depends on its timely and economical execution. To accomplish this goal, a variety of strategies and techniques are used. Road construction encounters obstacles such limitations and project delays on a global scale. To identify the main causes of delays and cost overruns in road construction projects in Libya, a survey of professionals in the field was carried out. After investigation, a total of fifty-five factors were found. Industry professionals participated in a study that identified 55 common and important criteria. Clients, consultants, and contractors with prior building industry expertise were given the questionnaire. The results of the study show that a number of factors regularly affect road construction in Libya. A number of important variables have been highlighted, including unrealistic contract durations and conditions, bad site management, a lack of specifications, payment methods during construction phases, weak government rules, inaccurate project cost projections, and poor coordination among stakeholders. Three significant categories management, politics and finance are highlighted in the ranking findings. It has been determined that the other groups workplace, material, and external are less impact on the cost overrun in construction projects.

Declaration of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contribution Statement

F. Tarhuni: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – Original draft; **R. Mahat:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – Review & editing

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