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COST AND TIME CONTROL IN CONSTRUCTION PROJECTS: A CASE STUDY OF KHARTOUM STATE

ABDELHAMID H. M. ALI
Civil Engineering Department, Faculty of Engineering Science, Omdurman Islamic University, Sudan

TAREG ABDALLA ABDALLA *
Civil Engineering Department, Faculty of Engineering Science, Omdurman Islamic University, Sudan
*Corresponding author: E-mail address: taregabdalla@oiu.edu.sd

AWWAL AL HAQQ
Civil Engineering Department, Faculty of Engineering, International University of Africa, Sudan

ADAM UMAR
Civil Engineering Department, Faculty of Engineering, International University of Africa, Sudan

ISMAIL HASSAN MOUHOUMED
Civil Engineering Department, Faculty of Engineering, International University of Africa, Sudan

IBRAHIM ABDI RAZAK MOHMED
Civil Engineering Department, Faculty of Engineering, International University of Africa, Sudan

ABSTRACT

Sustainable development requires scheduling and implementing construction project tasks considering cost, time, quality, environment, and energy factors. For a decade, there have been infrastructural developments and a population boom in Khartoum state, Sudan, but it is adversely known for many uncompleted construction projects. The good news is that the structural Engineers and Developers have put tremendous effort into reducing structural failures closely to zero, thereby reducing cost. Despite these efforts, many issues hinder the timely completion of projects. The purpose of this study is to narrate the current management of cost and time in construction sites in Khartoum state. This study randomly collects as much data and experiences as possible from contractors, Engineers, and others involved in construction projects for a broader understanding and to suggest the best solutions. The questionnaire includes a total of 21 questions divided into four sections. Hard copies and an online questionnaire were sent to more than 90 professionals working on construction projects. A relatively high response of more than 80% was received from eligible identified professionals, and the data were analyzed using SPSS software. The results of this study concluded that natural, political, and economic factors are the most important factors affecting cost and time control. Furthermore, good coordination, monitoring, and appropriate fund management are the key factors that play an essential role in reducing construction project implementation duration and cost delays.

INDEX TERMS - Cost overrun, time overrun, Quality, planning, Construction project, Questionnaire, Khartoum.

1. Introduction

It is well recognized in developing and developed countries that construction projects are essential for economic growth and national development. In developing countries, many construction projects fail due to poor quality, cost overruns, and delays in

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completing the project within a given timeframe [1]. Construction projects are intricate, time-consuming undertakings, and the total execution of a project usually consists of several stages requiring a diverse range of specialized services that begins with the initial planning to project completion [2]. In the construction industry, project control aims to ensure that projects are completed within time and budget and achieve other project goals. Project managers have a difficult job requiring them to assess plans regularly and progress to take corrective action [3]. However, construction projects run through successive and discrete levels, and inputs are from disparate players such as governmental agencies, financial organizations, lawyers, engineers, contractors, architects, manufacturers, suppliers, and building tradespeople [2]. Companies cannot survive in construction without efficiently planning and scheduling in today's competitive business environment. Resource management is a crucial part of the project planning of any company. Time and cost are essential factors in construction project planning [4]. However, high certainty in cost and time is one of the top priorities for construction clients. However, project management's task is to reduce or eliminate surprises of cost overrun and time overrun to the clients or owners [5].

Moreover, the construction industry has been facing numerous issues, one of which is time management issues which have been causing delays in project completion [6]. Sometimes, it is required to complete the project sooner than scheduled. This date is usually determined by the employer of high-level management based on objective and time restrictions [7]. Executing tasks effectively and on time is a significant issue in initiatives that beneficiaries are interested in. However, a crucial point for researchers is how to decide on the project's cost, time, quality, energy, and environmental consequences so that it will be advantageous to the project's executors in terms of cost and time to customers in terms of quality, and to other people in terms of energy consumption and pollution [8]. Generally, projects would take longer to be completed using less expensive resources or technologies. For instance, while using efficient tools and techniques may result in time savings, the associated costs rise [4].

A cost overrun is defined as an excess of actual cost over budget. A cost overrun may also be referred to as "cost escalation," or "cost increase," or "budget overrun." In other words, it is the additional cost above the estimate of the project's financial cost [9, 10]. The factors causing project delays and increases in cost overruns are poor project management, lack of proper training, design changes, inflation shortages of material and plants, unsuitable contractors, and increases in the prices of critical construction resources such as steel, cement, concrete, wood, sand, fine and platform aggregates, and other inputs and labor costs [1,11]. When the construction is completed, the difference between the estimated and actual costs is expressed as a percentage of the estimated costs to determine the project cost overrun [1, 12]. However, most construction projects experience cost overruns, putting a massive financial burden on the client or owner [13]. In contrast, the project delay is defined as a time overrun beyond the completion date specified in the contract for the delivery of the project or a part of the project [10, 12]. However, the factors causing delayed projects or time

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overrun are a low-skilled workforce, the complication of work, improper knowledge of the project manager, inaccurate evaluation of project duration, imprecision of the material estimate, and lack of appropriate software knowledge [11].

It is challenging to envisage any project's successful completion without planning [14]. In order to plan and manage a successful project, the three project parameters of time, cost, and quality should be carefully considered [15]. Cost-time balancing is one of the essential issues in project control and planning [16]. Project cost management is a management activity that deals with forecasting, planning, control, cost finding, analysis, and evaluation of the contractors' use to control project costs [17] Budgeting, estimating, planning and managing, cash flow forecasting, cost coding system, financial cost reporting, and judgment are key cost management techniques. The overall planning process in a project budget plays an important role. It evaluates the economic consequences of the plan and provides financial feedback so that plans can be monitored and revised [18]. The successful completion of cost, time, and quality objectives is due to the project management success, which is direct; project success is purchased with the final project objectives [19]. Construction project execution within the assumed budget and schedule time while at the same time ensuring the quality standard is a vital factor that determines the success of a construction project [20, 21].

Successful project management aims to ensure the project's completion on time and within budget and specifications. The previous studies showed limited researches geared at studying the influencing factors regarding incomplete construction projects in Khartoum state, Sudan. This study aims to identify the main factors of cost and time control in the construction sector for incomplete projects in Khartoum state and then suggest the best solutions and recommendations.

2. **Methodology**

This study adopts mostly quantitative methods using a questionnaire survey to gather data from construction Engineers and contractors. It was also analyzed by visiting some companies and sites to have some interviews with experienced workers and managers to triangulate data obtained from the questionnaire survey to expand, enhance, and create depth to the results of the questionnaires by elaborating and investigating some issues listed. This questionnaire survey aims to establish the current practice of time and cost control in construction industries in Khartoum state, including control methods. The questionnaire survey gathers some useful statistical insights from primary users. It contains questions about cost control, work rate problems, time management, etc. Open questions were included to know the user's point of view. The statistical package for the social sciences (SPSS) software was used to analyze the data obtained.

Data Collection

The data was collected from a field and questionnaire. The field visits were made to different (Number of sites) construction sites across Khartoum state to assess the current situation, and onsite workers filled out the questionnaire for the required

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information. The same questionnaire was distributed electronically via a link to various engineers and construction companies to collect online surveys via a google form. The data collection flowchart of the study is presented in Figure 1.

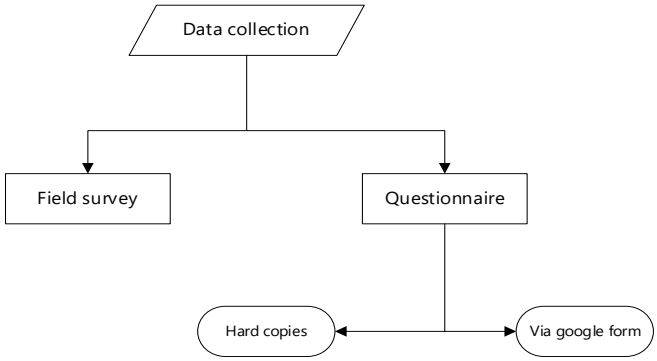

Fig. 1. The data collection flow chart of the study

Questionnaire design

The questionnaire garnered tremendous statistical insight from sources of data collection. It contains the questions solely purposely for the study by identifying key construction sites and companies, as well as open questions to know the worker's point of view of the area. A list of questions was sent to experienced professionals in construction projects to collect data. Quick and large collected volume of quantitative data from the questionnaire is the main reason behind selecting this process. In addition, the respondents expressed their honest opinions freely and liked to respond due to the availability of enough time to think before answering the questions in the questionnaire. An unambiguous, simple, accurate, and short questionnaire was vital to getting the highest response rate. The survey questions were designed to be simple and easy to follow, with many multiple-choice questions: yes/no, always/in some cases, and sometimes. This survey includes a total of 21 questions divided into four sections. The first section was related to general information about the respondent's years of experience, specialization, and job type. The second and third sections are related to questions about their opinion regarding the time and cost most affecting factors, and the last section was an open question. In this research, hard copies and an online questionnaire were sent to more than 90 professionals working in the construction industry in Khartoum state, Sudan. A relatively high response of more than 80% was received from eligible identified professionals. The data were analyzed using SPSS software.

Case study

Thousands of incomplete construction projects across Khartoum state reflect the existential problem in overall construction management at various sites. The study was carried out to determine these problems and suggest solutions. Figure 2 (a) and (b) show some images of incomplete projects.

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(a) (b)

Fig. 2. uncompleted projects, (a) clinic at international university of Africa and (b) faculty of Quran at international university of Africa

3. Results and Discussions

3.1 Participant's data analysis

Table 1 presents the participant data analysis in the questionnaire. The data shows the highest percentage of the participants that partook in the questionnaire are male Engineers, with a record of 60.5%, and a record number of female Engineers, with a record of 39.5 %, including their professional fields and their respective companies. The data also captures key details of years of practical experience, which shows 60.6% of total years of experience above 5 years, which makes the data rich with reliable information on the study discussed.

Table 1: Participant's Data Analysis

Question	Option	Percentage (%)
Gender	Male	60.5
	female	29.5
Profession	Civil engineer	60.5
	architect	28.9
	Electrical	10.9
Job type	Designer	34.2
	Administrator	7.9
	Supervisor	22.1
	Planning manager	2.6
	Bill of quantity controller	2.6
	manager	10.5
Company/Organization	UNITAMS TANESCO	2.6
	TANESCO	2.6
	PROBUILD	2.6
	Rapid Building System Factory	2.6
	Prestige Engineering	2.6
	S. M. B mining and oil and gas company	2.6
	Moon Engineering	5.4
	Dar Al Tamleek for Construction and Contracting	10.5
	AC techno construction	2.6
	M. B. C. Engineering Solutions Co. Ltd	2.6
	CTC group	7.9
	Sigma Development Co. Ltd.	2.6
	Self Employed	52.6
Work sector	Private sector	86.8
	Public sector	10.5

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3.2 Factors affecting Time control

Table 2 and Figure 3 show the general factor affecting time control, respectively. The data shows the common factors that affect the time schedule in the construction project. These factors include natural and human factors. The key interests are the weather and change in the design of projects which all the participants agreed that they significantly affect the time allotted for the project as none of the participants had zero reservations about choosing (No). In contrast, the participants agreed that the political and economic factors had the highest percentage affecting time control, which showed 68.4%.

Table 2: General Factors Affecting Time Control

Factor	Categories affected	Always (%)	In most cases (%)	Sometimes (%)	No (%)
Natural Factors	**Time & Cost**	**18.4**	**47.4**	**34.2**	**0**
Design Change	**Time**	**36.8**	**39.5**	**23.7**	**0**
Cheap Tender	**Time**	**28.9**	**36.8**	**23.7**	**10.5**
Multiple Projects	**Time**	**31.6**	**42.1**	**18.4**	**7.9**
Politics & Economics	**Time**	**68.4**	**18.4**	**10.5**	**2.6**

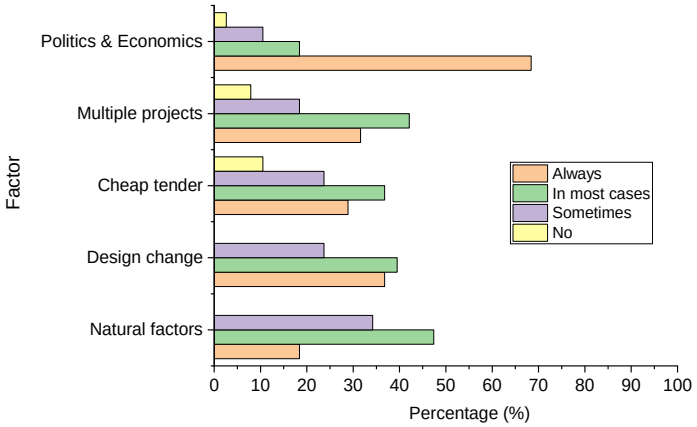

Fig. 3. General factors affecting time control

3.3 Factors Propelling Costly Construction

Table 3 and Figure 4 show the general factors that propel the construction project's costs. The data shows the factors that mostly affect cost in projects. The "yes" and "no" columns indicate whether that factor affects the cost of construction projects or not. As shown in the table, the high import duties 86.8%, forex exchange 94.7%, and inessential construction 78.9% are the components that have more impact on the costly construction. Therefore, we need to be more careful with them.

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Table 3: Factors Propelling Costly Construction

Factor	Categories Affected	Participants Records	
		Yes (%)	No (%)
High import duties	Cost	86.8	13.2
Few locally sourced materials	Cost & Time	39.5	60.5
Shipping cost	Cost	73.7	26.3
Forex Exchange	Cost	94.7	5.3
Costly Equipment rental	Cost	71.1	28.9
Inessential construction	Cost	78.9	21.1
Poor soil and deep foundation	Cost	31.6	68.4
Costly Wages	Cost	13.2	86.8

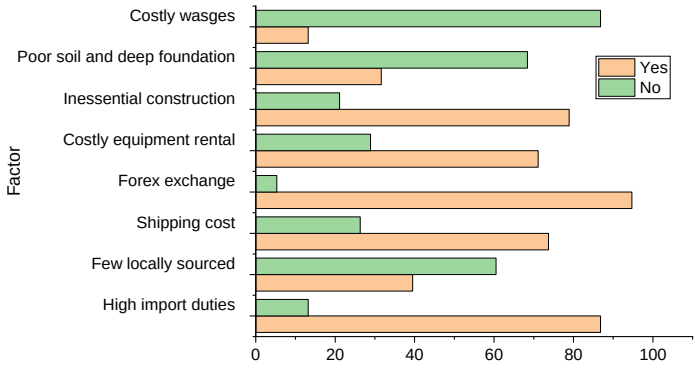

Fig. 4. Factors Propel Costly Construction

3.4 Delays in materials delivery

Table 4 and Figure 5 show delays in materials delivery affecting project time. The data shows that a price increment of 92 % and labor shortages of 81.6% are the most influential factors in delaying a project. So, investing more in these two factors is advisable, while traffic congestion of 36.8% had low effects on material delivery delays.

Table 4: Delays in Materials Delivery Affecting Project Time

Factor	Categories	Participants Records	
		Yes (%)	No (%)
import paperwork	**Cost & Time**	**60.5**	**39.5**
Traffic congestions	**Time**	**36.8**	**63.2**
Price Increment	**Cost**	**92.2**	**7.9**
Cargo clearance	**Time**	**60.5**	**39.5**
Remote site locations	**Time**	**68.4**	**31.6**
Labor shortages	**Time**	**81.6**	**18.**

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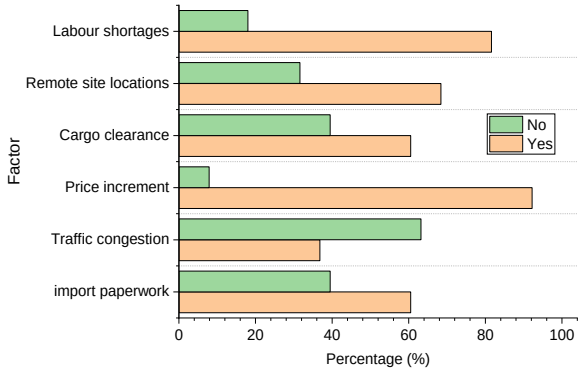

Fig. 5. Delays in materials delivery affecting project time

3.5 A solution to minimize the delay in construction projects

Table 5 and Figure 6 presents a solution to reduce construction project implementation and cost delay. Based on the outcome data, two factors are most likely to solve our problem of delay and cost increase: appropriate fund management of 76.3% and good coordination of 86.8% are the keys to reducing delay in the construction project.

Table 5: A Solution to Minimize the Delay in Construction Projects Implementation and Cost

Factor	Categories	Participants Records	
		Yes (%)	No (%)
Reliable logistics coordination	**Time**	**42.1**	**57.9**
Quality Control	**Cost**	**50**	**50**
Appropriate fund management	**Cost**	**76.3**	**23.7**
Adequate employment	**Time**	**44.7**	**55.3**
Good coordination	**Time**	**86.8**	**12.2**

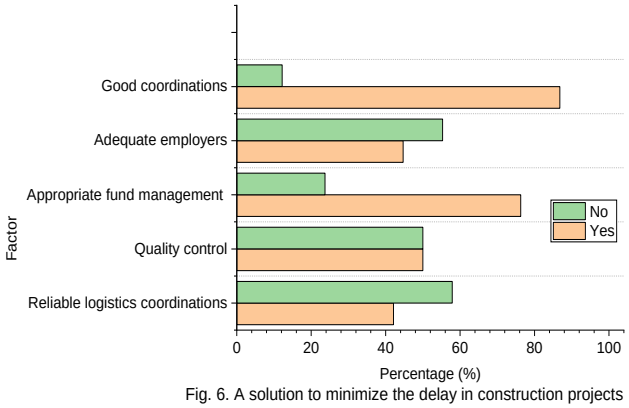

Fig. 6. A solution to minimize the delay in construction projects

3.6 Solution for construction material delivery

Table 5 and Figure 7 show the solution for construction material delivery. The data showed that curtailed paperwork of 76.3% and early material orders of 94.7% have the

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highest percentage in solving the delivery materials delay; therefore, need to be performed as early as possible.

Table 5: Solution for Construction Material Delivery

Factor	Categories	Participants Records	
		Yes (%)	No (%)
Curtailed paperwork	**Time**	**76.3**	**23.7**
Alternative delivery route	**Time**	**57.9**	**42.1**
Acquired required materials	**Cost**	**71.1**	**28.9**
Early material orders	**Time**	**94.7**	**5.3**

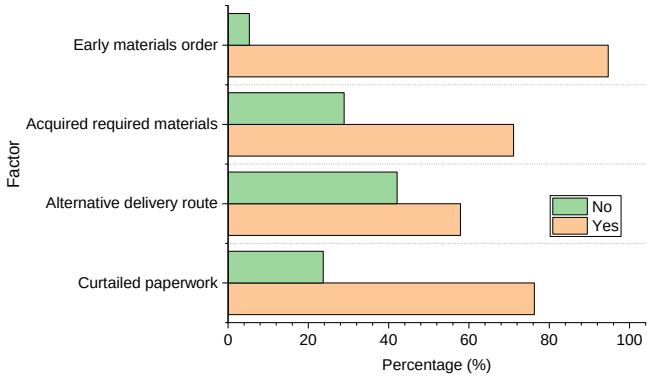

Fig. 7. Solution for construction material delivery

4. **Conclusions**

This study uses the questionnaires to collect the data and process it using the SPSS software present amicable solutions to overcoming the obstacles faced by Engineers, developers, and clients, starting from the beginning to the end of projects. The authors reached a good view and solutions about the obstacles that hinder the process of cost and time control in construction projects in Khartoum state, Sudan. The salient points from the current study are concluded below:

1. Natural, political, and economic factors are the most important factors affecting time control in construction projects.
2. Price increment and labour shortage are the significant factors affecting materials delivering delays in construction projects.
3. Good coordination and appropriate fund management are the key factors that play an important role in reducing construction project implementation and cost delays.

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Conflict of interest

The authors declare that there are no conflicts of interest with this research.

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