



## Causes and Effects of Delays in Road Construction Projects in Sudan

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**Abstract:** Construction delay is one of the serious concerns of the road industry in Sudan. The study aims to identify the causes of delays that have adverse effects on road projects in terms of time, cost and quality. Literature of different types of delays, their causes and effects on road construction projects were intensively reviewed. The study identified a number of causes of delays at great risk and have adverse effects on construction of road projects. A questionnaire based on 15 causes and 5 effects was sent to the clients, consultants and contractors. The collected data were analysed using the Relative Importance Index (RII). The results showed that the contractor is most commonly responsible for project delay (37%), followed by the client (33%) and the consultant (30%). The study findings reveal that the top five main delay causes are payment delay by client, funding problems, conflicts among the project parties, suspension of work due to the client or consultant, and project schedule changes. On the other hand, cost and time overrun, poor quality of work due to rush, and disputes are the main effects of delays. The study concluded that adequate construction budget and payments on time should be the main factors for the project success.

**Keywords:** *Causes, construction projects, delays, effects.*

### 1. INTRODUCTION

Completion of a project within the specified time frame is considered to be one of the critical factors for project success [1]. However, many projects face construction delays and this issue has become a chronic problem worldwide [2].

Delays in road construction projects due to many reasons are a major problem facing the road industry. The incapability of completing construction of road projects in time and within a certain budget is a serious problem worldwide. Several causes of delays have been identified in many countries of the world and there are differences due to different environments and techniques applied in road construction. Delays in the completion of road projects results in negative effects, which are reflected in the cost of the project and the desired revenues from projects, in addition to the quality of those projects.

Many researches have been conducted in different countries to identify the causes of delay and its adverse effects. It is necessary to create awareness of these causes and their negative effects on the quality of roads.

In Sudan, many road projects experience extensive delays, thus exceeding initial time and cost estimates. Delay in road construction is considered one of the most challenges facing the road industry and has a negative effect on the success of road projects in terms of time, cost, quality and safety. Therefore, the purpose of this study is to identify the causes of delays and their effects on road construction projects according to the views of clients, contractors and consultants through a questionnaire survey.

### 2. LITREATURE REVIEW

Delay in construction projects is the time difference between the project completion date stated in the contract and the completion

date. It is defined as the period of time beyond the date specified in the contract that the parties agreed upon for delivery of a project [3]. Lo et al. [4] define delay as slowing down work without stopping construction completely and this can result in time overrun beyond the contract date being agreed upon by the parties to deliver the project.

In fact, any project consists of a set of activities, and the completion of any one of these may be delayed due to a delayed start or an extension of the duration of the activity. Whereas the start of an activity may be delayed for a specific reason and its duration may be extended. Delays in completing an activity may cause delays in subsequent activities, which in turn may delay project completion. Due to the fact that road construction projects often suffer from delays, the literature contains more discussion on this issue. This section aims to provide an overview of construction delays on road projects, including the types of delays found by researchers in the road construction industry. This is followed by some previous studies related to the causes of road construction delays and their effects on project success.

#### 2.1 Types of delays

Construction delays can be categorized according to the liability of the construction parties, the occurrence of the delay and its effects. The four most common types of project delay addressed in the literature include non-excusable delays, excusable compensable delays, excusable non-compensable delays, and concurrent delays. Identifying the type of delay helps to find out its cause [5]. Non-excusable delays occur due to the contractor's ignoring the terms agreed upon in the contract. Factors that cause this kind of delay may be weather conditions, poor project site management, contractor financing, failure to manage work

according to contract schedule, and failure to adhere to contract specifications [6].

Excusable delays with compensation occur due to unforeseen events beyond the contractor's control. These delays are not attributable to the contractor's fault or negligence. When the contractor encounters this type of delay, he is entitled to time extension as well as compensation for the delay [7].

Excusable delays without compensation occur where neither the client nor the contractor is deemed responsible. Factors contributing to this type include unforeseen weather conditions that prevent or affect work, protest from manpower, and unexpected delays in the delivery of equipment and materials where the contractor is not responsible. This delay allows for an extension of time to finish construction without giving any compensation to the contractor [8].

Concurrent delays occur when both the owner and contractor are responsible for the delay. These delays consist of two or more independent delays that occur at the same time due to different causes. The contractor has the right to an extension of time but not delay damages, whereas the owner does not receive liquidated damages [9].

## 2.2 Causes of delays

It was found that the identification of causes leading to delays in road construction varies from study to study in the literature. Several studies have been reviewed to assess the causes of delays in road construction projects.

Noulmanee et al. [10] identified the main causes of delays in highway construction in Thailand and concluded that delays can be caused by all parties involved in the project. The main causes come from insufficient and incompetent subcontractors, lack of resources, incomplete and unclear drawings, and deficiencies in the relationship between the consultant and the contractor.

Vasilyeva-Lyulina et al. [6] investigated delay factors that include weather-related delays, delays caused by subcontractors, inefficiency of a contractor in managing a construction site, contractor mismanagement of project financing, labor shortages, failure to manage work according to contract schedule, and failure to meet specifications of contract.

Sambasivan and Soon [11] identified the top ten causes of delay in the Malaysian road industry. They include improper contractor planning, poor contractor site management, inadequate contractor experience, insufficient owner financing for the project, delayed payments for completed work, problems with subcontractors, shortage in construction materials, lack of equipment and failure, poor communication and relationship between the parties in the project, and mistakes during the construction stages.

Mahamid et al [12] who conducted a research in the West Bank, Palestine, found that there are 52 delay causes in road construction projects. The top 5 factors are political situation, limited movement between area of west bank segmentation, awarding of a project to the lowest bidding price, delay in payment by the owner, and lack of equipment that must be available to improve project performance. Assaf et al. [13] identified 56 causes of delays in Saudi road construction projects. They concluded that contractors considered the most important delay factors to be the preparation and approval of

shop drawings, delays in payment by the owner, and design changes. The main delay factors for consultants were cash problems, many different subcontractor schedules, and slow owner decision-making. The owners considered that the most important delaying factors were design mistakes, lack of skilled labor and inexperience of engineers.

Al-Momani [14] investigated the causes of delay in 130 public projects in Jordan and found that the main causes of delay were related to designer mistakes and changes during construction, weather and site conditions, delays in site delivery, and economic conditions in the country.

Thapanont et al. [15] identified five top factors affecting road construction delays in Thailand which are incomplete drawings, inefficiency of equipment, poor financial status of contractors, inexperience of project engineers, and delays in mitigating environmental impact.

Chan and Kumaraswamy [16] in their study mentioned five major delay factors which are poor risk management and supervision, unforeseen site circumstances, slow decision making, disagreements between consultant and contractor, and design changes in the process.

Kaming et al [17] studied delay factors that have been categorized under cost and time overruns. The results showed that the main factors influencing cost overrun are: material cost increase due to inflation, inaccurate material estimation and degree of complexity. On the other hand, under time overrun, the most important factors causing delays are design changes, poor labor productivity, inadequate planning, and lack of resources.

## 2.3 Effects of delays

Cost, time, and quality have their proven importance as the prime measures for project success. Delays on construction projects are a universal phenomenon. They are usually accompanied by cost overruns. Delay has negative effects on clients, contractors, and consultants in terms of growth in adversarial relationships, mistrust, litigation, arbitration, cash-flow problems, and a general feeling of trepidation towards each other [18]. This problem is not unique to developed countries but is also experienced in most of the developing economies [19]. A project may not be regarded as a successful endeavor until it satisfies the cost, time, and quality limitations applied to it. However, we may find a construction project that fails to achieve its goal within the specified cost, time, and quality [20].

The success of a project is measured based on time, quality and the amount of work completed within a specific budget. Thus, it is necessary to manage cost and schedule overruns when undertaking construction projects. Completion of construction projects by means of overall effective usage of cost and time will result in cost savings for the country and therefore contribute to economic development [21]. Several researchers have identified the effects of delays in road construction projects. A study by Aibinu and Jagboro [21] revealed six effects of delay on project delivery in Nigerian construction industry which are time overrun, cost overrun, dispute, arbitration, total abandonment and litigation Sambasivan and Soon [11] disclosed the same effects of delay in Malaysian construction industry.

Kaliba et al. [19] stated that the effects of delays resulted from factors which are not identified and resolved. Numerous factors can influence cost and time overruns in various types of projects, and client satisfaction will decrease if the cost of a project or schedule exceeds the planned budget.

Haseeb et al [22] identified the effects of delays in Pakistan construction industry as clash, claims, total desertion and slowing down the growth of the construction sector.

Ramabodu and Verster [23] found that critical factors that cause cost overruns in construction projects are changes in scope of work on site, incomplete design at the time of tender, contractual claims (extension of time with cost), lack of cost planning and monitoring of funds, delays in costing variations and additional works. These critical factors in turn are the delay factors.

Chileshe and Berko [24] in their study indicated that causes cost overrun in Ghanaian road construction sector are delay in monthly payments to contractors; variations; inflation, and schedule slippage. Again, these explain the causes of delays and the effect of cost overrun.

Pourrostan and Ismail [25] identified six main factors which caused delays in Iranian construction projects as cost overrun, time overrun, total abandonment, disputes, litigation and arbitration.

Kikwasi [26] identified some of the resulting effects of delays which include cost and time overrun, compromised quality, arbitration, disputes, litigation, low profit margin or financial loss, revocation of contract, and total abandonment of project.

Sunjka & Jacob [27] identified eight outcomes of schedule overruns, budget overrun: a project is said to face a budget overrun if it is completed at a cost that is higher than that budgeted; time overrun: a project is said to encounter time overrun if the stipulated completion time is exceeded; bad public relations: consultants, contractors and clients risk their public reputation if projects are delayed; poor project quality: issues related to project quality may arise if there is inferior workmanship and/or use of inferior quality materials; arbitration: a project may incur additional cost and time following the engagement of professional arbitrators; litigation: courts may be used to resolve disputes, especially when severe penalties are at stake; total abandonment: unresolved issues that result in delays in the execution of a project can lead to total abandonment; and disputes and claims: these are the result of losses incurred due to delays by either party in the contract.

Zou et al [28] found time-related risks that have a direct influence on project delivery, namely tight project schedule, design changes, variations by owner. Aiyetan et al [29] indicated that the three most important factors that negatively affect the delivery time performance of a construction project are: the quality of management during construction; Quality management during design and design coordination.

## 2.4 Prevention of delays

There are many reasons for prevention of delays like proper planning and analysis of the requirements in detail, managing of available resources, conducting training and knowledge transfer, identify risks, estimation and allocation of work and escalation issues.

The mitigation of delays can be achieved by adopting the process of knowledge management and project learning which gives insight into the various problems and their solutions. In fact the lessons learnt feedback from projects is a real eye opener and helpful for others to avoid similar issues. Prevention of delays by adopting innovative and teamwork helps in planning and analyzing the requirements in detail which will allow the mapping of resources and identifying the risks. The works can then be estimated, allocated and modularized for execution. The issues that can lead to delays need to be escalated, identified and resolved on a priority to ensure that they do not become a reason for delay.

Good management of delays allows for project objectives to be achieved and to allocate credibility which helps in project success in terms of safety, cost, time and quality. It should therefore be a priority for the owner and contractor to identify the causes for delaying the project to reduce the scope of its effects on the project. When the contractor is liable for the delay, the loss caused by the delay must be covered by the contractor. When the owner is responsible for the delay he must give the contractor additional time to complete the project [30].

## 3. STUDY METHODOLOGY

In order to achieve the research objective, it was decided to conduct two stages of study. The first is a comprehensive review of the relevant literature covering identification of causes and effects of construction delays in road projects and presentation of the findings of some previous studies. The second stage was to prepare a questionnaire which was designed to identify the most important causes and effects of construction delays in road projects in Sudan.

The study participants (population) comprised engineers working at the Sudan Roads Authority (client organization), consultants (highway engineers and team leaders) who have been supervising road works and contractors (contracts managers, site agents and managing directors) who have been involved in the actual construction of roads.

The clients for this study are the Sudan Roads Authorities, namely the road cooperation of Khartoum state and ministry of roads and bridges, which are headquartered in Khartoum, Sudan's capital city. The Roads Authorities are a natural choice as the client, considering that almost all road construction projects in Sudan are administered by them.

The sample size of 82 respondents was randomly selected from 9 construction firms, 6 consulting firms, and 2 clients. The selected consultants and contractors are local registered firms with good experience in road construction. Clients respondents were selected from the road cooperation of Khartoum state and ministry of roads and bridges.

### 3.1 Questionnaire design

Questionnaires were used to gather information for the study. The structure of a questionnaire was divided into three parts: Part 1 is related to general personal information of the respondent. Part 2 includes the list of the identified causes of delay in road construction projects. Part 3 contains the adverse effects of construction delays. For each cause a question was asked: What is the degree of severity of this cause on project

delay? The severity was categorized on a three-point scale as follows: high, moderate, low.

From the literature reviews, there are 15 causes and 5 effects of highway construction delay found in many researches that are selected for the study as summarized in Tables 1 and 2.

Questionnaires were sent to the clients, senior managers and engineers at the headquarters offices. Other questionnaires were sent to team leaders or highway engineers of consultants who have been involved in the design and supervision of contracts administered by the Roads Authority. The third set of questionnaires was sent to managing directors, contracts managers and site agents of contractors who have been involved in roads projects under the Roads Authority. Of the 30 questionnaires distributed to the Roads Authorities, 25 were returned (response rate of 83.3%). There are few consulting firms that are involved in the supervision of projects administered by the Roads Authorities. Of the 30 questionnaires that were distributed to them, 27 were returned (90% response rate). For contractors, those with more than two years' experience working with the Roads Authorities were randomly sampled. 40 questionnaires were sent out and 30 were returned (response rate of 75%). Eighty two out of 100 questionnaires were returned fairly filled for the analysis. The 15 causes and 5 effects of delay are listed in Tables 1 and 2 were used in the questionnaire.

### 3.2 Data analysis

The analysis had combined all groups of respondents (clients, consultants, and contractors) in order to obtain significant results. In this study, the Relative Importance Index (RII) was used to rank the cause and effects of delays, as shown in Equation 1.

$$RII = (\sum W) / (A \times N) \quad (1)$$

Where; W = weight given to each factor by respondents, A = highest weight, and N = total number of respondents. For the purpose of this study A = 3 and N = 82.

The RII was used to rank the different causes. These rankings made it possible to cross-compare the relative importance of the factors as perceived by the three groups of respondents (i.e. Clients, consultants, and contractors) [31]. Each cause's RII perceived by all respondents were used to assess the general and overall rankings to give an overall picture of the causes of construction delays in road construction industry. The same procedure was adopted for ranking the effects. The indices (RII) were then used to determine the rank of each item. These rankings made it possible to cross compare the relative importance of the elements as perceived by the three groups of respondents. The weighted average for each item for the three groups of respondents is to be determined, and ranks are assigned to each item representing the perception of the three groups.

Ranking the importance of delay factor and its effect which have 3 levels; 3 = very important, 2 = important, and 1 = not important. The calculated values of RII for the delay factors and their effects are shown in Tables 1 and 2 below.

## 4. RESULTS AND DISCUSSION

The total number of questionnaires distributed to clients, contractors, and consultants are one hundred sets and the

respondents are 82 which represent 82%. The proportion of the respondents comprised of 37% contractors, 33% consulting firms, 30% clients. Majority of respondents (72%) have years of experience between 5 and 10. Clients, consultants and contractors have indicated that they have experienced delays in projects they were involved with varying degrees. In particular, 75%, 70% and 52% for clients, consultants and contractors respectively have had projects delayed.



Fig. 1. the proportions of questionnaire respondents

### 4.1 Causes of delays

A number of causes of delays in construction projects were listed for respondents to rank. Respondents were requested to rank these causes by using 3-point scale meaning 3 = strongly agree, 2 = agree, 1 = disagree. The results are shown in Table 1 below.

Table 1. Respondents Ranking of Causes of Delays

No.	Causes	RII			RII	Rank
		client	consultant	contractor		
1	delay in site handover to the contractor	0.67	0.65	0.84	0.72	6
2	slow mobilization of equipment	0.57	0.77	0.47	0.60	12
3	project schedule changes	0.77	0.70	0.79	0.75	5
4	design changes	0.69	0.62	0.72	0.68	9
5	poor project management	0.73	0.64	0.76	0.71	7
6	conflicts among the project parties	0.72	0.84	0.90	0.82	3
7	incompetent contractors	0.76	0.69	0.43	0.63	11
8	poor financial ability of contractors	0.73	0.72	0.44	0.63	11
9	shortage and lack of equipment	0.76	0.77	0.50	0.68	9
10	shortage and lack of materials	0.55	0.47	0.62	0.55	13
11	procurement and supply problems	0.72	0.46	0.78	0.65	10
12	insufficient experience of the consultant	0.56	0.73	0.80	0.70	8
13	delays in payment to contractors	0.91	0.88	0.94	0.91	1
14	suspension of work due to the client or consultant	0.71	0.69	0.92	0.77	4
15	funding problems	0.93	0.86	0.83	0.87	2

Results indicate seven highly ranked causes as delays in payment to contractors, funding problems, conflicts among the project parties, suspension of work due to the client or consultant, project schedule changes, delay in site handover to the contractor, poor project management. Other causes ranked as medium are:

Insufficient experience of the consultant, shortage and lack of equipment, design changes, and procurement and supply problems. Some of these causes were identified in other countries as previously reviewed in literature. However, major causes of delays seem to differ significantly from one country to another.

These results are important in stimulating researches on the subject matter in various parts of the world as to whether the causes of delays differ geographically. Though limited by the sample size, this study is an attempt to establish the status on the subject in Sudan that can form a base for comparison with other parts of the world.

### 5. Effects of delays

Delays have had a number of effects to construction projects. Respondents were requested to rank these effects by using 3-point scale meaning 3 = very important, 2 = important and 1= not important. The results are as given in Table 2 below.

**Table 2.** Respondents Ranking of Effects of Delays.

No.	Causes	RII			RII	Rank
		client	consultant	contractor		
1	Time overrun	0.93	0.84	0.84	0.87	2
2	Cost overrun	0.96	0.86	0.81	0.88	1
3	Disputes between the client and the contractor	0.76	0.70	0.76	0.74	4
4	Poor quality of work due to hurry	0.73	0.79	0.76	0.76	3
5	Arbitration	0.67	0.59	0.54	0.60	5

Results indicate five highly ranked effects as cost overrun, time overrun, poor quality of work due to hurry, disputes between the client and the contractor, and arbitration. These results are more less the same as those obtained by other researchers from different countries as previously mentioned in literature.

### 6. CONCLUSION

The study was conducted to determine and evaluate the most severe and most frequent factors causing delays and their effects in Sudan construction projects. A survey based on a questionnaire was carried out among randomly selected contractors, consultants, and clients. Based on the study results, the following conclusions are drawn:

- The data analysis showed that 37% of the respondents from the contractors, 33% consulting firms, 30% clients.
- In this study, 15 different causes of delays and 5 effects of these delays were identified and ranked based on their relative important index (RII).
- With regard to the ranking of individual delay factors, the five most important causes are delays in payments to contractors, funding problems, conflicts among the project

parties, suspension of work due to the client or consultant, and project schedule changes.

- The results revealed that the effects of these delays are: cost overrun, time overrun, poor quality of work due to hurry, disputes between the client and the contractor, and arbitration.

On the basis of these findings, the following recommendations are made.

- Owners pay progress payment to contractors on time because it affects the contractors' ability to finance the work and leads to time overrun. The contractor can be paid on time if a payment guarantee clause is introduced in the contract.
- Contractors should manage their financial resources and plan cash flow by utilizing progress payment.
- Better communication and coordination with construction parties (contractor, consultant and owner), so the objectives could be achieved at the specified time, cost, and quality.
- Consultant should be more flexible in evaluating contractor works. Compromising between the cost and high quality should be considered.
- The client should not award a contract to the contractor when the client does not have adequate finances to execute the project.
- There is an urgent need for offering training courses in project scheduling, time and cost control, and management of equipment and human resources.
- Adequate construction budget, timely issuing of information, finalization of design and project management skills should be the main focus of the parties in project procurement process.

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