Sudan University of Science and Technology

College of Graduate Studies

Factors Of Cost Overrun In Sudan Railways Projects

عوامل تجاوز التكلفة في مشاريع السكك الحديدية في السودان

A Thesis Submitted in partial fulfillment of the Requirements for the Degree of Masters of Sciences (M.SC) in Civil Engineering

(Constriction Management)

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January 2020

الآية

قال تعالى:

{ وَأَنْزَلْنَا الْحَدِيدَ فِيهِ بَأْسٌ شَدِيدٌ وَمَنَافِعُ لِلنَّاسِ}

صدق الله العظيم

(سورة الحديد – الآية 25)

DEDICATION

I would like to dedicate this work to:

The martyrs spirit of great December Revolution, you were the fuel of the revolution burned to enlighten us the way.

My grandmother spirit you are bliss that I will keep crying for loss in all my life.

My mother I still depend on her and she Take care of me Such as child Even though I grew up a lot, your wishes for me in your kind silent prayers was behind all my success.

My father who taught me the meaning of life, Bear difficulties for me, you are a support and friend.

My sisters and brothers, you are the grace of God, guide me to the righteousness and add a special beauty to my life.

ACKNOWLEDGEMENT

First and foremost, thanks to Allah who gave me the strength to complete this research

I am very grateful to my supervisor, Dr. Mona Adam for her valuable advice, continued support and patience during my research. I was encouraged by her tremendous knowledge and abundant experience all the time in my academic research.

I would like to thank my friends at the Sudan Railways Corporation for their kind and supportive help that made my research period a wonderful time.

As well, I would like to thank all of my friends for their support.

Finally, I would like to express my gratitude to my parents, sisters and brothers. For their tremendous understanding and encouragement throughout my life, without them it would have been impossible for me to complete my studies.

ABSTRACT

The three measures of efficiency of a project are time, quality, and cost. The overall goal for project is to implement the project in the shortest time, the lowest cost and the highest quality. Infrastructure projects as generally do not finish according to the specified budget.

The phenomenon of cost overruns considered as a common phenomenon in these kind of projects and has been given great attention in the academic literature.

The primary objective of this study is to attempt to identify the major cost overrun factors in railways construction projects in Sudan and rank these factors Based on the frequency of their occurrence, which can serve as a way forward for future projects to deal with these cost overruns.

The study is based on previous a literature review investigating factors which have significant influence on cost overruns and also a questionnaire distributed to engineers who work in the field of railways construction in Sudan.

The questionnaire contain 18 potential factors of cost overruns in railways construction projects in Sudan, Distributed to 100 engineers work in this field and a total of 85 respondents were received and analyzed by using the spss 2014 program and Through this questionnaire, the study showed that the top (5) from the (18) factors which identified are Economic inflation, change orders, Project delay, inaccurate estimate of quantities to be implemented, and poor budget preparation Contribute more to cost overruns.

The study also showed that the factors of cost overrun that most frequent in terms of the frequency of occurrence are: Economic inflation, Change orders, Project delay, and Owner delay in the payment of benefits contractors, Poor

planning in the decision-making process due to political and administrative factors.

The Study recommended developing Solutions to limit spread of cost overrun phenomenon it can be summarized in good project planning, audit in the calculation of the quantities required to complete, track and measure the project progress, follow up the contractor's performance, facilitate the routine procedures, enact laws that limit administrative corruption, separate consultant from owner.

المستخلص

المقاييس الثلاثة لكفاءة أي مشروع هي الوقت، الجودة، والتكلفة وغالباً ما يكون الهدف العام لاي مشروع هو تنفيذ المشروع في اقصر زمن وأقل تكلفة وأعلى جودة، وعموماً مشاريع البنية التحتية غالبا لاتنتهي وفقاً للموازنة المحددة حيث تعتبر ظاهرة تجاوز التكلفة ظاهرة مشتركة في هذا النوع من المشاريع وقد حظيت بقدر كبير من الاهتمام في الادبيات الاكاديمية.

الهدف الاساسي من هذه الدراسة هو محاولة تحديد العوامل الرئيسة لتجاوز التكلفة في مشاريع السكك حديدية في السودان وترتيب هذه العوامل وفقا لمدى تكرار حدوثها في المشاريع، حيث يمكن ان تكون بمثابة الطريق الى الامام للمشاريع المستقبلية في التعامل مع هذه التجاوزات.

تستند الدراسة على مراجعة الادبيات السابقة للتحقيق في العوامل التي لها تأثير كبير على تجاوزات التكلفة وأيضًا توزيع استبيان على المهندسين الذين لديهم معرفة في مجال تشييد مشاريع السكك الحديدية في السودان. يحتوى الاستبيان على 18 عاملاً محتملاً لتجاوز التكاليف في مشاريع تشييد السكك حديدية في السودان موجه الي 100 مهندس يعمل في هذا المجال وكان أجمالي المستجيبون 85 مستجيب تم استلامها وتحليلها باستخدام برنامج spss 2014.

من خلال هذا الاستبيان أوضحت الدراسة ان أعلى (5) عوامل من 18 عامل قد يؤدي الى تجاوز التكلفة هي التضخم الاقتصادي، أوامر التغيير، التأخر في المشروع ، والتقدير الغير دقيق للكميات المراد تنفيذها، سوء التخطيط وعدم الاعداد الجيد لميزانية المشروع

وكذلك أوضحت الدارسة ان عوامل تجاوز التكلفة الاكثر تكراراً من حيث مدى تكرار حدوثها تتمثل في التضخم الاقتصادي، أوامر التغيير، تأخر المشروع، تأخر المالك في سداد مستحقات المقاولين، سوء عملية صنع القرار بسبب تدخل العوامل السياسية والإدارية.

وأوصت الدراسة بضرورة تطوير الحلول للحد من ظاهرة تجاوز التكلفة ويمكن تلخيصها في التخطيط الجيد للمشروع، التدقيق في حساب الكميات المراد تنفيذها، متابعة وقياس تقدم المشروع، متابعة اداء المشروع، تسهيل الاجراءات الروتينية، سن االقوانين الصارمة للحد من الفساد الاداري و فصل الاستشاري من المالك.

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1.1 General Introduction

The construction sector is responsible for building new houses, apartments, factories, offices and schools. It also builds roads, bridges, ports, railways, sewers and tunnels, among many other things. In addition, it maintains and repairs all of those structures and produces the basic materials such as concrete that are used to make them. The industry's significance is due not only to the fact that it provides the buildings and infrastructure on which virtually every other sector depends, but to the fact that it is such a sizeable sector in its own right. (OECD, 2008) Necessary infrastructure projects are large in scale, which is in danger of what Flyvbjerg, Bruzelius and Rothengatter (2003) called the "curse of the megaproject." Large-scale projects, especially in infrastructure, are often finished late and over the initially planned cost. (Anzinger, 2015) Cost overrun is the inherent part of most infrastructure projects despite of much acquired knowledge in project management. Cost overrun has become an almost natural part of infrastructure projects. Historical data over the last several decades indicates that cost performance has not improved over time no significant learning has occurred. (Srivastava & S. Patil, 2016), Cost overruns have been observed in a large share of infrastructural projects. Flyvbjerg, Skamris Holm, & Buhl (2003) presents results from a database with over 250 large infrastructural projects from a number of countries and from different time periods. One of the result, the overruns were highest in rail projects with cost overruns of 45%. For roads it was 20%. (Brunes & Lind, 2014)

1.2 Research problem

The basic goal of any industry is to achieve the completion of project within time and stipulated budget. It is the same with construction industry, achievement of this goal is a major challenge because of the complexity of the construction industry, since the literature generally recognizes cost overruns as a common feature of megaprojects, there is no reason to assume that this would be any different in the Sudan railways construction projects, it experiencing the problem of cost overruns on the other side the factors that lead to cost overruns are unclear.

1.3 Research Assumption ((hypotheses))

- Cost overruns in Sudan railways construction projects may be eliminated if their factors are identified clearly and managed well.
- Factors leading to cost overrun in railways construction projects in Sudan occur frequently.

1.4 Objectives of Research

The objective of research are:

- To identify the factors that lead to cost overrun.
- To Rank the factors of cost overrun on the basis of frequency of occurrence.
- To identify the top factors most frequent.

1.5 Research Methodology

The research methodology adopted to identify and rank the factors of cost overrun in Sudan railways construction project were a literature review which conducted to develop conceptual basis for the study and to get the potential factors leading to cost overrun, 18 factors were

identified from previous study Based on these factors the questionnaire was designed and Distributed to 100 engineers work in this field and a total of 85 respondents received and analyzed by using the program spss 2014.

1.6 Research lay out

Chapter one: presents an introduction to the research. It includes the problem statement, Objectives of Research, Research Methodology, and Research Assumption.

Chapter tow: presents the literature review and the previous efforts and studies which have been made in the railways construction project around the world about factor that lead to cost overrun in this projects.

Chapter three: discusses the research methodology which includes the information about the research design, research population, research location, questionnaire design, questionnaire reliability, research structure and statistical data analysis.

Chapter four: presents and discusses data analysis, statistical methods used, tables and information deduced from statistical analysis and statistical results.

Chapter five: summarizes the results and major finding, to present the conclusions and recommendations of this research.

CHAPTER 2

LITERATURE REVIEW AND PREVIOUS STUDIES

CHAPTER 2

LITERATURE REVIEW AND PREVIOUS STUDIES

2.1 Introduction

Initial railway development in the Sudan resulted from military activity rather than economic considerations. From 1820, the first rail line, started in 1875 from Wadi Haifa on the border with Egypt. (F.Due, 2011), Sudan has 4,725 kilometers of narrow-gauge, single-track railroads that serve the northern and central portions of the country. The main line runs from WadiHalfa on the Egyptian border to Khartoum and southwest to Al Ubayyid via Sannar and Kosti, Sudan, with extensions to Nyala in Southern Darfur and Wau in Western Bahr al Ghazal, South Sudan. Other lines connect Atbarah and Sannar with Port Sudan, and Sannar with Ad Damazin. A 1,400-kilometer line serves the al Gezira cotton-growing region. A modest effort to upgrade rail transport is currently underway to reverse decades of neglect and declining efficiency. Service on some lines may be interrupted during the rainy season. (Wikipedia, 2018)

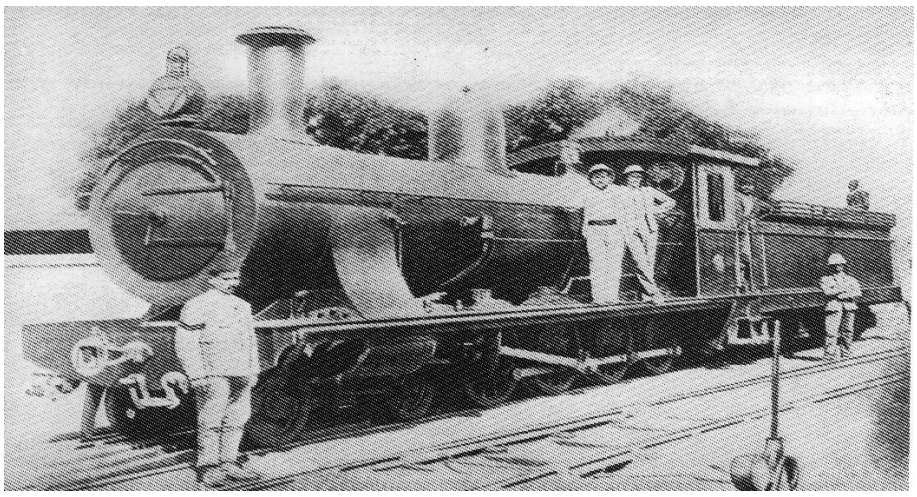

Figure 2-1 Sudan Railway in 1929 - Atbara

2.2 Track

The track or permanent way is the railroad on which trains run. It consists of two parallel rails fastened to sleepers with a specified distance between them. The sleepers are embedded in a layer of ballast of specified thickness spread over level ground known as formation. The ballast provides a uniform level surface and drainage, and transfers the load to a larger area of the formation. The rails are joined in series by fish plates and bolts and these are fastened to the sleepers with various types of fittings. The sleepers are spaced at a specified distance and are held in position by the ballast. Each component of the track has a specific function to perform. The rails act as girders to transmit the wheel load of trains to the sleepers. The sleepers hold the rails in their proper positions, provide a correct gauge with the help of fittings and fastenings, and transfer the load to the ballast. The formation takes the total load of the track as well as of the trains moving on it. The permanent way or track, therefore, consists of the rails, sleepers, fittings and fastenings, the ballast, and formation as show in fig(2.2) (Satish Chandra, 2007, p. 63)

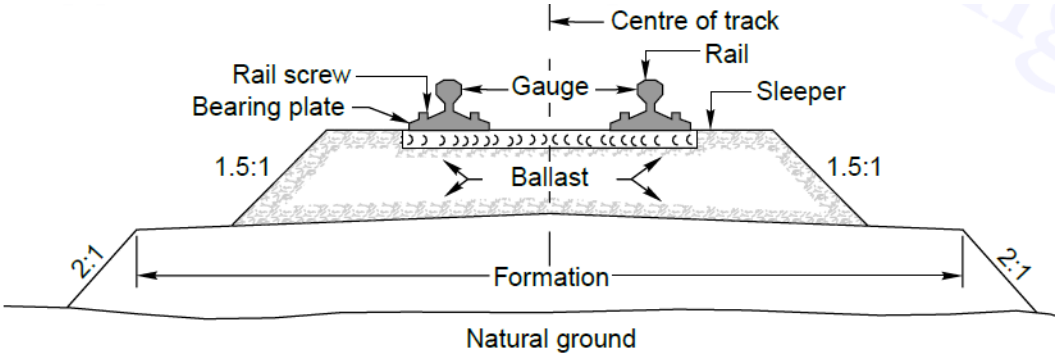

Figure 2-2 various components of a track

2.2.1 Rails

Rails are the members of track laid in two parallel lines to provide an unchanging, continuous, and level surface for movement of trains. To be able to withstand stresses, they are made of high-carbon steel. (Satish Chandra, 2007, p. 81)

2.2.2 Sleepers

Sleepers are the transverse ties that are laid to support the rails they have an important role in the track as they transmit the wheel load from the rails to the ballast. Several types of sleepers. (Satish Chandra, 2007, p. 106)

Different types of sleepers

- Wooden
- Steel
- cast iron sleeper
- Concrete

2.2.3 Ballast

The ballast is layer of broken stones, gravel, moorum, or any other granular material placed and packed below and around sleepers for distributing load from the sleepers to the formation. It provides drainage as well as longitudinal and lateral stability to the track. (Satish Chandra, 2007, p. 138)

2.2.4 Subgrade and Formation

Subgrade is naturally occurring soil which is prepared to receive the ballast. The prepared flat surface, which is ready to receive the ballast, sleepers, and rails, is called the formation. The formation is an important constituent of the track, as it supports the entire track structure. (Satish Chandra, 2007, p. 152)

2.2.5 Track Fittings and Fastenings

The purpose of providing fittings and fastenings in railway tracks is to hold the rails in their proper position in order to ensure the smooth running of trains. These fittings and fastenings are used for joining rails together as well as fixing them to the sleepers, and they serve their purpose so well that the level, alignment, and gauge of the railway track are maintained within permissible limits even during the passage of trains. (Satish Chandra, 2007, p. 166)

2.5 Classification of Construction Costs

The cost of a work unit is comprised of many cost elements. These cost elements include labor costs, material costs, plant and machinery costs, administration costs and other expenses (T.Subramani, P S Sruthi, & M.Kavitha, 2014).

2.6 Definitions

Cost: is the budgeted expenditure, which the client has agreed to commit for creating/acquiring the desired construction facility. (T.Subramani, P S Sruthi, & M.Kavitha, 2014, p. 3).

Actual costs: are defined as the accounted costs actually spent, as determined at the time of project completion (T.Subramani, P S Sruthi, & M.Kavitha, 2014, p. 3).

Estimated costs are defined as the budgeted or forecasted costs at the time of project approval, which are typically similar to costs presented in the business case for a project (T.Subramani, P S Sruthi, & M.Kavitha, 2014, p. 3).

Estimated Budget: Ibrahim (1995) stated that the Estimated Budget of a project is the calculation of the amount of the budget and wage costs of a building, as well as other costs associated with the implementation of the project. Budget in the same building will be different in each of regions, due to differences in prices of building materials and labor costs. Mentalini (2010) stated that the Budget Implementation Plan is a plan of the amount of the costs involved in the implementation of construction projects. Plan Project Budget planned and used as a guideline in order to expenditures not exceed the budget limits provided, but can achieve quality and job quality in accordance with the specifications stipulated in the contract (Rauzana, 2016).

Escalation: the anticipated increase in the total project cost over time resulting from factors such as inflation, market conditions and the like (Jaensch, 2012).

Direct costs: Direct costs are costs that can be correlated to a specific activity or a work item, which is being done or produced (T.Subramani, P S Sruthi, & M.Kavitha, 2014).

Direct cost of permanent work item = Direct material cost + Direct labor cost other direct expenses

Direct material costs cover all costs connected with materials, which are incorporated into permanent works of the project. Direct labor costs cover net expenses far procurement, maintenance, and wages of all category of workers employed at the work site for the execution of an item of project. Other direct expenses include all other expenses on account of services rendered, which can be directly attributed to and clearly identified with the execution of an activity or work item (T.Subramani, P S Sruthi, & M.Kavitha, 2014).

Indirect Costs: costs not directly attributable to work items such as on-site overheads. They do not include the contractor's off-site overheads and margin (Jaensch, 2012).

Indirect costs or Overhead costs: Indirect costs include all costs, which are attributable to a given project but cannot be identified with the performance of a specific activity or a work package. In other words, all costs other than direct costs are covered under indirect costs (T.Subramani, P S Sruthi, & M.Kavitha, 2014).

Contingency Cost: contingency cost is defined as the uncertainty of the cost of a cost estimate or budget to be allocated to the work item based on experience and implementation of projects in the past and is one of the integral part of the total estimated project cost (Rauzana, 2016).

Contingency cost: is the amount of funds provided as a backup to face the uncertainties relating to the construction project. Contingency cost is particularly important when previous experiences related to costs indicate that it is possible to expect events of unpredictable and lead to increased costs (Rauzana, 2016).

Cost overrun: An instance in which the provision of contracted goods or services are claimed to require more financial resources than was originally agreed between a project and a contractor (Gutae, 2015, p. 10).

Cost overrun: The amount by which actual costs exceed the baseline or approved costs (Gutae, 2015, p. 10).

Cost overrun: The difference between the original cost and the actual cost when the project is completed (Gutae, 2015, p. 10).

Construction cost overrun: is defined as the difference between forecasted and actual construction costs. Every construction company can be affected by cost overrun if it happens in their projects. However, the most affected company type is micro-scaled construction companies because they have limited capitals and they are more vulnerable to risks (Srivastava & S. Patil, 2016).

2.7 Project cost estimation

The construction of major transport infrastructure is a complex exercise, involving multidisciplinary teams, a construction lifespan of many years and budgets of hundreds of millions of dollars or more. There are many variables that must be taken into account when estimating the cost of a project (the General Purpose Standing Committee No. 3 Report ; no. 26., 2012).

Accurate cost estimation is a critical element of transport infrastructure. If a proponent under-estimates the cost, they may not have enough money to finish the project, completion may have to be delayed or funds may have to be taken from other budget areas; conversely, over-estimating the cost of a project may reduce the ability of other programs or projects to be funded, or result in a project not being constructed at all (the General Purpose Standing Committee No. 3 Report ; no. 26., 2012).

2.8 The challenges of project cost estimation

Estimating the cost of major infrastructure projects is a complex task. Mr Chris Lock, Deputy Director General, Transport for NSW, acknowledged that project costing is inherently uncertain because it is about predicting the future.4 (the General Purpose Standing Committee No. 3 Report ; no. 26., 2012).

Compared to road and other construction work, the estimation of railway infrastructure project costs is particularly challenging, because construction costs depend highly on the possession timeframes and duration (Li1, A. Landex2, K. B. Salling1, S. N. Madsen2, & O. A. Nielsen1, 2014)

Railway construction work prices are not transparently given in the market. As mentioned, the prices corresponding to the working time can only be estimated from case to case; while in the road construction market, nominal prices are rather relatively standardized known as Greenfield-market prices (G-Price). G-price, which can be found in many construction websites, is the base price corresponding to the standard 37 working hours per week during weekday daytime in Denmark. If planners collect such nominal prices instead of real prices to estimate the project cost, the risk of budget overrun is high (Li1, A. Landex2, K. B. Salling1, S. N. Madsen2, & O. A. Nielsen1, 2014).

Mr Lock, and other witnesses before the Committee, made reference to the work of Professor Bent Flyvbjerg, Professor of Major Programmer Management at Oxford University. In his book Megaprojects and Risk, An Anatomy of Ambition, Flyvbjerg noted a ‘calamitous history of cost overrun’ in major infrastructure projects worldwide. He observed that the difference between actual and estimated investment cost is often 50 to 100 per cent, and for many projects cost overruns end up threatening project viability. Flyvbjerg writes:

A main cause of overruns is a lack of realism in initial cost estimates. The length and cost of delays are underestimated, contingencies are set too low,

changes in project specifications and designs are not sufficiently taken into account, changes in exchange rates between currencies are underestimated or ignored, so is geological risk, and quantity and price changes are undervalued as are expropriation costs and safety and environmental demands.6 (the General Purpose Standing Committee No. 3 Report ; no. 26., 2012).

2.9 Cost overrun

The term cost overrun is often referred to as a budget increase, cost increase, or cost growth. A cost overrun should, however, be distinguished from cost escalation, which is used to express an anticipated growth in a budgeted cost due to factors such as inflation. A lack of a standard definition juxtaposed with the inappropriate distribution models has contributed to the formulation of inaccurate cost overrun probability forecasts. Nijkamp and Ubbels (1999), Flyvbjerg et al. (2002), and Odeck (2004), for example, defined a cost overrun as the difference between forecasted and actual construction costs (Rauzana, 2016).

Cost performance and the management of cost overruns is an important topic in many countries, the construction field, and it has been a discussion point in the political arena. The problem of cost overrun especially in road projects is a worldwide phenomenon. It has been one of the main causes for disputes among different stakeholders of construction projects such as clients, consultants and contractors. Project cost overruns can create a significant financial risk to clients. However, in spite of the risk involved, the history of the construction industry is full of projects that were completed with significant cost overruns (Gutae, 2015, p. 5). It is the phenomenon in which the client has to spend more money for the completion of project than the originally estimated i.e. the project goes over the budge (1Anant Narayan Shete, 2016)

2.10 Effects of cost overrun

Cost overruns have obvious effects on projects key stakeholders in particular, and on the construction industry in general. The various parties to a project contract do not necessarily have the same project goals and they have different understanding for project cost overrun**.** (Gutae, 2015, p. 12)

- **From the client point of view**: cost overrun implies added costs over and above those initially agreed up on the onset, resulting in less returns on investment.
- **To the end users:** cost overrun is the added costs that is passed on as higher rental/lease cost or price.
- **To the professionals**: cost overrun implies inability to deliver value-for-money and could well tarnish their reputations and results in loss of confidence.
- **To the contractor**: it implies loss of profit through penalties for non-completion, and negative reputations that could jeopardize chances of winning other projects, if at fault.
- **To the construction industry as whole**: a cost overruns could bring about project abandonment and a drop in building activities, bad reputation, and inability to secure project finance or securing it at higher cost due to added risks.

Some researcher of the construction industry describe the effects of cost overrun in different ways. For example, Arditi (1985) stated that the effects of cost overrun are not confined to the construction industry but also reflected in the state of the overall economy of a country. Similarly other researchers have signaled that delays and cost overruns in construction projects prevent the planned increase in property and service production from taking place, and this phenomenon in turn affects, in negative way, the rate of national growth (Gutae, 2015, p. 12).

2.11 Frequently identified cost overrun causes

Frequent Design Change during Construction Phase

Although it is very unlikely that a project can be delivered without any variation during the construction stage [32], a long process for processing design change orders negatively impacts on the duration and cost of a construction project. Change in a project's design could be part of a construction project nature because of its inherent complexity and uncertainty. Design change causes delay as its needs to be reviewed and approved by clients. However, this factor was found to cause cost overrun in different developing countries such as Vietnam, Indonesia, and Nigeria as well as developed countries such as Korea. The factor scored highly among other factors of cost overrun in developing countries. For example, in Zambia it scored second highest. Lack of clearly defined project objectives and scope was mainly the cause of frequent change orders in construction projects in these countries. **(Abdulelah Aljohani, 2017)**

Contractors' Financing

It is usual that contractors face financing issue during the construction phase as they normally pay for works and receive payment after completing part of projects or the whole projects. Thus, contractors should make sure that they have sufficient funds available to enable them to undertake projects. Moreover, they should put all financing processes under control by adopting an effective project financing method. All the above points emphasise that a reliable contractor's financial status plays a primary role in delivering projects on time. Moreover, poor controlling of cost and cash flow during the construction phase would directly increase the cost of implementing a project, or it might lead to project delay that leads to financial penalties. In other words, if contractors meet financial difficulties, project progression will be affected. However, it is not unusual that contractors' face financial difficulties during the construction

phase. For instance, a delay or inability to cover their direct and indirect costs. The contractor experiencing financial problems was found as a cause of projects' underachievement in different contexts and it was ranked in the top five important causes for project underachievement in the following location contexts: Nigeria, Ghana, and Vietnam (Abdulelah Aljohani, 2017).

Payment Delay

Slow or delayed payment to contractors for completed works is a very common complaint of contractors about project's client. It was identified in five different contexts and appears to occur more often in government funded projects because of a typically slow payment procedure (the public sector around the world is more bureaucratic because the level of power and decision-making is centralized). Failure to provide payment on time to contractors for the completed work will make it difficult for the contractor's to meet (typically due to relatively small cash reserves) project objectives. It is worth noting that late payment does not only consume contractor's time and money but more importantly it can affect the trust relationship between contractors and the owner. Moreover, payment delay by the owner might lead to an increase in the cost of projects as contractors increase their overhead cost to cover that risks (Abdulelah Aljohani, 2017).

Lack of Contractors' Experience

Construction projects are tending to become more complicated and therefore place pressure on time (project duration) and expertise. A lack of contractor experience (and expertise) of the projects' type and location might lead to a rework component for the project or delay which increases the cost of implementing a project. It has been cited that lack of experience is one of the critical causes affecting the construction projects performance by different authors.

A lack of contractor experience was one of the main causes of cost overrun in different developed countries such as Indonesia and Ghana (Abdulelah Aljohani, 2017).

Poor Cost Estimation

Cost estimating could be defined as the process where an estimator arrives at an expenditure of resources necessary to complete a project in accordance with plans and specifications. The preparation of a detailed cost estimate for a particular construction project requires collecting, retrieving, and manipulating large amounts of independent, but related, cost and non-cost data and information in a time-effective manner. Cost estimation for projects is a characteristically complex exercise. Although estimation techniques have improved over the years, they are still regarded as imperfect. Because of the high uncertainty of construction projects, clients along with the contractor become better informed about the specific technological and material requirements of the project works after a project moves from the design phase to the implementation phase. E.g. poor ground conditions.

There are several causes for an inaccurate cost estimate, and some of these causes may be similar to other causes of cost overrun. One of them is the psychology cause. Psychologists believe that most people tend to be more optimistic than realistic which is called optimism bias [36], [37]. In this situation, estimators and contractors make their decision based on delusional optimism (higher than actual rewards and lower than actual risks) rather than rational measuring of profits and losses. Other causes are: (Abdulelah Aljohani, 2017)

1) The data used to estimate the bid may be unreliable.
2) The absence of national database for prices to rely on.
3) Lack of estimators' experience.
4) Honest mistakes.

Poor Tendering Documents

Immature tendering documents were identified as causes of cost overrun in thirteen out of seventeen studies. Several factors have caused this issue including: the involvement of the designer as a consultant; communication gaps occurring between the contractor and designer; insufficient details in the working drawings and a lack of coordination between the parties. Also included is a lack of human resources in the design firm, the designers' lack of knowledge of available materials and equipment and the use of incomplete shop drawings and specifications (Abdulelah Aljohani, 2017).

Poor Material Management

Construction material is one of the most important elements in the execution of any construction projects. The importance of material management can be seen clearly from its definition. Patel and Vyas [38] define materials management as "the system for planning and controlling all of the efforts necessary to ensure that the correct quality and quantity of materials are properly specified in a timely manner, are obtained at a reasonable cost and most importantly are available at the point of use when required". The consequences of poor material management might result in late delivery of materials or risk of purchasing at higher prices, thus resulting in delay and cost overrun. With an increase in the number of construction projects in a single location, the local market cannot meet the high level of demand for building materials. Thus, a project's contractor might face a shortage of construction materials on the market or an increase of the material prices, which results in cost overrun. For large and complex construction projects where special materials are required, the risk of importing delay is raised as the construction industry depends on the international market to provide such materials.

Material price fluctuation and poor material management have been recognized as one of the main causes of cost overrun in fifteen studies out of

the seventeen, some of the countries that suffer from this cause are: Nigeria, Indonesia, Vietnam, Ghana, and Saudi Arabia.

Different causes could lead to poor material management such as: unreliable material suppliers, shortages of materials, an absence of adequate statistics on materials availability; fluctuations in the availability of construction materials; very long average waiting times and uncertainty about the deliveries of ordered materials; shortages of funds to procure materials, and inadequacy in terms of transportation (Abdulelah Aljohani, 2017).

Although the problem of cost overruns is generally acknowledged, the causes and explanations are subject to more debate. The literature has identified various causes of cost overruns, including poor project design and implementation, the inadequate funding of projects, bureaucratic indecision, the lack of coordination between enterprises, inflation, incompleteness of estimates, adjustments to projects, project size, project type, region, construction and implementation period. However, not all of these studies reach the same conclusions, for example, finds rather surprisingly as no other study has noted it previously, that smaller projects have relatively larger cost overruns compared to larger ones. The study by Flyvbjerg et al. (2004) concludes conversely that cost overruns are large for all project sizes. (Cantarelli, 2011, p. 4) Beside these causes, Flyvbjerg et al. (2007, 2002) provide four types of explanations for forecasting inaccuracy. Note the difference between causes and explanations. In line with the definition in Flyvbjerg et al. (2004), what is meant here by ‘cause’ is ‘to result in’; the cause is not the explanation of the result. Causes refer to the variables or factors that influence the cost overruns, such as the implementation period or the size of the project. Explanations are more general and might comprise several causes. Flyvbjerg et al. (2007, 2002) give the following types of explanations for forecasting inaccuracy: (Cantarelli, 2011)

- **Technical explanations**: these are ‘forecasting errors’ in technical terms e.g. imperfect forecasting techniques, inadequate data and lack of experience
- **Economic explanations**: these explain cost overruns either in terms of economic self-interests in terms of public interest, but both depict underestimation as deliberate and economically rational
- **Psychological explanations**: these include the concepts of planning fallacy and optimism bias (a systematic tendency for project appraisers to be overly optimistic)
- **Political explanations**: strategic misrepresentation; deliberately and strategically overestimating benefits and underestimating costs when forecasting the outcomes of projects.

Optimism bias and misrepresentation are both deception but the latter is intentional i.e. lying whereas the first is not, optimism bias is self-deception. A tracheotomy of explanations is also common, in which economic and political explanations are combined into one category i.e. political-economic explanations. The definition of economics in this dissertation is narrow and is much more comprehensive in the economic field. (Cantarelli, 2011, p. 5) Despite these explanations, cost overruns continue to be a problem in large-scale transport infrastructure projects. This asks for a different approach in studying cost overruns, namely from a theoretical perspective. A sound theoretical basis is particularly important as it substantiates the explanation and provides opportunities to define appropriate cures. Insight into the theories underlying the explanations for cost overruns has been the subject of only a few studies. A systematic overview of the theories that are used or can be used to explain cost overruns is however lacking. Moreover, an application of a specific theory to show how cost overruns can occur has not been conducted. (Cantarelli, 2011, p. 5)

In searching for an explanation for cost overruns, poor information control is often referred to Otten (1996) provides the following reasons: information is often controversial, information is used as an instrument to influence the decision-making, information-asymmetry, and information could be confidential. In addition, he argues that the ability to control projects is also a function of previously taken decisions, also known as “overstriking” or here translated into “lock-in”. This can be seen as institutional or behavior lock-in compared to the more commonly known technical lock-in Lock-in is a general phenomenon widely acknowledged in the literature, where the process of escalating commitment is also known as “entrapment, the “sunk-cost effect, the “knee-deep-in-the-big-muddy” effect, and the “too-much-invested-to-quit” effect. However, the institutional or behavioral form of lock-in has been addressed to a far lesser degree and in the context of cost overruns, no such concept has been thoroughly investigated , where the process of escalating commitment is also known as “entrapment the “sunk-cost effect, the “knee-deep-in-the-big-muddy” effect, and the “too-much-invested-to-quit” effect. However, the institutional or behavioral form of lock-in has been addressed to a far lesser degree and in the context of cost overruns, no such concept has been thoroughly investigated. Little is known about how lock-in emerges, whether it has actually taken place and to what extent it can explain cost overruns (Cantarelli, 2011).

International research shows that most infrastructure megaprojects experience cost escalations, but the overruns depend on project type and size. In the transportation sector, Bent Flyvbjerg, Nils Bruzelius, and Werner Rothengatter conducted the largest and most robust study of cost overruns on a sample of 258 major roads, tunnels, bridges, urban transit, and interurban rail projects in 20 countries on five continents. Each megaproject cost $100 million or more, and most were the biggest, highest-profile, and most complex transportation projects conducted in the jurisdiction at the time. The study concluded that nine

out of ten megaprojects experienced a cost overrun, and the average cost escalation was 28 percent. Rail projects in the sample experienced the largest cost escalations with the average overrun being 45 percent (Siemiatycki, 2015).

2.11 Previous Studies

1. Various studies have addressed the issue of cost overruns in transportation projects already. Merewitz, for example, suggests that the average cost overrun of infrastructure projects is a little above 50 percent. Morris (1990) found that projects under implementation, which were scheduled for completion during or before 1987, had an average cost overrun of 82%. Nijkamp and Ubbels (1999) conducted a comparative study between several Dutch and Finnish transport projects investigating the reliability of estimates, and found similar results. In most of the projects, cost overruns were common varying between 2 and 20%. Odeck (2003) investigated the statistical relation between actual and estimated costs for Norwegian road projects. His findings showed a mean cost overrun of 7.9%. A study by Flyvbjerg et al. (2003a) indicates that in 86 percent of the projects under consideration cost overruns appear with an average cost overrun of 28 percent (C. Cantarelli, 2009).

2. Many well-known large-scale transport infrastructure projects incur major cost overruns. One of the most famous “project disasters” in this respect is the Channel Tunnel. This undersea rail tunnel linking the United Kingdom and France is the longest of its kind with a length of about 50 kilometers. Construction cent higher than the forecasted costs (Cantarelli, 2011) Costs increased from £2600 million to £4650 million (1985 prices), which is 80 per in the past several decades, large construction projects have been known for their cost overruns and late completion times. Many factors are responsible for these cost overruns

such asunder estimation of costs to make the projects more viable, addition of scope during later stages of project planning and even during construction, changed conditions, etc. One of the most important contributing factors to the magnitude of cost overrun in large transportation projects are project delays. Furthermore, the length of project development phase from planning to construction seems tobe a major factor in the extent of cost overrun (Flyvbjerg, Holm & Buhl, 2004). The longer, larger projects tend to be more prone to cost overruns. (M.S.Ramabodu & JJP Verster, 2010).

3. Study conducted by Merrow, McDonnell [5] includes 52 Megaprojects from different regions around the world and their budgets between $0.5 and $30 billion (in 198 value US dollars). The results show that only 4 projects met their cost goals, while the rest accrued average cost overruns of 88%. From the USA, Pickrell's, studies of cost estimation in eight US rail projects identified an average cost overrun of 61%. Moreover, a Dutch study containing 78 projects (Road: 37 projects, Rail: 26 projects, Tunnel: 8 projects, Bridge: 7 projects) found an average cost overrun of 16.5%. Finally, a study published by Flyvbjerg, Bruzelius concerning the quality of the estimating of cost and demand in 258 transport projects located in twenty countries (constructed between 1927 and 1998) found that nine out of ten projects (86% of the projects) experienced cost overrun, with the overall average overrun being 28% (Abdulelah Aljohani, 2017).
4. Mette K. Skamris Holm in cooperation with Bent Flyvbjerg generated a database of 258 large transport infrastructure projects, the value of the sample was US 910 billion dollar (1995 year prices), and projects included in the sample were built between 1927-1998. In her thesis [4] she pointed that the sample had to be large enough to allow statistical analyses of cost overruns and benefit shortfalls, although 9 out of 10

projects had cost overruns. There were 58 rail projects among the others with an average cost overrun of 44.7%, ranging from -46 to +200%. There were no significant differences between urban, high-speed and ordinary rail projects (Trabo1, Landex, Nielsen, & Schneider-Tilli, 2013)

5. Ram Singh (2009), ―Delays and Cost Overruns in Infrastructure Projects: An Enquiry into Extents, Causes and Remedies‖ Ram Singh say media reports abound on instances of prolonged delays and excessive cost overruns infrastructure projects. Only a small number of projects get delivered in time and within the budget. Examples of successful project implementation, like construction of the Delhi Metro Rail, are few and appear only far in between (1Anant Narayan Shete, 2016).
6. Morris (1990) conducted one of the first empirical studies with a narrow focus on cost overruns in large projects. He argues that delays in project implementation and cost overruns have become a regular feature of public sector projects. The average cost overrun found in this study is 82%. As far as possible causes are concerned, Morris (1990) concludes that about 20 - 25% can be attributed to price increases, and the remaining 70-75% has to be explained in terms of real factors, such as delays in implementation. He gives the following main factors as the causes of delays and cost overruns: poor project design and implementation, inadequate funding of projects, bureaucratic indecision, and a lack of coordination between enterprises. (C. Cantarelli, 2009, p. 18).
7. The study by Arvan and Leite (1990) focuses on large-scale government sponsored procurement. They provide an explanation of cost overruns by assuming that the sponsor cannot pre-commit to the compensation

paid to the contractor when the contractor has some private cost information. (C. Cantarelli, 2009, p. 19)

8. Wachs (1987, 1989) reviews several forecasting models in the field of transportation. He finds that forecasts are often inaccurate, underestimating costs and overestimating traffic demand. He proposes two possible explanations for these optimistic forecasts. Firstly, 'forecasting is inherently exact and the observed errors result from imperfect techniques. Secondly, 'travel and cost forecasting is deliberately slanted to produce figures which constitute technical justification for public works programs favoured on the basis of political rather than economic or technical criteria'. Because the forecasting errors are always in the same direction - always an overestimation of traffic demand and an underestimation of costs -the first explanation seems, according to Wachs, to be less valid. In line with Ascher'sargumentation (1987) he concludes that 'the competitive, politically charged environment of transportation forecasting has resulted in the continuous adjustment of assumptions until they produce forecasts which support politically attractive outcomes'. He identifies three main sources of error in forecasting costs: changes of scope, assumed rates of inflation that are lower than actual rates of inflation, and delay. He concludes that about 40-90% of the total cost overrun can be explained by these factors, but a substantial part remains unexplained. Other causes can be found in the funding system commonly found in rail transit projects. There is an incentive with this kind of funding system to select the most optimistic assumptions in the development of cost estimates for projects. (Cantarelli, 2011, p. 18)
9. Various studies addressed cost overruns for transportation projects specifically. For example, Pickrell (1992) investigated the cost overruns and benefit shortfalls of 8 rail transit projects in the US. In his study,

Pickrell (1992) starts from the premise that forecasters overestimate rail transit ridership and underestimate rail construction costs and operating expenses. To understand these inaccurate forecasts, he points, on the one hand, to optimism among local officials and to inadequate planning processes on the other. He argues that the causes of under estimated costs lie in the structure of programmes and the existence of dedicated funding sources that provide few incentives for local officials to seek accurate information for evaluating alternatives. Fouracre et al. (1990) investigated cost overruns for 21 metro projects worldwide. Nearly all the metro systems incurred costs higher than expected. These overruns were attributed to 'a range of factors, including the additional costs of unforeseen service and utility diversions and other civil works problems, which could not be offset by contingency allowances; changes in specifications; currency devaluation and rises in interest charges'. According to the authors, most of the cost estimates were optimistic because there was little appreciation of the difficulties of the work. In addition, authorities lacked the management skills to mitigate errors in project planning and to keep effective control of costs. (C. Cantarelli, 2009, p. 19)

10. The Auditor General of Sweden (1994) is another study with a narrow focus on cost overruns involving transport projects. It covered 15 road and rail projects. The average capital cost overrun for the eight road projects was 86%, ranging between 2 and 182%, and for the seven rail projects this was 17%, ranging from minus 14% to plus 74%. The authors conclude that there is still a considerable element that cannot be explained by technical causes (C. Cantarelli, 2009, p. 19)

CHAPTER 3
RESEARCH METHODOLOGY

CHAPTER 3

RESEARCH METHODOLOGY

3.1 introduction

Cost overrun in Sudan Railways construction projects are as a result of many factors. Each cost overrun factor have different rate of occurrences And will therefore be impact on the project cost at completion. Some factors may happen frequently but their impacts on cost may be less severe. Whereas some other causes may happen rarely but their impact may be severe. Therefore, it is necessary to identify cost overrun factors based on occurrences, as well as their rank according to the frequency of occurrence. In this chapter, the research design and methodology followed to achieve the ultimate goal of the research which is specified previously will be discussed. In addition, data and information sources, research instruments, sample size and method of analysis are presented.

3.2 Research Design

The strategy followed in this research is based on the descriptive approach, which is based on collection of data related to the subject of the study for the purpose of describing, analyzing and explaining, in addition to clarifying relationships between them and some independent variables to reach to the appropriate generalizations.

First started with problem identification which has been done through unstructured literature review and informal discussion with colleagues and professionals in the sector; and then the research design was formulated. Then data and information sources were determined based on the formulated research design. On the basis of the data and information sources the research instruments were decided; and available documentary sources relevant to the

research were reviewed. The review includes books, journals, internet sources and other documents. After an in-depth literature review and desk study a questionnaire listing the various factor of cost overruns were distributed to clients which is represented by Sudan railways engineer and qualified contractors in railways construction to get their professional opinion based on experience. Upon obtaining the desired data, checking and sorting of data has been done. The data were then analyzed for cross-checking the validity and conformity of the information obtained through the overall research work. This survey-based research design has been selected as it is useful in demonstrating the prevalence of the problem.

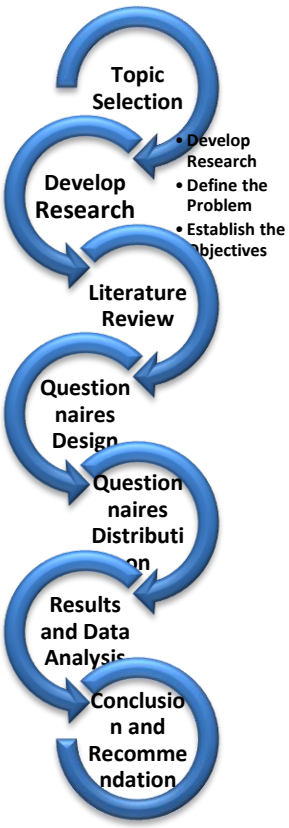

Figure 3-1 Flowchart of Research Methodology

3.4 Population and Sample

Restrictions on the selection process were imposed for respondents:

Where the selection process was focus on the aspect of experience with respect to owner which is represented by engineers who working in the Sudan

Railways It has been obtained from the Human Resources Department. And contractors which is represented by companies qualified to work in the railway sector in Sudan Local and foreign and their number is (25), (8) them implemented actual projects a questionnaire was distributed to them and it has been obtained from purchase Department.

The size of the sample required from each population was determined on the basis of statistical principles for this type of exploratory research. For such research, sample size was determined as follows: (Mohamed Elshaikh , March 2018)

$$n_0 = (p*q)/ V^2 \quad (1)$$

$$n = n0 / [1+ (n0 / N)] \quad (2)$$

Where:

n0: First estimate of sample size, P: The proportion of the characteristic being measured in the target population, q: Complement of „p" or 1-p, V: The maximum standard error allowed, N: The population size, n: The sample size. To maximize n, p is set at 0.5. To account for more error in qualitative answers of this questionnaire, maximum standard error V is set at 10% or 0.1.

The consultant's sample

The sample of consultants is represented by Sudan Railways Corporation which represents the owner at the same time. The total size of the society is 119 person and consists of managers, project managers, site managers and engineers in the Sudan Railway Corporation. It has been obtained from the Human Resources Department and when Substituting in Equations 1 and 2 above find that the minimum sample size of the consultant society should be (21).

The contractor’s sample

The sample of contractors focus was on a number of construction companies that carried out actual projects or have a projects Under construction it was (8) companies They were obtained from Procurement Department of the Sudan Railways Corporation. The questionnaires distributed to managers, project managers and site managers and site engineers because they are more familiar with the problems facing the implementation of the project.

In order to determine the size of the contractors' society tenders submitted by contractors' companies for the construction of railway projects in Sudan were reviewed to include the details of the project team and the engineers involved during the project implementation period. The simple size as follows:

Table 3-1 simple of contractor’s size

The Society Detail	Number
Company manager	8
Project managers	24
Site managers	32
Site engineers	48

Thus, the total size of society is 112. In order to obtain the sample size, when Substituting in Equations 1 and 2 above We find that the minimum sample size of the contractor’s society should be (21).

- The total sample size of the questionnaire, which includes contractors And consultants should be not less than (42) questionnaires.

3.5 Sources of Data and Research Instrument

The research instrument used to identify and rank factors of cost overrun in this research was questionnaire survey. It was employed to get professional

opinion and other relevant data through questionnaire. Besides this a literature review to develop conceptual basis for the study was also conducted.

3.6 Contents of the Questionnaire

A descriptive letter was attached to the questionnaire, in which the subject, purpose, objectives and contents,

The questionnaire contains two main sections:

- The first part of the questionnaire focused on general issues such as sector data and edge. The aim was to get a view of the respondents: Their experience, how long they had worked in the field of railway construction in Sudan, and Their opinion about the extent of the phenomenon of cost overruns in the railway construction projects in Sudan. There were five possible answers concerning to what extent they agreed with the statement made. We used options occur a lot, sometimes occurring, rarely occur, Do not occur, I do not know in order to have an exhaustive list of possible answers.
- This second section presents practical procedures for field study, data analysis and axial testing based on the assumptions below which represent the essence of the research:
- Cost overruns in Sudan railways construction projects may be eliminated if their factors are identified, clearly and managed well.
- Factors leading to cost overrun in railways construction projects in Sudan occur frequently.

The first axis addresses what are the factors that lead to cost overruns in Sudan railways construction projects" includes (18) phrase A list of major factors of cost overrun as read from the literature is presented and the respondent is asked to identify it. The analysis was done according to Fifth Likert Scale which consists of five levels:

Table 3-2 Fifth Likert Scale

Strongly agree	agree	sometime	disagree	strongly disagree
5	***4***	***3***	***2***	***1***

The second axis includes (18) phrase addresses "what do you think of the following factors of costs overrun in terms of the frequency of occurrence in Sudan railways construction projects the respondent is asked to state the frequency of occurrence of these factors in Sudan railways construction project. The analysis was done according to Fifth Likert Scale which consists of five levels:

Table 3-3 Fifth Likert Scale

occur a lot	sometimes occurring	I do not know	rarely occur	do not occur
5	***4***	***3***	***2***	***1***

The questionnaire respondents

The response to the questionnaire can be summarized in the following table:

Table 3-4 the number of survey participants and the response rate

Item	**respondents**	**Number**
1	Total questionnaires distributed to respondents	100
2	Questionnaires that have not been recovered	11
3	Questionnaires that have not been Completed	4
4	Total questionnaire returned	85
5	Response rate	85%

3.7 Data Analysis

The analysis of the data was carried out with the help of statistical package for social sciences (SPSS) version 14. Data were carefully analyzed statistically using reliability test, frequencies and factor analysis, Importance index, descriptive statistics.

Importance Index

Then Importance index for each factor was calculated according to the Equations (3) and (4) (Mohamed Elshaikh , March 2018)

Importance Index= $(Wi\ x\ Xi)/N$ (3)

Where:

Wi: the weight is assigned to the option of factor; Xi: the number of respondents who selected the option of factor; N: the total number of respondents.

- Importance index for sections calculated by the Following equation:

Importance Index = $5(x5) + 4(x4) + 3(x3) + 2(x2) + 1\ (x1) / (N)$ (4)

Reliability

Reckon that reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. Reliability in Research is influenced by random errors. As random error increases, reliability decreases. [69] Provided a commonly accepted rule of thumb for describing internal consistency using Cronbach's alpha is as follows (Mohamed Elshaikh , March 2018):

The coefficient of alpha is used to test the stability of the responses to the questionnaire. The coefficient measures the internal consistency of the questionnaire and its ability to give consistent results to the respondents' responses to the questionnaire. The alpha coefficient is between 0 - 100% and

is statistically acceptable if it results from 60% Then the tool is stable and we can generalize the results.

Table 3-5 Cronbach's consistency alpha *(Mohamed Elshaikh , March 2018)*

Cronbach's Coefficient Alpha	Internal Consistency Remarks
$\alpha \geq 0.9$	Excellent
$0.7 \leq \alpha < 0.9$	Good
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

A random sample had been selected from the total sample size to apply Reliability test, (15) samples of the total sample were tested before and after. The following table illustrates the Reliability test of the study hypotheses:

Table 3-6 Cronbach"s Alpha coefficient for the Reliability of all expressions of the questionnaire

Statement	**Number of questionnaire**	**rate**
Experimental Sample	15	%100
Total	**15**	**%100**

Cronbach"s Alpha (Before)

Reliability Statistics

Cronbach's Alpha	**Items**
.918	**44**

Through the table above reliability Statistics for questionnaire (.918) and Compared to Table (3-2) (Excellent) which means %91 Thus questionnaire has a high stability coefficient and this is what achieves the research purposes and makes statistical analysis acceptable.

Cronbach‟s Alpha (after)

Reliability Statistics

Cronbach's Alpha	Items
.918	44

Through the table above Reliability Statistics for questionnaire (.918) which means %91 this means that the questionnaire has a high stability coefficient when re-testing for the same samples this achieves the purposes of research and makes statistical analysis acceptable.

Chi- Square Distribution

Chi- square test is used to measure the range at which the observed frequencies are approaching or moving away from the expected frequencies.

We get Chi- square test According to the following equation:

$$x^2 = \sum_{i=1}^{n} \frac{(O_i - E)^2}{Ei} \qquad \textbf{(6)}$$

O_i // Repeated observations obtained

Ei // Expected frequency of study

$\sum_{i=1}^{n}$ // Total

n // Number of sample members

i // 1, 2, 3, 4, 5

Its p-value that determines whether there is a statistically significant between expected frequencies and observed frequencies by comparing the p-value with a significant level (5%), if it is less than 5%, this indicates that there are differences between the observed frequencies and the expected frequencies.

Standard deviation

To identify the extent of deviation of the responses of the members of the study for each of the terms of the variables of the study, and each axis of the principal of the arithmetic mean.

CHAPTER 4

RESULTS AND DISCUSSIONS

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents and discusses the analyses and results of the collected data, it includes a description of respondents, classification, experience, and there opinion about phenomenon of cost overruns in the railway construction projects in Sudan, it also includes the identification of potential factors that lead to cost overrun and ranking this factors Based on the frequency of their occurrence.

4.2 Section one: general information

Job title is in the organization

The respondents' answers were as shown in the table below:

Table 4-1 job title in the organization

job title in the organization	Frequency	Percent
Manager	13	15.3%
Project manager	24	28.2%
Site manager	10	11.8%
Site engineer	11	12.9%
Engineer	27	31.8%
Total	**85**	**100%**

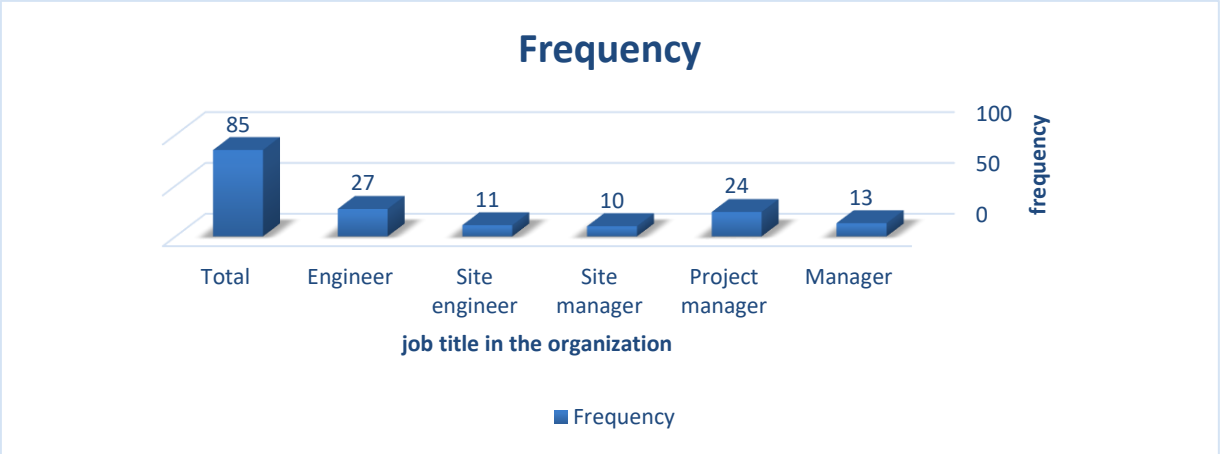

Figure 4-1 job title in the organization

From Table (4.1) and figure (4.1) above: 15.3% of respondents were managers, 28.2% Project Managers, 11.8% Sit Manager, 12.9% Site engineer, 31.8% Engineers. This means the highest percentage is (31.8%) Which represents the engineer's category.

Sector

The sector was divided to a public sector represented by engineers of the Sudan Railways and private sector represented by contractors; the respondents' answers were as shown in the table below:

Table 4-2 Sector

Sector	Frequency	Percent
Sudan railways corporation	61	71.7%
Contractor	24	28.2%
Total	**85**	**100%**

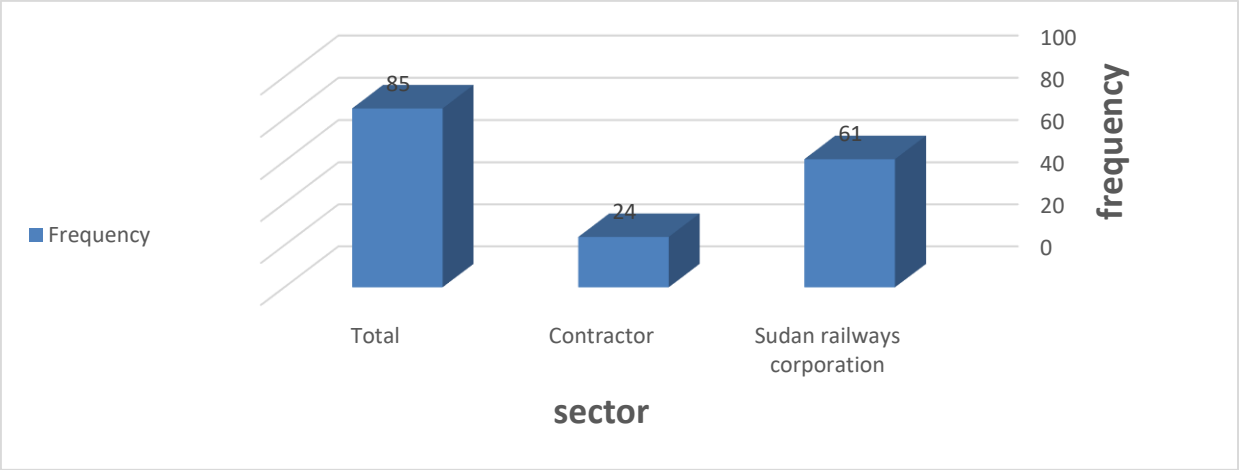

Figure 4-2 Sector

From Table (4.2) and figure (4.2) above: 71.7% of the respondents were public sector, 28.2% of the private sector, from the above we conclude that the categories of the Sudan Railway corporation the highest percentage.

Age

The respondents were divided by age and the following answers were given (Less than 25 years, More than 25 years and less than 35 years, More than 35 years and less than 45 years, More than 45 years) The answers were as shown in the table below:

Table 4-3 Age

Age	Frequency	Percent
Less than 25 years	8	9.4%
More than 25 years and less than 35 years	41	48.2%
More than 35 years and less than 45 years	13	15.3%
More than 45 years	23	27.1%
Total	**85**	**100%**

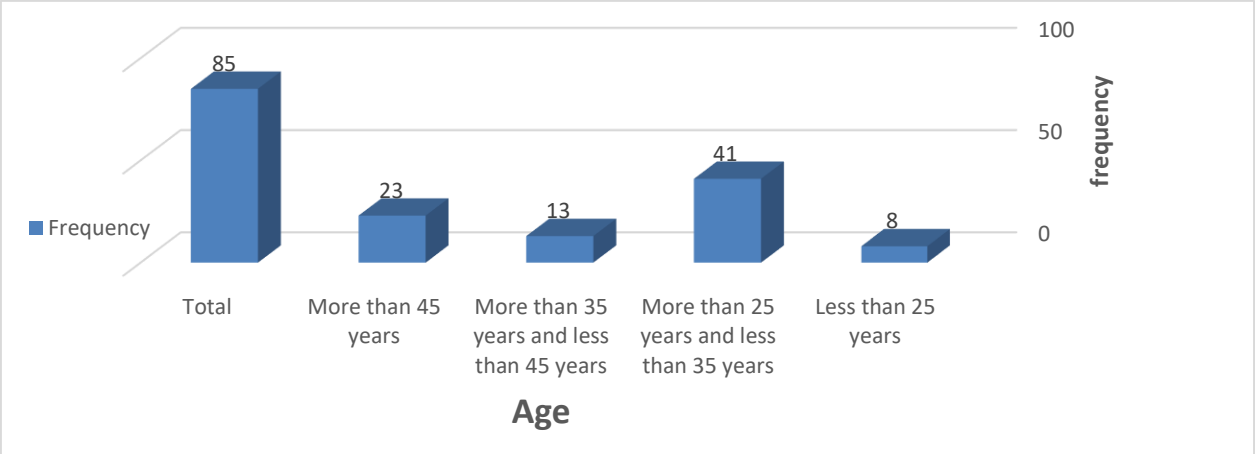

Figure 4-3 Age

From Table (4.3) and figure (4.3) above: 9.4% less than 25%, 48.2% More than 25 years and less than 35 years, 15.3% more than 35 years and less than 45 years, 27.1% more than 45 years. From the above, it is noted that the highest percentage among the age group (25 - 35 years).

Distribution of the respondents according to the number of years of your presence in the field of railway construction

The respondents were distributed according to their presence in the field of railways construction and the following answers were given (Less than five years - more than five years to 10 years - more than 10 years to 20 years - more than 20 years) and the answers of the respondents as shown in the table below:

Table 4-4 Distribution of respondents according to how many years you are in the field of the railways construction projects

How many years have you been in railways construction projects	Frequency	Percent
Less than 5 years	29	34.1%
More than 5 years to 10 years	26	30.6%
More than 10 years to 20 years	7	8.2%
More than 20 years	23	27.1%
Total	**85**	**100%**

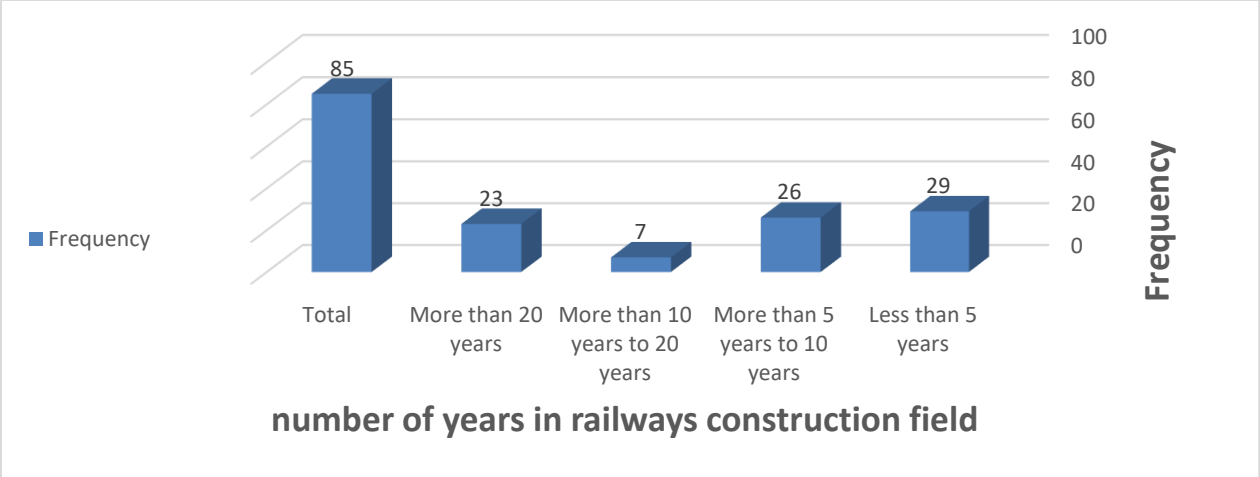

Figure 4-4 How many years have you been in railways construction projects

From Table (4.4) and figure (4.4) above: 34.1% less than 5 years, 30.6% more than 5 years and less than 10 years, 8.2% more than 10 years and less than 20 years, 27.1% more than 20 years. From the above, it is noted that the highest percentage included the category (5 - 10 years) and this indicates that the respondents are highly experienced and this supports the validity of the result.

Distribution of the respondents according to the number of years of your presence in the field of railway construction in Sudan

The respondents were distributed according to their presence in the field of railways construction in Sudan the following answers were given (Less than five years - more than five years to 10 years - more than 10 years to 20 years -

more than 20 years) and the answers of the respondents as shown in the table below:

Table 4-5 Distribution of respondents according to how many years you are in the field of the railways construction projects in Sudan

how many years have you been in the field of railways construction in Sudan	Frequency	Percent
Less than 5 years	31	36.5%
More than 5 years to 10 years	29	34.1%
More than 10 years to 20 years	3	3.5%
More than 20 years	22	25.9%
Total	**85**	**100%**

Figure 4-5 how many years have you been in the field of railways construction in Sudan

From Table (4.5) and figure (4.5) above: 36.5% less than 5 years, 34.1% more than 5 years and less than 10 years, 3.5% more than 10 years and less than 20 years, 25.9% more than 20 years. The highest percentage of the category is less than 5 years.

Distribution of respondents according to academic degree

The respondents were divided according to academic degree and the following answers were given (BA - Higher Diploma - Master - PhD - Other). The respondents' answers were as shown in the table below:

Table 4-6 Distribution of respondents according to academic degree

Academic degree	Frequency	Percent
Bachelor	59	69.4%
High diploma	7	8.2%
Master	15	17.6%
Other	4	4.7%
Total	**85**	**100**

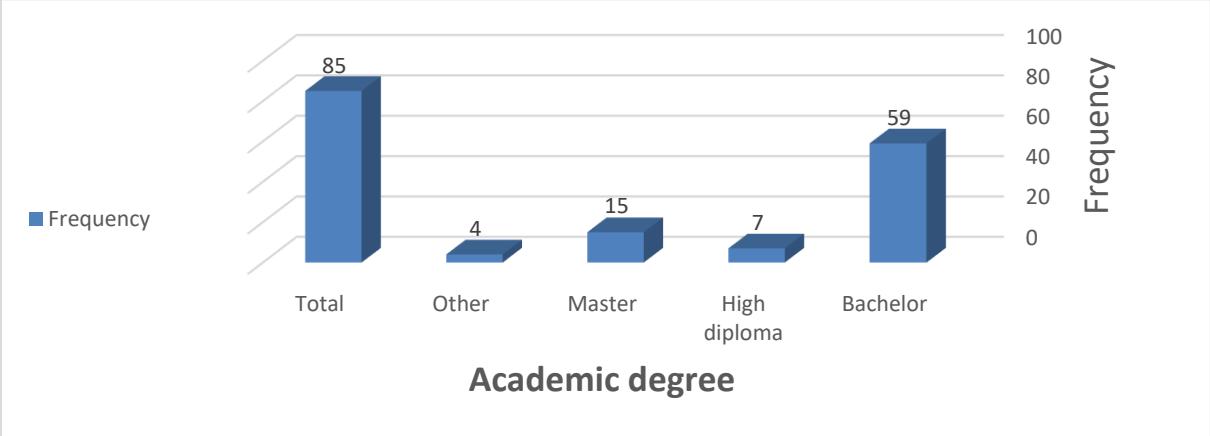

Figure 4-6 Distribution of respondents according to academic degree

From Table (4.6) and figure (4.6) above: 69.4% of the respondents were academic BA, 8.2% high diploma, 17.6% master and 4.7% answered otherwise Which is not mentioned. The above indicates that the sample in question is academically qualified and the majority of the sample surveyed from the bachelor's degree.

Distribution of respondents according to Professional degree

The respondents were divided by years of experience and the following answers were given (graduate, specialist, Consultant, other). The respondents' answers were as shown in the table below:

Table 4-7 Distribution of respondents according to Professional degree

Professional degree	Frequency	Percent
Graduate	56	65.9%
Specialist	17	20%
Consultant	7	8.2%
Other	5	5.9%
Total	**85**	**100**

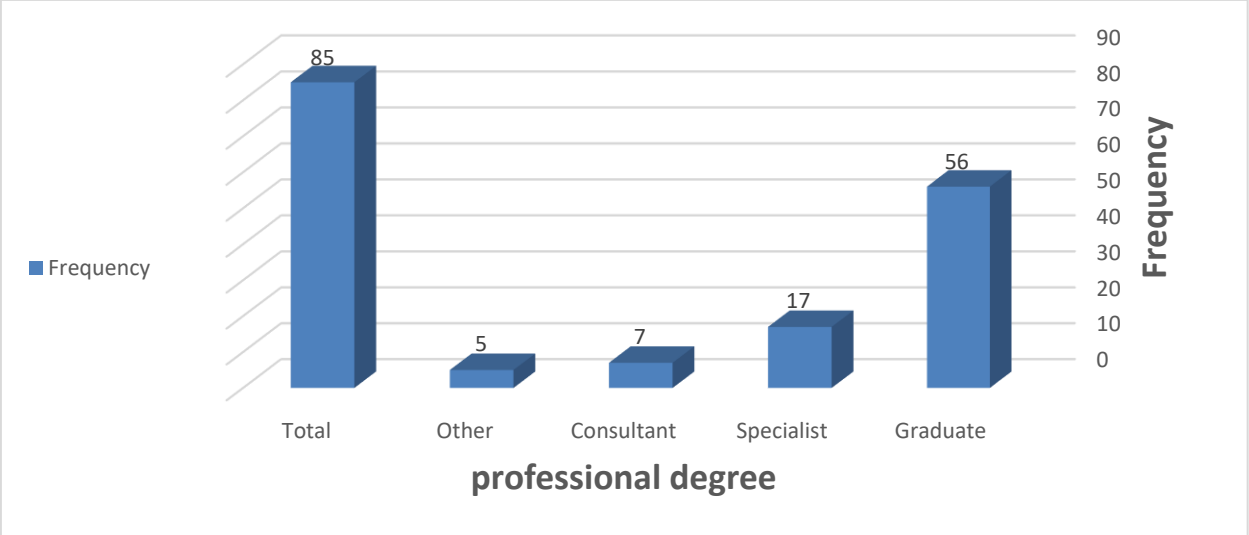

Figure 4-7 Distribution of respondents according to Professional degree

From Table (4.7) and figure (4.7) above: 65.9% of the respondents were professional graduates, 20% were specialists, 8.2% were consultants and 5.9% were not mentioned.

What do you think about the extent of the phenomenon of cost overruns in the railway construction projects in Sudan?

The respondents were distributed according to the question above and the following answers were given (occur a lot, sometimes occurring, rarely occur,

do not occur, I do not know). The respondents' answers were as shown in the table below:

Table 4-8 extent of the phenomenon of cost overruns in railways construction projects in Sudan

What do you think about the extent of the phenomenon of cost overruns in railways construction projects in Sudan	Frequency	Percent
Occur a lot	55	64.7%
Sometimes occurring	24	28.2%
Rarely occur	2	2.4%
Do not occur	1	1.2%
Neutrality	3	3.5%
Total	**85**	**100**

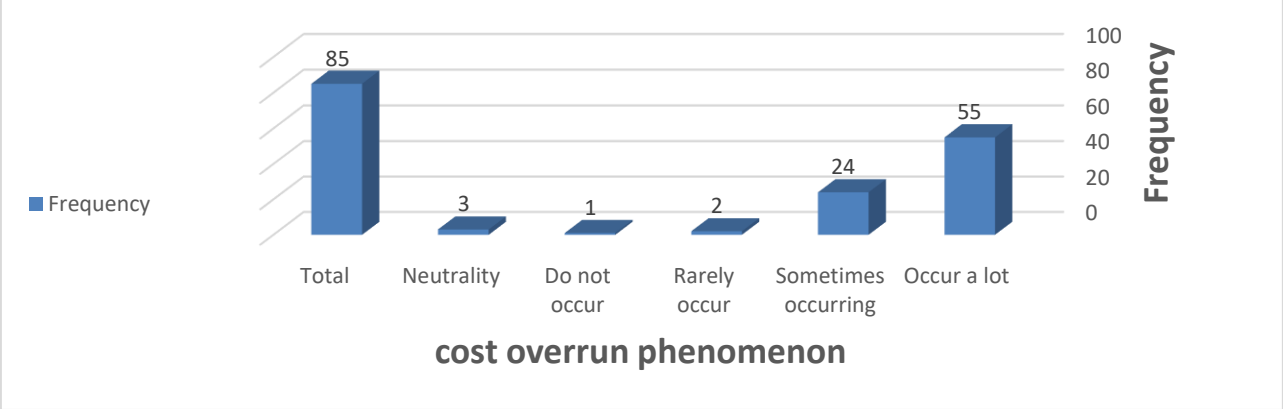

Figure 4-8 extent of the phenomenon of cost overruns in railways construction projects in Sudan

From Table (4.8) and figure (4.8) above: The prevalence of cost overruns in the railway construction projects in Sudan is Occur a lot by 67.7%, 28.2% Sometimes occurring, 2.4% rarely occurs ,1.2% Do not occur, 3.5% Neutrality.

4.3 Section Two: Ratio analysis and iterations of the axes of hypotheses

The first hypothesis: In your opinion what are the factors that lead to cost overruns in the railways construction projects in Sudan. The primary objective

of this section is to choose to impose research that says (Cost overruns in Sudan railways construction projects may be eliminated if their factors are identified, clearly and managed well), to achieve this goal, respondents were asked about their perceptions and the answers were limited to (Strongly Agree - Agree - sometime- Disagree - Strongly Disagree). The results were as follows:

Table 4-9 Frequency and percentage of responses of the study subjects

Item	Phrase	Strongly agree	agree	Sometimes	Disagree	Strongly disagree
F1	Cost overruns often depend on change orders in the design, specifications or scope of the project, etc.	31	40	4	9	1
		36.5%	47.1%	4.7%	10.6%	1.2%
F2	Cost overruns often depend on an inaccurate estimate of the Quantities to be implemented	34	28	9	13	1
		40%	32.9%	10.6%	15.3%	1.2%
F3	Cost overruns are often affected by of project delay	34	36	11	3	1
		40%	42.4%	12.9%	3.5%	1.2%
F4	Cost overruns are often depend on technical problems (geotechnical) unexpected difficult to predict problems such as soil and water leakage ..etc.	8	34	26	13	4
		9.4%	40%	30.6%	15.3%	4.7%
F5	Cost overruns often depend on poor planning and poor budget preparation	38	19	10	16	2
		44.7%	22.4%	11.8%	18.8%	2.4%
F6	Cost overruns often depend on the expansion of subcontracting	16	13	33	18	5
		18.8%	15.3%	38.8%	21.2%	5.9%
F7	Cost overruns often depend on poor decision-making due to political and organizational pressures	24	28	20	11	2
		28.2%	32.9%	23.5%	12.9%	2.4%
F8	Cost overruns often depend on the delay of the owner in paying contractor benefits	20	30	25	8	2
		23.5%	35.3%	29.4%	9.4%	2.4%
F9	Cost overruns often depend on unexpected events such as security problems, heavy rain, accidents at work, etc.	13	39	23	10	0
		15.3%	45.9%	27.1%	11.8%	0%
F10	Cost overruns often depend on economic inflation	45	29	6	3	2
		52.9%	34.1%	7.1%	3.5%	2.4%
F11	Cost overruns are often the result of internal disputes between the parties to the project	10	17	35	21	2
		11.8%	20%	41.2%	24.7%	2.4%
F12	Cost overruns often depend on poor reporting and poor contractor performance monitoring	16	24	21	17	7
		18.8%	28.2%	24.7%	20%	8.2%
		10	25	24	23	3

F13	Cost overruns are often depend on the difficulty of obtaining resources and the lack of skilled workers	11.8%	29.4%	28.2%	27.1%	3.5%
F14	cost overruns often it depends on cognitive bias among the people (weighted personal interest over the interests of the project)	21	14	26	19	5
		24.7%	16.5%	30.6%	22.4%	5.9%
F15	Cost overruns often depend on the absence of a previous experience of the same type of project	18	32	15	13	7
		21.2%	37.6%	17.6%	15.3%	8.2%
F16	Cost overruns often depend on delays, procedures such as permit extraction, etc.	19	34	19	11	2
		22.4%	40%	22.4%	12.9%	2.4%
F17	Cost overruns often depend on poor contract management	29	18	21	14	3
		34.1%	21.2%	24.7%	16.5%	3.5%
F18	Cost overruns often depend on the delay of the consultant or the owner in approving the stages, materials or deliveries	15	26	25	15	4
		17.6%	30.6%	29.4%	17.6%	4.7%

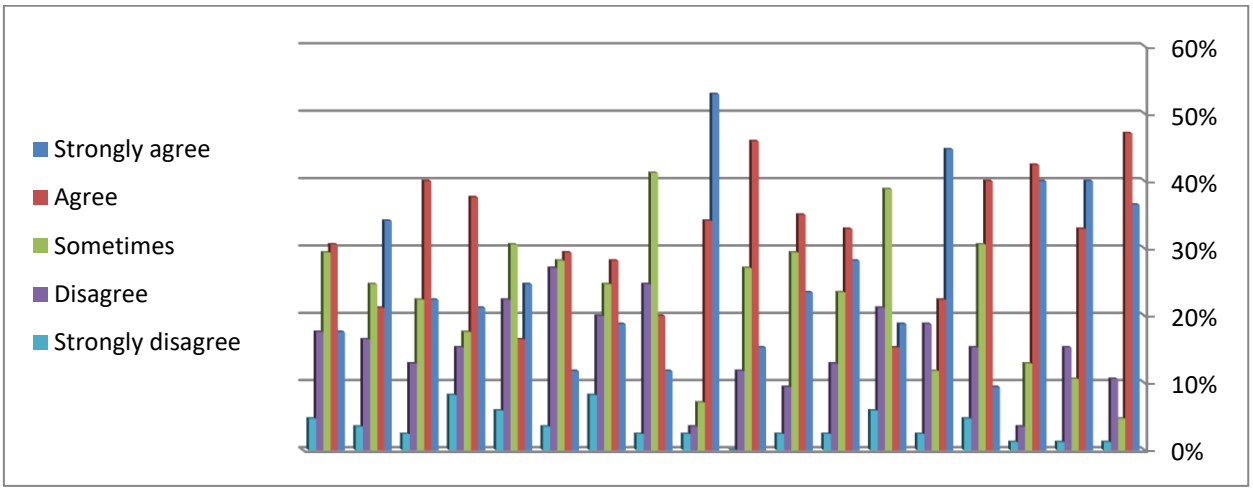

Figure 4-9 observation of study according first hypothesis

- First Factor: (Cost overruns often depend on change orders in the design, specifications or scope of the project) 36.5% of the respondents confirmed this strongly agree, 47.1 % Agree, 4.7% sometimes 10.6% Disagree, 1.2% strongly disagree, this result confirms that the majority of the respondents consider agreeing this factor.
- Second Factor: (Cost overruns often depend on an inaccurate estimate of the Quantities to be implemented) 40% of the respondents confirmed this strongly agree, 32.9 % Agree, 10.6% sometimes 15.3% Disagree, 1.2%

strongly disagree, this result confirms that the majority of the respondents consider agreeing this factor.

- Third Factor: (Cost overruns are often affected by of project delay) 40% of the respondents confirmed this strongly agree, 42.4 % Agree, 12.9% sometimes 3.5% Disagree, 1.2% strongly disagree, this result confirms that the majority of the respondents consider agreeing this factor.
- Fourth Factor: (cost overruns are often depending on technical problems (geotechnical) unexpected difficult to predict problems such as soil and water leakage) 9.4% of the respondents confirmed this strongly agree, 40 % Agree, 30.6% sometimes 15.3% Disagree, 4.7% strongly disagree, this result confirms that the majority of the respondents consider agreeing this factor.
- Fifth Factor: (Cost overruns often depend on poor planning and poor budget preparation) unexpected difficult to predict problems such as soil and water leakage) 44.7% of the respondents confirmed this strongly agree, 22.4% Agree, 11.8% sometimes 18.8% Disagree, 2.4% strongly disagree, this result confirms that the majority of the respondents consider agreeing this factor.
- Sixth Factor: (Cost overruns often depend on the expansion of subcontracting) 18.8% of the respondents confirmed this strongly agree, 15.3% Agree, 38.8% sometimes 21.2% Disagree, 5.9% strongly disagree, this result confirms that the majority of the respondents consider agreeing this factor.
- Seventh Factor: (Cost overruns often depend on poor decision-making due to political and organizational pressures) 18.8% of the respondents confirmed this strongly agree, 15.3% Agree, 38.8% sometimes 21.2% Disagree, 5.9% strongly disagree, this result confirms that the majority of

the respondents consider agreeing this factor frequently during project execution.

- Eighth Factor: (Cost overruns often depend on the delay of the owner in paying contractor benefits) 23.5% of the respondents confirmed this strongly agree, 35.3% Agree, 29.4% sometimes 9.4% Disagree, 2.4% strongly disagree; this result confirms that the majority of the respondents consider agreeing this factor.
- Ninth Factor: (Cost overruns often depend on unexpected events such as security problems, heavy rain, accidents at work) 15.3% of the respondents confirmed this strongly agree, 45.9% Agree, 27.1% sometimes 11.8% Disagree, 0% strongly disagree; this result confirms that the majority of the respondents consider agreeing this factor.
- Tenth Factor: (Cost overruns often depend on economic inflation) 52.9% of the respondents confirmed this strongly agree, 34.1% Agree, 7.1% sometimes 3.5% Disagree, 2.4% strongly disagree; this result confirms that the majority of the respondents consider agreeing this factor.
- Eleventh Factor: (Cost overruns are often the result of internal disputes between the parties to the project) 11.8% of the respondents confirmed this strongly agree, 20% Agree, 41.2% sometimes 24.7% Disagree, 2.4% strongly disagree; this result confirms that the majority of the respondents consider agreeing this factor.
- Twelfth Factor: (Cost overruns often depend on poor reporting and poor contractor performance monitoring) 18.8% of the respondents confirmed this strongly agree, 28.2% Agree, 24.7% sometimes 20% Disagree, 8.2% strongly disagree; this result confirms that the majority of the respondents consider agreeing this factor.
- Thirteenth Factor: (Cost overruns are often depending on the difficulty of obtaining resources and the lack of skilled workers) 11.8% of the

respondents confirmed this strongly agree, 29.2% Agree, 28.2% sometimes 27.1% Disagree, 3.5% strongly disagree; this result confirms that the majority of the respondents consider agreeing this factor.

- Fourteenth Factor: (cost overruns often it depends on cognitive bias among the people (weighted personal interest over the interests of the project) 24.7% of the respondents confirmed this strongly agree, 16.5% Agree, 30.6% sometimes 22.4% Disagree, 5.9% strongly disagree; this result confirms that the majority of the respondents consider agreeing this factor.
- Fifteenth Factor: (Cost overruns often depend on the absence of a previous experience of the same type of project) 21.2% of the respondents confirmed this strongly agree, 37.6% Agree, 17.6% sometimes 15.3% Disagree, 8.2% strongly disagree; this result confirms that the majority of the respondents consider agreeing this factor.
- Sixteenth Factor: (Cost overruns often depend on delays, procedures such as permit extraction) 22.4% of the respondents confirmed this strongly agree, 40% Agree, 22.4% sometimes 12.9% Disagree, 2.4% strongly disagree; this result confirms that the majority of the respondents consider agreeing this factor.
- Seventeenth Factor: (Cost overruns often depend on poor contract management) 34.1% of the respondents confirmed this strongly agree, 21.2%% Agree, 24.7% sometimes 16.5% Disagree, 3.5% strongly disagree; this result confirms that the majority of the respondents consider agreeing this factor.
- Eighteenth Factor: (Cost overruns often depend on the delay of the consultant or the owner in approving the stages, materials or deliveries) 17.6% of the respondents confirmed this strongly agree, 30.6% Agree, 29.4% sometimes 17.6% Disagree, 4.7% strongly disagree; this result

Summary of the first hypothesis

The percentage of those who were strongly agree and agree (58.1%), while the percentage of those who are not agree and strongly disagree (18.9%), Either the sample and those who did not show specific answers were 23%. This finding indicates that the majority of the respondents agree with (the majority of the statements that measure the first hypothesis) and they were (58.1%).

The majority of the surveyed respondents agree with the terms in the table above, Where we find that their responses to these statements indicate the positive trend.ie, their agreement on the goals, But it is noted that the results obtained from the table does not mean that all the observations in the study agree with all Phrases in the table above. And there are individuals who do not agree, In order to test the existence of statistically significant differences between the numbers of those who agree and who have no specific opinion and did not agree with the results. Chi-square test was used to indicate the differences between the responses on each of the axis expressions.

Table 4-10) the arithmetical averages, the standard deviations, and the chi-square test for the first hypothesis: Cost overruns in Sudan railways construction projects may be eliminated if their factors are identified, clearly and managed well

Item	Phrase	Mean	STD	Chi-Square(a,b)	Df	Asymp. Sig.
F1	Cost overruns often depend on change orders in the design, specifications or scope of the project, etc.	1.929	.9733	71.412	4	.000
F2	Cost overruns often depend on an inaccurate estimate of the Quantities to be implemented	2.047	1.1117	43.882	4	.000
F3	Cost overruns are often affected by of project delay	1.835	.8708	66.941	4	.000
F4	cost overruns are often depend on technical problems (geotechnical) unexpected difficult to predict	2.659	1.0066	37.412	4	.000

	problems such as soil and water leakage ..etc.					
F5	Cost overruns often depend on poor planning and poor budget preparation	2.118	1.2384	42.353	4	.000
F6	Cost overruns often depend on the expansion of subcontracting	2.800	1.1526	24.588	4	.000
F7	Cost overruns often depend on poor decision-making due to political and organizational pressures	2.282	1.0868	25.882	4	.000
F8	Cost overruns often depend on the delay of the owner in paying contractor benefits	2.318	1.0143	32.235	4	.000
F9	Cost overruns often depend on unexpected events such as security problems, heavy rain, accidents at work, etc.	2.353	.8824	24.129	3	.000
F10	Cost overruns often depend on economic inflation	1.682	.9285	86.471	4	.000
F11	Cost overruns are often the result of internal disputes between the parties to the project	2.859	1.0018	36.118	4	.000
F12	Cost overruns often depend on poor reporting and poor contractor performance monitoring	2.706	1.2230	9.765	4	.045
F13	Cost overruns are often depend on the difficulty of obtaining resources and the lack of skilled workers	2.812	1.0745	23.176	4	.000
F14	cost overruns often it depends on cognitive bias among the people (weighted personal interest over the interests of the project)	2.682	1.2365	14.941	4	.005
F15	Cost overruns often depend on the absence of a previous experience of the same type of project	2.518	1.2210	20.353	4	.000
F16	Cost overruns often depend on delays, procedures such as permit extraction, etc.	2.329	1.0396	32.824	4	.000
F17	Cost overruns often depend on poor contract management	2.341	1.2106	21.529	4	.000
F18	Cost overruns often depend on the delay of the consultant or the owner in approving the stages, materials or deliveries	2.612	1.1137	18.941	4	.001

a 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 17.0.
b 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 21.3

In Table (4.10) it is noted that the calculation of all hypothesis's ranges between "1.835-2.859". The standard deviation of these terms' ranges from (.8708-1.2384). This indicates the homogeneity of respondents' responses to

the terms, when the standard deviation is small, this is evidence of the homogeneity of respondents' responses.

It is also noted that the value of the significance level is less than the value of the significance level (0.05) for all phrases, Thus hypothesis that (Cost overruns in Sudan railways construction projects may be eliminated if their factors are identified, clearly and managed well) can't be rejected.

Table 4-11 Ranking the factors that lead to cost overruns in railway construction projects in Sudan

Item	Phrase	Rank
F1	Cost overruns often depend on economic inflation	87%
F2	Cost overruns often depend on change orders in the design, specifications or scope of the project, etc.	84%
F3	Cost overruns are often affected by of project delay	82%
F2	Cost overruns often depend on an inaccurate estimate of the Quantities to be implemented	73%
F5	Cost overruns often depend on poor planning and poor budget preparation	67%
F16	Cost overruns often depend on delays, procedures such as permit extraction, etc.	62%
F7	Cost overruns often depend on poor decision-making due to political and organizational pressures	61%
F9	Cost overruns often depend on unexpected events such as security problems, heavy rain, accidents at work, etc.	61%
F8	Cost overruns often depend on the delay of the owner in paying contractor benefits	59%
F15	Cost overruns often depend on the absence of a previous experience of the same type of project	59%
F4	cost overruns are often depend on technical problems (geotechnical) unexpected difficult to predict problems such as soil and water leakage ... etc.	49%
F18	Cost overruns often depend on the delay of the consultant or the owner in approving the stages, materials or deliveries	48%
F12	Cost overruns often depend on poor reporting and poor contractor performance monitoring	47%
F13	Cost overruns are often depend on the difficulty of obtaining resources and the lack of skilled workers	41%
F14	cost overruns often it depends on cognitive bias among the people (weighted personal interest over the interests of the project)	41%
F6	Cost overruns often depend on the expansion of subcontracting	34%
F17	Cost overruns often depend on poor contract management	34%
F11	Cost overruns are often the result of internal disputes between the parties to the project	32%

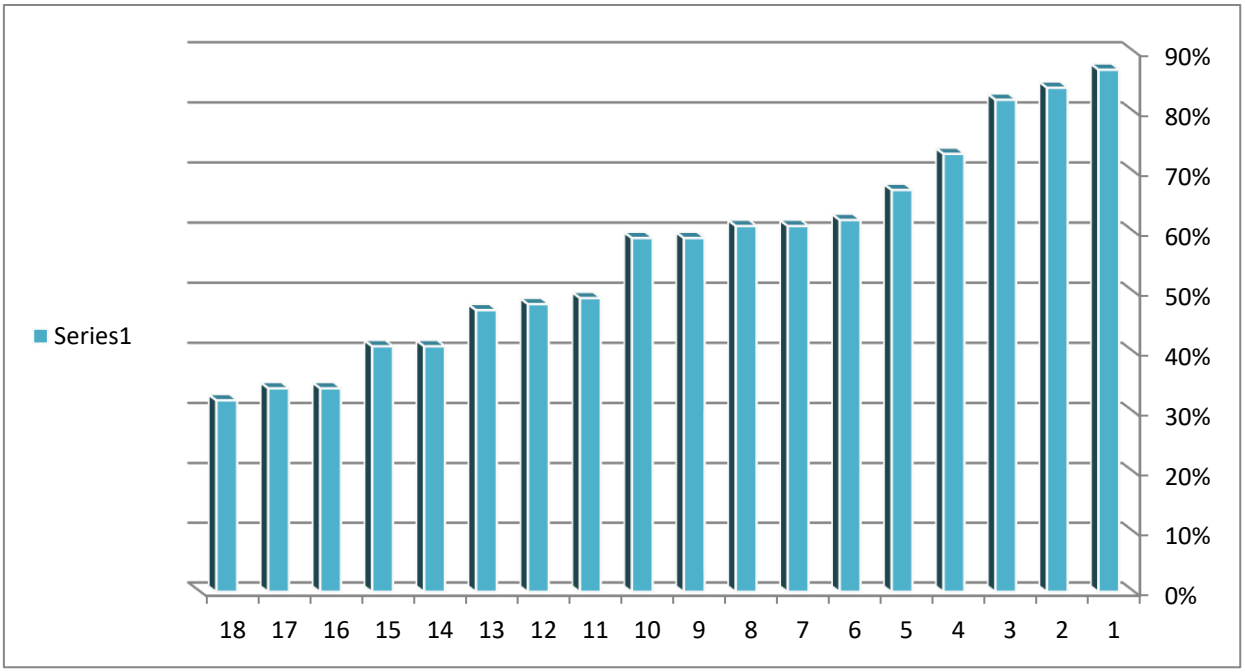

Figure 4-10 Ranking the factors that lead to cost overruns in railway construction projects in Sudan

The second hypothesis: In your opinion, what do you think of the following factors of costs overrun in terms of the frequency of occurrence in Sudan railways construction projects:, The primary objective of this section is to choose to impose research that says **(**Factors leading to cost overrun in railways construction projects in Sudan occur frequently) to achieve this goal, respondents were asked about their perceptions and the answers were limited to (occur a lot - sometimes - neutral - rarely - Do not occur).

Table 4-12 Frequency and percentage of responses of study subjects to the second axis

Item	Phrase	occur a lot	Sometimes occurring	Natural	Rarely occur	Do not occur
F1	Change orders	31	39	3	10	2
		36.5%	**45.9%**	**3.5%**	**11.8%**	**2.4%**
F2	The inaccurate estimation of the quantities to be implemented	37	23	7	13	5
		43.5%	**27.1%**	**8.2%**	**15.3%**	**5.9%**
F3	Project delay	38	31	4	8	4
		44.7%	**36.5**	**4.7%**	**9.4%**	**4.7%**
F4	Unexpected technical problems are difficult to predict	13	34	15	17	6
		15.3%	**40%**	**17.6%**	**20%**	**7.1%**
F5	Poor planning and poor preparation of project budget	35	20	13	10	7
		41.2%	**23.5%**	**15.3%**	**11.8%**	**8.2%**
F6	Expansion of subcontracting	16	19	26	11	13
		18.8%	**22.4%**	**30.6%**	**12.9%**	**15.3%**
F7	Poor planning in the decision-making process due to political and administrative factors	29	32	15	5	4
		34.1%	**37.6%**	**17.6%**	**5.9%**	**4.7%**
F8	Owner delay in the payment of benefits contractors	30	35	9	6	5
		35.3%	**41.2%**	**10.6%**	**7.1%**	**5.9%**
F9	Unexpected events, such as security problems or heavy rain…. Etc	14	45	12	13	1
		16.5%	**52.9%**	**14.1%**	**15.3%**	**1.2%**
F10	Economic inflation	36	15	3	4	0
		74.1%	**17.6%**	**3.5%**	**4.7%**	**0%**
F11	Internal disputes between the parties to the project	14	30	19	19	3
		16.5%	**35.3%**	**22.4%**	**22.4%**	**3.5%**
F12	Weak reports and poor monitoring of contractor performance in the project	15	24	15	21	10
		17.6%	**28.2%**	**17.6%**	**24.7%**	**11.8%**
F13	Difficulty in obtaining resources and lack of skilled workers	15	24	24	14	8
		17.6%	**28.2%**	**28.2%**	**16.5%**	**9.4%**
F14	cognitive bias among the people (weighted personal interest over the interests of the project)	19	19	18	19	10
		22.4%	**22.4%**	**21.2%**	**22.4%**	**11.8%**
F15	There is no previous experience of the same project type	16	24	11	20	14
		18.8%	**28.2%**	**12.9%**	**23.5%**	**16.5%**
F16		21	39	13	10	2

	Delay routine procedures such as extraction, permits ... etc	**24.7%**	**45.9%**	**15.3%**	**11.8%**	**2.4%**
F17	Poor contract management	28	25	14	14	4
		32.9%	**29.4%**	**16.5%**	**16.5%**	**4.7%**
F18	The delay of the consultant or the owner in the adoption of stages or materials or deliveries	26	27	12	14	6
		30.6%	**31.8%**	**14.1%**	**16.5%**	**7.1%**

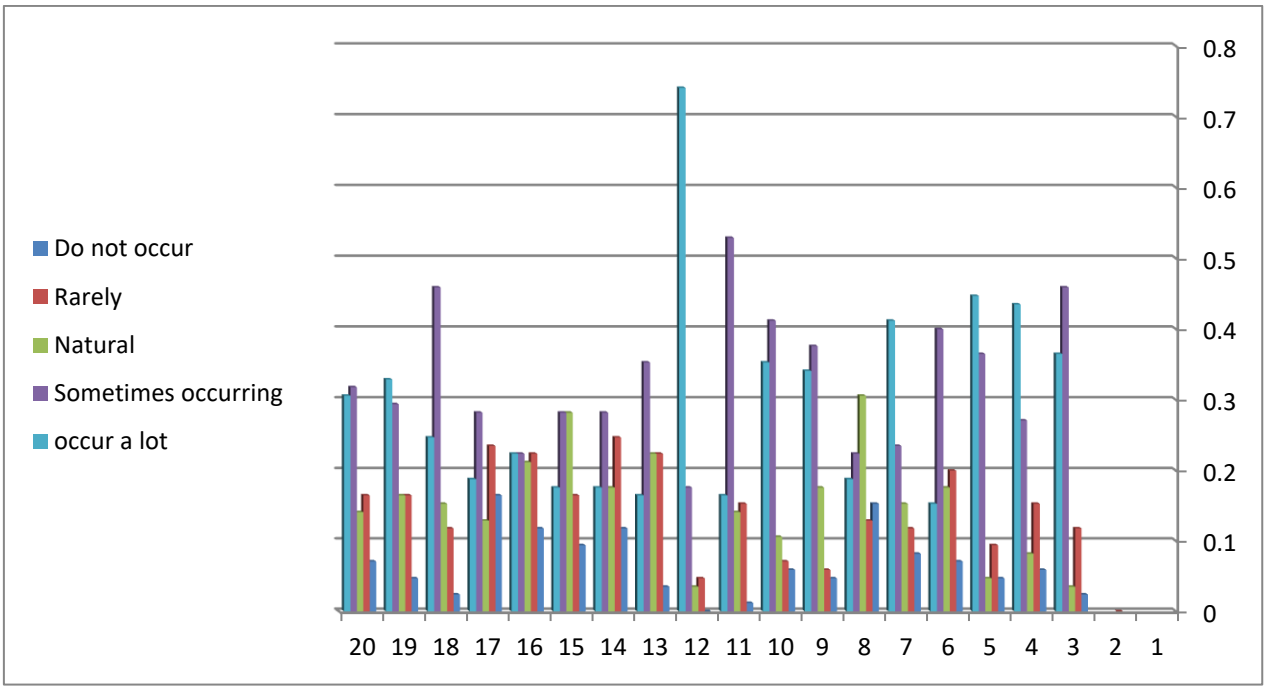

Figure 4-11 observation of study according second hypothesis

Table (4.12) shows

- First Factor: (Change orders) 36.5% of the respondents confirmed this occurs a lot, 45.9% Sometimes occurring, 3.5% natural 11.8% Rarely occur, 2.4% do not occur, this result confirms that the majority of the respondents consider occurring this factor.
- Second Factor: (The inaccurate estimation of the quantities to be implemented) 43.5% of the respondents confirmed this occurs a lot, 27.1% Sometimes occurring, 8.2% natural 15.3% rarely occur, 4.9% do not occur, this result confirms that the majority of the respondents consider occurring this factor.
- Third Factor: (Project delay) 44.7% of the respondents confirmed this occurs a lot, 36.5% Sometimes occurring, 4.7% natural 9.4% rarely occur, 4.7% do not occur, this result confirms that the majority of the respondents consider occurring this factor.
- Fourth Factor: (Unexpected technical problems are difficult to predict) 15.3% of the respondents confirmed this occurs a lot, 40% Sometimes occurring, 17.6% natural 20% rarely occur, 7.1% do not occur, this result confirms that the majority of the respondents consider occurring this factor.
- Fifth Factor: (Poor planning and poor preparation of project budget) 41.2% of the respondents confirmed this occurs a lot, 23.5% Sometimes occurring, 15.3% natural 11.8 rarely occur ,8.2% do not occur, this result confirms that the majority of the respondents consider occurring this factor.
- Sixth Factor: (Expansion of subcontracting) 18.8% of the respondents confirmed this occurs a lot, 22.4% Sometimes occurring, 30.6% natural 12.9% rarely occur, 15.3% do not occur, this result confirms that the majority of the respondents consider occurring this factor.
- Seventh Factor: (Poor planning in the decision-making process due to political and administrative factors) 34.1% of the respondents confirmed

this occurs a lot, 37.6% Sometimes occurring, 17.6% natural 5.9% rarely occur, 4.7% do not occur, this result confirms that the majority of the respondents consider occurring this factor.

- Eighth Factor: (Owner delay in the payment of benefits contractors) 35.5% of the respondents confirmed this occurs a lot, 41.2 Sometimes occurring,10.6% natural 7.1% rarely occur, 5.9% do not occur; this result confirms that the majority of the respondents consider occurring this factor.
- Ninth Factor: (Unexpected events, such as security problems or heavy rain…. Etc.) 16.5% of the respondents confirmed this occurs a lot, 52.9% Sometimes occurring, 14.1% natural 15.3% rarely occur ,1.2% do not occur; this result confirms that the majority of the respondents consider occurring this factor.
- Tenth Factor: (Economic inflation) 47.1% of the respondents confirmed this occurs a lot,17.6% Sometimes occurring,3.5% natural 4.7% rarely occur ,0% do not occur; this result confirms that the majority of the respondents consider occurring this factor.
- Eleventh Factor: (Internal disputes between the parties to the project) 16.5% of the respondents confirmed this occurs a lot, 35.3% sometimes occurring, 22.4% natural 22.4% rarely occur, 3.5% do not occur; this result confirms that the majority of the respondents consider occurring this factor.
- Twelfth Factor: (Weak reports and poor monitoring of contractor performance in the project) 17.6% of the respondents confirmed this occurs a lot, 28.2% Sometimes occurring, 17.6% natural 24.7% rarely occur, 11.8% do not occur; this result confirms that the majority of the respondents consider occurring this factor.
- Thirteenth Factor: (Difficulty in obtaining resources and lack of skilled workers) 17.6% of the respondents confirmed this occurs a lot, 28.2% Sometimes occurring, 28.2% natural 16.5% rarely occur, 9.4% do not

occur; this result confirms that the majority of the respondents consider occurring this factor.

- Fourteenth Factor: (Cognitive bias among the people (weighted personal interest over the interests of the project) 22.4% of the respondents confirmed this occurs a lot, 22.4% Sometimes occurring, 21.2% natural 22.4% rarely occur, 11.8% do not occur; this result confirms that the majority of the respondents consider occurring this factor frequently during project execution.
- Fifteenth Factor: (There is no previous experience of the same project type) 18.8% of the respondents confirmed this occurs a lot, 28.2% Sometimes occurring, 12.9% natural 23.5% rarely occur, 16.5% do not occur; this result confirms that the majority of the respondents consider occurring this factor.
- Sixteenth Factor: (Delay routine procedures such as extraction, permits ... etc.) 24.7% of the respondents confirmed this occurs a lot, 45.9% Sometimes occurring, 15.3% natural 11.8% rarely occur, 2.4% do not occur; this result confirms that the majority of the respondents consider occurring this factor.
- Seventeenth Factor: (Poor contract management) 32.9% of the respondents confirmed this occurs a lot, 29.4% Sometimes occurring,16.5% natural 16.5% rarely occur, 4.7% do not occur; this result confirms that the majority of the respondents consider occurring this factor.
- Eighteenth Factor: (The delay of the consultant or the owner in the adoption of stages or materials or deliveries) 30.6% of the respondents confirmed this occurs a lot, 31.8% Sometimes occurring, 14.1% natural 16.5% rarely occur, 7.1% do not occur; this result confirms that the majority of the respondents consider occurring this factor.

Summary of the second hypothesis

percentage of respondents who responded occur a lot (30%), While the percentage of respondents who responded occur sometime (33%), while the proportion of those who answered was neutral (15.2%). while the sample and those who responded rarely occur (15%) And percentage of those who answered don't occur (6.8%). This finding indicates that the majority of respondents agree that the following cost overruns in railway projects in Sudan occurrence frequency with a total 63%. Notes the majority of observed units are Agree to the Phrases in the table above where find their answers about these phrases indicate in the positive trend, which means agreeing to the objectives. But note that the results obtained from the table do not mean that all members of the study units agree to all the Phrases in the table above, there are individuals who don't agree. In order to test the existence of statistically significant differences between the numbers of those who agree and who have no specific opinion and did not agree with the results. Chi-square test was used to indicate the differences between the responses on each of the axis expressions.

Table 4-13 arithmetical averages, the standard deviations, and the chi-square test for the second hypothesis: Factors leading to cost overrun in railways construction projects in Sudan occur frequently

Item	Phrase	Mean	STD	Chi-Square(a,b)	Df	Asymp. Sig.
F1	Change orders	1.976	1.0463	67.647	4	.000
F2	The inaccurate estimation of the quantities to be implemented	2.129	1.2890	40.941	4	.000
F3	Project delay	1.929	1.1421	62.118	4	.000
F4	Unexpected technical problems are difficult to predict	2.635	1.1736	25.294	4	.000
F5	Poor planning and poor preparation of project budget	2.224	1.3218	29.294	4	.000
F6	Expansion of subcontracting	2.835	1.3079	8.118	4	.087
F7	Poor planning in the decision-making process due to political and administrative factors	2.094	1.0870	40.353	4	.000
F8	Owner delay in the payment of benefits contractors	2.071	1.1317	48.353	4	.000
F9	Unexpected events, such as security problems or heavy rain…. Etc	2.318	.9662	64.118	4	.000
F10	Economic inflation	1.388	.7730	113.541	3	.000
F11	Internal disputes between the parties to the project	2.612	1.1137	22.471	4	.000
F12	Weak reports and poor monitoring of contractor performance in the project	2.847	1.3048	7.176	4	.127
F13	Difficulty in obtaining resources and lack of skilled workers	2.718	1.2112	11.294	4	.023
F14	cognitive bias among the people (weighted personal interest over the interests of the project)	2.788	1.3371	3.647	4	.456
F15	There is no previous experience of the same project type	2.906	1.3941	6.118	4	.191
F16	Delay routine procedures such as extraction, permits ... etc	2.212	1.0246	46.471	4	.000
F17	Poor contract management	2.306	1.2250	21.882	4	.000
F18	The delay of the consultant or the owner in the adoption of stages or materials or deliveries	2.376	1.2722	19.765	4	.001

a 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 17.0.
b 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 21.3.

In Table (4.13) it is noted that the calculation of all hypothesis's ranges between (1.835- 2.859). The standard deviation of these terms' ranges from

(.8708-1.2384). This indicates the homogeneity of respondents' responses to the terms, when the standard deviation is small, this is evidence of the homogeneity of respondents' responses.

It is also noted that the value of the significance level is less than the value of the significance level (0.05) for all phrases; Thus hypothesis that (Factors leading to cost overrun in railways construction projects in Sudan occur frequently) can't be rejected.

Phrases (F6-F12-F14-F15), they do not support results because the value of the significance level is greater than (0.05)

Table 4-14 Ranking of the following cost overruns in terms of frequency of occurrence in the railway construction projects in Sudan

Item	Phrase	Rank
F10	Economic inflation	92%
F1	Change orders	82%
F3	Project delay	81%
F8	Owner delay in the payment of benefits contractors	77%
F7	Poor planning in the decision-making process due to political and administrative factors	72%
F2	The inaccurate estimation of the quantities to be implemented	71%
F16	Delay routine procedures such as extraction, permits ... etc	71%
F9	Unexpected events, such as security problems or heavy rain…. Etc	69%
F5	Poor planning and poor preparation of project budget	65%
F17	Poor contract management	62%
F18	The delay of the consultant or the owner in the adoption of stages or materials or deliveries	62%
F4	Unexpected technical problems are difficult to predict	55%
F11	Internal disputes between the parties to the project	52%
F15	There is no previous experience of the same project type	47%
F12	Weak reports and poor monitoring of contractor performance in the project	46%
F13	Difficulty in obtaining resources and lack of skilled workers	46%
F14	cognitive bias among the people (weighted personal interest over the interests of the project)	45%
F6	Expansion of subcontracting	41%

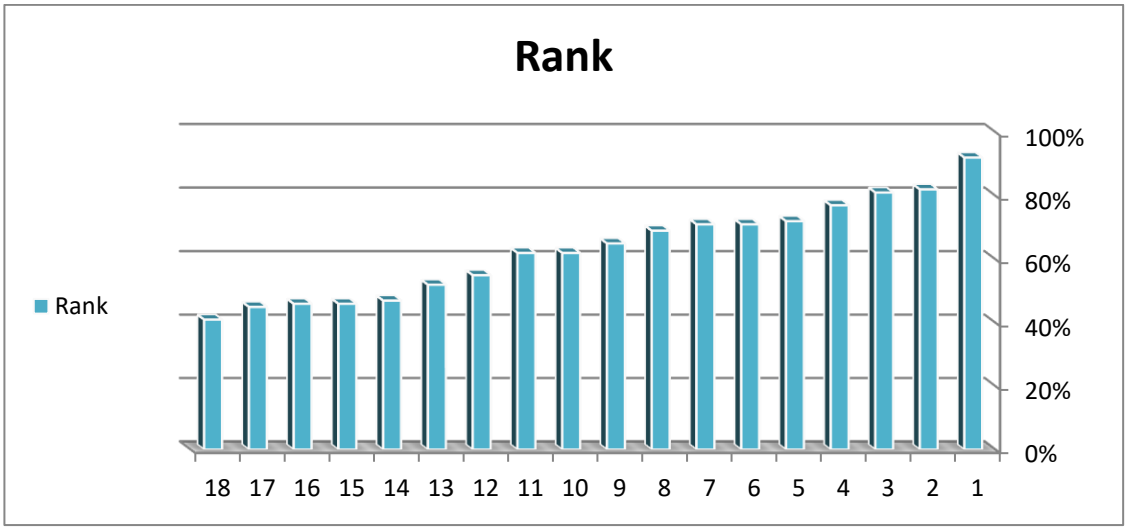

Figure 4-12 the order of cost overruns in terms of the frequency of occurrence in the railway Construction projects in Sudan

4.4 Other Factors costs overrun are mentioned by respondents:

item	Factors of cost overruns mentioned by the consultant (owner)	Factors of cost overruns mentioned by the contractors
1	The difficulty of obtaining tools and equipment from abroad and the process of external transfers is complicated by the US embargo on the Sudanese economy	Since the work has become managed on the system of self-financing of a contractor, the instability of fiscal policies of the country becomes the biggest cause of overriding.
2	Making technical decisions without consulting specialists	Weak financing market and high interest rate.
3	Poor overall performance and lack of training in general for the employees of the projects from the owner and the contractor.	Weak qualification of construction companies and weak role of engineers working in the sense of capital control and not the professional side.
4	Lack of professionalism of construction companies in the technical field.	The consultant is often qualified for the task.
5	Water shortage So many projects go through areas Dry cellular.	The scope of work is not specified in precise detail.
6	Many taxes from the state and the lack of visibility towards projects in general.	Project time is set before project implementation is planned.
7	Inhibitions on land, beside difficult to reach with land resources owners compromises.	In the Sudan Railways the owner is the consultant himself.

8	Different prices of materials in the markets.	Follow the traditional methods of management.
9	Objection by citizens to the implementation of the project and their demands for services not included in the project budget	Non-commitment of the parties to the contract by Contract documents.
10	Contractors' use of mistakes in contracts caused costs to increase	Lack of railway rehabilitation institutes
11		Weak experience of team
12		Lack of clarity in specifications since the beginning of the work

CHAPTER 5

CONCLUSIONS AND RECOMMENDATION

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The previous literature was reviewed to identify the factors that lead to cost overruns in similar studies conducted in different countries around the world. 18 factors were identified that potential lead to cost overruns in railways construction projects. These factors were evaluated by a carefully prepared questionnaire to achieve the research.

Through the proof of hypotheses, the study confirmed the following;

1- Cost overruns depend on change orders in the design, specifications or scope of the project, etc.
2- Cost overruns depend on an inaccurate estimate of the Quantities to be implemented
3- Cost overruns affected by of project delay.
4- Cost overruns depend on technical problems (geotechnical) unexpected difficult to predict problems such as soil and water leakage ... etc.
5- Cost overruns depend on poor planning and poor budget preparation
6- Cost overruns depend on the expansion of subcontracting
7- Cost overruns depend on poor decision-making due to political and organizational pressures.
8- Cost overruns depend on the delay of the owner in paying contractor benefits
9- Cost overruns depend on unexpected events such as security problems, heavy rain, accidents at work, etc.
10- Cost overruns depend on economic inflation

11- Cost overruns are result of internal disputes between the parties to the project

12- Cost overruns depend on poor reporting and poor contractor performance monitoring

13- Cost overruns depend on the difficulty of obtaining resources and the lack of skilled workers.

14- cost overruns depend on cognitive bias among the people (weighted personal interest over the interests of the project)

15- Cost overruns depend on the absence of a previous experience of the same type of project.

16- Cost overruns depend on delays, procedures such as permit extraction, etc.

17- Cost overruns depend on poor contract management.

18- Cost overruns depend on the delay of the consultant or the owner in approving the stages, materials or deliveries.

The five most important factors of cost overruns in terms of frequency of occurrence in railway construction projects in Sudan are:

F1	Economic inflation	92%
F2	Change orders	82%
F3	Project delay	81%
F8	Owner delay in the payment of benefits contractors	77%
F7	Poor planning in the decision-making process due to political and administrative factors	72%

5.2 Recommendation

Recommendations from study

Based on the conclusions identified previously, and the results obtained from this research, the following points can be recommended.

1. Attempt to stay within the scope that was originally planned by Minimize the change order of projects to a minimum and Commitment to the project schedule to avoid project delays thus can reduce the phenomenon of cost overruns.
2. Audit in the calculation of the Quantities required to complete the project well and Good preparation of the project budget.
3. Paying a lot of attention to project planning and comprehensive technical studies of the geophysical nature of the area.
4. Constantly track and measure the projects progress, follow up the contractor's performance and prepare good performance reports.
5. Good contract management and careful selection of an experienced contractor of the same type of project.
6. Facilitate the routine procedures upon which the implementation of the work depends on the issuance of permits to start the implementation of the work, delivering completed works by the consultant, and ratification of payments.
7. Enact laws that limit administrative corruption.
8. It is necessary to have a specialist consultant separate from the owner

Recommended Future Work

1. Research can be conducted on Assess the impact of factors that lead to cost overruns in railway projects in Sudan on the final cost of the project.
2. Research can be conducted on the impact of the geographical location of the project on the size of the cost overruns.
3. Research can be conducted on impact of project size on the size of cost overruns.
4. Research can be conducted on Remedies of Cost Overruns in railways construction projects in Sudan.

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APPENDICES

APPENDICES

بسم الله الرحمن الرحيم

Sudan University of Science & Technology

Questionnaire about factors of cost overrun in sudan railways construction projects

Nots :This questionnaire is for scientific research purposes only, and all data will remain confidential

Please write or choose the most appropriate answer from your point of view

Section One :

General information about the person who will fill out the questionnaire and the organization that works for it

Name (optional).....

Your job title is in the organization .....

Sector :

sudan railways corporation ☐ private ☐

Age

Less than 25 years ☐ More than 25 years and less than 35 years ☐

More than 35 years and less than 45 years ☐ More than 45 years ☐

How many years have you been in railway construction?

Less than five years ☐ More than five years to 10 years ☐

More than ten years to 20 years ☐ More than 20 years ☐

How many years have you been in the field of railway construction in Sudan

Less than five years ☐ More than five years to 10 years ☐

More than ten years to 20 years ☐ More than 20 years ☐

Academic degree

Bachelor ☐ High Diploma ☐

master ☐ Ph.D. ☐

Other ☐

(mention it)**.....**

Professional degree

graduate ☐ specialist ☐

Consultant ☐ Other ☐

(mention it)**.....**

What do you think about the extent of the phenomenon of cost overruns in the railway construction projects in Sudan

occur a lot ☐ Sometimes occuring ☐

Rarely occur ☐ Do not occur ☐

I do not know ☐

Section II

(Please indicate the answer that accurately represents your point of view)

In your opinion what are the factors that lead to cost overruns in sudan railways construction projects

Item	Phrase	Strongly agree	agree	sometime	disagree	Strongly disagree
1	Cost overruns often depend on change orders in the design, specifications or scope of the project, etc.					
2	Cost overruns often depend on an inaccurate estimate of the Quantities to be implemented					
3	Cost overruns are often affected by of project delay					
4	cost overruns are often depend on technical problems (geotechnical) unexpected difficult to predict problems such as soil and water leakage ... etc.					
5	Cost overruns often depend on poor planning and poor budget preparation					
6	Cost overruns often depend on the expansion of subcontracting					
7	Cost overruns often depend on poor decision-making due to political and organizational pressures					
8	Cost overruns often depend on the delay of the owner in paying contractor benefits					
9	Cost overruns often depend on unexpected events such as security problems, heavy rain, accidents at work, etc.					
10	Cost overruns often depend on economic inflation					
11	Cost overruns are often the result of internal disputes between the parties to the project					
12	Cost overruns often depend on poor reporting and poor contractor performance monitoring					

13	Cost overruns are often depend on the difficulty of obtaining resources and the lack of skilled workers					
14	cost overruns often it depends on cognitive bias among the people (weighted personal interest over the interests of the project)					
15	Cost overruns often depend on the absence of a previous experience of the same type of project					
16	Cost overruns often depend on delays, procedures such as permit extraction, etc.					
17	Cost overruns often depend on poor contract management					
18	Cost overruns often depend on the delay of the consultant or the owner in approving the stages, materials or deliveries					

Other factors can lead to cost overruns:

1- .....

2- …….

5- ……

3-……

4- ……

Section III

In your opinion, what do you think of the following factors of costs overrun in terms of the frequency of occurrence in Sudan railways construction projects:

item	factor	occur a lot	Sometimes occuring	I do not know	Rarely occur	Do not occur
1	Change orders					
2	The inaccurate estimation of the quantities to be implemented					
3	Project delay					
4	Unexpected technical problems are difficult to predict					
5	Poor planning and poor preparation of project budget					
6	Expansion of subcontracting					
7	Poor planning in the decision-making process due to political and administrative factors					
8	Owner delay in the payment of benefits contractors					
9	Unexpected events, such as security problems or heavy rain…. etc					
10	Economic inflation					
11	Internal disputes between the parties to the project					
12	Weak reports and poor monitoring of contractor performance in the project					
13	Difficulty in obtaining resources and lack of skilled workers					
14	cognitive bias among the people (weighted personal interest over the interests of the project)					
15	There is no previous experience of the same project type					

16	Delay routine procedures such as extraction, permits ... etc					
17	Poor contract management					
18	The delay of the consultant or the owner in the adoption of stages or materials or deliveries					

Thank you for your cooperation

Researcher

بسم الله الرحمن الرحيم

جامعة السودان للعلوم والتكنولوجيا

كلية الدراسات العليا

إستيان حول عناصر تجاوز التكاليف في مشاريع تشييد السكك الحديد في السودان

تنبيه : هذا الإستبيان بغرض البحث العلمي فقط ، وستظل كافة البيانات التي به محل السرية التامة.

الرجاء كتابة أو إختيار الإجابة الأكثر ملاءمة من وجهة نظرك

القسم الأول :

معلومات عامة عن الشخص الذي سيقوم بتعبئة الاستبيان والمؤسسة التي يعمل لديها

الاسم (اختياري):.....

المسمى الوظيفي لك في المؤسسة:.....

القطاع :

هيئة سكك حديد السودان ☐ **خاص** ☐

العمر

اقل من 25 سنة ☐ **اكثر من 25سنة واقل من 35 سنة** ☐

اكثر من 35 سنة واقل من 45 سنة ☐ **اكثر من 45 سنة** ☐

كم عدد سنوات تواجدك في مجال تشييد السكك الحديد

اقل من خمس سنوات ☐ **أكثر من خمس سنوات الى 10 سنوات** ☐

أكثر من عشر سنوات الى 20 سنة ☐ **اكثر من 20 سنة** ☐

كم عدد سنوات تواجدك في مجال تشييد السكة حديد في السودان

اقل من خمس سنوات ☐ **أكثر من خمس سنوات الى 10 سنوات** ☐

أكثر من عشر سنوات الى 20 سنة ☐ **اكثر من 20 سنة** ☐

الدرجة الاكاديمية

بكالوريوس ☐ **دبلوم عالي** ☐

ماجستير ☐ **دكتوراه** ☐

اخرى ☐

(اذكرها).....

الدرجة المهنية

خريج ☐ **اخصائي** ☐

مستشار ☐ **اخرى** ☐

(اذكرها).....

ما هو رأيك في مدى انتشار ظاهرة تجاوزات التكلفة في مشاريع تشييد السكة حديد في السودان

تحدث كثيراً ☐ **تحدث نادراً** ☐

تحدث احياناً ☐ **لا تحدث** ☐

لا اعرف ☐

القسم الثاني

(فضلا قم بتأشير الإجابة التى تمثل وجهة نظرك بدقة)

في تقديرك ماهي العوامل التى تؤدي الى تجاوز التكاليف في مشاريع تشييد السكك حديد في السودان

الرقم	العبارة	اوافق بشدة	اوافق	احياناً	لا اوافق	لا اوافق بشدة
1	غالبًا ما تعتمد تجاوزات التكاليف على أوامر التغيير في التصميم او مواصفات او نطاق عمل المشروع..الخ					
2	غالبًا ما تعتمد تجاوزات التكاليف على تقدير غير الدقيق للكميات المراد تنفيذها					
3	غالبًا ما تتأثر تجاوزات التكاليف بزيادة المدة الزمنية للمشروع					
4	غالبًا ما تعتمد تجاوزات التكاليف على مشكلات فنية (جيوتقنية) غير متوقعة يصعب التنبؤ بها مثل مشاكل التربة وتسرب المياه... الخ					
5	غالبًا ما تعتمد تجاوزات التكاليف على سوء التخطيط و عدم الاعداد الجيد لميزانية المشروع					
6	غالبًا ما تعتمد تجاوزات التكاليف على التوسع في التعاقد من الباطن					
7	غالبًا ما تعتمد تجاوزات التكاليف على سوء عملية صنع القرار بسبب الضغوط السياسية والتنظيمية					
8	غالبًا ما تعتمد تجاوزات التكاليف على تاخير المالك في دفع استحقاقات المقاولين					
9	غالبًا ما تعتمد تجاوزات التكاليف على وقوع احداث غير متوقعة مثل المشاكل الأمنية او هطول امطار غزيرة او الحوادث في موقع العمل....الخ					
10	غالبًا ما تعتمد تجاوزات التكاليف على التضخم الأقتصادي					
11	غالبًا ما تكون تجاوزات التكاليف بسبب النزاعات الداخلية بين اطراف المشروع					
12	غالبًا ما تعتمد تجاوزات التكاليف على ضعف تقارير و ضعف مراقبة اداء المقاولين في المشروع					
13	غالبًا ما تعتمد تجاوزات التكاليف صعوبة الحصول على الموارد وقلة العمال المهرة					
14	غالبًا ما تعتمد تجاوزات التكاليف على التحيز المعرفي بين الناس (ترجيح المصلحة الشخصية على مصلحة المشروع)					
15	غالبًا ما تعتمد تجاوزات التكاليف على عدم وجود تجربة سابقة من نفس نوع المشروع					
16	غالبًا ما تعتمد تجاوزات التكاليف على التأخير روتين الإجراءات كاستخراج والتصاريح ...الخ					
17	غالبًا ما تعتمد تجاوزات التكاليف على سوء إدارة العقود					
18	غالبًا ما تعتمد تجاوزات التكاليف على تاخير الاستشاري او المالك في اعتماد المراحل او المواد او التسليمات					

عوامل اخرى يمكن ان تؤدي الى تجاوز التكاليف:

1- .....

2- .....

3- .....

4- .....

5- .....

القسم الثالث

حسب وجهة نظرك ما رايك في عوامل تجاوز التكاليف التالية من حيث مدى تكرار حدوثها في مشاريع تشييد السكة حديد في السودان :

الرقم	العامل	تحدث كثيراً	تحدث احياناً	محايد	تحدث نادراً	لا يحدث
1	أوامر التغيير					
2	التقدير غير الدقيق للكميات المراد تنفيذها					
3	طول المدة الزمنية للمشروع					
4	مشكلات فنية غير متوقعة يصعب التنبؤ بها					
5	سوء التخطيط و عدم الاعداد الجيد لميزانية المشروع					
6	التوسع في التعاقد من الباطن					
7	سوء التخطيط في عملية صنع القرار بسبب العوامل السياسية والادارية					
8	تأخر المالك في دفع استحقاقات المقاولين					
9	احداث غير متوقعة مثل المشاكل الامنية او هطول الامطار.....الخ					
10	التضخم الأقتصادي					
11	النزاعات الداخلية بين اطراف المشروع					
12	ضعف تقارير و ضعف مراقبة اداء المقاولين في المشروع					
13	صعوبة الحصول على الموارد وقلة العمال المهرة					
14	التحيز المعرفي بين الناس (ترجيح المصلحة الشخصية على مصلحة المشروع)					
15	عدم وجود تجربة سابقة من نفس نوع المشروع					
16	تاخير روتين الإجراءت كاستخراج والتصاريح ...الخ					
17	سوء ادارة العقود					
18	تاخير الاستشاري او المالك في اعتماد المراحل او المواد او التسليمات					

نشكرك لحسن تعاونك

الباحث