Factors that contribute towards cost overruns in an African Mega-project

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Abstract

Mega-projects improve the livelihoods of people and boost the country's economy. When mega-projects are to be constructed, the government notifies the public of the details including the budgeted cost. Most of these projects spiral out of control when it comes to budget and time. State-owned entity (SOE) mega-projects are funded by taxpayers' money and as a result of cost overruns, the extra funds required to cover the extra expenses are resourced from other departments' budgets or borrowed from other countries. Developing countries are hit the hardest when it comes to cost overruns in projects. The literature review results show that there are many explanations for cost overruns however these explanations can be summarised into four categories i.e. political, technical, economical and psychological. A case study methodology of one African mega-project is investigated to determine the contributing factors towards cost overruns. Data is collected through interviews and company documents. The findings of the case study reveal that variation orders and contractual claims during the execution phase of an African mega-project contribute as factors towards cost overruns. Innovative project management measures need to put in place in order to eradicate cost overruns.

Keywords
Cost overruns, Developing countries, Mega-projects.

1. Introduction

Cost overruns are a worldwide problem and affect many industries across the world which consequently affects specific project performance. Flyberg (2009) states that infrastructure mega-projects cost overruns average from a range of 20.4% to 44.7% and that globally 9 out of 10 projects have cost overruns. Cost overruns are caused by many different factors and impact the final project cost at completion. Pultarova (2016) recently reports on a survey analysis conducted by Ernst and Young, a professional services firm, of the performance of 100 of the world's largest mega-projects, including nuclear power plants, hydropower projects and offshore and onshore wind farms (Ernst and Young Global Limited 2016). The survey findings are that 57% of the projects are running wildly over budget while 64% experience delays, with 35% experiencing delays of up to 2 years. Majority of mega-projects are implemented by (SOEs) to stimulate economic growth by addressing the social needs of the population and creating jobs. SOEs operate off taxpayers' money, and when cost overruns occur, it increases the amount of wasteful spending. Projects are often not managed responsibly, nor do the officials get blamed when these cost overruns occur. Instead, contractors are merely blamed for their poor performance. Project cost overruns by SOEs are a significant problem because taxpayers bear the financial burden (Edward, 2009). Therefore the risks associated with developing and planning these projects become high. Burns, Shields & Shrestha (2013) has done a study on 363 public projects and discovers that the size and the duration of a project has an impact on cost overruns i.e. the larger and longer a project is, the greater the risk of increased costs.

Countries will be impacted differently by the cost overruns of projects due to different economic conditions, geographical locations, and working environments. Over the past 70 years, there has been no improvement in cost overruns of infrastructure projects (Bruzelius, Flyberg & Rothengatter (2002).

Cantarelli, Flyberg, Molin & van Wee (2010) say that cost overruns can be summarised into four main categories: political, technical, economical and psychological. These four categories are explained in more detail in table 1.

Table 1: Appropriate theories for explaining cost overruns

Categories	Explanations
Political	Deliberate cost underestimation, manipulation of forecasts, private information.
Technical	Optimism bias among local officials, cognitive bias of people, cautious attitudes towards risk.
Economic	Deliberate underestimation due to lack of incentives and resources, inefficient use of resources, dedicated funding process, poor financing/contract management, strategic behaviour.
Psychological	Forecasting errors including price rises, poor project design and incompleteness of estimates, scope changes, uncertainty, inappropriate organizational structure, inadequate decision-making process and inadequate planning process.

This research is set out to investigate the contributing factors of cost overruns in an African mega-project and to identify where within the project phases they occur. Cost overruns affect both developed and developing countries, however developing countries seem to be hit hardest because of skills shortage and lack of experience. Undeveloped countries are nations with decreasing economy, little industrial activity, low human development, and corrupted governance. Table 2 summaries the findings of cost overruns in developing countries:

Table 2: Explanations of cost overruns in developing countries

Country	Study	Explanations of cost overruns
Nigeria	Ameh, Soyingbe and Odusami (2010)	Construction-related factors in telecommunication projects are the ranked the highest reason for factors associated with cost overruns Other major factors associated with cost overruns in descending order included the following: fluctuations in the price of materials, the high cost of imported materials and lack of contractor experience.
Nigeria	Saidu and Shakantu (2017)	Projects have an average cost overrun of 44.5% (that range from 5.5-216.0%), with an average project completion of 52.4%, and within an average estimated time limit of 91.4%. The reasons for the cost overruns are not known however, it suggested that continuous evaluation and analyses of cost overruns at different phases of the project might enable mitigation measures.
Peninsular Malaysia	Memon, Rahman and Aziz (2012)	The contractor's explanation for cost overruns are fluctuations of prices of material, design changes request by the client, delay of interim payments which affects cash flow and financial standing.
East Malaysia, Saban	Idrus, Ramanathan, Sambu (2011)	Change in design during the construction stage and the variations the client instructed.
Malaysia	Idrus and Sambu (2011)	Mismanagement by the contractors, clients, and consultants which all contributed towards the cost overrun.
Malaysia	Idrus, Potty and Ramanathan (2012)	Cost overruns for Design and Build projects - highest rated factors for time and cost overruns are labour-related issues.
Brazil	Callegari, Szklo, Schaeffer (2018)	Mega-projects fail to deliver to the countries' demands be because the amount of risk associated with these projects forms a disproportionate to the financial economies they generate.
Nigeria	Ononuju and Ubani (2013)	Government policies, political powers, and political parties have an influence on projects which results in projects being affected by inflation of prices for equipment and material, payment terms, design errors and scope creep. The study also shows that most public sector projects are abandoned when political influences have been identified and not resolved.
Nigeria	Aigbavboa, Dosumu & Sunday (2017)	Variation costs are due to design errors, the design errors are caused by a lack of coordination among the project teams
South Africa	Aigbavboa, Lusa & Thwala (2015)	Variation orders are associated with time and cost overruns, affected quality, and cause disagreements/disputes between parties, with loss of productivity

South Africa	Baloyi and Bekker (2011)	Factors causing cost overruns into three categories: client-related, contractor- and supplier-related, and external factors. The factors they identify for the cost overruns are the material price increase, incorrect estimates of quantities, scope changes during the construction stage, variations in the cost estimates made by consultants and the contractors, labour cost hikes, shortage of skilled labour, and late issuance of site instructions.
South Africa	Lentsoane (2016)	Inadequate systems interface or integration management, contractual claims, labour unrest or strikes, project or package complexity, inaccurate budget cost estimates, design or engineer changes, Inadequate system or integration management (construction stage)

It is critical to understand the causes of cost overruns in achieving successful project completion. A project can be defined as successful when it is completed on time and in budget. Adequate planning and a clear understanding of the project objectives must be known in order to achieve this. A project management life cycle model illustrated in figure 1 assists with monitoring the project objectives to ensure the project is completed on time and within budget. The model breaks down a project into four logical phases: Initiating, planning, executing and closing (PMBOK, 2013). The model also assists to reduce the risk of scope creep, under-delivery/ project failure.

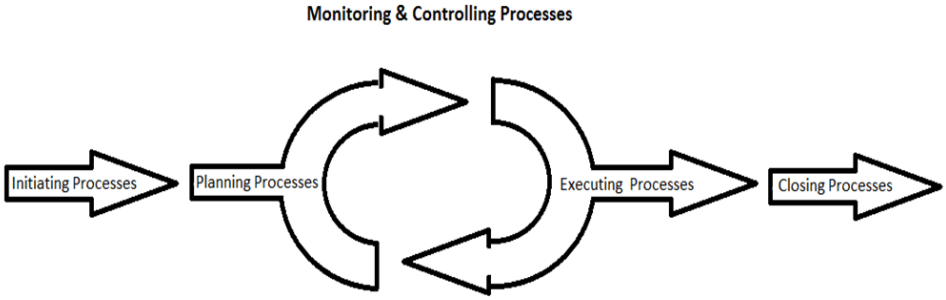

Figure 1: Single-Phase Project (PMBOK® 2013:42)

2. Methodology

For this research process, the Onion Model, also known as the Research Onion, is adopted. The onion is made up of different layers which illustrates the stages that are required to be covered when developing a research strategy. The stages that are covered in the onion model are used for identifying the research process i.e. philosophy, approach, methodological choice, strategy, time horizon, population and sample, data collection and analysis (Lewis, Saunders & Thornhill, 2016). A case study research strategy has been adopted for this paper aided by mixed methods (qualitative and quantitative) approaches. A single-case is investigated because of the uniqueness and the access the researcher has to the case. Yin (2006) argues that is shouldn't matter whether a researcher uses a single-case or multiple-cases, but instead focus on the analytic generalisation and find similarities to previous theories. "Single-case studies are appropriate when the case is special (in relation to established theory) for some reason. This might arise when the case provides a critical test of a well-established unique or has something special to reveal" say Rowley (2002). Primary data is collected by qualitative interviews conducted with industry professionals (Project Controllers, Quantity Surveyors, Contracts Managers, Construction Managers, Engineers, and Cost Engineers) working on the project. Semi-structured interviews are conducted because Parker (2005) argues that a structured interview does not exist because "people always spill beyond the structure, before the interview starts and when the recorder has been turned off". The interviews are structured to frame the conversation in accordance to cost overruns in the project. All the questions asked by the researcher are intended to lead the interviewee into providing factors that contribute towards cost overruns in the project. To obtain a complete picture from the qualitative interviews secondary data is also collected. The secondary data in the form of company documents, reports, presentations, and emails have been collected. The cross-sectional time horizon of this research is from 2015 to end 2017.

3. Result Analysis

The mega-project (ABC Project) is in the energy sector and managed by the South African public utility with a sole mandate is to provide electricity for the country. South Africa is a developing country facing problems of electricity production and distribution. The country produces large quantities of coal and finds that constructing additional coal-fired power stations would be a viable financial option. South Africa has not built a Greenfield coal-fired power station since the year 1996. ABC Project comprises of six coal-fired units generating 800MW (Megawatts) of electricity totalling to the sum of 4800MW. The duration of ABC Project was initially estimated to be six years from 2007 to 2014 (The South African electricity public utility, 2015), it is not completed yet, and has fallen behind schedule and budget. The previous acting Chief Executive Officer (CEO) of The South African electricity public utility Brian Molefe says that some of the delays are due to strikes, political intervention, delays, and the lack of funds (Gqirana, 2015). Abraham Masango the South African electricity public utility's head of capital projects says that the reason for the revised estimates is because The South African electricity public utility did not do very well with the upfront project planning and construction estimation (Mantshantsha, 2016). In August 2017 unit 1 came into commercial operation (Mena Report, 2016). And in March 2018 Unit 2 was synchronised and also joined the national grid (ABB, 2018). The current controls and instrumentation (C&I) Contractor commenced on site in 2015. During the execution phase of the C&I works on site, the South African electricity public utility has been facing numerous challenges that are affecting both the time and cost of ABC Project which is leading the project to encounter cost and time overruns. Some of the cost and time overruns are due to the South African electricity public utility issuing the C&I Contractor with variation orders (VO). Not only that but also the C&I Contractor submitting contractual claims to the South African electricity public utility. From the interviews and secondary data collected, the factors contributing towards cost overruns are mentioned below.

3.1. Unit 1

The budgeted cost/tendered amount for Unit 1 is R 267,079,334.67 with a scheduled completion date of 19 December 2016. During the execution phase of Unit 1, the C&I Contractor experienced delays of access to certain areas of work in the Unit. The coordination of the plant is managed by The South African electricity public utility who realised that Unit 1 was falling behind schedule and therefore issued the C&I Contractor with an instruction to accelerate their work so that the completion date of Unit 1 can be achieved earlier. The C&I Contractor submitted a VO proposal which included the cost impact to accelerate works in Unit 1 from May 2016 to end July 2016 see table 3. The VOP was accepted by The South African electricity public utility and a VO was issued. The second instruction issued by The South African electricity public utility to the C&I Contractor was for operational support required to assist with operating Unit 1. The C&I Contractor submitted a VOP including the cost impact for providing support from January 2017 to end April 2017 see table 3. The VOP was approved by The South African electricity public utility and a VO was issued. The two VOs only have a cost impact.

Table 3: Unit 1 VOs

No.	Unit	Variation orders	Cost Impact	Time Impact
1	Unit 1	Unit 1 - Acceleration (May 2016 to July 2016)	R 249 million	N/A
2	Unit 1	Unit 1 - Operational Support (Jan 2017 to April 2017)	R 21 million	N/A

The C&I Contractor submitted contractual claims for the delayed access in Unit 1 and for the demobilization of the extra employees brought on to the site during the acceleration period. Both claims have a cost and time impact see the table 4 below.

Table 4: Unit 1 claims

No.	Unit	Claims	Cost Impact	Time Impact
1	Unit 1	(Take over completion) TOC only achieved 12 Oct 2017 versus Key Date of 18 Nov 2016	R 40 million	10.5 months
2	Unit 1	Demobilisation claim (June 2016 to Jan 2017)	R 129 million	8 months

3.2. Unit 2

The budgeted cost/tendered amount for Unit 2 is R 207,296,564.83 with a scheduled completion date of 20 November 2017. During the execution phase of Unit 2, the C&I Contractor was already behind schedule because of the late completion of Unit 1 and also experienced delayed access to certain areas of work in the Unit. Similar to Unit 1, The South African electricity public utility instructed the C&I Contractor to accelerate. The C&I Contractor submitted a VOP which included the cost impact to accelerate works in Unit 2 from June 2017 to end September 2017 see table 5. The VOP was accepted by The South African electricity public utility and a VO was issued.

Table 5: Unit 2 VOs

No.	Unit	Variation orders	Cost Impact	Time Impact
1	Unit 2	Unit 2 - Acceleration (June 2017 to September 2017)	R 289 million	N/A

The C&I Contractor submitted contractual claims for the delayed access in Unit 2 and for work delays that were beyond the control of the contractor. The cost and time impacts for this cliam is summarised in table 6.

Table 6: Unit 2 claims

No.	Unit	Claims	Cost Impact	Time Impact
1	Unit 2	First Fire (Coal) should have started 23 Aug 2017 Damage U2 Gas Heater stopped Steam Blow, may result in a min. further 1 month extension.	R 40 million	2 months

The qualitative and quantitative data from the case study have been grouped together according to the two units and data is interpreted and present in bar charts using Microsoft Excel. This type of data presentation is used to present values of different categories.

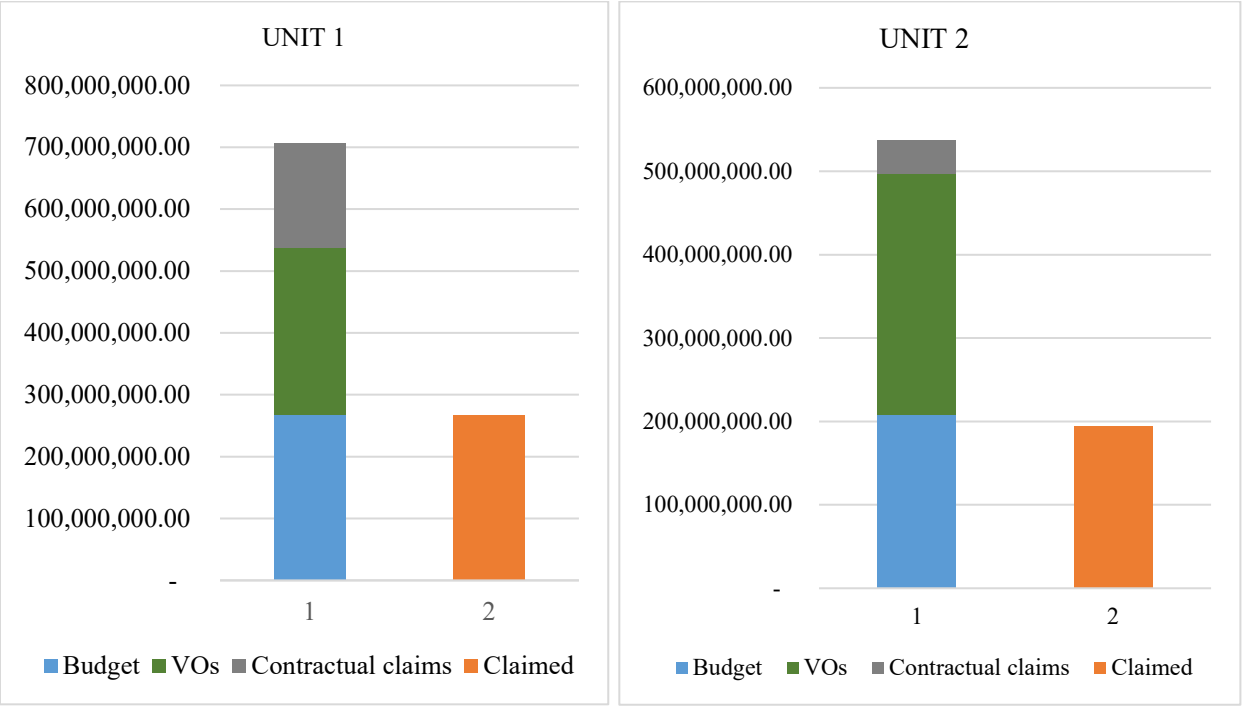

Figure 2: Unit 1 & Unit 2 costs

In figure 1 the C&I Contractor has claimed 99.91% progress of the Unit's tendered/budgeted cost. The additional 2 VOs and 2 contractual claims for Unit 1 have increased the overall cost of the Unit. The budget has increased from the initial amount of R267 million to R706 million. In addition to the cost overruns experienced in Unit 1, there is also an 8 month delay. The initial completion date was planned for December 2016, but the actual completion was August 2017.

In figure 2 the C&I Contractor has claimed 93.72% progress of the Unit's tendered/budgeted cost. The additional VO and contractual claim for Unit 2 have increased the overall cost of the Unit. The budget has increased from the initial amount of R207 million to R537 million. In addition to the cost overruns experienced in Unit 2, there is also a 4 month delay. The initial completion date was November 2017, but the actual completed was March 2018.
Both Units experience time delays and cost overruns which impact the overall cost to completion and the completion date of ABC Project.

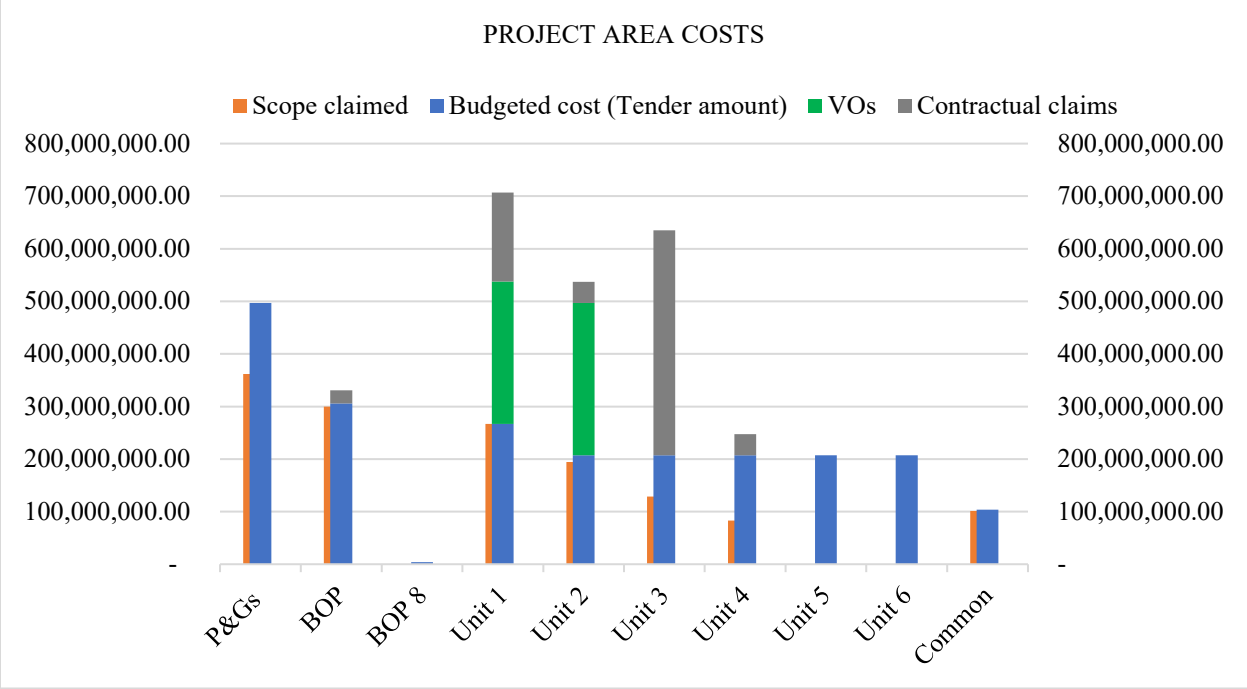

Figure 3: Project area costs

In addtion to the results determined from Unit 1 and Unit 2, there are other areas that are affected by cost and time overruns during the research period. Figure 3 shows areas BOP (Balance of Plant), Unit 3 and Unit 4 having contractual claims. The C&I Contracor submitted delayed access claims that include cost and time impacts.
From the research study, it can be said that factors contributing towords cost overruns in megaprojects are VOs and contractual claims during the execution phase of the project. The explanatory analysis of cost overruns can be summarised by the following explanations which are also supported by the other researchers:

A study conducted in Nigeria by Aigbavboa, Dosumu & Sunday (2017) find that cost overruns are due to design errors caused by a lack of coordination among the project teams which result in variation orders. In South Africa, a study by Aigbavboa, Lusa & Thwala (2015) determines that variation orders are associated with time and cost overruns, affected quality, and cause disagreements/disputes between parties and resulting in loss of productivity.

Idrus and Sambu (2011) did a study in Malaysia on cost overruns and identified that mismanagement by the contractors, clients, and consultants all contributed towards the cost overruns.

Conclusion

It has been identified from past studies that cost overruns is a persistent problem. Mega-projects seem to be more complex because of the project size, public stakeholders and technology involved. These large projects tend to have a higher risk and therefore increase the chances of failure. Innovative measures need to be put in place that will address cost overruns i.e. improve cost estimation techniques. Project management practices need to be implemented that will manage the projects by tracking and reporting on project progress. Employees and contractors with the required experience should be selected to works on projects of a similar nature, so they will be bringing the skills and lessons

learned from other projects. This paper only looked at one mega-project within South Africa, other factors that cause cost overruns need to be investigated. Further studies are required to be conducted which compare similar projects within the African continent to determine these factors and how they can be mitigated.

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