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Investigation of Project Delay in Construction Projects in the South African Rail Industry

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Abstract

The construction industry is one of the largest contributing sectors towards the Gross Domestic Product of countries globally, and South Africa is no exception. The construction industry in South Africa is marred with persistent and extensive delays. This study investigates the project delay factors in construction projects, particularly the Passenger Rail Agency of South Africa and Transnet traction substation projects in the South African railway engineering environment. The research also presents the remedial actions and mitigations suitable to be implemented to manage project delays in the project engineering environment. The research was conducted through a literature review and a questionnaire survey and the research approach was deductive. An online questionnaire survey was employed to collect primary data. The literature review revealed eight top project delay-causing factors in traction substation projects, forming the basis of the questionnaire; and the questionnaire results correlated with the literature review. This paper proposes suitable measures to manage delays in construction projects, improving the quality of work and managing cost and schedule overruns.

Keywords

Project delays, construction industry, project management

1. Introduction

In the modern era, the construction industry significantly contributes towards the global economy through employing and developing an infrastructure. Project delays are major challenges, hindering the successful completion of construction projects (Srdic and Selih 2015). Quality, time and cost are considered the primary requirements to be met for a project to be regarded as successful. Of the three, the construction industry perceives time to be a crucial parameter to evaluate the success of the project (Ansah and Shahryar 2018). According to Kazaz, Ulubeyli and Tuncbilekli (2012), project performance is heavily affected by delays experienced in the project.

Hussain, Zhu, Ali, and Xu (2017) mentioned that termination of contracts, disputes, extension of time schedules, interrupted work, budget overrun and unhappy clients contribute to project delays. Events in the project engineering environment suggest that it is becoming custom for several construction projects to attempt to remedy the problem of project delays by spending more funds (contingency) to accelerate and fast-track the project. These endeavours aim to meet the set milestones, such as adding more resources to the project or working overtime. Nielsen, Özdemir and Gündüz (2013) suggest that the norm of relying on contingency has set a negative precedent in the project environment to solve project delay challenges.

Several researchers, including Williams (2016), conducted studies on project success factors. The team selection for a project is a crucial factor (Duke 2016) that could either make or break the project; and Williams (2016) stated that the iron triangle, comprising time, quality and cost, are the considered factors determining the project's failure or success.

2. Problem Statement

The construction industry is marred with project delays, both in South Africa and globally (Marks and Ellis 2017). Too many construction projects are delayed, due to schedule overruns, resulting in negative cost implications

(Nkobane 2012; Abdul-Rahman, Takim and Min, 2009). Project delays in the construction industry continue to derail several projects. This research focussed on causes of delays on selected traction substation construction projects that Transnet and the Passenger Rail Agency of South Africa (PRASA) undertook and embarked on.

The research objectives of this work were to (1) identify factors that cause delays in traction substation projects in railway engineering; and (2) to suggest mitigation that may be implemented to minimize project delays.

3. Literature review

Based on comprehensive literature of the Gross Domestic Product (GDP) of several global countries, the agricultural and construction sectors appear as the leading contributors to GDP, with a combined average contribution of 10% (Ofori-Kuragu *et al*., 2016). Amoatey and Ankrah (2017) postulate that uncontrolled factors such as weather conditions disrupt the project schedule. Other challenges emanate from technical, political, social, environmental and economic issues.

Yang, Chu and Huang (2013) mention that delays in the project schedule are typically due to late scope changes by the client or the developer and the design changes by the engineers or late delivered drawings. Zidane and Andersen (2018) revealed the top causes of delays and they included workers' low productivity; insufficient availability of construction equipment; complex designs, requiring more time; payment delays by the client; mismanagement of funds by the contractor; favouring lowest bid prices over experienced and reputable contractors; and political interference.

Venkateswaran and Murugasan (2017) studied The Road over Bridge (ROB) construction projects. The identified contributing delay factors included the acquisition of land, incapacitated and in-experienced contractors, relocation of the existing services from site to commence with the project, failure to grant site access to the contractor timeously and long turnaround time for permit approval (Venkateswaran and Murugasan 2017). In the view of Marks and Ellis (2017), factors such as a rapid increase in the price of materials, extended durations to approve the designs, long lead items not procured timeously, changes to the original scope of projects, improper pre-feasibility studies, regular breakdown of machinery on site and labour unrests, contribute to construction project delays.

Studies in Ghana indicate that the country's construction industry contributes 8.2% to its GDP (Ofori-Kuragu *et al.* 2016). The construction industry in Ghana was under scrutiny for the past few years, due to failure of delivering infrastructure development projects timeously and within a budget. Abdul-Rahman *et al.* (2006) state that construction project delays is not a peculiar challenge but a general phenomenon. If project completion occurs after the agreed dates on the project schedule, it has negative cost implications on the project.

The majority of foremost projects in Iran receive funding from Government and undergo Government processes, such as the budget approval discussion held in parliament. Political interference often tends to hinder smooth and timeous budget approvals (Samarghandi *et al*. 2016). Procurement processes are often prolonged. Risk management plans and proactive planning are of utmost important to minimize delays.

According to Samarghandi *et al*. (2016), delays in a construction project may be defined as the extension of the project duration. This definition contradicts the pre-set project plan, due to unforeseen circumstances. History reveals that project delays were always part of construction projects. The difference between the past and the present is the accelerated rate of project delays. Several industry experts and researchers who conducted studies on the subject such as Duke (2015) and Stoudt (2013) recommend implementing improved project management practices and employing good engineering ethics.

The figure below indicates the processes of Government-funded projects in Iran.

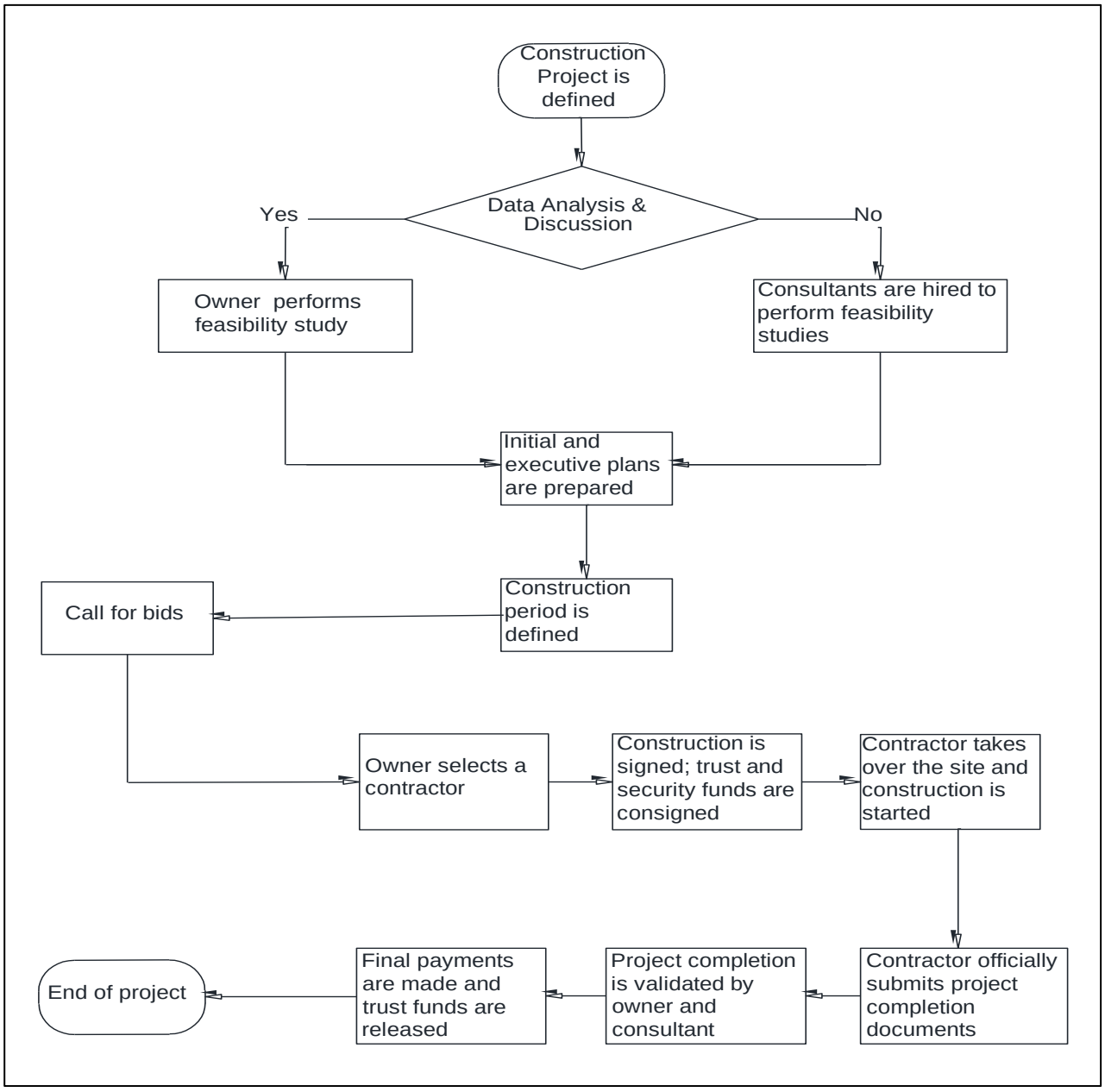

Figure 1. High level overview of government funded construction projects in Iran (Samarghandi *et al.* 2016)

The construction phase of the project is crucial, and it affects the total cost of the project by 35% to 50%, making it the main driver of the project (Rentschler *et al*. 2017). The overruns and delays in construction projects are often caused by low productivity, pressed schedules, outsourcing, shortage of qualified works, complex projects, non-compliance to regulations, complex contract agreements or arrangements and adoptions of new technologies (Rentschler *et al*. 2017). Delays in the construction industry indicate global widespread problems; most of them are caused by design errors, poor contract administration and a lack of client supervision (Ali and Rahmat 2010). Refer to Table 1 for the summary of delay factors as identified by various researchers, accompanied by the corresponding research question.

Table 1. Summary of delay factors

Delay-causing factor	**Author/s**	**Research question**
1. Scope changes	▪ Yang and Wei (2010) ▪ Yang, Chu *et al*. (2013) ▪ Chanmeka, Thomas *et al*. (2012)	How frequently are the scope creeps and changes experienced in construction projects?
Design changes during construction	▪ Elawi, Algahtany and Kashiwagi (2016) ▪ Chanmeka, Thomas *et al*. (2012) ▪ Parsons (2015) ▪ Zidane and Andersen (2018)	How frequently are the design changes experienced in construction projects?
Unavailability of the client for supervision/oversight/approval	▪ Yang, Chu *et al*. (2013) ▪ Srdic and Selih (2015) ▪ Doloi, Sawhney *et al*. (2012)	How frequently are does the client become unavailable in construction projects?
Shortage of project resources	▪ Zidane and Andersen (2018) ▪ Parsons (2015)	How frequently are the shortage of project resources experienced in construction projects?
Squeezed construction schedule	▪ Rentschler *et al*. (2017) ▪ Zidane and Andersen (2018)	How frequently are the squeezed construction schedules experienced in construction projects?
External interference, such as politics and weather	▪ Ansah and Sorooshian (2018) ▪ Hussain *et al*. (2017) ▪ Yang, Chu *et al*. (2013) ▪ Stoudt (2013) ▪ Parsons (2015)	How frequently are the external interference experienced in construction projects?
Land acquisition	▪ Elawi, Algahtany and Kashiwagi (2016)	How frequently are the land acquisition problems experienced in construction projects?
Payment difficulties	▪ Hussain *et al*. (2017) ▪ Amoatey and Ankrah (2017)	How frequently are the payment difficulties experienced in construction projects?

4. Research Methodology

The study employed a deductive research approach and quantitative research. A quantitative research's purpose is to answer questions, such as "how much or how many?" It involves measuring quantities under investigation (McCusker and Gunaydin 2015). The research design block diagram is depicted in Figure 2.

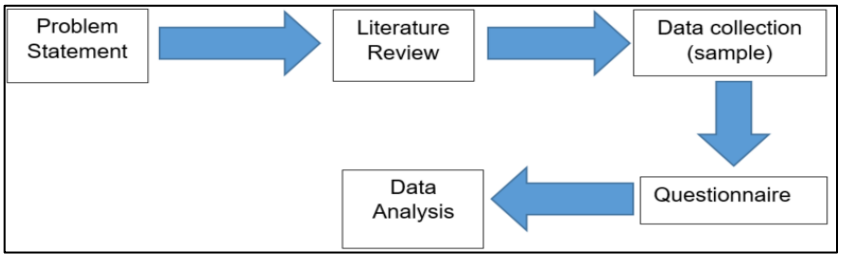

Figure 2. Research design block diagram

For this research, both primary and secondary sources were employed to collect the data needed to perform this study successfully. The primary data is referred to as the data or information collected from direct experience, indicating

that it is a research field where the researcher interacts directly with the field experts (Saunders, Lewis and Thornhill 2012). The questionnaire survey method was employed to collect primary data. The secondary data was conducted in a form of literature reviews from peer-reviewed journals, conference paper, reports and books.

Harrison and Mason (2008) referred to sampling as a procedure or a process used to select participants for research from a particular target population. The study mentioned that in quantitative research, conclusions drawn by researchers, are often based on the general characteristics of a population that interests them. It is not always practical to study the entire population due to the issues regarding cost implications, logistics and time constraints. The samples representing the target population, are often used to conduct the studies as they share the characteristics of a target population.

The focus for this research is the construction projects in the South African rail industry. The target areas were the construction sites in the Gauteng province, the Mpumalanga province and the KwaZulu-Natal province. Table 2 represents the geographical sample areas where the questionnaire survey were performed, including interviews when necessary. Several traction substation projects were proceeding and in the construction phase in these sample areas for Transnet and PRASA.

Table 2. Questionnaire sample areas

Province	**City/Town**	**Municipality**
Gauteng	Johannesburg	Johannesburg Metropolitan
Gauteng	Pretoria	Tshwane Metropolitan
KwaZulu-Natal	Richards Bay	uMhlathuze Local Municipality
Mpumalanga	Ermelo	Gert Sibande District Municipality
KwaZulu-Natal	Newcastle	Newcastle Local Municipality
Gauteng	Heidelberg	Lesedi Local Municipality

A questionnaire for this research comprises a set of questions, whereby the aim was to distribute them to the identified target population, indicating the population of field experts embarking on traction substation construction projects in the railway engineering industry. The questionnaire was distributed online, whereby an email were sent to the respondent; a questionnaire survey link was provided. Every individual's response contributed to an improved understanding of the challenges of construction projects. All responses were of equal importance. It did not take longer than fifteen minutes of the participants' time to complete this exercise. The questionnaire structure comprised four main sections:

4.1 Section A: Demographics - The participants' personal background data

The first part of the questionnaire focussed on demographics, whereby general information, such as the participants' discipline and working experience were requested.

4.2 Section B: The project manager's role

The second section of the questionnaire focussed on the manner in which construction projects is administered, paying special attention to the abilities of project managers. The objective of this section of the questionnaire was to understand the perception of respondents concerning project managers. This included issues such as: Do they think project managers needs to attend technical courses? Would they say that the technical training would improve the technical competency of project managers (especially newly appointed project managers)?

4.3 Section C: Causes of project delays

The third section of the questionnaire used a Likert scale of 1 to 5, whereby respondents were required to answer how frequently they have encountered the project delay causes that were identified in the literature review in construction projects (traction substation projects) they were involved in.

4.4 Section D: Recommended mitigations

The participants were also required to provide an indication of the extent that they agree or disagree on the mitigations identified from the literature review; do they believe they would be suitable to manage project delays?

The target group for this research encompassed the following stakeholders in PRASA and Transnet's substation construction projects: Project managers, electrical engineers and technicians, civil engineer and technician, construction managers, quantity surveyors, architects, quality inspectors, cost engineers, SHE officers and planners. The questionnaires also targets the same professionals from the contractor and consultant's teams respectively, rendering engineering and project management services to PRASA and Transnet. Figure 3 illustrates the direction taken when this research was conducted.

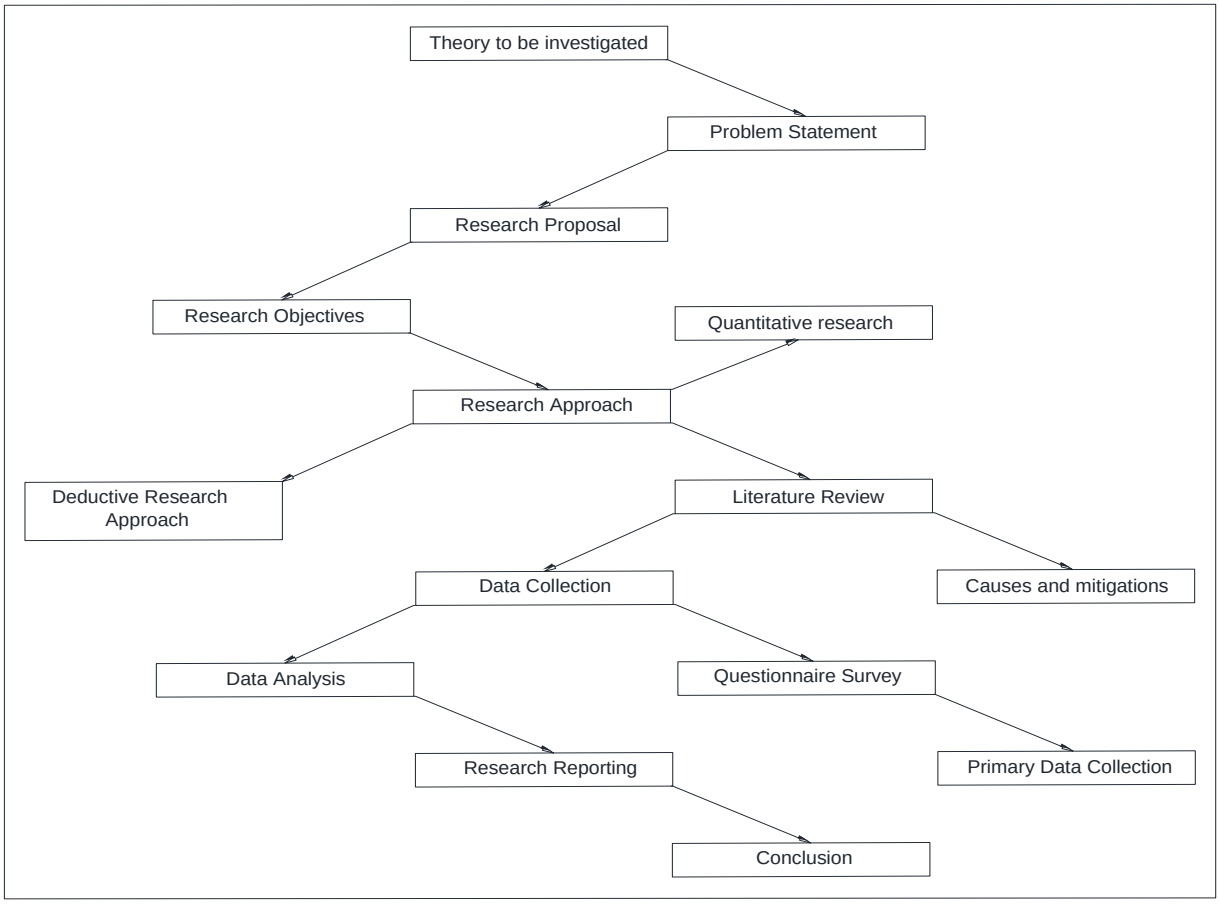

Figure 3. Research mind map

To ensure a creditable outcome, it was of utmost importance that the researcher collecting the data did not participate as a research subject. It is a moral and ethical obligation to ensure pure, truthful, reliable results that are not tampered with. The research held reliable ethical principles and high moral standards, indicating great respect for all participants. All participants were treated as anonymous agents. Individuals with diminished autonomy were entitled to protection; therefore, they were not forced to participate in this research.

5. Results and Discussion

The questionnaire was distributed using an online programme and eighty-three responses were recorded. None of the participants abandoned the process during participation. All the responses are valid as the online survey was instituted to hinder respondents to continue to the following question without answering the current or the previous question. The system prohibited submission at the end of the survey, should a question be unanswered during the process. Figure 4 below represents the questionnaire response rate.

Figure 4. Online survey response rate

5.1 Section A: Demographics

The target group for this study was mainly the individuals with first-hand experience in construction projects, targeting traction substations. The employees from railway engineering companies (Transnet and PRASA) (including consultants and contractors) participated in the survey. The figure below indicates that 40 of the 83 respondents in the survey represented electrical engineers (48%). Civil engineers were presented with the second highest percentage, registering 20% on the chart, followed by project managers, indicating 7%.

The findings revealed that several individuals in the construction industry, particularly in railway engineering, are the youth. They are still capacitating themselves and gaining experience. Results illustrates that 37% of the construction project teams comprise individuals with less than five years' experience in the industry. Results indicates the results of the survey respondents' working experience within the project engineering environment. The questionnaire sample areas focused on three provinces: Gauteng, Mpumalanga and KwaZulu-Natal. The survey results indicated Gauteng, presenting the highest number of respondents in the survey, particularly in Johannesburg Metropolitan with an 86% participation in the survey.

5.2 Section B: The role of project managers in project management

The aim of this section was to establish the role for project managers in construction projects and whether they fulfil their duties. This section of the questionnaire focussed on the manner that construction projects are being administered, with emphasis on the capabilities and abilities of project managers. The objective of this section of the questionnaire is to understand the perception of respondents concerning project managers. The factors of concern include: Do they sense that project managers need to attend technical courses? Do they believe that technical training would improve the technical competency of project managers (especially newly appointed project managers)? Table 4 below indicates the summary of responses to section B of the questionnaire.

Table 4. Summary of section B's survey Responses

Question	Count	Score
Have you been part of a project team for a construction project? e.g. project manager, designer, quantity surveyor, contractor, consultant etc.	83	1.06
Do you think project managers needs to attend technical courses?		1.07
Would you say that the technical training could improve the technical competency of project managers (especially newly appointed project managers)?	83	1.06
Is proactive planning and timeous identification of potential delay risks one of the traits for a good project manager?	83	1.02
Do you think to expedite construction projects; it is advisable to run independent construction activities concurrently?	83	1.16
Does the client have a right to change the scope of work?	83	1.13
Do you think that the consultant or contractor are entitled to dispute the scope creeps imposed on them by the client?	83	1.19
Do you think a good project manager should micro-manage his/her project team?	83	1.76
Do you think a good project manager should be a dictator in order for the project to succeed?	83	1.83
Does the client have a right to change the scope of work?	83	1.1
	Average	**1.24**

The score in Table 4 indicates that the results can be interpreted according to the following ratings used: "Yes" = 1 and "No" = 2. The scores in Table 4 indicate that "Yes" was the most general response to the questionnaires, hence the average questionnaire score recorded as 1.24. The questionnaire findings signify that 81 of the 83 survey participants observed that proactive planning and timeous identification of delay risks are traits of a good project manager. Only 2% of respondents believed the contrary.

Most respondents indicated that efficient project managers provide leeway and flexibility to their project team, applying their own methods when performing their duties. They should not dictate or micro-manage the team. Only 24% of the respondents indicated that project managers should monitor the project team closely, constantly reporting on their performance. Questionnaire respondents expressed their disagreement on the client's rights to change the scope of work. Most respondents (87%) unfavoured scope changes by the client. Recorded results indicated that 81% of participants were of the notion that the consultants and contractors are entitled to dispute the scope creeps, imposed by the client.

Respondents' feedback received (93%) believe that it would be in the best interest of the project if project managers attend technical courses. Respondents believe that if project managers could have an improved understanding of basic aspects, such as the project scope and milestone, it could minimise planning errors and irregularities. The participants signified that technical training would be of immense benefit to project managers, especially to in-experienced newly appointed project managers. Training would improve their technical competency.

5.3 Section C: Causes of project delays

The figure below shows the summary of the responses to section C of the questionnaire.

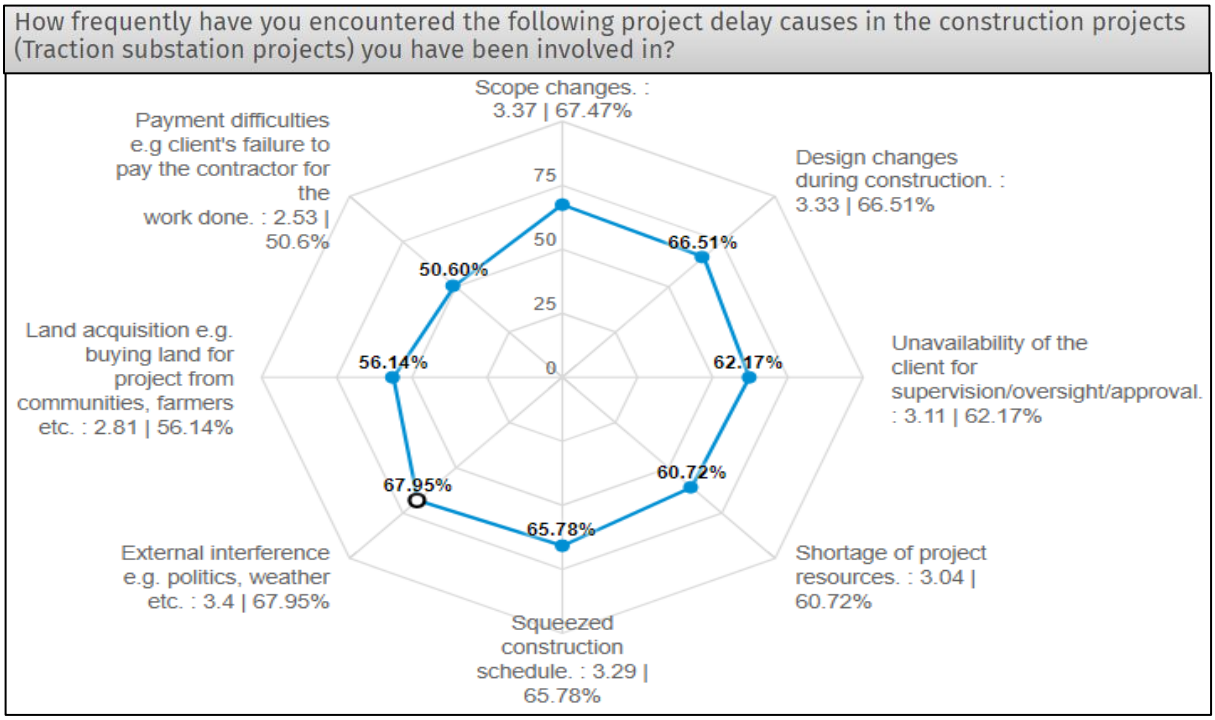

Figure 5. Survey response to section C of the questionnaire

The third section of the questionnaire used a Likert scale of 1-5, whereby respondents had to answer how frequently they encountered project delay causes in construction projects, identified in the literature review (traction substation projects). The collected data submitted that the survey participants sensed that resource shortages also contributed to project delays; 36% claimed experiencing resource shortages occasionally; 25% of respondents indicated that they experienced the resource shortages often in the duration of their projects.

The results indicated that scope changes are often experienced in construction projects. This could be because of factors, such as an indecisive client, technological changes, financial constraints amongst others (according to the literature review). Over 40% of the feedback identified a setback in construction projects is caused by changes made to designs during construction phase of the project and this is experienced often. Only 6% of the participants indicated that they did not encounter delays, caused by design changes in their projects. Land acquisition from farmers and communities seems to indicate a minor challenge for traction substation projects, since several respondents (40%) indicated that they encountered related challenges in their projects occasionally but not often.

5.4 Section D: Recommended mitigations

A majority of 58% strongly agreed that proactive planning and timeous identification of risks in construction projects could be instrumental in minimizing project delays. The captured results also indicated that only 4% of respondents disagreed, whilst 8% was undecided. Forty-six respondents (from 83) agreed that independent project activities may be run parallel or simultaneously, to expedite the project's progress.

From the literature review, scope changes were identified as some of the most general project delay-causing factors. Yang and Wei (2010), Yang, Chu *et al.* (2013) and Chanmeka, Thomas *et al.* (2012) listed scope changes as delay factors in their respective elements. Based on the feedback from the questionnaire survey, it indicates that from 83 survey responses, 33 (40%) indicated that scope changes are experienced often in construction projects, hindering the progress of the project. Nine individuals (11%) indicated that they always experienced delays due to scope changes in all their project involvements.

Elawi, Algahtany and Kashiwagi (2016), Chanmeka, Thomas *et al*. (2012); Zidane and Andersen (2018), and Parsons (2015) (in their respective publications), included the design changes during construction amongst the project delay-causing factors. The survey results emphasized theory indicated in the literature; over 40% of respondents attested that they encountered delays in their daily running of projects; as a result, the progress of the project was often affected. The shortage of project resources was also emphasized to cause delays in construction projects (Zidane and Andersen, 2018; Parsons, 2015). The results show that the majority of respondents sensed that only at certain times the project was delayed due to a shortage of project resources. This information suggests that project managers in these projects, performed their duties well, allocating project resources; 36% of respondents indicated that they did not often experience delays due to resource shortages.

Rentschler *et al*. (2017) suggested the implementation of the following mitigation in construction projects to manage delays: Timely project planning is encouraged; Run independent construction activities in parallel; Allow for contingency; Involve the construction team in engineering processes, such as designs and Organise labourers accordingly. The survey participants sensed that it would expedite the construction activities if independent activities in construction projects could run parallel or simultaneously; 55% agree, whilst 25% strongly agreed with the proposed mitigation. The scores in Table 5 below indicate that the results can be interpreted according to the following ratings: Strongly disagree = 1; Disagree = 2; Undecided = 3; Agree = 4 and Strongly agree = 5. The scores below indicate that most responses were "Agree" and "Disagree"; the average score is 4.32.

Table 5: Summary of section D's survey responses

Question	**Count**	**Score**
Proactive planning and timeous identification of potential delay risks.	83	4.42
Run independent construction activities in parallel.	83	4.02
Involve construction team in the engineering processes such as designs.	83	3.95
Ensure that the planning and engineering teams has worked on a similar project previously with the one being undertaken.	83	3.9
Understanding of laws, rules and regulations that could hinder the project.	83	4.35
Ensure availability of project funding prior to construction commencement.	83	4.54
Prepare a detailed construction plan.	83	4.55
Appoint experienced and reputable contractors & consultants.	83	4.37
Do not appoint a contractor based on the lowest bid price.	83	4.35
Promote good engineering ethics & accountability	83	4.66
Keep to set milestones and key dates	83	4.42
	Average	4.32

6. Conclusions and Recommendations

6.1 Conclusion

Delays affect several construction projects in South Africa and globally. History reveals that project delays were always part of construction projects. The difference between the past and the present is the accelerated rate of the project delays. Delays in the construction environment are categorized into excusable delays. These delays are caused by external interferences, such as weather and politics. They are also classified into the category of non-excusable delays. The prescribed processes and procedures were not followed in some phases of the project. Some projects are simple; they may be completed in a brief period and without difficulties. Certain projects are complex and are extended over long intervals.

Various authors from the reviewed literature indicated that delays in construction projects have negative implications on the economy of several countries globally; the construction industry is one of the largest contributors to the GDP of several countries. The questionnaire survey respondents agreed and validated the identified project delay factors as indicated in the literature review. The most general project delay-causing factors in traction substation projects were identified; suitable mitigations were recommended in this study. Several researchers established that project delays are not peculiar in the project engineering environment, but that they are common. Delays vary from project to project; it could be hours, days, weeks or even years. That does not necessarily indicate the extent of the financial loss incurred. It is possible that the project that was delayed by a few hours, suffered a severe financial setback, additional to a project suspended for a year.

6.2 Recommendations

A general viewpoint for several authors and researchers is that it may not be possible to avoid delays completely. Recommendable remedial actions and suitable mitigations are available that could be introduced and implemented in construction projects to manage project delays. The feedback from the research questionnaire and the literature review, recommends the following measures for project management implementation to manage project delays:

- Project managers need to attend technical courses. The technical training could improve the technical competency of project managers (especially newly appointed project managers).
- Efficient project managers should not micro-manage their project team; they need to let them freely express themselves. They need to assess them, based on their productivity.
- The good traits of a good project manager indicate proactive planning and timeous identification of potential delay risks.
- To expedite construction projects, it is advisable to run independent construction activities concurrently.
- An efficient project manager needs to manage scope changes or scope creeps, imposed on the project by the client.

The research revealed the following mitigations to be suitable to manage project delays in construction projects, particularly traction substation projects:

- Proactive planning and timeous identification of potential delay risks.
- Running of independent construction activities in parallel.
- Involving construction teams in the engineering processes, such as designs.
- Understanding of laws, rules and regulations that could hinder the project.
- Ensuring availability of project funding, prior to the construction commencement.
- Preparing a detailed construction plan and adhering to the set milestones.
- Appointing experienced and reputable contractors and consultants.
- Refraining from appointing a contractor, based on the lowest bid price only.
- Promoting good engineering ethics and accountability.

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Biographies

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