

# **The Main Causes of Delays in the Projects within the Coal Line Program: A Substations Case Study**

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## **ABSTRACT**

Over the years South African railway company embarked on a Market Demand Strategy (MDS), a capital investment program for expanding the organization's infrastructure. The MDS entailed many programs, with one of them being the 81 million tons per annum (mtpa) program, which was baselined to be finished by September 2017, but the electrical power upgrade cluster was delayed. The current research determined the root causes of delays in railway substation projects. The research presented preventative measures and mitigations suitable to address the root causes of delays. The study was conducted through semi-structured interviews to obtain primary data and review the project administrative database to obtain secondary data. The study revealed thirty-three root causes of delays in the undertaken railway substation project. Furthermore, the study proposed comprehensive preventative measures and remedial actions to manage delays in railway substation projects.

## **Keywords**

Causes of delays, project delays, substations, project management, railway

## **1. Introduction**

Project success is explained by meeting the iron triangle requirements within cost, quality, and schedule (Masood 2015). A small number of projects are finished within the originally approved schedule and cost (Singh 2010). A delay is the time past the date of completion defined in the contract or past the date commonly agreed on by parties for the delivery of the project (Zack 2003). Contractors, owners, third parties, or force majeure (Vasilyeva-Lyulina et al. 2015) are all possible causes of project delays.

Masood (2015) recommended the following remedial actions to the delays in railway construction projects: the implementation of risk assessment for unfavorable weather conditions, careful selection of contractors, proper scheduling, and planning, and ensuring timely payments, design, and approvals. Singh (2010) suggested that project size and implementation stage be a minimum where necessary and extensive contract management takes place during execution.

### **1.1 Statement of the Problem and Objectives**

The export coal expansion to 81 million tons per annum (mtpa) program consists of several projects and it was planned to be completed by September 2017. By March 2018 the program was 80,1% complete (Transnet Freight Rail 2018). By that time the project was already delayed by 1.025 years. None of the new Direct Current (DC) substations met their approved baseline dates. According to Xaba (2011), 55% of South African railway major projects undertaken between 2005 and 2011 did not meet their objectives. The research aims focused on determining the main causes of project delays within the coal 81mtpa program through a new DC substations case study.

The study objectives were to (1) determine the root causes of delays in the new DC substations in the railway environment, and (2) to further suggest and recommend, remedial actions and mitigations.

## 2. Literature Review

Delays are the foremost problem and a common trait of all construction projects almost all over the world. The literature revealed that root causes and remedial actions are different from country to country, and their magnitude differs from project to project.

A completed case study of a new 12 km track doubling project between Chengannur and Mavelikkara, had a probability of being delayed by seven months when considering the delay factors with delay in materials delivery and financial problems being the major delay factors. The study reveals that the delays in projects caused by the contractor were the most numerous or higher compared to those caused by the owner and other stakeholders (Aswathi and Thomas 2013).

Motlathledi and Nel (2019), embarked on research to determine the causes of delays in the Railway project environment of South Africa. The research examined the root cause of delays on a chosen traction substation construction project undertaken by Transnet and the South African Passenger Rail Agency. The top eight root causes of delays in the traction substation were identified and later ranked from causes most often occurring to those least often occurring. The research feedback recommended management interventions and suggested mitigations to manage causes of project delays in traction substations (Motlathledi and Nel 2019).

The root causes of delays can either be internal or external. Owners, consultants, and contractors are classified as the internal sources of delay. External sources of delays are beyond the control of the project, for example, social issues, politics, and weather conditions (Amoatey and Ankrah 2017). Table 1 below lists the root causes of delays in railway infrastructure projects studied by different authors:

Table 1. Summary of root causes of delays in the railway infrastructure projects

Study Paper & Authors	Root Causes of Delays
Investigation of Project Delay in Construction Projects in the South African Rail Industry (Motlathledi and Nel 2019).	<ul style="list-style-type: none"> <li>• External disturbances such as weather conditions and politics.</li> <li>• Changes in scope.</li> <li>• Changes in design during the execution phase [Fron End Loading –(FEL-4)].</li> <li>• Compressed construction schedule.</li> <li>• Client unavailability for supervision/monitoring/approval.</li> <li>• Lack of project resources.</li> <li>• Acquisition of land.</li> <li>• Payment problems/distress/hardship.</li> </ul>
Assessment of Delay Factors in Saudi Arabia Railway/Metro Construction Projects (Gopang et al. 2020).	<ul style="list-style-type: none"> <li>• “Client's decision-making process and changes in control procedures.”</li> <li>• “Design errors (including ambiguities and discrepancies in details/ specifications).”</li> <li>• “Labor skills level.”</li> <li>• “Design changes by client or consultant.”</li> <li>• “Issues regarding permissions/approvals from other stakeholders.”</li> </ul>
Identification of Critical Factors for Delay in Metro Rail Projects in India (Mittal and Paul 2018).	<ul style="list-style-type: none"> <li>• Delay in the land acquisition process and granting of site access to contractors.</li> <li>• Changing position of utilities and contingency services.</li> <li>• Scope amendment.</li> <li>• Late payment.</li> <li>• Uncertainty of subsurface impacts and alterations in ground conditions.</li> <li>• Scarcity of construction material.</li> <li>• Delays in the engineering design approval.</li> <li>• Insufficient labor.</li> <li>• Insufficient data gathering and unfinished feasibility study before implementation.</li> <li>• Delays in obtaining required permits.</li> </ul>

## 3. RESEARCH METHODOLOGY

A qualitative research methodology was utilized to answer the research questions. A qualitative research method is an in-depth and innovative kind of research that was very important when studying a few cases in detail.

### 3.1 Qualitative Design Process

Even though a unified qualitative research methodology may not exist, for the current study, the following qualitative design process was presented to evaluate the root causes of delays in the new DC substations.

**Process 1:** Problem statement development. The research problem is the delays encountered in railway

infrastructure projects. Research questions identify the main causes of the delays within the 81 mtpa program coal line, a substations case study.

**Process 2:** The literature review on the delay factors, and root causes of delays in the railway infrastructure project and the mitigations that are implemented to prevent these root causes of delays.

**Process 3:** The research methodology for data collection and analysis is qualitative, collecting both the primary (personal interview) and secondary data (company administrative database).

**Process 4:** Inductive research analysis was applied to both interview and archival data. Interview feedback was transcribed, arranged data then broken down into small fragments to identify emerging themes and trends. Archival reports were read, converting raw data to relevant data through a line-by-line open coding system and data extraction to obtain graphical occurrences and ratings of the root causes of delays.

**Process 5:** The analyzed data and results were utilized to answer the study questions, and further provided mitigations and recommendations

### **3.2 Research Formulation**

A member of the South African railway company established the current research as a result of various observed delays that occurred within the new DC substations. The case study was selected. Table 2 displays the delayed four new DC substations.

Table 2. Delayed new DC substations

<b>Project Name</b>	<b>Baseline date</b>	<b>Actual completion date</b>
New DC Substation A	11 March 2016	30 May 2017
New DC Substation B	11 March 2016	15 March 2018
New DC Substation C	31 March 2016	26 June 2019
New DC Substation D	11 March 2016	31 March 2020

All the substations were delayed, none met their approved dates but at least one met the approved date of the overall program of September 2017.

## **4. Data Collection Methods**

Conducting research requires data (Blumberg et al. 2014). The current study collected both primary and secondary data (archival data). The former was collected through personal interviews and the latter was obtained through the existing administrative database of the organization.

### **4.1 Interview Data**

The interview was established to obtain a depth of information and understanding from the participant's own experiences (Yin 2016) about delays that occurred in the new DC substations. A purposive sample of sixteen participants was selected. These were professionals from different departments involved in the new DC substation project. The email invitations were sent to all participants explaining the purpose of the research, the structure of the interview, participants' rights and protection, time, date, and location of the interview. The following professionals were interviewed: project director, senior project manager, project managers, procurement officer, quality officers, construction manager, engineer, site supervisor, quantity surveyors, environmental practitioner, risk practitioner, health and safety practitioner, and contractors. The personal interview exceeded the information secured from telephonic and self-administered studies, such as web surveys (Blumberg et al. 2014).

Interview questions were semi-structured and aided by interview guidelines. The semi-structured questions started with specific questions and with predefined answer choices provided by the researcher. It allowed the interviewee to follow his/her own thoughts later and provided information from the participants' understanding regarding the root causes of delays. Each audio-recorded interview lasted about 30 to 40 minutes. All the participants were selected because they are information-rich sources due to their level of involvement in the four new DC substations.

### **4.2 Archival Data**

Secondary data are vital and represent another form of primary evidence in qualitative research (Yin 2016). The following historical information was carefully selected and made available. The data were analyzed to respond to the study problems, project reports, project change notices, lesson-learned reports, risk registers, time-related compensation events, and early warnings.

The historical data obtained were meant for the successful management of the projects from inception to closeout. The information was stored internally in the administrative database of the company and was available with full

access to the members of the project team and provided enough data to determine the current study problem. The information was created with a different intention and was used for qualitative analysis (Blumberg et al. 2014). Most of the archival data were created directly by study participants and were used to complement the data generated from personal interviews with the study participants (Yin 2016). The collected data minimized the issues and challenges of reflexivity and were not influenced by the current research inquiry because it was generated for a different purpose. In contrast, a personal interview can be reflexive in two ways with the interviewer's influence on the interviewee or vice versa. Although the archival data is not vulnerable to reflexivity, it was utilized with care and attention (Yin 2016).

## **5. Data Analysis Method**

The process of collecting data and analyzing data is interactive. The qualitative analysis process generally entails the creation of data categories, appropriately allocating data to suitable categories, and acknowledging the data relationship of categories (Saunders et al. 2007).

Qualitative data analysis can be approached from either an inductive or deductive perspective. The current research analysis used the inductive-based approach to better understand the causes of the delays. Preliminary and secondary data analysis commenced during the data collection and continued thereafter. During the data collection and analysis vital themes, links, and patterns were recognized, and a conceptual framework was developed (Saunders et al. 2007).

Firstly, all sixteen audio-recorded interviews were carefully transcribed and stored in a file name that preserves confidentiality and anonymity. The interview data were reviewed to understand the participant's view of the projects and then the information was formally arranged in some meaningful order before formal analysis started (Yin 2016; Saunders et al. 2007). Arranged data were broken down into small fragments for transformation and reduction purposes. Fragments were reorganized into different categories and sequences. This was done in a tabular format, a list of forms, and graphically to find patterns and trends in the research data. The researcher's own judgement was identified at that stage, and precautionary measures were taken to eliminate or state the biases (Yin 2016) and (Saunders et al. 2007).

Secondly, archival data of the Project Status Report (PSR) were analyzed using the open-coding system to determine the occurrences of root causes of delays. Furthermore, an open code system was implemented to lessons learned summary information (reasons) of "what went bad" to classify and determine graphically the occurrences of the root causes of delays. Project Change Notice (PCN) and Compensation Event (CE) extracted were to determine the root causes of delays and graphically rate them according to delay duration.

The detailed interpretation of both interview and archival data brought the entire analysis together and helped to explain the meaning of the findings. Data presentation assisted in the interpretation of data and conclusions. The study considered the following attributes when conducting interpretations: completeness, fairness, empirical accuracy, value-added, and credibility (Yin 2016; Saunders et al. 2007).

Thirdly the two summarized information sources between interview and archival data were compared to spot the similarities and differences of root causes of delays and identify remedial actions. The last and final procedure was concluding, linking the study interpretations and main findings it further captured the importance of the entire study and drew the conclusions (Yin 2016).

## **6. Data Analysis and Discussions**

Results in the current case study from interviews and archival data were analyzed and presented to indicate the root causes of delays, their mitigations, remedial actions, and project management approaches to address delays within coal portfolio infrastructure projects.

### **6.1 Interview Data Discussion**

Semi-structured interview results collected from sixteen professionals involved in the new DC substations were dissected. Semi-structured interviews were divided into the following sections:

Section A - Demographics, Section B - Project Background, and Section C- Project Root Causes of Delays.

Section D-M - Project Management Knowledge Areas (Evaluated causes of delays and mitigations within the 11 knowledge areas).

Section D - Project Scope Management, Section E - Project Procurement Management., Section F - Project

Schedule Management, Section G - Project Cost Management, Section H - Project Stakeholder Management, Section I - Project Communications Management, Section J - Project Quality Management Section K - Project Integration Management, Section L - Project Risk Management, Section M - Project Resource Management, and Section N - General (PLP and Knowledge area).

### 6.1.1 Section A - Demographics

Table 3 Displays the profile of the participants.

Table 3. Participant profile

Participant (Interviewee)	Years in Organization	Role/Position	Project Management Experience
Procurement Officer	8 years	Procurement Leader	14 years
Project Manager	8 years	Project Manager	Over 20 years
Project Director	30 years	Project Director	20 years
Client	Over 10 years	Project Manager	Over 10 years
Senior Project Manager	9 years	Senior Project Manager	14 years
Construction Manager	17 years	Construction Manager	10 years
Site Supervisor	8 years	Site Supervisor	12 years
Health and Safety Practitioner	7 years	Health and Safety Practitioner	12 years
Quality Officer	9 years	Quality Officer	16 years
Project Engineer	10 years	Project Engineer	13 years
Environmental specialists	10 ears	Environmental specialists	10 years
Risk Manager	12 years	Risk Manager	9 years
Quantity Surveyor A	9 years	Quantity Surveyor	9 years
Quantity Surveyor B	9 years	Quantity Surveyor	9 years
Contractor A	5 years	Contractor Project Manager	15 years
Contractor B	30 years	Managing Director, Owner, Supplier of Material	20 years

All research participants have been working in their respective organizations for more than five years, and they all have more than eight years of experience in project management, and they are specialists in their respective duties.

### 6.1.2 Section B - Project Background

A total of 13 out of 16 participants were involved in all substations, while 11 out of the 16 participants were involved in the execution phase of the Project Lifecycle Process (PLP). Quantity Surveyor A worked in Substation A and Substation B, while Quantity Surveyor B worked on all substations but mainly Substation C and Substation D. Contractor A and Contractor B worked on Substation C and Substation D respectively.

The Procurement Officer, Senior Project Manager stated that Front End Loading (FEL-1 -conceptual phase) was skipped, and FEL-3 (Feasibility) and FEL-4 (Execution) combined, Project Director stated that FEL-2 (Pre-feasibility) was done, FEL-3 skipped, then went straight to execution. The client mentioned that the project jumped FEL-3, while Project Engineer and Environmental Specialists stated that FEL-3 and FEL 4 were combined.

### 6.1.3 Section C - Project Root Causes of Delays and Section D-M - Project Management Knowledge Areas

#### The analyzed interview feedback or findings from the sixteen study participants

- The feedback of the participants was analyzed to find clues regarding the root causes of delays, remedial actions, and management approaches in the new DC substations project. Twenty-two root causes of delays were identified, fifteen remedial actions or mitigations that could be adopted were suggested and ten management approaches to manage root causes of delays in the railway substation project were recommended.
- According to the research findings, most root causes of delays were analyzed and addressed later during the project and by then the damage was already done. Other root causes of delays were outside the capacity of the project team.

- The top three stakeholders that contributed to the causes of delays in the study were the contractor, consultant, and client in that ranking order, with the community as the lowest contributor to delays. Figure 1 below displays the percentage of participants' views regarding the stakeholders that contributed to the root causes of the delay.

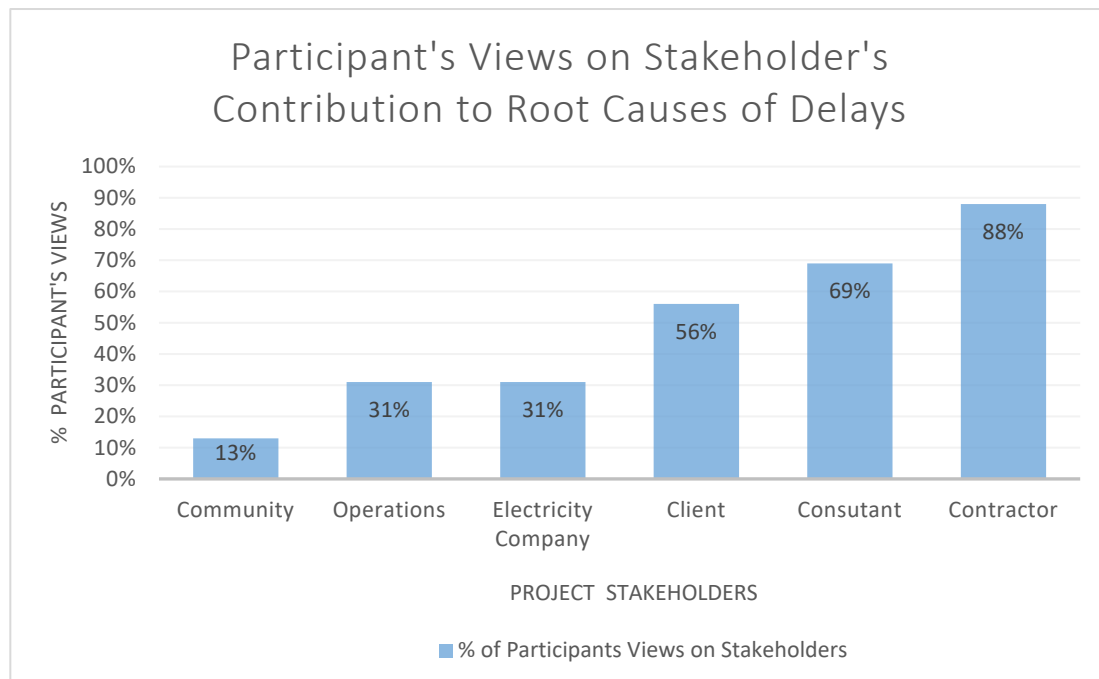


Figure 1. Participants' views on project stakeholders as contributors to the cause of delays.

The contractor is viewed as the greatest contributor to delays in the new DC substations projects, while the community was viewed as the lowest contributor to delays.

- Projects encountered local labor recruitment delays, due to community pushbacks which are regarded as non-compensable delays. Most stakeholders influencing the project schedule were identified and impacted the project both negatively and positively, but often negatively even causing delays.

### **Analyzed knowledge areas of Project Management Body of Knowledge (PMBOK)**

- The research findings revealed the combined issues of delays around the late application and receiving the Environmental Impact Assessment (EIA) and Water Use License Application (WULA) permits accounted for most delays.
- The project had a sufficient budget from the client. No financial problems with the contractor at Substation A and Substation B, but Substation C and D contractors had cash flow management problems.
- The project scope for the four new DC substations was clear but additions/scope changes impacted the project schedule negatively causing delays.
- Procurement was effective in the beginning (tendering) but later became ineffective by appointing inexperienced contractors and allowing advance payment without assessing the risk.
- The project schedule was properly developed but experienced various challenges, some were unforeseen, others self-inflicted which caused the project to be behind schedule most of the time.
- The overall communication in the project was fairly good, timeous communication sharing, and technical and progress meetings, were conducted.
- The quality standard of the project is highly rated, and specifications and quality control measures were enforced and followed.
- Integrated change control was implemented properly using Project Change Notice (PCN) and New Engineering and Construction Contract (NEC), but project changes delayed the project.
- The project encountered delays regarding resources, the contractor's late delivery of materials, substandard materials, and incompetent personnel. The internal team was well-resourced but lacked risk resources.
- Risk management met objectives, and risks and mitigation were identified during feasibility, but there were risk resource constraints, unforeseen circumstances, and insufficient risk workshops. Most risk impacts were both positive and negative.

### 6.1.4 Section N - General (Project Lifecycle Process (PLP) and Knowledge Area)

- The PLP is viewed as effective on paper/document, but it was not properly followed as stages (FEL-1 and FEL-3) were skipped. The implementation and application were ineffective in this project and even a closeout report was not concluded.
- Project Risk Management is the highest knowledge area that needs improvement, followed equally by both Communication and Resource Management while Stakeholder Management and Cost Management are the lowest knowledge areas that need improvement.

All the participants did not mention the project’s schedule management and quality management, as needing improvement. Figure 2 below displays the percentage of participants’ views about the project management knowledge that needs improvement

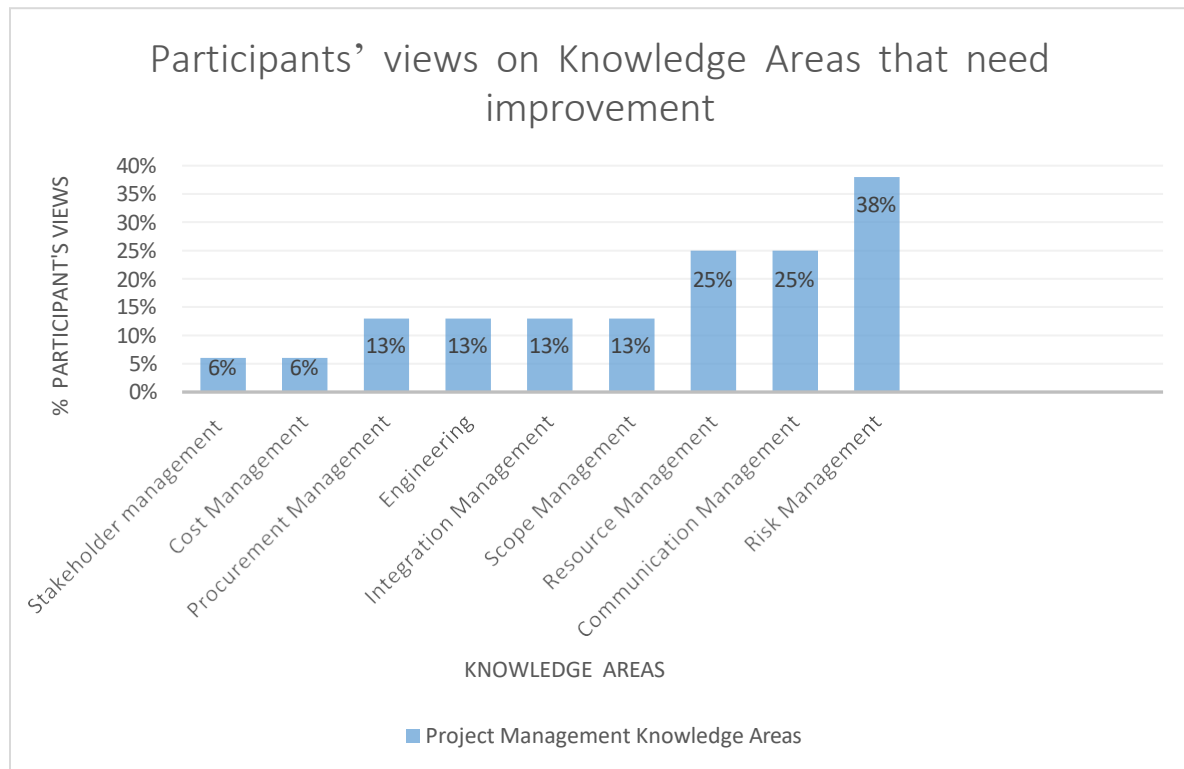


Figure 2. Participants’ views on project management knowledge areas

## 6.2 Archival Data Discussion

Archival data collected were created directly or indirectly by the sixteen study participants and were stored internally in the administrative database (company archives). The data were meant for the successful management of the projects from inception to closeout. Archival data collected were project reports, Project Change Notices (PCNs), NEC compensation events and early warnings, lessons learned, and risk registers.

### 6.2.1 Project Status Report (PSR)

The report contains the following about the project to mention a few, executive summary, milestone dates, milestone comments, percentage of progress, project issues, and impact. The open code system was applied to this project information to determine the root causes of delays. Figure 3 shows the root causes of delays extracted from the PSR.

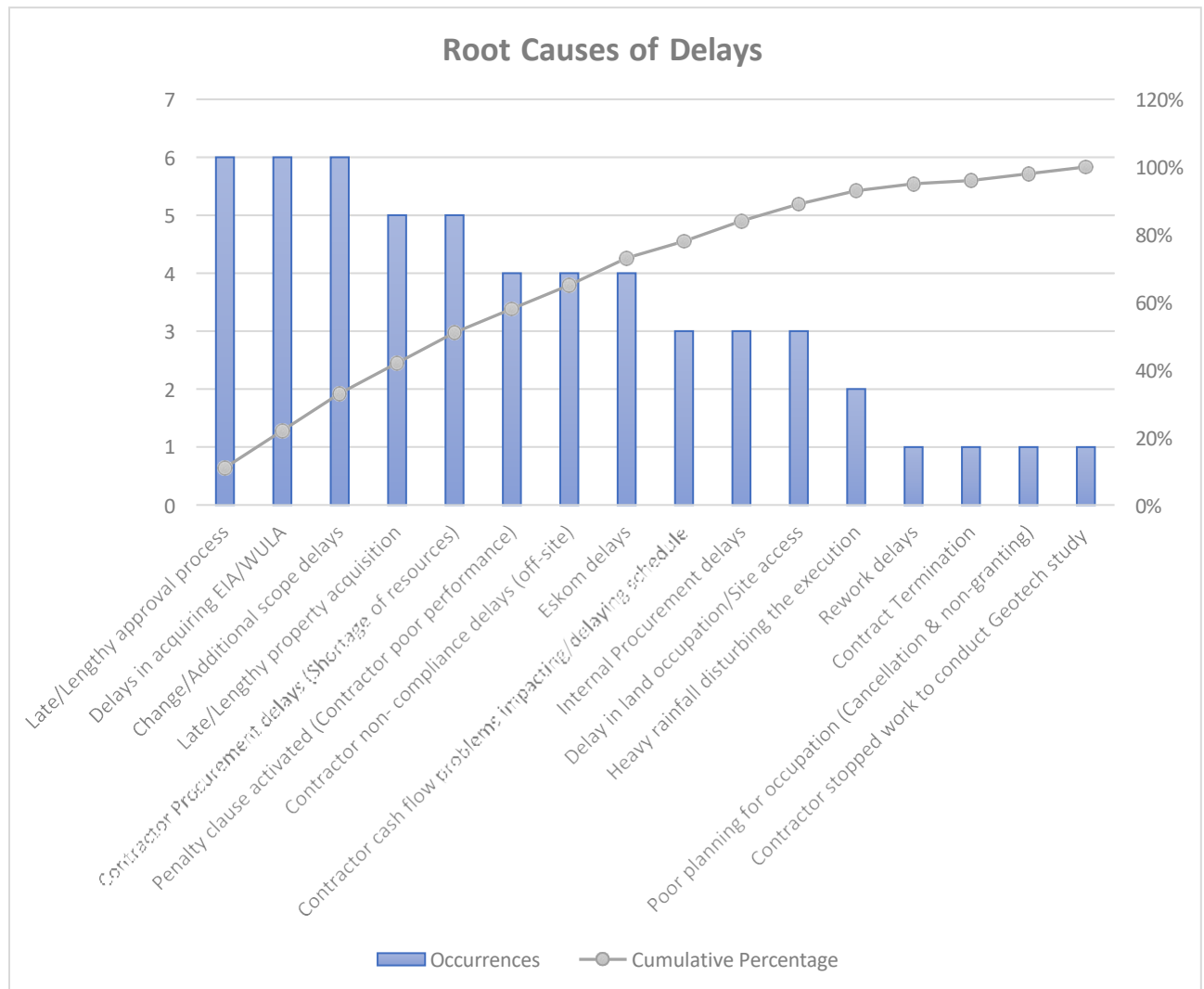


Figure 3. Root causes of delays from Project Status Report

The top five root causes of delays that occurred more often in the PSR were a late/lengthy approval process, delays in acquiring EIA/WULA permits, change/additional scope delays, late/lengthy property acquisition, and contractor procurement delays due to a shortage of resources.

### 6.2.2 Project Change Notice (PCN) and Compensation Event (CE)

A PCN is an internal document used for the successful management of project changes (in terms of time, cost, and scope) between the consultant and owner. A Compensation Event (CE) is a contractual document used to manage contracts, changes, and communications between the project manager and the contractor (Institution of Civil Engineers 2013). Based on the PCN and CE, the combined issues of delays around the late application and receiving the EIA and WULA permits accounted for more than one year of delays. The issue of contractor termination of contract due to poor performance accounted for one year and six months of delays.

### 6.2.3 Lessons Learned

Lesson-learned meetings were conducted with inputs from various stakeholders. The lesson-learned information was analyzed using the open-coding system to first determine the root causes of delays and secondly the suggested mitigation/improvement/lessons. Figure 4 shows the root causes of delays extracted from lessons learned.



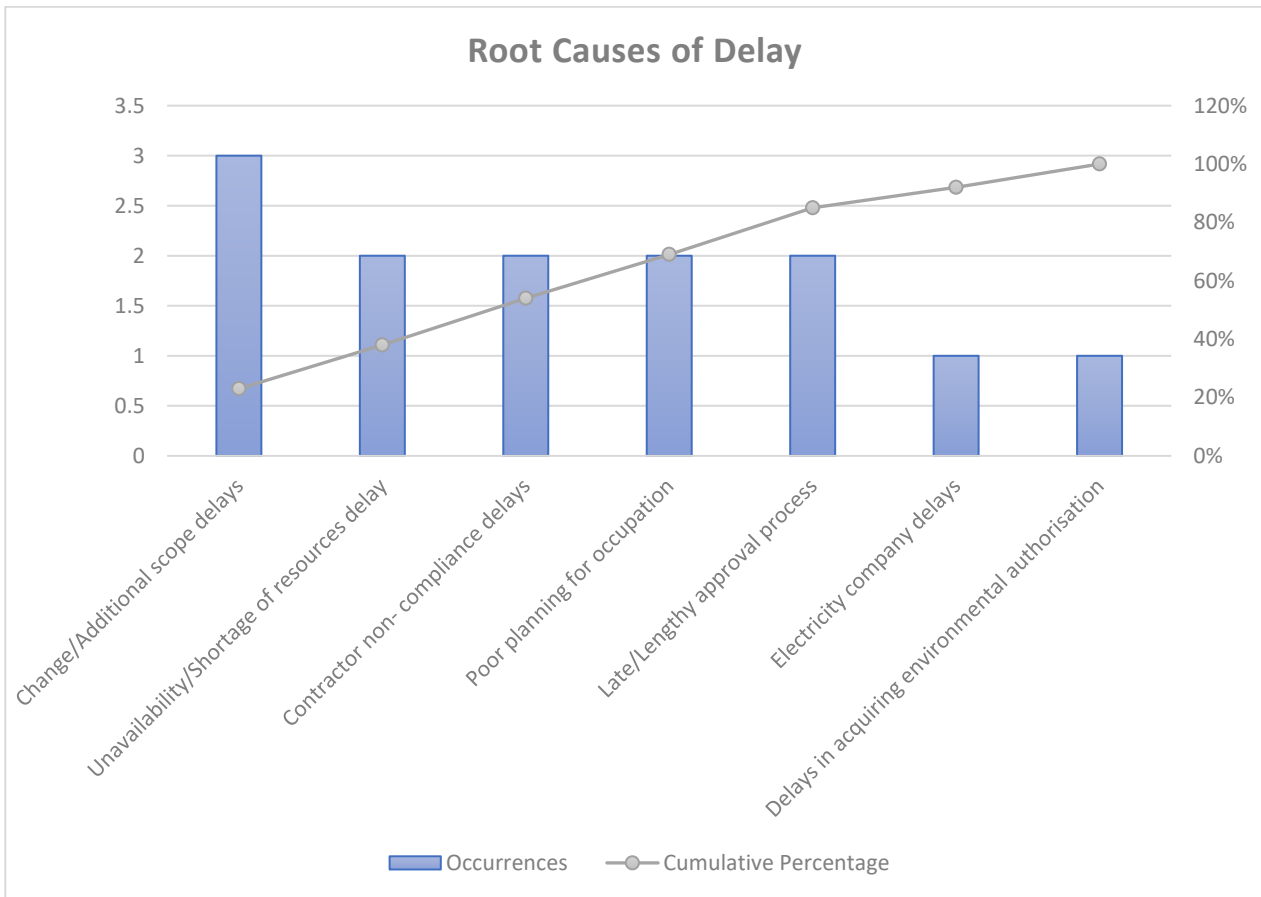


Figure 4. Root causes of delays from lessons learned

The root causes of delays that occurred more frequently were change/additional scope delays, due to under-scoping as construction of the track switch structure was not catered for.

Furthermore, an open code system was implemented for the lesson-learned summary information and suggested mitigations/improvements/lessons.

#### 6.2.4 Risk Register

Twenty-one individual risk descriptions that have a probability of impacting the project schedule or being root causes of delays were recorded with their respective proposed mitigations/actions.

### 7. Results and Recommendations

#### 7.1 Results

Below are the 33 consolidated root causes of delays from the interview and archival results. First are the top five ranked, root causes of delays that occurred more often in the PSR according to open code analysis:

- Lengthy approval process by multiple people in the railway company (late approval process).
- Delays or late in acquiring EIA and WULA.
- Owner requirement specification not clear/unclear or changes in scope.
- Late/lengthy property acquisition.
- Contractor delays in procurement of materials.

Secondly are the rest of the consolidated root causes of delays:

- 81 mtpa business case scope was not properly developed.
- Incorrect and faulty equipment supplied by the depot.
- Incorrect certification of the personnel by the contractors.
- Procurement strategy and vendor issues.
- Risk management lacking and not respected.

- Poor pre-planning and under-scoping of the project.
- Local labor recruitment delays due to community pushback.
- The project skipped the PLPs.
- Poor planning for occupation (cancellation and non-granting occupation).
- Unfavorable site conditions (waterlogged site) and extreme weather (heavy rain).
- Alteration/design change of construction of the platform.
- The hiring of inexperienced contractors/upcoming contractors.
- The contractor not having the resources or capability to execute the work.
- Contractor cash flow problems.
- South African electricity company's 11 kV (kilovolt) line interference with the project site.
- South African electricity and railway companies' misalignment of scope.
- Termination of the contract and appointment of a new contractor.
- Contractor non-performance (penalties charged).
- Contractor non-compliance delays (off-site).
- Internal procurement delays.
- Delay in the land occupation/site access.
- Rework delays.
- Delays caused risk analysis and postponement of council settings during the procurement period.
- The supply development contractor failed to deliver machinery as per the agreement.
- Turnover and reassignment of project personnel.
- Theft, the safety of contractor's staff, equipment, and materials.
- Road access is not suitable for lifting equipment (transformer).
- Labor unrest and wage demands due to national industrial action.

All the 33 root causes of delays from the data findings were grouped according to project management knowledge areas (PMBOK), indicating the areas impacted by causes of delay. Table 4 displays identified root causes of delays according to knowledge areas.

Table 4. Root causes of delays as per knowledge area

<b>Project Management Knowledge Areas</b>	<b>Root Causes of Delays</b>
Integration Management	<ul style="list-style-type: none"> <li>• South African electricity and railway companies' misalignment of scope.</li> </ul>
Scope Management	<ul style="list-style-type: none"> <li>• Owner requirement specification not clear/unclear or changes in scope</li> <li>• 81 mtpa business case scope was not properly developed.</li> <li>• Poor pre-planning and under-scoping of the project.</li> <li>• Alteration/design change of construction of the platform.</li> <li>• The project skipped the PLPs.</li> </ul>
Quality Management	<ul style="list-style-type: none"> <li>• Rework delays.</li> </ul>
Resource Management	<ul style="list-style-type: none"> <li>• Incorrect and faulty equipment supplied by the depot.</li> <li>• Incorrect certification of the personnel by the contractors.</li> <li>• The hiring of inexperienced contractors/upcoming contractors.</li> <li>• The contractor not having the resources or capability to execute the work.</li> <li>• Turnover and reassignment of project personnel.</li> <li>• Theft, the safety of contractor's staff, equipment, and materials.</li> <li>• Road access is not suitable for lifting equipment (transformer).</li> </ul>
Risk Management	<ul style="list-style-type: none"> <li>• Risk management lacking and not respected.</li> <li>• Unfavorable site conditions (waterlogged site) and extreme weather (heavy rain).</li> <li>• Delays caused risk analysis and postponement of council settings during the procurement period.</li> </ul>
Procurement Management	<ul style="list-style-type: none"> <li>• Contractor delays in procurement of materials.</li> <li>• Procurement strategy and vendor issues.</li> <li>• Termination of the contract and appointment of a new contractor.</li> <li>• Contractor non-performance (penalties charged).</li> <li>• Contractor non-compliance delays (off-site).</li> <li>• Internal procurement delays.</li> <li>• The supply development contractor failed to deliver machinery as per the agreement.</li> </ul>
Stakeholder Management	<ul style="list-style-type: none"> <li>• Labor unrest and wage demands due to national industrial action.</li> <li>• South African electricity company's 11 kV (kilovolt) line interference with the project site.</li> <li>• Local labor recruitment delays due to community pushback.</li> </ul>
Cost Management	<ul style="list-style-type: none"> <li>• Contractor cash flow problems.</li> </ul>

Schedule Management	<ul style="list-style-type: none"> <li>• Lengthy approval process by multiple people in the railway company (late approval process).</li> <li>• Delays or late in acquiring EIA and WULA.</li> <li>• Late/lengthy property acquisition.</li> <li>• Poor planning for occupation (cancellation and non-granting occupation).</li> <li>• Delay in the land occupation/site access.</li> </ul>
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## 7.2 Recommendations

The study findings from consolidated interviews and archival data recommended the following mitigation and remedial actions that could be adopted and implemented in the substation railway projects to address the root causes of delays:

- Educate top managers to enforce the project life cycle fully.
- Conduct scope workshops and design checks before tendering.
- Proper evaluation of contractors during tendering to select the people who understand and can do the job.
- Stop the contractor on site when not complying with the specifications.
- Have a weekly risk meeting to check the progress of the risks identified.
- Have a repository of lessons learned in the organization, learn from what has happened, and implement it earlier in planning the next project.
- Allow communications transfers from feasibility study to execution.
- Conduct land research, zoning, and transfer of land.
- Operations must allow enough time (outages) for project execution.
- Don't use old equipment from the depots.
- Implement project life cycle fully (inclusive of EIA and Permit); it is designed to provide a high probability of success for projects.
- Involve all stakeholders at feasibility or earlier.
- Avoid advance payments and manage suppliers of contractors.
- Conduct proper project planning well in advance (schedule contractual compliance, follow project schedule).
- Conduct site planning to identify any risks on site (site constraints and plan for alternative access method).
- On-site assessment by experts to determine all scope and risks before occupation application.
- Delegation of responsibilities to other competent persons.
- Train more resources and test engineers.
- All scope should be included in the business case during feasibility and signed off by all stakeholders.
- The drawing coordinator should be nominated to satisfy all internal stakeholders for quicker drawing acceptance.
- Recruit competent staff. The incentive to retain staff.
- Insurance to cover theft. In the tender process specify suitable security measures and ensure compliance.
- Keep alert of planned national industrial action.

The feedback from the interview data recommended the following management approaches to manage the root causes of delays in the railway substation project:

- Management should not bypass the stages of project lifecycle processes because of the pressure.
- Management should set up realistic project targets.
- Business leaders are to have awareness and understanding of projects and their performance scorecard should be project measured.
- Put competent people in place to run the project early on during the inception stage.
- Encourage full implementation of the PLP with gate reviews.
- Spend much time coordinating, controlling, and organizing all project team members.
- Micromanage the project and try to know every detail of the project.
- Improve stakeholder engagement, risk assessment, and communication.
- Encourage the appointment of a competent contractor that knows the culture of the organization.
- Encourage proper planning.
- Conduct more project monitoring and have fortnightly project meetings instead of monthly.

## 8. Conclusion

In conclusion, the overall study achieved the objectives and answered the research questions sufficiently, by identifying the 33 root causes of delays within the new DC substations and ranking the top five root causes of delays. Furthermore, 23 mitigations and remedial actions were recommended, that could be adopted and implemented in the substation railway projects to address the root causes of delays. In addition, the study suggested management approaches and ways that can be implemented to reduce and mitigate delays within coal portfolio infrastructure

projects. Comprehensive root causes of delays, mitigations, remedial actions, and management approaches identified in the study were compared with the global railway literature and found to be relevant across railway industries.

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## Biographies

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