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Zama Water Treatment Project: Optimization using Project Management Techniques

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Abstract

This paper examines how project management techniques can be utilised as strategic tools to enhance infrastructure projects more efficiently and effectively. It refers mainly to the Zama water treatment project in South Africa. This research illustrates the efficacy of PERT (Program Evaluation and Review Technique), CPM (Critical Path Method), and project crashing in resolving the region's water quality and infrastructure problems. The primary objective is to optimise the Zama water treatment project's planning, monitoring, and control to ensure project success. Information was collected from Hydro Novo Ltd in collaboration with the Municipal Chairperson of Utility Services. The data provided in the tables facilitated the development of the project management model following the fundamental principles of these approaches. The model was solved with the assistance of QM for Windows. The solution revealed that the project duration could be reduced from 78,6 weeks (completion time) to 57 weeks, costing R6,212,500 additional. By crashing the project, the municipality ensures a quicker resolution to the water quality issues, significantly improving the social, economic, and quality of life conditions in the Zama community and supporting the stability and growth of local businesses. The sensitivity analysis suggests that reducing the project duration to 65 or 60 weeks can be viable. It would save a lot of time at an acceptable cost and minimise risks while providing substantial benefits to the community. Furthermore, the study demonstrates how project management tools can enhance the success of infrastructure projects in resource-limited areas, ultimately contributing to sustainable water management in South Africa.

Keywords
Project Management, PERT (Program Evaluation and Review Technique), CPM (Critical Path Method), Project Crashing, Water Treatment

1. Introduction
People in Zama, South Africa, continue to fight for access to clean and safe water (Njilo 2024). Despite numerous interventions that have been made to address the issue, water quality in the region continues to fall below acceptable health standards, compromising public health and social well-being (Infrastructure News 2025). This predicament is worsened by outdated infrastructure, constrained resources, and difficulty implementing effective project management

(SAnews 2024). Historically, poor project management has significantly contributed to infrastructure failures, exacerbating the water crisis. The Zama water treatment project intends to overcome such challenges using a cost-effective project management system integrating advanced techniques like PERT, CPM, and project crashing. This unique approach focuses on optimising resource allocation, reducing project duration, and minimizing costs, which seemingly were not adopted in previous efforts. Project management tools are vital in ensuring timely project completion, effective use of resources, and effective coordination with all stakeholders. The mechanisms played a crucial role in overcoming the complexities involved in the water treatment project (Shirle et al. 2022). This paper explores the application of project management techniques in addressing the Zama water treatment project's logistical, financial, and operational issues, helping South Africa achieve its broader objectives of sustainable water management (Olley et al., 2024). The case study demonstrates how projects can be effectively managed by applying PERT, CPM, and Project Crashing techniques, serving as an example to other communities engaged in similar projects by showcasing improved planning, time management, and cost.

1.1 Objectives

Infrastructure projects in resource-limited areas often face delays and go over budget because of poor planning and monitoring systems (Bagshaw 2021). Although project management tools are available, advanced methods like PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method) are not used as often as they should be. This results in inefficiencies and poor project outcomes (Suharni and Lily 2023). This paper explores how PERT, CPM, and project crashing techniques can improve project planning, tracking, and control in a local infrastructure project - the Zama water treatment project. The study identifies the critical path by calculating important project metrics such as the earliest and latest start and finish times (ES, EF, LS, LF) and slack times for each activity. It improves how resources are allocated (Bagshaw, 2021). The Project's total duration and cost were also estimated to ensure it can be completed on time and within budget. The paper also highlights how PERT, CPM, and project crashing can be useful as simple, cost-effective tools for better decision-making. These methods help prevent delays and inefficiencies, enhancing the infrastructure project's success (Pinha and Ahluwalia 2019)

2. Literature Review

Effective project management plays a critical role in building infrastructure. It ensures that projects are completed promptly, within costs, and according to quality specifications (Elnaz et al. 2020). Render et al. (2019) explain that PERT and CPM assist in scheduling, planning, and controlling work in a project by identifying the critical activities, utilising resources more effectively, and determining the project duration. Project crashing assists in reducing project duration through the utilisation of additional resources or more effective utilisation of the existing resources to complete critical activities ahead of schedule without affecting quality (Kelly 2011).

The Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) are significant management tools that assist with planning, scheduling, and monitoring large projects (Render et al. 2019). According to Shah (2021), PERT is a statistical tool used to evaluate and plan various tasks required to accomplish a project. It mainly focuses on task duration and how likely various estimated durations are. Contrarily, CPM is a rigid deterministic technique used to compute the longest chain of activities scheduled to complete a project (Bagshaw, 2021. It aims at the most critical activities directly impacting the project duration (Bagshaw 2021). The two techniques utilise network diagrams to show project activities and their relationships, making scheduling and managing the project easier (Mathur 2023).

Project crashing involves shortening project schedules by applying additional resources to critical activities to minimise the overall time required by the project (Heizer et al. 2020). Islam et al. (2012) examined a math model for approximating the project completion probability following the cutting of PERT/CPM networks with time and cost trade-offs. Applying PERT and CPM methods in infrastructure construction has saved planning time and resources (Itani 2023). In the construction industry, the usage of the Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM) has helped lessen the time to finish a project, along with furnishing a means of planning project schedules (Mostafa 2023). The tools allow project managers to chart project schedules, examine potential delays, and commence corrective actions in advance (Pellerin and Perrier 2019).

PERT and CPM were developed in the late 1950s due to the increasing complexity of handling projects in various industries. PERT was developed by the US Navy in 1958 to control the Polaris missile project, emphasising project scheduling changes and uncertainties (Shah 2021). Meanwhile, DuPont developed CPM for construction and industry project scheduling. The technique assists in identifying the critical activities and the optimal application of resources (Bagshaw 2021). Both methods have evolved and applied to contemporary project management, contributing significantly to the development of the field (Itani 2023).

The Critical Path Method (CPM) was developed in the late 1950s. It assisted in identifying critical activities that can be completed quicker to enable the project to be completed earlier (Kerzner 2017). With advancements in project management methods and software, accelerating projects was a standard method of managing projects that must be completed within a limited period (Meredith, Shafer & Mantel 2021). There are also several case studies illustrating the application of these methods.

For instance, in a study by Nigam and Atmah (2022), CPM and PERT were examined for use in bullet train projects. Using CPM, the authors were able to determine those key activities that would affect project completion, and where PERT was applied, it was utilised to determine the estimated time to complete the project. Both applications provided an all-encompassing means of handling complex transport projects (Nigam and Atmah 2022). One such study by Kholil, Alfa, and Hariadi (2018) examined the problem of planning residential development projects with the CPM and PERT techniques to reduce time. The study showed that applying the techniques in project planning enabled housing projects to be completed earlier; thus, they can effectively be used in the construction sector (Kholil et al. 2018). WEC Projects also constructed a water treatment plant for Kasane Water Treatment Works in Botswana that can treat 16 million litres of water daily to address the growing demand for safe drinking water in the region. Effective project management had the work carried out within the planned time and utilising resources effectively (WEC Water - Engineering the Water of Tomorrow 2024).

The Zama Water Treatment Project addresses the longstanding water quality issues in the region. The project entails the upgrade of the Flipdrift Water Treatment Works and the reconstruction of the Rooinoord Wastewater Treatment Works (SAnews 2024). With the knowledge of what to do and what can hinder progress, project management techniques such as PERT, CPM, and Project Crashing can assist in successfully delivering this water treatment project on time. With a socially impactful imperative, this project will supply clean water to the Zama community, mitigating the humanitarian, socio-economic and health challenges experienced by the habitats.

3. Methods

The project company and the Chairperson of Municipal Utilities Services gathered information about the water treatment project. This information was used to identify the activities that must be carried out, their necessary sequences, and the time that they would require to complete the project. The activities' normal and crash times and normal and crash costs were also gathered to speed up the project at a minimal cost. The data was put into QM for Windows, and the resulting solution was analysed in the results section.

4. Data Collection

Case Study – Zama Rooinoord Wastewater Treatment Project

State of Zama Water

Water quality in Zama has been problematic for many years. The greatest cause of concern is the Rooinoord Wastewater Treatment Plant, which has failed to treat the wastewater. This has led to the pollution of the Apels River. This river is a crucial source of drinking water for Zama. The quality of the water has been deplorable, leading to numerous health issues, such as an outbreak of cholera in 2023 that claimed over 20 lives (Pmg.org.za, 2024; Moatshe, 2025). The upgrading of the Rooinoord plant continues, with a guarantee that the residents will have clean water by 2026 (Tshikalange 2024).Zama's water crisis originated from various elements, involving deteriorating infrastructure, Contamination of water sources, and management failures. The Rooinoord Wastewater Treatment Plant, which is expected to purify sewage before the water goes into the Apies River, a main source of water for Zama, has been dysfunctional for years. This led to untreated, poor-quality water contaminating the river.

Hydro Novo Ltd and the Water Treatment Project

Hydro Novo Ltd is a leading water treatment firm specialising in providing new and sustainable water solutions. Since 2010, the company has delivered numerous projects across Africa, supplying clean water to millions of individuals.

In 2024, Hydro Novo Ltd won the contract to end the water crisis in Zama, a suburb plagued by poor water quality due to the rundown Rooinoord Wastewater Treatment Plant.

The company is a technology-driven engineering organisation that designs, constructs, finances, runs and manages water treatment plants. Plants purify polluted water to distribute high-quality Consumable and industrial process water from almost any water origin. This project focused on adding a reverse osmosis (RO) plant to the current water treatment facility to improve it significantly. This innovation will enhance the purification process by eliminating pollutants more efficiently than existing techniques, guaranteeing adherence to strict water quality standards, and promoting environmental preservation. To ensure a smooth integration, the RO plant will be placed strategically next to the current infrastructure, with pre-treatment systems upgraded and current processes modified.

The project has many components and tasks. The Chairperson of Municipal Utilities Services and the project company supplied essential information to schedule and carry out the project efficiently. This information included the tasks to be carried out, the order in which they must be carried out, and how long each task is expected to last, as shown in the project timetable.The project starts with Activity A (Economic Feasibility), which lasts about 2 to 6 weeks to establish if it is economically feasible. Concurrently, Activity B (Stakeholder Engagement) occurs within 1 to 3 weeks. The stakeholder meetings enabled the community, private sector, and government participation. This engagement is critical in community projects that ensure the end user's needs are adequately defined; key players of different interest groups are connected to ensure effective coordination.

Once the outcomes of these initial activities are reviewed, Activity C (Environmental Feasibility & Regulatory Approvals) and Activity D (Project Funding & Budget Finalization) begin. Activity C occurs within 3 to 8 weeks, and Activity D occurs within 3 to 7 weeks. After approvals and funding are obtained, Activity E (Site Selection & Land Acquisition) is started. Finding and acquiring appropriate land for the project requires 2 to 6 weeks. As soon as the site has been determined, two crucial activities are conducted: Activity F (Engineering Designs), which takes 4 to 10 weeks to come up with detailed designs, and Activity G (Water Quality Analysis & Technology Selection), which requires 3 to 8 weeks to determine the most appropriate treatment technology. Once such selections and designs are complete, Activity H (Procurement of Equipment & Materials) is initiated to procure necessary parts in 4 to 9 weeks.

Then, Activity I (Site Preparation & Groundwork) is carried out in 3 to 8 weeks and comprises land clearing, grading, and foundation laying. After preparing the site, construction starts with Activity J (Constructing the Water Treatment Plant) for 6 to 15 weeks. Succeeded with three of its dependent tasks: Activity K (Treatment Equipment Installation) for 5 to 11 weeks, Activity L (Water Pipeline Laying and Connections) for 5 to 14 weeks, and Activity M (Constructing Water Storage Facilities) for 5 to 12 weeks. After completing all the construction activities, Activity N (Electrical & Control System Installation) integrates these essential systems within 4 to 9 weeks.

Activity O (System & Water Testing for QA) is conducted between 2 and 6 weeks after system installation to validate performance. Upon successful completion of testing, Activity P (Pilot Operation & Monitoring Performance) is implemented between 3 and 7 weeks to ensure the stability of the operation. At the same time, Activity Q (Site Cleaning & Waste Disposal) takes 1 to 4 weeks to meet the environmental laws, and Activity R (Community Awareness & Training) takes 2 to 4 weeks to educate the local population. On monitoring, Activity S (Operator Training & Capacity Building) is carried out within 3 to 6 weeks to make the employees ready. Finally, Activity T (Final Handover & Certification) is done in 2 to 6 weeks, formally finishing the project. As each activity is concluded, Activity U (Full-Scale Operation & Maintenance) starts, guaranteeing operations continue for 3 to 7 weeks.

Table 1. Project Activities and Duration

Activity		Precedence	Optimistic (weeks)	Most likely	Pessimistic
Economic Feasibility	A	-	2	4	6
Stakeholder Engagement - Community, Private Sector, Government	B	-	1	2	3
Environmental Feasibility & Regulatory Approvals	C	A, B	3	5	8
Project Funding & Budget Finalization	D	A,B	3	5	7
Site Selection & Land Acquisition	E	C, D	2	4	6
Engineering Designs	F	E	4	6	10
Water Quality Analysis & Technology Selection	G	E	3	5	8
Procurement of Equipment & Materials	H	FG	4	6	9
Site Preparation & Groundwork	I	H	3	5	8
Construction of Water Treatment Plant	J	I	6	9	15
Installation of Treatment Equipment	K	J	5	8	11
Water Pipeline Laying & Connections	L	J	5	9	14
Construction of Water Storage Facilities	M	J	5	7	12
Installation of Electrical & other Control Systems	N	K, L, M	4	6	9
System & Water Testing for Quality Assurance	O	N	2	4	6
Monitoring Performance & Pilot Operation	P	O	3	5	7
Site cleaning & Waste Disposal	Q	O	1	3	4
Community Awareness & Training	R	O	2	3	4
Operator Training & Capacity Building	S	P, Q	3	5	6
Final Handover & Certification	T	Q, R, S	2	4	6
Full-Scale Operation & Maintenance	U	T	3	5	7

Crashing Analysis

We conducted a crashing analysis to shorten the project timeline and have it completed at a minimum cost. The table below shows the average time and crash durations, along with the associated costs:

Table 2. Crashing Analysis

Activity	Mean Time (weeks)	Crash Duration (weeks)	Normal Cost (ZAR)	Crash Cost (ZAR)
Economic Feasibility	4	3	250000	325000
Stakeholder Engagement - Community, Private Sector and Government	2	1	180000	225000
Environmental Feasibility & Regulatory Approvals	5,2	4	500000	650000
Project Funding & Budget Finalization	5	3	400000	520000

Site Selection & Land Acquisition	4	3	600000	750000
Engineering Designs	6,3	5	800000	1040000
Water Quality Analysis & Technology Selection	5,2	4	450000	585000
Procurement of Equipment & Materials	6,2	4	1000000	1250000
Site Preparation & Groundwork	5,2	4	700000	910000
Construction of Water Treatment Plant	9,5	7	5000000	6500000
Installation of Treatment Equipment	8	6	3000000	3900000
Water Pipeline Laying & Connections	9,2	7	4500000	5850000
Construction of Water Storage Facilities	7,5	5	2500000	3250000
Installation of Electrical & other Control Systems	6,2	4	1500000	1950000
System & Water Testing for Quality Assurance	4	3	900000	1170000
Monitoring Performance & Pilot Operation	5	3	750000	975000
Site cleaning & Waste Disposal	2,8	1	300000	390000
Community Awareness & Training	3	2	350000	455000
Operator Training & Capacity Building	4,8	3	600000	780000
Final Handover & Certification	4	3	400000	520000
Full-Scale Operation & Maintenance	5	4	1200000	1560000

The project aims to ensure that Zama residents have access to clean water by the end of 2026, with significant progress already made

5. Results and Discussion

5.1 PERT Results

The Windows QM output shows that the project will take 78.5 weeks. The critical path activities are A, C, E, F, H, I, J, L, N, O, P, S, T, and U, and they all have zero slack. If these activities are postponed, the project will take longer to complete.

Table 3. Project Schedule Analysis from QM for Windows

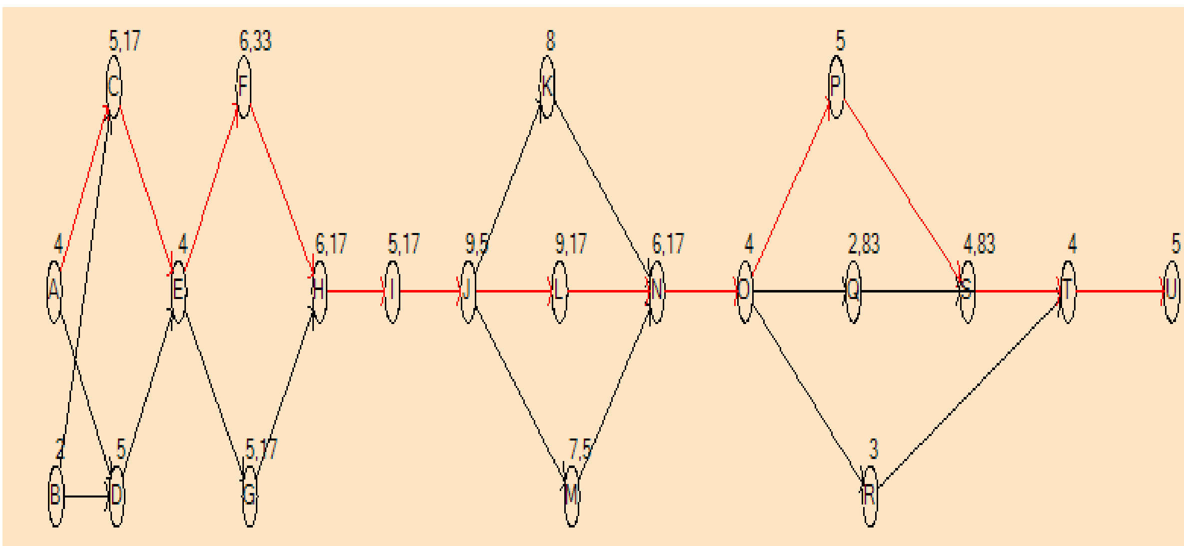
Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack	Standard Deviation	Variance
Project	78,5						3,3	11,2
A	4	0	4	0	4	0	,7	,4
B	2	0	2	2	4	2	,3	,1
C	5,2	4	9,2	4	9,2	0	,8	,7
D	5	4	9	4,2	9,2	,2	,7	,4
E	4	9,2	13,2	9,2	13,2	0	,7	,4
F	6,3	13,2	19,5	13,2	19,5	0	1	1
G	5,2	13,2	18,3	14,3	19,5	1,2	,8	,7
H	6,2	19,5	25,7	19,5	25,7	0	,8	,7
I	5,2	25,7	30,8	25,7	30,8	0	,8	,7
J	9,5	30,8	40,3	30,8	40,3	0	1,5	2,3
K	8	40,3	48,3	41,5	49,5	1,2	1	1
L	9,2	40,3	49,5	40,3	49,5	0	1,5	2,3
M	7,5	40,3	47,8	42	49,5	1,7	1,2	1,4
N	6,2	49,5	55,7	49,5	55,7	0	,8	,7

O	4	55,7	59,7	55,7	59,7	0	,7	,4
P	5	59,7	64,7	59,7	64,7	0	,7	,4
Q	2,8	59,7	62,5	61,8	64,7	2,2	,5	,3
R	3	59,7	62,7	66,5	69,5	6,8	,3	,1
S	4,8	64,7	69,5	64,7	69,5	0	,5	,3
T	4	69,5	73,5	69,5	73,5	0	,7	,4
U	5	73,5	78,5	73,5	78,5	0	,7	,4

Early Start (ES), Early Finish (EF), Late Start (LS), and Late Finish (LF) values give us information about the project schedule. E (Membrane and Equipment Installation) begins in week 9.2 and ends in week 13.2. Then, F (Installation of Energy Efficient System) takes place from week 13.2 to week 19.5. J (Process Trial and Testing)

Figure 1. Project Network generated from QM for Windows

occurs from week 30.8 to week 40.3. L (Optimisation) runs from week 40.3 to week 49.5. The concluding activities, S (Final Inspection & Validation), T (Commissioning), and U (Handover & Close-out) bring the project to a close at week 78.5. At the same time, non-critical activities such as A (Cleaning and Excavation), B (Building Construction), and G (Site Utilities Installation) have positive slack so that flexibility does not affect the project end date. A



(Cleaning and Excavation) has 0 slack, so it must be completed on schedule. In contrast, B (Building Construction) has 2 weeks of slack, and G (Site Utilities Installation) has 1.2 weeks of slack, allowing some flexibility in scheduling.

The project variance is a sum of the variance of the critical activities, while the standard deviation is a square root of the project variance. The variance and standard deviation indicate the degree of uncertainty of the activity duration and risk to the project schedule. For example, J (Process Trial and Testing) and L (Optimisation) have a larger variance (2.3), indicating that there may be threats to the schedule. Overall, the project is scheduled to be completed in 78.5 weeks, and critical activities must adhere to the schedule strictly to avoid delays. Non-critical tasks allow some flexibility in scheduling, but they must be observed carefully to keep the project on schedule.Figure 1 outlines the activities required to complete the Zama Water Treatment Project. The red arrows indicate critical activities that have no slack.

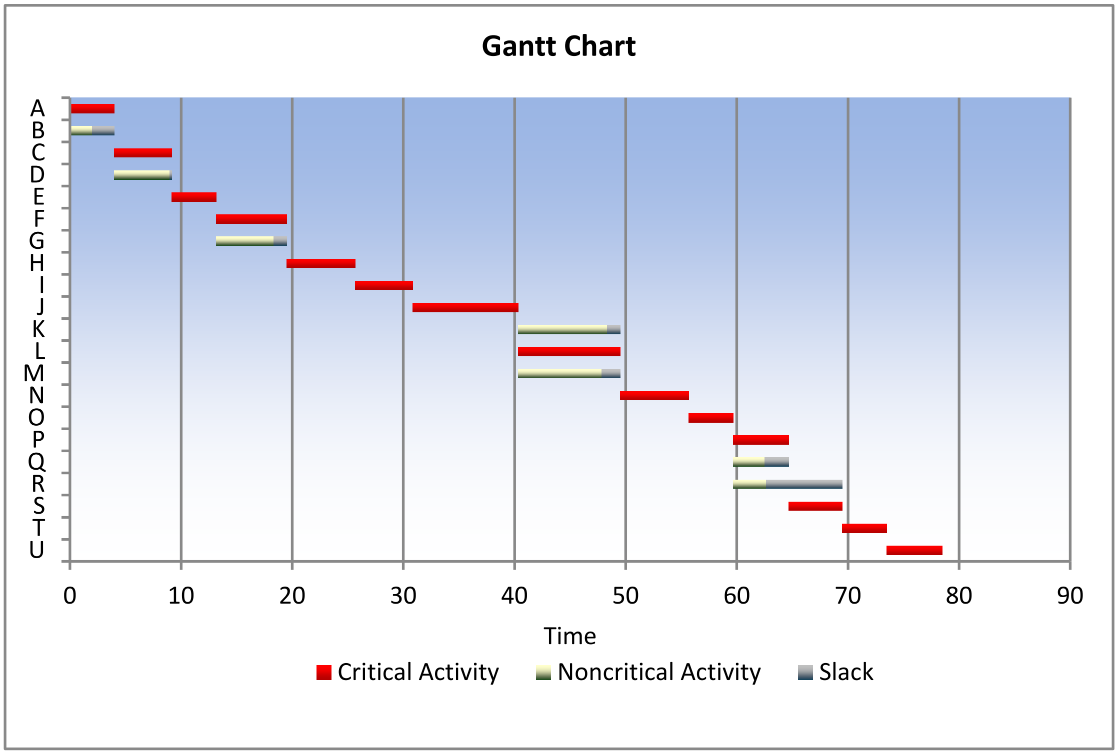


Figure 2 Gantt Chart generated from Excel QM

Figure 2. depicts the Zama water-treatment project Gantt chart, which visually represents the project schedule, showing the start and end dates of each activity, their duration, and dependencies.

5.2 Project Crashing and Sensitivity Analysis

QM for Windows calculations show that the project's duration is shortened from 78.6 weeks to 57 weeks by speeding up the activities at an extra cost of R6,212,500. The major activities that are shortened for this to happen are D (Process Plant Design), E (Membrane and Equipment Installation), F (Energy Efficient System Installation), J (Process Trial and Testing), and K (Optimisation). Furthermore, D is shortened by 1 day for R60,000, E by 1 week for R150,000, F by 1.3 weeks for R240,000, J by 2.5 weeks for R1,500,000, and K by 1 week for R450,000. Additional reductions are made to L, N, O, P, S, T, and U, further optimising the schedule. Non-critical activities, such as B (Building Construction), G (Installation of Site Utilities), and Q (Miscellaneous Work), are left unchanged as they have sufficient slack time. This improved schedule provides an optimal balance between time savings and cost efficiency by enabling the project to be completed in less time while maintaining the budget.

Table 4. Project Crashing Analysis from QM for Windows

Activity	Normal time	Crash time	Normal Cost	Crash Cost	Crash cost/pd	Crash by	Crashing cost

Project	78,6	57					
A	4	3	R250000	R325000	R75000	1	R75000
B	2	1	R180000	R225000	R45000	0	R0
C	5,2	4	R500000	R650000	R125000,0	1,2	R150000
D	5	3	R400000	R520000	R60000	1	R60000
E	4	3	R600000	R750000	R150000	1	R150000
F	6,3	5	R800000	R1040000	R184615,4	1,3	R240000
G	5,2	4	R450000	R585000	R112500,0	0,2	R22499,98
H	6,2	4	R1000000	R1250000	R113636,4	2,2	R250000
I	5,2	4	R700000	R910000	R175000,0	1,2	R210000
J	9,5	7	R5000000	R6500000	R600000	2,5	R1500000
K	8	6	R3000000	R3900000	R450000	1	R450000
L	9,2	7	R4500000	R5850000	R613636,4	2,2	R1350000
M	7,5	5	R2500000	R3250000	R300000	0,5	R150000
N	6,2	4	R1500000	R1950000	R204545,5	2,2	R450000
O	4	3	R900000	R1170000	R270000	1	R270000
P	5	3	R750000	R975000	R112500	2	R225000
Q	2,8	1	R300000	R390000	R50000	0	R0
R	3	2	R350000	R455000	R105000	0	R0
S	4,8	3	R600000	R780000	R100000	1,8	R180000
T	4	3	R400000	R520000	R120000	1	R120000
U	5	4	R1200000	R1560000	R360000	1	R360000
TOTALS			R25880000				R6212500

The project crashing analysis began with the objective of achieving the minimum duration of 57 weeks at a cost of R6,212,500. Stepwise sensitivity analysis provides a picture of how different levels of acceleration influence cost effectiveness. Instead of crashing the whole project, partial reductions can be explored to determine whether partial crashing offers a more cost-effective balance between time and expense.

Table 5. Sensitivity analysis

Project Duration (Weeks)	**Total Crashing Cost (ZAR)**	**Total Weeks Reduced**	**Average Cost per Week Saved (ZAR)**
78.6 (No Crashing)	R0	0	-
70	R2,500,000	8.6	R290,698
65	R4,000,000	13.6	R294,118
60	R5,500,000	18.6	R295,699
57 (Fully Crashed)	R6,212,500	21.6	R287,615

Cost-Time Trade-Off Analysis

The following table displays a sensitivity analysis that shows how reducing the project duration in increments affects costs.

The sensitivity analysis shows the idea of diminishing returns because the average cost saved each week is more or less the same, ranging from R287,000 to R295,000. We need to take a closer look at the incremental cost of saving each extra week to see when it is no longer feasible to save more time. If the company wants to save funds and achieve good outcomes, reducing the project to 65 or 60 weeks would be preferable instead of hurrying and finishing it in 57 weeks, given the trade-off. In this manner, they can eliminate health and environmental risks and invest their funds appropriately. In deciding, the sponsors must determine whether it is within their budget and concomitant benefits to the community. Crashing minimises the suffering from the water crisis, but the extra cost of crashing must be affordable. If the project is not crashed, the normal period would have serious adverse effects, such as ongoing health threats, rising healthcare expenses, lost productivity, extended poor living conditions, environmental deterioration, and increased school and hospital absenteeism.

The R6,212,500 extra spent on crashing the project would be far smaller than the damages and costs that might be incurred. The local businesses would experience difficulties ranging from increased absenteeism, inflated operating costs, supply chain disruption, diminished consumer spending, and discouraged investments. By crashing the project, the company provides a faster solution to the water quality problems, enhancing the social, economic, and quality of life status in the Zama community and facilitating the stability and growth of local enterprises. In addition, the sensitivity analysis suggests that a partial reduction of the project duration to 65 or 60 weeks can be a viable option. It would save a lot of time at an acceptable cost and minimise risks while providing substantial benefits to society.

6. Conclusion

The Zama water treatment project is a good example of applying project management tools to overcome challenging infrastructure issues. Using PERT, CPM, and project crashing, the project team determined the critical activities, improved resource utilisation, and shortened the project duration from 78,6 weeks to 57 weeks at an extra cost of R6 212500. This method guarantees a timely supply of clean water to the Zama community and acts as a model for other communities facing similar challenges. Applying these methods proves that they can potentially make infrastructure work more efficiently. Finally, it advances people's quality of life and public health.

Lesson Learned

The Zama water treatment project highlights several key lessons. The project duration was reduced by implementing project management techniques from 78.6 weeks to 57 weeks, confirming that the methods can manage resources effectively. While reducing project duration, balancing time savings with cost implications is essential. The additional cost of R 6 212500 for crashing activities was justified by the significant reduction in project time, highlighting the need for careful cost-benefit analysis.Effective coordination with all the stakeholders involved, including the Municipal Chairperson of Utilities Services and the project company, was crucial in gathering accurate data and ensuring smooth project implementation. Successful stakeholder collaboration and communication were fundamental in overcoming logistical, financial, and operational challenges (Pinha & Ahluwalia 2018).

The project faced different challenges, from approval bottlenecks to limited resources. However, navigating through these challenges using project management tools enabled efficient utilisation of project resources, including time for the project's success. In addition, the project helps realise the overall objective of sustainable water management in South Africa. In solving the recurring issue of water quality in Zama, the project can be a model for similar communities facing the same problem. Ensuring the availability of safe and clean water is a considerable contribution to the public's health and the well-being of society. The project's success in providing clean water to the Zama community highlights the importance of infrastructure projects in improving the quality of life for residents.

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