Shaft Sinking and Project Execution: A Case Study of the Konkola Deep Mining Project in Zambia

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Abstract: ***This case study examines the Konkola Deep Mining Project (KDMP), a large-scale brownfield development initiated to extend the lifespan of the Konkola Copper Mines in Zambia. The project aimed to tap into copper ore resources beyond existing dewatering and tramming infrastructure by sinking and equipping a new shaft to a depth of 1505 meters. Using project management methodologies, the research evaluates the planning, execution, and closure stages of KDMP, highlighting the use of a pure project structure and extensive risk management strategies. The study draws on interviews, field verification, and project documentation to provide insights into the complexities of mine shaft sinking and large-scale infrastructure development. Key lessons underscore the importance of comprehensive planning, robust execution frameworks, and the practical use of project management tools in megaproject environments.***

Keywords: Shaft Sinking, Copper Mining, Project Management, Konkola Deep Mining Project, Zambia

1. Introduction

Zambia's copper mining sector was established in the 1920s under what was called Zambia's consolidated copper mines, ZCCM. The first commercial mine was established in 1928, Roan Consolidated Copper Mine (1978). During this period, most of the mines were sunk. The sinking of a mine shaft is an activity that does not happen often. Many people have worked in mines and even retired without experiencing the sinking of a mine shaft. Therefore, for this reason I took interest in developing a case study for the Konkola Deep Mining Project, where a new shaft was sunk, so that many people could learn and understand what is involved in such a huge undertaking.

Kajewski, Malhotra, and Ritzman (2015) define a project as an interrelated set of activities with a start and end point, which results in a unique outcome for a specific allocation of resources. Kajewski, Malhotra, and Ritzman (2015) further define project management as systemized, phased approach to defining, organizing, planning, monitoring, and controlling projects. This case study presents an opportunity to see how project management is put into practice through the Konkola Deep-Mining Project.

Purpose statement:
This study aims to document the planning, execution, and challenges of the Konkola Deep Mining Project, focusing on shaft sinking practices to provide insights into project management applications within Zambia's mining sector.

2. Background to the Study

Konkola Copper Mines PLc, the Konkola mine site, is located some 150 km north of Kenneth Kaunda International Airport in the copperbelt province of Zambia. The mine was established in 1957 and has been in operation since then. The main commodity that the mine produces is copper. In the early 2000s, the mine forecasted inaccessible copper ore resources below 950mL and 590mL – the lowest dewatering and tramming levels of the mine respectively, which posed a threat to its existence; this was when the mine was under Anglo-American control. A plan was then hatched to sink a new mine shaft that would extend the mine life by about 50 years. All feasibility studies were done, but before the project could commence, there was a change of government in 2003, which saw the mine change ownership, in 2004, from Anglo America to Vedanta Resources. Although the mine had changed ownership, the plan to sink a new mine shaft and extend the mine life did not die. With Vedanta Resources in charge, the Konkola Deep Mining Project began in 2006.

3. Literature Survey

3.1 Introduction

In the mining industry, as far as mineral extraction from the earth is concerned, there are two methods commonly used, i.e. opencast mining and underground mining. Open-cast mining is employed in cases where mineral deposits are close to the earth's surface, maintaining exposure to the surface throughout the mining period, Anglo American (2024). On the other hand, underground mining is used in cases where mineral deposits sit way below the earth's surface, Anglo American (2024). Of interest in this case study is the latter method, underground mining, which involves vertical entry into the mine as one of the entry methods. The vertical entry is called a shaft.

Establishing an underground mine via a shaft requires sinking, also known as shaft sinking; which involves drilling, blasting, lashing, and hoisting. To achieve this, project management has to be used. There have been many shaft sinking projects around the world, employing different technologies. In Zambia, the first underground mines were established in the 1950s, the recent ones being at Konkola Copper Mines and more recently at Mopani Copper Mines. From the early 1950s, when the first underground mines were sunk, the next shaft sinking project was undertaken at the Konkola copper mines, the Konkola mine site.

Despite having many documented shaft sinking projects around the world, none have been documented in Zambia. Therefore, this case study will fill the knowledge gap here in Zambia and present an opportunity for scholars and other interested parties to get a feel for what is involved in a shaft sinking project on Zambian soil.

3.2 Theoretical Framework

3.2.1 Shaft Sinking

Shaft sinking is the process of sinking a mine shaft from the surface to a predetermined depth. In other words, it is an excavation into the earth from the surface. This is achieved by conventional drill and blast means or mechanized methods; both of which involve 4 phases. According to Kicki, Sobczyk and Kaminski (2015), these phases are:

1) Shaft collar establishment, pre-sink and shaft sinking infrastructure.
2) Installation and commissioning of the sinking infrastructure of the shaft.
3) Routine phases of the shaft sinking cycle i.e. drill, blast, muck, and hoist.
4) Disassembly of shaft sinking equipment at shaft bottom; once the desired depth is achieved.

Figure 1 below shows a typical sinking cycle.

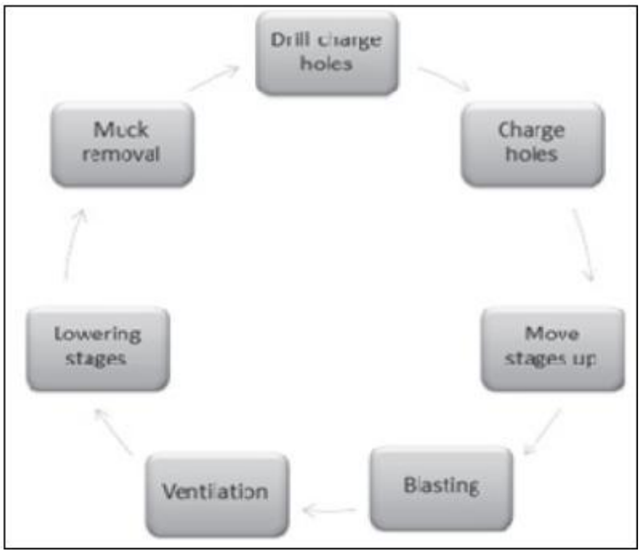

Figure 1: Typical Sinking Cycle (Kicki, Sobczyk and Kaminski (2015)).

In the case of the Konkola deep mining project of sinking No.4 Shaft, the same phases, as outlined by Kicki, Sobczyk and Kaminski (2015), were followed. The site was identified, excavations started, and the shaft collar was cast in concrete. The installation and commissioning of the shaft sinking equipment then followed. This included the stage winder, sinking headgear, sinking stage, BMR winder for hoisting of kibbles, the kibble etc. Then came the core process of the sinking cycle, which involved drilling, blasting, mucking, and hoisting. After the sinking and concrete lining of the shaft was done, as well as equipping, to a depth of 1505m, the sinking stage was disassembled at the bottom of the shaft. The kibble was also removed.

3.2.2 Project Management

Understanding project management comes from understanding a project. Tonnquist (2009) defines a project as a methodology with a strong focus on the goal, is time bound, and has appropriate resources. The successful execution of a project requires that it is properly managed. Kerzner (2013) defines project management as the planning, organizing, directing, and controlling of company resources to achieve desired objectives. The undertaking such a complex shaft sinking project requires proper employment of project management. Kerzner (2013) further emphasizes the need to have functional personnel assigned to a specific project as a means of utilizing a systems approach to project management.

3.2.3 Phases of the Project

A project has four major phases of its life cycle, these are Initiation, Planning, Execution, and Closure, Kerzner (2013).

Project Initiation: According to Kerzner (2013), project initiation begins the project lifecycle. In this phase, a business case is developed, and a project charter is created. A feasibility study is carried out. Basically, goals and objectives are set, sponsor is identified, and funding is secured. How the project will be structured, the establishment of a project team, is also part of the initial phase. As Kerzner (2013) alluded to, roles and responsibilities have to be properly and clearly organized; every role should have a unique description to avoid shared responsibilities which might cause certain activities not being done and consequently cause project delays.

Project Planning: This phase involves making plans for the execution phase, see Kerzner (2013). Designs are made and approved in this phase. Project activities are planned in terms of time and cost using various planning methods such as work breakdown structures (WBS), to ensure that all activities required to achieve goals are included, Kerzner (2013). Work breakdown structures are a foundation for network diagraming such as the precedence diagraming method (PDM), Kerzner (2013). Furthermore, a resource management plan is put in place in this phase to ensure that each project activity has the required resources, Kerzner (2013). Activity durations, costs, schedules and milestones are all put in place in this phase. Last but not least, a quality assurance plan and a risk management plan is made, i.e., risks are identified and mitigation measures put in place, Kerzner (2013).

Project Execution: According to Tonnquist, B. (2009), this phase involves executing the project plan and using feedback to monitor and control progress. If there are any deviations from the expectation, corrections are made to ensure that desired results or outcomes are achieved. It should be noted that project meetings and steering committee meetings are to be held regularly as they provide means of feedback and decision making, where issues arise, respectively; Tonnquist, B. (2009).

Project Closure: In this phase, acceptance tests are carried out and documented. The project is handed over, learnings are taken, and next steps are planned.

3.3 Empirical Framework

3.3.1 Project Initiation

As mentioned in the background of section 2, the need for the KDMP came about due to the inaccessibility of the copper ore resource below 950mL and 590mL, the lowest dewatering and tramming levels of the mine respectively, at the KCM Konkola mine site. A feasibility study was conducted and a business case developed, Konkola Copper Mines, KCM (20204). The sole sponsor was Vedanta Resources. The project was estimated to cost $1 billion, KCM (2024). The project manager, Mr. Billy Sakala, was assigned to the project, and the rest of the project team was constituted. It is worth mentioning here that the project structure took on a Pure Project Structure, where team members worked exclusively for the project manager; in line with what Kajewski, Malhotra and Ritzman (2015) had explained on project structures. Figure 2 shows how the Konkola deep-mine project was structured.

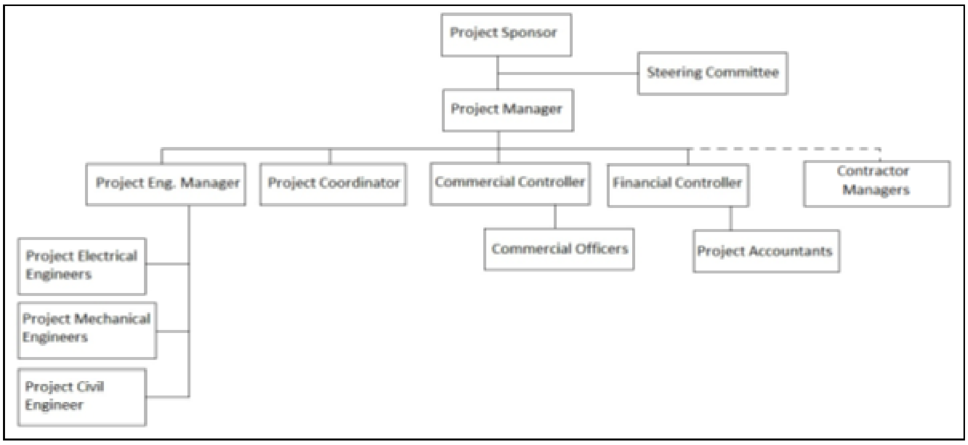

Figure 2: KDMP structure, KCM (2024)

3.3.2 Project Planning

The planning phase of the project involved quite a number of things which included the engagement of the project consultant, i.e., DRA from South Africa. The project design consultant was TWP, from South Africa. The main shaft sinking contractor was GLTA, from South Africa as well. All project designs, scopes of work, technical specifications, and method statements were done by TWP in collaboration with KCM project engineers; who were the approvers of all designs on behalf of KCM. Refer to Appendix A for a sample of a design drawing done by TWP.

A Work Breakdown Structure (WBS), which included all the project work, was done by a combined team of KCM, GLTA and DRA personnel. The WBS was followed by the development of a network diagram, which is a network planning method according to Kajewski, Malhotra, and Ritzman (2015). The network diagram was developed using the Program Evaluation Review Technique (PERT) and the Critical Path Method (CPM) to develop relationships between activities and assign durations to activities. This led to the development of a project schedule and milestones; refer to Appendix B and Appendix C for a sample of the project schedule and milestones, respectively. The risk management plan was developed where major project risks and mitigation measures were clearly identified. Table 1 below shows some major project risks and their mitigation actions.

Table 1: Major project risks and mitigation actions, KCM (2024)

S. no.	Description of Risk	Consequences	Mitigation Actions
1	Inadequate funding	Stalling of project, Aborting of project	Secure full funding of the project
2	Delay in product/ service delivery	Delay in installation/ execution leading to overall project Delay	Prompt order placement, prompt order payments, tracking of orders
3	Damage to equipment	Increased costs through replacement, delay to the project	Formulation of safe work procedures and risk assessments
4	Injury to personnel	Project delays, costs through penalties, project abortion in extreme cases	Formulation of safe work procedures and risk assessments
5	Water	Flooding, causing delays and possible abortion of project in extreme conditions	Formulation of pumping procedure and risk assessment, and securing of pumping equipment
6	Ground condition	Weak ground conditions causing collapse of ground, thereby leading to delays and possible project abortion in extreme conditions	Formulation of ground support procedure and risk assessment

3.3.3 Project Execution

The execution of the project, in addition to mobilization and other preliminary activities, started with the sinking of No. 4 Shaft; spanning 9.4m x 7m (elliptical), as the main project activity. See Appendix G for the permanent shaft dimensions. The project was carried out in two phases. The first was called Mid-Shaft Loading (MSL) and the second was called Bottom-Shaft Loading (BSL). In the MSL phase, the shaft sinking and equipping was done from surface to 1010 mL, while in the BSL phase, the shaft sinking and equipping was done from 1010 mL to 1505 mL, KCM (2024). Refer to Appendix G for a permanent shaft configuration as built.

Major equipment installed, to support the shaft sinking activity, was the sinking headgear (refer to Appendix A) and the winding plants. There were two winding plants installed, one for the movement of the stage and the other for hoisting blasted material to the surface using a Kibble. In a shaft-sinking environment, there are two important pieces of equipment attached to the winding plants. The first one is a stage, which is used for providing services such as ventilation, water, compressed air, and power into the shaft. The second one is a kibble, which is used to carry men and material in and out of the shaft.

In shaft sinking, the process started with excavators and cranes to dig and hoist material, respectively, up to a certain depth i.e. about 15 to 20 m below the surface. The shaft collar was then installed to provide support to the shaft. Below a depth of about 20m, the Stage (attached to a winder), sinking headgear, and kibble (attached to the other winder) were installed. The shaft sinking cycle then started with drilling holes, using a rig, cleaning the holes, charging the holes with explosives and eventually carrying out blasting. This was followed by lashing of the blasted material and finally hoisting of the material up to the surface. Then the concrete lining of the shaft was followed before the next cycle. This process continued until the shaft was sunk to the required depth of 1505m (see Appendix F for the full depth of the shaft).

As the shaft sinking was sunk, development of the various stations was carried out in parallel, and other works on the stations commenced. These works included the mining of the crusher stations and loading stations, as well as the mining of the tips; among other works. After the shaft sinking was completed, the shaft was equipped with steels. Along with that, the stations were also equipped with various equipment and infrastructure. Permanent winding plants were also set up on the surface; these included the 8 tone Koepe Service Winding Plant, the 37 tone Koepe Rock Winding Plant and the 26 tone Blair Multi Rope (BMR) Winding Plant. The MSL was the first to be commissioned in 2010 and was followed by BSL in 2012.

Feedback meetings provided a means of monitoring the progress of the project, where the status of the project was discussed. Any lapses that were detected were immediately assigned action plans to prevent delays in the project.

Figure 3 shows the project status discussed in one of the review meetings. Note that project progress reports were generated on a daily basis, while project review meetings were held weekly and monthly. This was in fulfillment of the monitoring and control aspects of the execution phase.

Safety is an important aspect of project work and as such, safety statistics were closely monitored to ensure adherence to safety regulations and prevent delays in the project. Table 2 below shows safety statistics discussed at one of the review meetings.

Table 2: Safety statistics discussed in one of the project review meetings, KCM (2024)

Parameters	For the month May'11			Cumulative (From Apr'11)		
	KCM	Contractor	Total	KCM	Contractor	Total
RTD	0	1	1	0	1	1
LTI (1-3 days)	0	0	0	0	0	0
MSD-R	0	0	0	0	0	0
FATAL	0	0	0	0	0	0
Total Injuries	0	1	1	0	1	1
Man-hours Worked	11,232	256,089	267,321	22,464	483,198	505,662
Total Man-hours lost	0	0	0	0	0	0
LTIFR	0.00	0.00	0.00	0.00	0.00	0.00
LTISR	0	0	0	0	0	0
Last Lost Time Injury occurred on		20-Mar-11			20-Mar-11	
No. Of Days Without Lost Time Injuries		65			65	

Monthly Progress Report- May 2011 Konkola Deep Mining Project KCM, Zambia

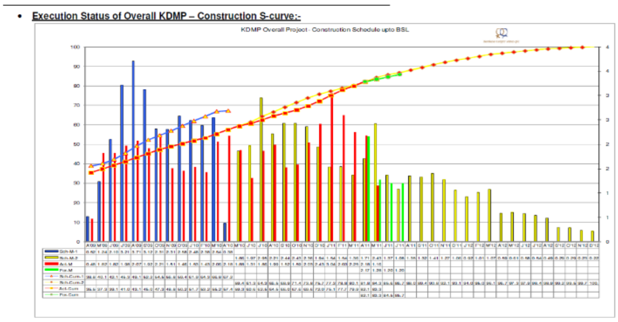

Figure 3: General KDMP execution status, KCM (2024)

3.3.4 Closure of the Project

The closure of the project occurred in 2013. By then, all installed equipment was commissioned and signed off (refer to Appendices D1 and D2 for signed off duty calculations for the Koepe Service Winder and the BMR Winder respectively). Training was conducted on operations and maintenance, and the No. 4 Shaft infrastructure was handed over to the production team. Most of the project personnel were taken to the production team to start the operations and maintenance, as there was no more project work for them. Tables 3 and 4 below show part of the parameters obtained at the time of commissioning the BMR Winder.

Table 3: BMR Winder temperatures at commissioning, KCM (2024)

SUMMARY OF TEMPERATURE RUNS

M/C Serial No.	D21426101	D21426101
Type of Test	Open Circuit	Short Circuit
Length of Test Hours	4	6
Volts	870	–
Amps	–	9700
Shunt Volts	108	39
Shunt Amps	525	21.6
Speed (R.P.M.)	73	73
Ambient °C	22	22.5
Inlet/Outlet Air °C	22 25	19 27.5
Ventilation	Forced Vent	Forced Vent
Enclosure	All Covers Fitted	All Covers Fitted
Air Quantity (C.F.M.)	65286	65286
	Temp.Rise °C	Temp.Rise °C	Temp.Rise °C
Armature Winding CE/DE	6 7	36 32	
Armature Core CE/DE	7 8	32 30	
Armature Winding by Ductor	–	–	
Main Pole	32	17	
Shunt Field by Resis.	47	11	
Compole	12	33	
Compole + Cpstg Wdg by Resis.	–	49.5	
Series by Resis.	–	–	
Compensating Winding	8	41	
Commutator IN/OUT	10 13	26 34	
Banding Wire CE/DE	7 6.5	46.5 33	
Bearings CE/DE	4 3	6 1.5	
Frame	6	7	

Table 4: BMR field transformer primary and secondary injection tests, KCM (2024)

SECONDARY INJECTION TESTS LATCHED

Plug setting			RED ELEMENT		WHITE\EARTH ELEMENT		BLUE ELEMENT		EARTH LEAKAGE	
			Amps	Secs	Amps	Secs	Amps	Secs	Amps	Secs
1	1.0	Min. OP. Current Start Finish	2,32	/					0,50	/
		Plug BR. Cont								
		Zero T.S.								
		Reset Time								
		PSM 2	4,2	3,22					1,0	1,042
		PSM 5	10,5	0,445					2,5	1,038
		PSM 10	21	0,123					5	1,033
		Flag LEDS	OK						ok.	
		INST. 423A	0,0945							

EI 42% 0,125 4,3x 60mS

10% DMT 1,0 secs

PRIMARY INJECTION

C.T. RATIO 30/5		PROTECTION				AMMETER		METERING			
FAULT	PRIMARY CURRENT	RED	WHITE	BLUE	SPILL	INJECTED CURRENT	INDICATED CURRENT	RED	WHITE	BLUE	SPILL
R-R	30	5,03	10mA	9,6mA	4,94A	30	—				
R-W	30	5,01A	5A	T	1,4mA	30	30				
R-B	30	5,01A	1,6mA	5,0A	2,8mA	30	—				
Neutral											
R-N											

3.4 Conceptual Framework

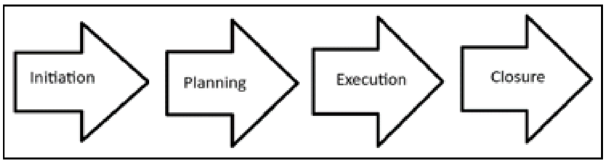

Figure 4: Conceptual project framework

Figure 4 above shows the conceptual project framework starting with the initiation phase, then followed by the planning phase, the execution phase, and finally the closure phase. One phase feeds into the other as shown in figure 4 above, and there is no other way to go about the sequence than to follow it the way it is. PMI (2000) affirms this sequence when they explain that any project has to be initiated by need and there are a number of things to do in the initiation phase to get the required bye in and funding for the project. Once that is achieved, the planning phase follows; where designs are done, schedules and milestones are created, costs are allocated, the risk management plan is created, etc. It's only when the planning phase is completed that the execution can be started. In the execution phase, the project plan is implemented, monitored, and controlled to achieve the desired goals and objectives. Once the goals and objectives are achieved, only then can the project be completed. In the closure phase, commissioning is done and KPIs signed off and documented, learnings are drawn, and next steps are outlined. This is the model that any project should follow.

4. Problem Definition

Since the establishment of the Zambian mines, in the 1920s, there has been documentation regarding the shaft sinking activities on Zambian soil. This study aims at bridging the gap by providing insight into why such a big project is undertaken, the cost of undertaking a shaft sinking project, the project management aspect of it and the risks associated with it.

5. Methodology

5.1 Introduction

Research methodology describes the procedures and techniques used to identify and analyze information on a specific research topic. The research methodology also includes means of data collection and analysis and the framework within which the research is carried out.

5.2 Research approach

This research was based on both qualitative and quantitative research, i.e., it took on a mixed-method research methodology.

5.3 Research strategy

The strategy employed in this research was to focus on the project framework and shaft sinking and equipping as the core activities. The strategy also included the verification of various project information such as the winder through puts, depth of the shaft, cross-sectional dimensions of the shaft, various installations, etc. Verification was done through observations made through site visits.

5.4 Research design

The design of this investigation was such that interviews were conducted, one-one and telephone, project documents were studied, and site visits were made to make certain observations.

5.5 Reliability and validity of the study

Information provided through this research is considered very reliable and valid as it was physically verified through review of the documents and site visits to the installed infrastructure.

5.6 Ethical and legal considerations of the study

The information produced from this research remains confidential and should be treated as such. This research is for knowledge sharing and access to it should not be given without the permission of the researcher or the University of Zambia.

6. Results and Discussion

6.1 Introduction

This chapter presents the results obtained from the research on KCM's Konkola Deep Mining Project. The results show why the project was undertaken, the cost of the project, what was involved in the project, how contracts were done, how the project was carried out (in terms of framework), and how the project was structured. The results are presented in tables, charts and schematics.

6.2 Need for the project

As explained in section 1.3, the need for the KCM Konkola deep mining project was because of the diminishing ore resource due to inaccessibility of the copper ore resource below the existing infrastructure that posed a threat to the survival of the company. Figure 5 below shows KCM's Konkola mine historical performance from 1956 to 2006.

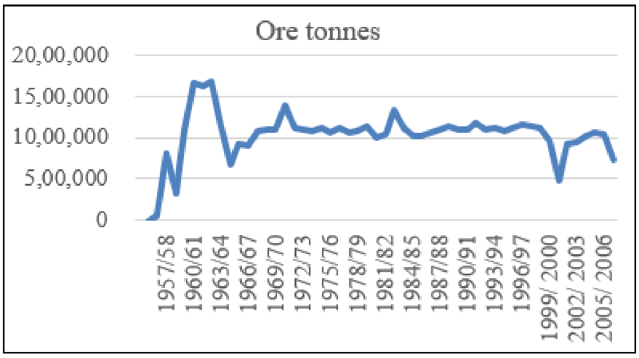

Figure 5: Konkola mine historical production performance, KCM (2024)

6.3 Project cost and financiers

The project cost about $1 billion and the sole financier was Vedanta Resource, the major shareholder for Konkola Copper Mines; KCM (2024). Figure 6 below shows the estimated cost of the project.

Revised Project Cost Proposal

Packages	Budget Approved by the Board on 18th October 2007	Current Estimate for Board's Approval
Shaft Systems	**344.00**	**515.00**
Package A (Shaft No.4, Deepening of Shaft No1 and1390mL pump chamber)	260.00	422.00
Package B (Pipe shaft, Three Vent shaft and expansion of pump chamber)	54.00	83.00
Rehabilitation of No. 1 Shaft	16.00	10.00
Owner's Engineer	14.00	Considered under respective package
Tramming	**62.00**	**70.00**
Locomotives, Cars and Tips	10.00	10.00
Tramming Up gradation	47.00	40.00
Waste rock crush & grind	5.00	20.00
Primary Development	**77.00**	**101.50**
Primary Development	47.00	47.00
Decline	10.00	32.00
Temporary Pump Chamber on 1185mL	11.00	11.00
Delineation Drilling Underground	3.00	1.50
UG Backfill reticulation –pipes	6.00	10.00
Mining Equipment	**61.00**	**61.00**
Ventilation Fans Underground	8.00	8.00
Mobile Equipment	38.00	38.00
UG Workshop, Communication etc	15.00	15.00
Concentrator	**88.00**	**101.50**
Backfill Plant	12.00	15.50
Concentrator	71.00	86.00
Services	**47.00**	**56.00**
Localized Services (Mine)	4.00	4.00
Pre operative & Admin expenses	23.00	37.00
Utility Expenses (Air, Electricity, Water)	10.00	5.00
Surface Infrastructure (Industrial water, drainage, roads, storage, accommodations)	10.00	10.00
Total	**674.00**	**905.00**
Financing Cost	--	62.00
Start-up and Commissioning Cost of Concentrator	--	6.00
Grand Total	**674.00**	**973.00**

vedanta

Figure 6: Estimated KDMP project cost, KCM (2024)

6.4 What was involved in the project

The Konkola Deep Mining Project involved the sinking of 4 Shaft (from surface to 1505 mL), the equipping of the shaft, installation of crusher stations (at 985 mL and 1390 mL), the installation of loading complex' (at 1010mL and 1390mL), the sinking of a ventilation shaft, the installation of winding plants (Koepe Service Winder, BMR Winder and Koepe Rock Winder), and installation of the 1390 mL pump chamber (deferred). Figure 7 below shows a summarized scope of work for the KDMP. See Appendix H for a detailed schematic of the scope of work for the KDMP.

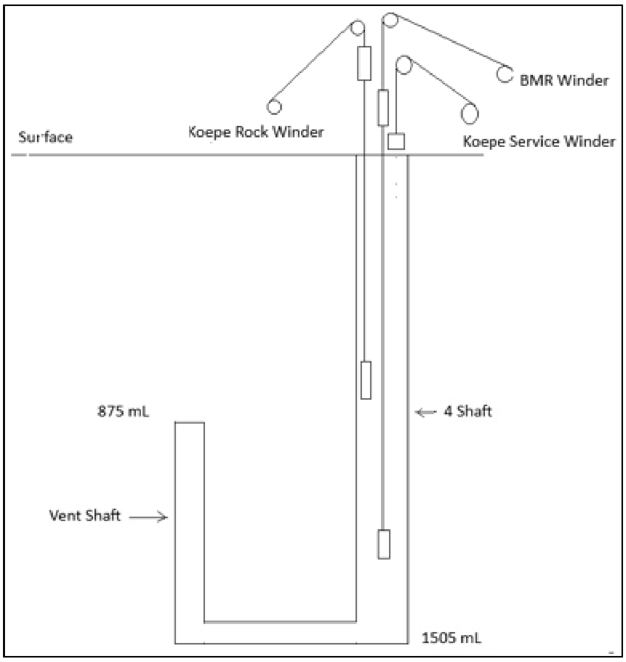

Figure 7: Summarized schematic of the KDMP scope, KCM (2024)

6.5 Contract procurement

To ensure that the project was on course, contract procurement was synchronized with the project schedule. The idea was to ensure that products and services were on site, in time for execution, to avoid project delays. From the project schedule, a procurement schedule was drawn (see figure 8 below). Table 5 below shows some of the contracts drawn for the execution of the project.

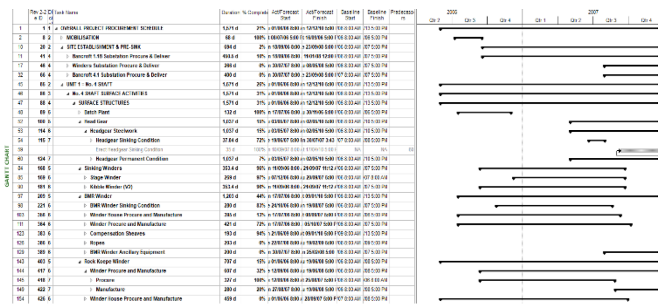

Figure 8: General KDMP procurement schedule, KCM (2024)

Table 5: List of some of the KDMP contracts, KCM (2024)

Sno	Contract Number	Contract Description	Contractor
1	KCM/KDMP A/006	Sinking and Equiping No.4 Shaft	GLTA
2	KDM 011	KDMP Design Support	TWP
3	KDB 3009	Shaft and Station Steelwork for 4 Shaft	Shanghai Matsuo
4	KD 1089	Soil Testing	Wade Adams
5	KCM/KDMP A/002	Primary Development of 4 Shaft	GLTA
6	KDM 863	Project Quality and support services to shaft streelwork	Cosira
7	KDM 966	Supply and Delivery of the KDMP No.4 Shaft Surface Conveyor Automation	DRA

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8	KDM 143	Manufacture and supply of KDMP 4 Shaft Winder Ropes	CASAR
9	KDM 220	Supply , Installation and Commissioning of KDMP 4 Shaft Winder HT Panels	Actom
10	KDM 150	Supply, Installation and Commissioning of Jaw Crusher System	FLSmidth

6.6 How the project was carried out

Table 6 below shows the comparison between how the project was carried out and how it should be carried out, i.e., empirical framework versus conceptual framework.

Table 6: Empirical framework versus conceptual Framework

Actual project phases	Conceptual project phases
Initiation	Initiation
Planning	Planning
Execution	Execution
Closure	Closure

6.7 Project structure

The KDMP project took on a pure project structure as can be seen from figure 4. The project manager was totally in control and those under him worked for him only.

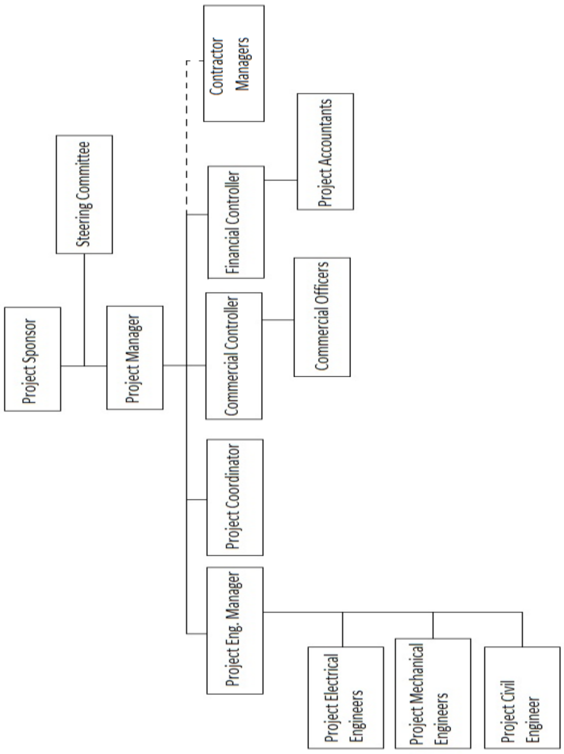

Figure 9: KDMP structure, KCM (2024)

6.8 Interviews and data verification

6.8.1 Interviews

Interviews were conducted with Mr. Mehorotra Sufal (project coordinator), on the 13th of November 2024, with Mr. Billy Sakala (project manager), on the 15th of November 2024, and with Mr. Perries Musonda (project SHE manager), on the 19th of November 2024 via telephone. Table 7 below shows a summary of the information obtained from the interviews.

Table 7: Summary from interviews conducted

Why the Project	Project Cost	Major Risks	Infrastructure Constructed	Main Contractors
To unlock the copper ore resource below 1075mL	$1 billion	Water	Winding plants	TWP
		Weak ground conditions	No. 4 Shaft (mine shaft)	DRA
		Injury to personnel	Surface conveyors	GLTA
		Equipment damage	Loading complexes	ACTOM
		Inadequate funding	Crusher stations	SIEMAG
			Tips	
			Ventilation shaft	

6.8.2 Data verification

Site visits were conducted to verify some project information like the dimensions of the shaft, shaft depth and infrastructure installed through the project. Table 8 below presents a summary of information verified.

Table 8: Verified project information

Shaft Parameters	Winding plants	Plants/Infrastructure
9.4m x 7m Elliptical	Koepe Rock Winder (450/750TPH)	No. 4 Shaft
Depth: 1505 mL	Koepe Service Winder (5/5.5 trips/h)	Ventilation Shaft
Shaft stations: 16	BMR Winder (500/646TPH)	985 mL and 1390 mL crushing stations
		1010 mL and 1430 mL loading complexes
		Surface conveyors
		81.5m Steel Headgear
		4 Ore tips
		2 Waste tips

6.9 Discussion

The results presented shows the reduction in copper production as a result of the inaccessible copper ore resource below 950mL and 590mL – the lowest dewatering and tramming levels of the mine respectively, which gave birth to the KDMP as can be seen in figure 5. The project cost about $1 billion as can be seen from figure 6, and it was solely financed by Vedanta Resources. The results also show that the major activities of the KDMP were sinking and equipping of No.4 Shaft, sinking of a ventilation shaft, installation of crusher stations, installation of loading complexes, and installation of winding plants as seen in figure 7 and Appendix H. The results further show that the project was executed in the with the conceptual project frame work, which simply means that there is no short cuts to undertaking such complex projects. This can be seen from the comparison of the empirical and conception frameworks

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of the project as shown in figure 9. The procurement plan, as seen from the procurement schedule in figure 6, presents a critical aspect of project planning as it shows how the procurement of products and services is tied to the overall project schedule to prevent project delays. The structure of the KDMP project took on a Pure Project structure as can be seen from figure 4.

Section 4.8 presents the information obtained from the interviews and site visits for project insight and data verification, respectively. It is clear from this information that the project was undertaken to unlock the copper ore resource sitting below 1075mL to extend the life of Konkola mine, which had a decreasing copper ore resource. It is also clear that the major project risks were water, weak ground conditions, and injury to personnel, equipment damage, and inadequate funding. The project cost about $1 billion. Note that the Koepe Rock Winder and BMR Winder throughputs, 450TPH and 500TPA respectively, are less than their designed capacities (750TPH for Koepe Rock Winder and 646TPH for BMR Winder) because of state of the equipment in the ore hoisting value chain. The actual values can be increased with the injection of the required spares.

7. Conclusion

7.1 Summary of the research

This research was about the KCM Konkola Deep mining project, where the new No.4 shaft was sunk and equipped. The project went through the four core project life cycle phases, namely initiation, planning, execution, and closure. This project was initiated due to the inaccessibility of the copper ore resource, below 950mL and 590mL – the lowest dewatering and tramming levels of the mine respectively, at KCM's Konkola mine site. Therefore, the company had to come up with a strategy to extend the life of mine by 50 years and stay in business. The project cost about $1 billion. This case study is for knowledge sharing, a learning resource.

7.2 Conclusions of the study

An engineering case provides a medium through which learning (e.g. analyzing, applying knowledge, drawing conclusions, etc.) takes place. And so, such a project provides means of learning and the basis on which to better future similar projects and, of course, bearing in mind the cost aspect. The academic community needs to try to simulate the reality of professional engineering practice. With too little information, one must make assumptions. With too much, or conflicting, information, one must judiciously select the most appropriate. Nothing is more intellectually demanding than making decisions when you do not have complete information. Real engineering practice generates multiple solutions to a problem and selects the optimal one.

This case study contributes significantly by documenting a rare instance of shaft sinking in Zambia, offering practical guidance to engineers and project managers. It fills a documented gap in local mining literature and serves as a model for future infrastructure undertakings.

The following lessons were picked from the research:

i) A project of this magnitude is only initiated when there is a need that is in line with the overall company strategy and objectives. In this particular case, the diminishing Ore resource of KCM's Konkola mine (due to inaccessibility of copper ore resource below existing infrastructure) gave birth to the KDMP project to increase the life of mine (LOM) to 50 years.
ii) A Brownfield shaft sinking and equipping project costs about $1 billion.
iii) Project planning is key to smooth project execution. And for such huge projects, it is imperative that all the life cycle phases of the project be done properly for better management of the project.
iv) A project like this one has high risks, and so it is important, in the planning phase, to develop a risk management plan to avoid project delays and ensure smooth running.

7.3 Contribution of the study

This study adds to the body of knowledge of project management through the case of KCM's Konkola Deep Mining Project. More so, it sheds light on how a shaft sinking project is managed in practical terms.

7.4 Recommendations of the study

In as much as project schedules were in place, I highly recommend that project management software like Microsoft Projects be used fully for proper management of the project. This is based on observations made during the research, where calculations of slack on project activities was not done. Also, critical path calculations were not continuously done. These calculations are easily computed by project management software when properly used. With the efficient use of project management software, monitoring and controlling functions of the project become efficient.

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Author Profile

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