Exploring the impact of original equipment manufacturer aftermarket services in the mining industry in South Africa

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ABSTRACT

This is a comprehensive study of the relationship between the South African mining industry and original equipment manufacturers (OEMs), emphasising the advantages and challenges of using OEM services. The study is situated within the context of South Africa's mining industry, which is a significant contributor to the country's GDP and employment rates. Key challenges in equipment maintenance and cost management are examined, highlighting the role of maintenance in equipment reliability and cost reduction. OEMs play a crucial role within this context, driving innovation and providing aftermarket services, but they also face challenges in balancing cost-effectiveness, product quality, and sustainability.

The study emphasises the importance of collaboration between the mining industry and OEMs to address unique local conditions effectively. It comprises a qualitative research approach, employing interpretive and inductive paradigms to gather and analyse data. The research process follows rigorous ethical standards, ensuring the privacy and confidentiality of participants. The study's trustworthiness is upheld through criteria such as transferability, credibility, dependability, and confirmability.

The findings of the qualitative research are presented and compared to the theoretical background. Key objectives, including examining the advantages and disadvantages of using OEM spares and aftermarket services, determining service level requirements, and assessing perceptions of mining companies towards OEMs, are addressed.

The results highlight issues such as high costs, skills drainage, local community development requirements, and the demand for long-term contracts and service-level agreements. The study provides practical recommendations to address these challenges, emphasising communication, investment in training, on-site OEM representatives, collaborative maintenance models, and improved service delivery.

While acknowledging geographical limitations, the study contributes valuable insights into the mining industry and OEMs in South Africa, fostering a more collaborative and efficient relationship. Potential future research areas that can further enhance the understanding of these issues in the South African mining context are identified.

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LIST OF ABBREVIATIONS

CIM	Chief Inspector of Mines
DMRE	Department of Mineral Resources and Energy
GDP	Gross Domestic Product
MHSA	Mine Health and Safety Act
MHSI	Mine Health and Safety Inspectorate
NWU	North-West University
OEM	Original Equipment Manufacturer
PGMs	Platinum Group Metals
POPI	Protection Of Personal Information
R&D	Research and Development
SLA	Service-level Agreement

CHAPTER 1: NATURE AND SCOPE OF THE STUDY

1.1 INTRODUCTION

The mining industry is one of the most important industries in the world. The industry is responsible for thousands of jobs and provides metals, raw materials, and minerals critical to the global economy (Scot Forge, 2021). The minerals and raw materials extracted from mining activities are the foundation for innovation and modern living (Scot Forge, 2021).

According to MCSA (2021), the direct contribution in 2021 of the mining industry in South Africa to the gross domestic product (GDP) was R481 billion, which resulted in an 8.7% contribution to the entire South African economy. This contribution increased from 7.1% in 2020 (MCSA 2021). The Mineral Resources and Energy minister of South Africa, Gwede Mantashe, stated that the government believes the mining industry can contribute at least 12% of the total GDP, but that depends on getting numerous interventions right (News 24, 2021).

The unemployment rate of South Africa in the fourth quarter of 2021 was 35.3% or 7 921 000 people. In the same period, the mining industry was responsible for employing 370 000 people, or 2.54% of the total employment in South Africa (Nedbank, 2022:2).

Around the globe, billions of dollars are spent on the maintenance of equipment (Dhillon, 2008:115). Even though progress has been made in the maintenance of engineering equipment, it remains challenging due to factors such as size, complexity, safety, cost, and competition (Dhillon, 2008:115). In the mining industry, maintenance costs vary between 40 and 50% of the operating cost of the equipment and 20 to 35% of the total mine operating cost (Dhillon, 2008:116).

1.2 BACKGROUND TO THE STUDY

Setzkorn (2017:2) asserts that maintenance is an essential function of the mining industry as it improves the availability and reliability of the equipment. Proper maintenance reduces overall maintenance costs, improves delivery performance, and ensures higher product quality. All the advantages mentioned allow the mine to have a competitive advantage (Setzkorn, 2017:3).

To ensure that equipment stays in a working or operational condition as per its designed capacity, without breaking, a repetitive process of maintenance needs to be implemented (Setzkorn, 2017:10). The availability of mining equipment, according to Setzkorn (2017:22), should be around 90% of the total working time with the remaining 10% allocated to unplanned maintenance such as breakdowns.

Visagie (2005:13) states that certain factors need to be considered by mining organisations if they want to benefit from outsourcing one or more of their business processes and functions:

- Understand the maintenance process (supply chain).
- The worldwide re-engineering tendency regarding outsourcing.
- The logic behind the outsourcing decision itself.
- Lack of quality maintenance vs. controlled maintenance.

Visagie (2005:14) names two critical considerations that need to be taken into account by mining organisations when the outsourcing of maintenance becomes an important improvement initiative:

1. Are the mining plants considering outsourcing capable of addressing maintenance challenges?
2. Should maintenance be performed by employees inside the organisation (internally) or externally by contracting maintenance organisations or using OEMs?

Research and development (R&D) and aftermarket services are particularly important for original equipment manufacturer (OEM) companies. They have formed technology alliances with the mining companies (Fessehaie, 2017:10). It is stated by Fessehaie (2017:10) that budget allocation to R&D assists in innovation and technology to reduce energy use, to improve operational productivity, to improve health and safety, as well as to improve the environmental impact. This could be an essential issue to consider in the post-Covid environment.

1.3 DEFINITION OF TERMS

Of the many definitions of **maintenance** that exist (Ferreira *et al.*, 2020:247; Huffman *et al.*, 2020:3; Poór & Basl, 2019:2; Roda & Macchi, 2021:2; Setzkorn, 2017:10), the definition, “the combination of all technical and associated administrative actions intended to retain an item in or restore it to a state in which it can perform its action required” (Setzkorn, 2017:10) will be used for the remainder of this study.

Hussain *et al.* (2021:169) define the **mining industry** as a cluster of processes involved with managing, extracting, and processing naturally occurring minerals in solid or liquid form from the earth’s surface.

An **original equipment manufacturer (OEM)** is a company that manufactures parts and products used as inputs to produce another more complex product (Kagan, 2021).

Wellener *et al.* (2020:2) define **aftermarket service** as selling and delivering spare parts, maintenance, and other value-added services to the client.

In-house maintenance is defined as the organisation’s own maintenance personnel, usually with more years of service at a facility than a maintenance contractor team. It, therefore, has a higher understanding of the organisation’s expectations (Davis, 2017).

Equipment availability is defined by Lachance (2019) as a metric used to measure the time, as a percentage, that a piece of equipment is available to be used and is also the amount of time the equipment is available for production and actually running.

A **service-level agreement (SLA)** is defined as a clear guideline provided to the service provider by the client, and it stipulates what needs to be done, when it needs to be done, and according to what standards (Henshall, 2019).

1.4 PROBLEM STATEMENT

Due to more challenging economic conditions in the mining industry, many mining companies are attempting to cut costs by moving away from OEM spares and services when conducting maintenance (Mining Weekly, 2016). This move could

result in a scenario where maintenance costs could significantly increase in the long run, especially on significant equipment, if OEM components are not used, and the safety of the organisation's employees will also be compromised (Mining Weekly, 2016).

It is required from the mining companies that the OEM must supply solutions to reduce cost and improve productivity, rather than just supplying them with products (Fessehaie, 2014:5). The mining industry is also under pressure to improve safety, health, and the condition of the environment. This pressure forces the OEM to continuously invest finances and resources in R&D to meet the client's demand and to assist them in relieving the pressure placed on mining houses (Fessehaie, 2014:14). According to Fessehaie (2014:14), the OEM faces the following critical success factors: product quality and durability, after-market services and products, cost competitiveness, and lead times.

To improve the relationship between the OEM and the mining industry in South Africa, the OEM must identify and understand the needs of its clients (Reynders, 2018:1). The conditions of the mining industry in South Africa are unique. A need exists between the OEM and the mining companies for collaborations to operate best in these unique conditions (Reynders, 2018:60,61).

There is an existing need to discuss and communicate the benefits and risks of OEM service contracts with mining companies (van Tonder, 2008:iv). It is also recommended by van Tonder (2008:iv) that training must be provided to the managers of the OEM companies to manage an SLA successfully.

The mining industry is refraining from using the OEM for aftermarket services due to barriers between the two entities, such as lack of information and understanding, financial restrictions, and perceptions formed by both the mining industry and the OEMs. This can lead to a reduction in the availability and efficiency of mining equipment, reducing the mining sector's contribution to the South African GDP and increasing unemployment. This leads us to the following primary research question: "What are the advantages and challenges of aftermarket services of OEMs in the South African mining industry?

1.5 RESEARCH OBJECTIVES

1.5.1 Primary objective

The study's primary objective is to explore the advantages and challenges of aftermarket services of OEMs in the South African mining industry.

1.5.2 Secondary objectives

The secondary objectives of the study are:

- to determine the advantages and disadvantages of using OEM spares through a qualitative study.
- to determine the service-level requirements by the mining industry for the OEMs.
- to determine the quality, technology, and availability perceptions of mining companies in South Africa towards the OEMs.
- to make recommendations about areas of improvement to increase the collaboration between the mining industry and the OEMs.

1.6 SCOPE OF STUDY

1.6.1 Field of study

The field of study is classified as operations management.

1.6.2 Sector/industry/business under investigation

The industry and businesses under investigation are the mining industry and the OEM businesses supplying mining equipment, spares, and aftermarket services to the mining industry. This selection involved both underground and open-cast mining organisations. The OEM equipment involved in the study was yellow mining machinery and mine plant and processing equipment.

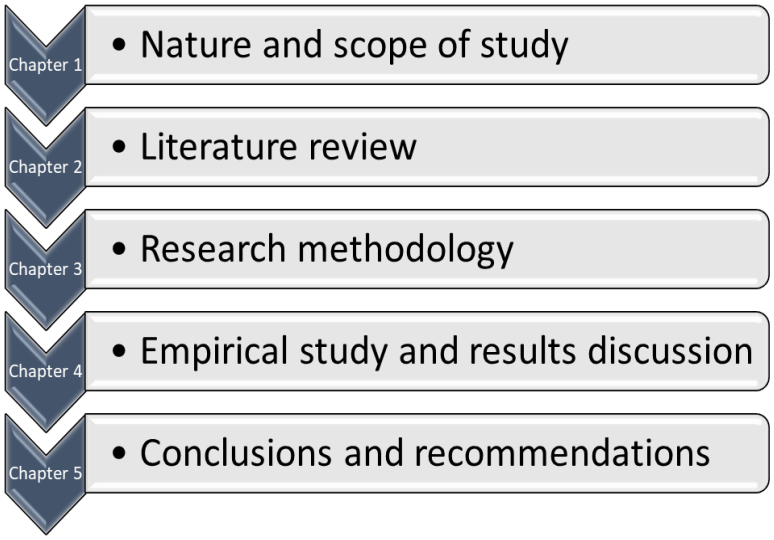
1.6.3 Geographical demarcation

The geographical demarcation of the study was limited to mining industries operating within the borders of South Africa. The study was limited to OEM businesses supplying spares, equipment, and aftermarket services to mining companies within the borders of South Africa.

1.7 LAYOUT OF THE STUDY

The study is constructed in five chapters. Figure 1.1 below indicates the titles allocated to the five main chapters of the study.

Figure 1-1: Layout of the study



CHAPTER 2: LITERATURE REVIEW

2.1 MINING INDUSTRY OF SOUTH AFRICA

The transition from an agricultural domain in South Africa to the most industrialised nation in Africa started in the 19th century in the Witwatersrand Basin after the discovery of the goldfields in 1886 (Antin, 2013:1). The discovery of the goldfields was the historic turning point for South Africa and presaged the emergence of the modern industrial state (Antin, 2013:1).

In 1860, in the Northern Cape, in the area that later became Kimberley, the world's largest diamond deposit had already been discovered (Antin, 2013:1). However, according to Antin (2013:1), it was the capital and labour-intensive industry deep-level gold fields mining industry that had the most significant impact on the trajectory of the future Republic of South Africa.

The South African mining industry is an important sector, contributing approximately 10% to the country's GDP over the last decade, and is also considered the most significant contributor to the exports of South Africa (Leeuw, 2012:ii). The latest GDP figure in 2021, according to DMRE (2022), dropped to 7.5% year on year. The mining industry has been essential to the economic and social narrative of South Africa. It is a critical provider of government revenue, employment, infrastructure, and investment in the region (Hanusch *et al*., 2019:7).

Leeuw (2012) stated that the strength of the mining industry in South Africa stems from its mineral endowment and mining expertise over decades of mining and has led to the establishment of cities such as Kimberley and Johannesburg. The mining industry also contributed to creating Africa's largest economy and stock exchange (Leeuw, 2012:ii). According to Hanusch *et al*. (2019:9), the country also possesses the world's richest mineral deposits, and it is estimated that Southern Africa has non-energy minerals worth more than US$2.4 trillion, making it the world's wealthiest mining jurisdiction.

The mining industry in South Africa is considered a top producer of commodities such as coal, gold, diamonds, iron ore, and platinum group metals (PGMs). It is considered one of the largest export sectors, contributing to 28% of the country's total exports (Hanusch *et al.,* 2019:20). The mining industry represents as little as 3%

of formal employment in the country. Still, due to the high wages earned by employees working in this sector, every new job created in the sector lifts 1.3 people out of poverty (Hanusch *et al*., 2019:20).

DMRE (2022) listed more than 1 700 active mines in South Africa, mining 53 minerals in 2022. Adeaga and Walubengo (2022) listed the following as the top five biggest mining companies in South Africa:

- Anglo-American
- BHP Billiton
- Rio Tinto
- Kumba Iron Ore Ltd
- Sibanye-Stillwater

The Department of Mineral Resources and Energy (DMRE) is a South African governmental department that assumes the custodianship on behalf of its citizens of all the mineral resources in the country (Mineral Resources, 2015:301). The DMRE regulates and promotes the mining and minerals sector for growth, development, and transformation, and also ensures that all citizens of South Africa derive sustainable benefits from the mineral wealth of the country (Mineral Resources, 2015:301).

The DMRE aims to develop an energy and mineral resources sector that promotes social equity, economic development and growth, and sustainability of the environment (DMRE, 2022). DMRE (2022) also stated that their mission is to ensure that they will transform, regulate, and promote the energy and minerals sector to ensure that all South Africans benefit sustainably from the country's mineral wealth.

It is revealed by Mineral Resources (2015:302) that the strategic goals of the DMRE are as follows:

- Contribute to the development of skills in the mining sector.
- Promote sustainable resource management.
- Create sustainable jobs in the mining industry.
- Reduce the impact that mining has on the environment.
- Optimise resource utilisation by attracting and developing appropriate skills in the mining sector.

- Promote corporate governance.
- Implement risk management strategies in the mining sector to provide a framework for managing safety and health risks.
- Enforce health and safety compliance and promote best practices in the mining industry.
- Promote increased mining activity in South Africa and facilitate value-added extraction of mineral resources and facilities.
- Implement transformation policies to redress past imbalances, to be achieved through broader participation in the mining industry.

The Mine Health and Safety Act 29 of 1996 (MHSA) was implemented to ensure a safe and healthy work environment in the mining industry. The Act establishes the standard of care resting on the mine owners in South Africa (The Resolve Group, 2003:3). For the mine owner to comply with his duties, an ongoing risk management system must be established (The Resolve Group, 2003:3).

The MHSA also established the Mine Health and Safety Inspectorate (MHSI), and the Chief Inspector of Mines (CIM) is at the head of this Act (The Resolve Group, 2003:3). The responsibility of the CIM is to enforce and promote the compliance of the mining industry to the MHSA (The Resolve Group, 2003:3). Regular mine inspections achieve this, conducting inquiries and inspections into health and safety incidents, and the imposition of financial penalties and prosecutions (The Resolve Group, 2003:3).

The three main methods of mining are open-pit, underground, and underwater mining (Anglo American, 2022). There are multiple stages in mining and a range of equipment and machinery is required for successful operations. The different stages, as well as the required capital equipment, of a global value chain (GVC) type of mining in South Africa, according to Fessehaie (2014:12,13), can be seen in Table 2.1 below:

Table 2-1: Stages of mining with required equipment

Stage of mining of the GVC-type mine	Required capital equipment
Exploration	Exploration drill rigs and drilling equipment
Mine development	Development drill rigs
	Trucks and loaders
	Electrical equipment
	Shafts
	Hydraulic and pneumatic equipment
Underground mining	Material handling equipment (conveyors, scrapers, and locomotives)
	Drill rigs and drilling equipment
	Ventilation equipment
	Valves and pumps
	Head gear such as chains, cables, and motors
	Winders, cages, and hoists
	Roof and wall bolting systems
	Rolling stock
Open-pit mining	Excavators
	Trains, trucks, and loaders
	Drill rigs and drilling equipment
	Rolling stock
	Draglines
	Power shovels
	Conveyors
	Power shovels
	Coal cutters
Minerals processing	Crushers and grinders
	Agitators and pressure vessels
	Thickeners
	Power generation systems
	Bins and silos

	Ball mills and screens
	Material handling pumps and conveyors
	Solid/liquid separation equipment
	Reagents and chemicals
Smelting	Refractories
	Furnaces
	Pumps
	Electronic process control systems
	Dryers
	Classifiers
	Floatation tanks
	Filters
	Mixers
	Washers, scrubbers, and separators
Refining	Tanks
	Filters
	Dryers
	Conveyors
	Thickeners

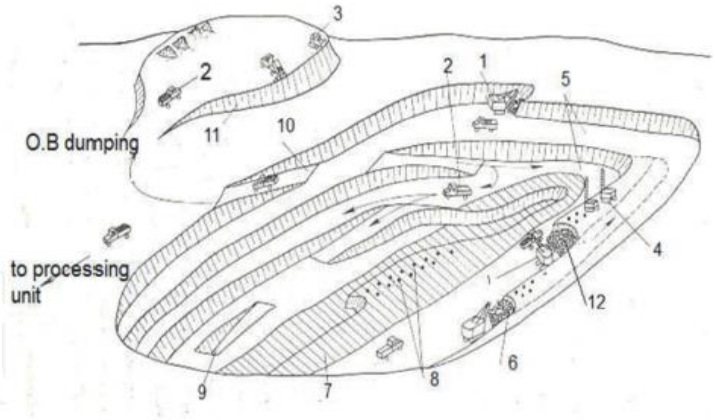
Source: (Fessehaie, 2014:12,13)

South Africa's output originates from both open-pit and underground mining, and the expenditure on capital equipment is much higher for underground mining (Fessehaie (2014:13).

Open-cast mining is a surface mining method used to exploit and extract near-surface ore deposits while dumping the waste, tailing, and overburden at a specified disposal site (Altiti, 2021:1). Traditional open-pit mining is described by Altiti *et al.* (2021:1) to have a cone-shaped excavation and uses one or more horizontal benches for mining equipment to access and extract the ore.

Figure 2.1 below gives a visual illustration of the layout of a typical open-pit mine and the required equipment used in open pit mining (Altiti *et al.,* 2021:9).

Figure 2-1: Visual illustration of open-pit mine

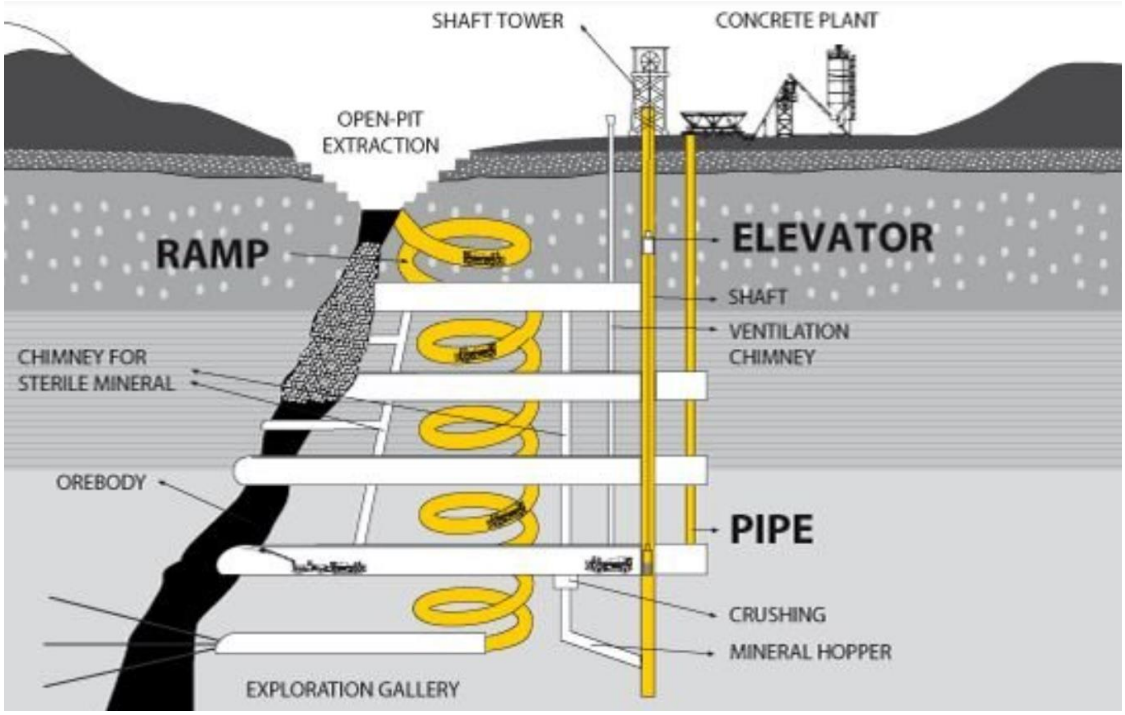


1. Excavator
2. Truck
3. Bulldozer
4. Drilling machine
5. Mining level
6. Detonated mass
7. Ore body
8. Blasting boreholes
9. Fourth level haulage Bench
10. First level access
11. O.B. Tips
12. Mining face

Source: (Altiti *et al.*, 2021:9)

Underground mining, according to Lumanao (2017), is the exploitation of minerals in which the extraction thereof is carried out underneath the earth's surface. The choice of an underground mine is related to the degree of ground support required to make it safe and productive at all costs and the geology of the deposit (Lumanao, 2017). Figure 2.2 below gives a visual illustration of the layout of a typical underground mine, as well as the basic required equipment used in this type of mining operation.

Figure 2-2: Visual illustration of underground mine



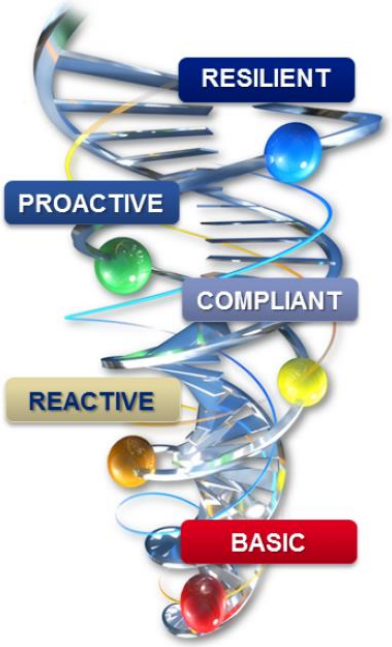
Source: (Lumanao, 2017)

An essential part of an underground mine is mine hoists, which are used to extract ore from underground to the surface, as well as the transportation of equipment and miners to various underground levels of the mine (Giraud & Galy, 2018:1).

2.2 AFTERMARKET MAINTENANCE IN THE MINING INDUSTRY

Foster and Hoult (2014:64) found that companies can exhibit five different maturity levels when referring to different organisational elements, as seen in Figure 2.3 below.

Figure 2-3: Anglo American Plc maturity model



Source: (Foster & Hoult, 2014:64)

Any mining company aims to become resilient (the ability to eliminate any problem before it occurs) in their approach to safety, risk management, training and competency, procurement, knowledge, contract management, and maintenance, just to name a few of the management systems (Foster & Hoult, 2014:63,64). These results and goals can only be reached by investing time, resources, and finances in technology and systems. That will allow the mining companies to improve from their current maturity levels.

Financial pressure has been placed on global mining companies, and they have been forced to reduce costs and improve productivity (Fessehaie, 2014:14). It is also mentioned by Fessehaie (2014:14) that mining companies are forced to form more intense relationships with fewer suppliers that are more capable of supplying quality spares and delivering specialised services.

Equipment maintenance is not only required for the performance and availability of the mining equipment, but also by law. According to the Mine Health and Safety Act 29 of 1996 General Machinery regulation 8.8 (2) (MHSC, 2018:128), the employer

(referring to the mine owner) must ensure that reasonable practical measures are in place to ensure that no person gets injured by any machinery failing as a result of:

- incorrect installation.
- incorrect design.
- non-compliance or incorrect use of proper safety and operating procedures.
- poor maintenance.

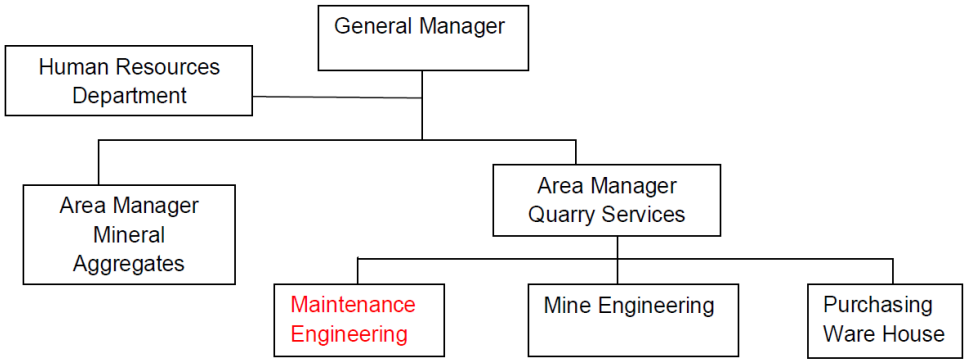
One of the leading causes of injury, according to Hardcat (2020), is the failure to address critical maintainability issues, and regardless of the effectiveness of any safety programme at the mine, the risk associated with risky maintainability on mining equipment cannot be mitigated. A high safety risk is associated with the maintenance of mining equipment, and maintenance workers are more likely to be exposed to hazards than any other mine employees (Hardcat, 2020).

2.3 MINING IN-HOUSE MAINTENANCE

In-house maintenance is defined by Hayes (2022) as the maintenance activity performed using employees within the company instead of relying on outsourcing the maintenance activity through another company to perform those required maintenance activities.

The in-house maintenance at a mine is typically the responsibility of the maintenance engineer, and the engineer is responsible for improving equipment reliability, serviceability, and availability (Dey, 2022). Figure 2.4 below is an example of an organogram of a mining company and indicates the importance of the maintenance engineer in the management structure of a mining company (Makinde, 2014:3).

Figure 2-4: Organogram of a typical mining company



Source: (Makinde, 2014:3)

It is indicated by Sindhuja (2022), the function and duties of the maintenance department can be listed as follows:

- Inspections
- Repairs
- Engineering
- Overhaul
- Construction
- Salvage
- Maintenance/Preventive maintenance

Inspecting equipment is a routine task where the condition of the plant facilities is examined to determine the need for repairs, and inspections are completed to ensure the efficient and safe operation of machinery and equipment (Sindhuja, 2022). The intensity of use of the equipment will determine the frequency of inspections, and items removed during maintenance will be inspected to determine the repair feasibility (Sindhuja, 2022).

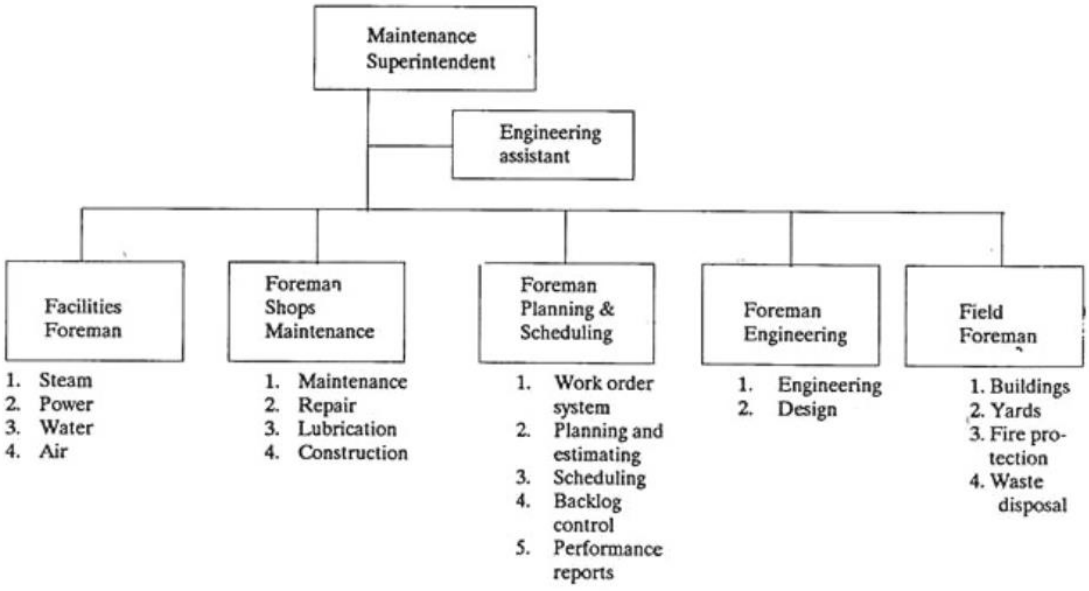
Repairs are usually unplanned tasks, and the maintenance department carries out these corrective repairs to alleviate unsatisfactory conditions, whereas maintenance and preventive maintenance are considered planned tasks (Sindhuja, 2022).

Maintenance is the act of maintaining existing equipment through minor installations of equipment and replacements, and preventive maintenance involves the maintenance of equipment before a breakdown occurs (Sindhuja, 2022).

Engineering involves the improvements or alterations in existing equipment to minimise breakdowns. The maintenance department supervises and engineers construction projects that will later become part of the mine plant (Sindhuja, 2022).

Regardless of the size of the mining operation, it is of utmost importance that some parts of the leading organisation should be the maintenance of the critical assets of the company (Sindhuja, 2022). According to Sindhuja (2022), the maintenance department's organisational structure must consist of clear divisions of authority with little overlap. It should keep an optimum number of employees reporting to an individual, as seen in the maintenance organogram example in Figure 2.5 below.

Figure 2-5: Maintenance organogram



Source: (Sindhuja, 2022)

Multiple trades and positions are required in the maintenance department, according to Tomlingson (2016), to assist the maintenance engineer in performing the required duties and responsibilities. The most basic maintenance departments in mining operations, as indicated by Tomlingson (2016), are the following:

- Electrical department: Responsible for all electrical equipment maintenance.
- Instrumentation department: Responsible for all instrumentational equipment maintenance
- Fitting department: Responsible for equipment such as pumps, hydraulic pipes, compressors, and valves.
- Boilermaker department: Responsible for fabrication, installation, and maintenance of guards, gratings, and pipes.
- Projects department: Responsible for all new projects and modifications.
- Civil and structural department: Responsible for repairs and maintenance of concrete and building structures.
- Mechanical department: Responsible for diesel engine and vehicle repairs.

Each department has a foreman responsible for their department and reports directly to the maintenance engineer (Tomlingson, 2016).

2.4 CONTRACT LABOUR AND ENGINEERING COMPANY SERVICE PROVIDERS

Costs, operating targets, and profitability place mining companies under permanent pressure, and mining companies cut costs, drop weight, and reassess their investments when a downcycle begins (Pieterse, 2018). Even after signs of revival in the industry, mining companies still opt to outsource services instead of hiring in-house maintenance specialist teams (Pieterse, 2018).

The mining industry outsources the engineering maintenance function to engineering companies or mining contract labour, also known as labour brokers, to conduct maintenance on their equipment. Keel (2018) stated that 30% of the total employment in the mining industry is made up of atypical forms of employment, such as engineering companies and labour brokers.

Contract labour refers to seasonal or temporary employment where the duration depends on the mining company's needs (Rangefront, 2021). The labour is usually managed by a third party that assists in recruiting, screening, and placing employees in different mine contracting positions (Rangefront, 2021). The duties performed by the contracted labour and the skillset of the labour, according to Rangefront (2021), depend on the tasks and positions they are hired for. In most cases, they will work with other contractors or permanent mining professionals during a shutdown or on a project.

Temporary employment services, also known as labour brokers, are companies that provide labour to the mining client, and even though the work takes place on the client's premises, the labour broker still employs the labour force. Measuredability (2022) indicated that the labour broker is reasonable for all administration related to the employees, such as leave, payroll, and taxes.

Legislations have stepped in to lay down the rules and regulations to protect the workers under temporary employment of labour brokers, as the labour broker companies have come under scrutiny over the years (Alcock, 2022). The labour broker sector is strictly regulated to protect the relationship between the worker and labour broker, as well as the relationship between the labour broker and outsourcing client (Alcock, 2022).

An engineering company provides multiple engineering services to its clients, and the term engineering services includes multiple activities such as development, planning, construction, management, design, and maintenance (AB Consultants, 2020). The following list of engineering services is mentioned by AB Consultants (2020) as typical services provided by engineering companies:

- Mechanical engineering services
- Chemical engineering services
- Electrical engineering services
- Civil engineering services
- Interdisciplinary engineering services

RGBSI (2022) also mentioned services such as simulation and testing, reverse engineering, technical documentation, and engineering consulting, as engineering companies provide their clients with a range of services.

2.5 OEM AFTERMARKET SPARES AND SERVICES

Mining organisations are increasingly moving toward outsourcing the maintenance function instead of following their in-house maintenance approach due to limited knowledge and flexibility (Visagie, 2005:20). This allows the mining industry to focus on its core business, and the OEM has taken over the innovation industry (Fessehaie, 2014:15).

The mining industry is forced to return aftermarket repairs to the OEM, mitigating the financial risks and complications when using non-OEM-approved service providers (Mining Weekly, 2019). According to Mining Weekly (2019), a service-level agreement (SLA) with the OEM allows the mining company peace of mind, knowing that their equipment is maintained by genuine parts and trained and skilled technicians and artisans.

A service-level agreement is a clear guideline provided to the service provider by the client, and it stipulates what needs to be done, when it needs to be done, and according to what standards (Henshall, 2019). Trust is of utmost importance to maintain a successful SLA, and OEM service providers need to understand what is expected from them, and they need to be held accountable for their actions (Henshall, 2019).

The mining industry places a high value on the variety of specialised and critical services that the OEM supplies them with. This includes services such as parts distribution, component repairs, after-sale services, specialists, and technical support during breakdowns (Reynders, 2018:60).

Reynders (2018:62,63) mentioned that the OEM tends to focus more on the following contributing factors at the management and strategic level:

- OEM local manufacturing
- Value for money services and products
- Product promotion and distribution
- High-quality service delivery
- International resourcing and purchasing
- Co-operation by initiating a successful relationship between OEM and client
- Skilled and competent staff and training programmes

2.6 COMPARISON BETWEEN DIFFERENT MAINTENANCE STRATEGIES

In this section, a comparison will be compiled to illustrate the advantages and challenges of the following types of maintenance strategies by mining companies in South Africa:

- In-house maintenance of the mining companies in South Africa.
- Outsourcing spares and maintenance labour teams to labour brokers or engineering companies.
- Outsourcing spares and maintenance labour teams to OEM companies.

Table 2.2 below lists the advantages and challenges of in-house maintenance conducted by mining companies in South Africa.

Table 2-2: Advantages and challenges of in-house maintenance

In-house maintenance conducted by mining companies in South Africa	
Advantages	**Challenges**
In-house employees are likelier to obtain more experience and service and more knowledge of the business and its expectations (Davis, 2017; Lydon, 2016; Wells, 2014).	There is a degeneration of skills in South Africa and worldwide, affecting the capacity of mining companies to carry out regular in-house maintenance services (Engineering News, 2017; Pieterse, 2018).
The in-house maintenance team handles the response time to a breakdown much more rapidly, resulting in less downtime (Davis, 2017; Lydon, 2016; Service Channel, 2022; Wells, 2014).	Inefficient mining practices and processes result from increasing mining costs, decreasing commodity prices, and declining reserves (Engineering News, 2001).
Companies choose in-house technicians to save and control costs by avoiding markups and controlling travel and labour costs (Hayes, 2022; Service Channel, 2022).	The mining industry lacks mine-based skills due to retrenchments of skilled employees during a down cycle (Pieterse, 2018).
In-house maintenance teams are dedicated to	The wages and benefits such as medical aid,

one client, and planning does not have to occur between other clients (Service Channel, 2022).	pension, vacation, and general overheads of in-house staff may have become too expensive (Davis, 2017; Hayes, 2022; Service Channel, 2022; Wells, 2014).
An in-house technician's overall service and quality of work will be high due to the amount of time spent at the exact location, thereby increasing the technician's accountability (Service Channel, 2022).	It may take technicians of an in-house organisation longer to respond to a breakdown if they are held up by high-priority work or if there is insufficient coverage initially (Service Channel, 2022).
There are fewer security risks if a company uses in-house employees and, therefore, better control of intellectual property (Hayes, 2022).	If the in-house maintenance team does not have the required knowledge, skills, and resources, the quality of work will suffer. In that case, the technician's performance relies on company investments in training and appointing the right people (Service Channel, 2022).
In-house employees are more likely to make decisions with the company's core vision in mind (Hayes, 2022).	Smaller companies do not have enough work demands to justify the in-house team (Hayes, 2022).
Using in-house employees leads to an additional revenue stream, as competitors must find these services elsewhere at an additional cost (Hayes, 2022).	

Table 2.3 below lists the advantages and challenges of mining companies outsourcing spares and maintenance labour teams to labour brokers or engineering companies in South Africa.

Table 2-3: Advantages and challenges of outsourcing spares and maintenance to labour brokers and engineering companies

Outsourcing spares and maintenance labour teams to labour brokers or engineering companies in South Africa	
Advantages	**Challenges**
An established engineering service provider consists of multiple engineering disciplines, allowing the mining client to maintain smaller engineering teams from the service provider (Vista Projects, 2023).	Turnover of employees is much higher at a contracting company, resulting in the loss of skills and intellectual knowledge (Davis, 2017; Lydon, 2016; Wells, 2014).
Engineering company provides consultation to the mining company needing expert solutions and advice and can take on projects and work to simulate, evaluate, design, and test products (Vista Projects, 2023).	Contracting companies' primary focus is to ensure that their own functional contribution is met without considering the overall aim of the client (Keel, 2018; Pieterse, 2018).
Engineering companies provide knowledge of all relevant codes and standards (Engineering News, 2017).	Creating revenue is the primary driver of the contracting company, which could lead to the surfacing of natural conflict with the mining client (Keel, 2018).
Engineering companies work with a variety of clients and industries, allowing for more knowledge and experience (Vista Projects, 2023; Wells, 2014).	Contract workers do not have the same benefits as permanent mine employees, are usually paid less, and are signing incomplete contracts (Keel. 2018). They are, therefore, seen as easily recycled, which places the permanent workers in an unflattering light when making difficult or unnecessary demands (Keel, 2018).
An engineering company is held completely accountable for the success and failure of a project (AB Consultants, 2020).	When outsourcing labour, mining companies are challenged to fill in-house senior positions (Pieterse, 2018).
Outsourcing leads to sharing the risk between the service provider and the mining company (Bizcommunity, 2018; Engineering News, 2001).	Depending on specific markets and locations, there may be limited skills and a limited craft pool, and this demand could lead to an increase in the hiring cost of labour from a labour company (Lydon, 2016; Wells, 2014).

The outlay of funds to employ specialised technical skills is initially reduced when these maintenance functions are outsourced to a contractor, and this includes a further reduction in the capital when the contracting company provides its own hardware, tools, and systems (Engineering News, 2001; Lydon, 2016; Wells, 2014).	The management style of the labour contracting company may differ from that of the mining company, which can cause conflict between the two entities due to confusion and conflicting priorities (Lydon, 2016; Wells, 2014).
Outsourcing leads to optimising plant, mining, and utilisation rates and improved labour productivity (Keel, 2018).	Maintenance contracting companies could lead to intellectual property theft and cyber-security risks for the mining company (Davis, 2017; Hayes, 2022; Lydon, 2016).
The mining company can better utilise capital as the mining company shares capital exposure with the contracting party, resulting in financial flexibility (Keel, 2018; Pieterse, 2018).	Mining companies struggle due to a lack of control over contracting companies in terms of instructing the workforce and setting task priorities (Davis, 2017; Hayes, 2022).
When outsourcing services, mining companies are free from long-time labour commitments (Mining Weekly, 2022; Pieterse, 2018).	
When outsourcing services, the mining company gains access to specialists with the latest technology and a wide range of skills, reducing downtime (Davis, 2017; Lydon, 2016; Pieterse, 2018).	
Outsourcing services assist in avoiding the negligence of duties and allow for learning and mentorship of mine employees (Pieterse, 2018).	
Contract labour companies assist in filling the labour gaps for contracts that cannot justify permanent employment and work well with projects with fluctuating labour needs	

(Rangefront, 2021; Wells, 2014).	
Contracting labour companies manage all the hiring details of the contract employees, such as recruitment, labour laws, taxes, benefits, salaries, and conflict resolution (Davis, 2017; Lydon, 2016; Mining Weekly, 2022; Rangefront, 2021; Wells, 2014).	
Specialised services can be utilised by the mining company on demand by obtaining these employees from the labour contracting company without the need for time and money spent on in-house development (Lydon, 2016; Wells, 2014).	

Table 2.4 below lists the advantages and challenges of mining companies outsourcing spares and maintenance labour teams to OEM companies in South Africa.

Table 2-4: Advantages and challenges of outsourcing spares and maintenance to OEM companies

Outsourcing spares and maintenance labour teams to OEM companies in South Africa	
Advantages	**Challenges**
High emphasis is placed on the importance of using OEM spares to ensure machines are maintained at a higher level to provide a longer equipment lifespan, saving the client	The OEM service and spare costs are expensive, and prices are inflexible (Buelow, 2018; GES Repairs, 2022).

money in the long run (Engineering News, 2017; Howden, 2022; Peterkin, 2019).	
Upgrading and refurbishing services by the OEM ensures mines' safety and environmental compliance (Engineering News, 2017).	OEM maintenance contractors will be less proficient in maintaining their competitors' equipment, and suggestions for replacements or modifications will be made to replace the competitors' products with their own in order to benefit (Lydon, 2016).
The OEM exclusively sells its parts and products and has near complete customization available (Bryant, 2022).	OEM parts and products carry expensive development costs, and a high minimum order quantity is required from their clients (Bryant, 2022).
OEM parts are of high quality and are tested according to strict testing and standards (Howden, 2022; Intrepidsourcing, 2022; Peterkin, 2019).	The OEM forces its clients to use their spares to avoid voiding warranties and contracts, forcing their clients to rely solely on the OEM services and abilities (Buelow, 2018).
Clients benefit from specialized technology and keep all intellectual property and trademarks of the OEM product (Intrepidsourcing, 2022).	The salespeople of the OEM have little experience in maintaining the equipment sold, which could lead to recommendations on keeping stock of equipment that rarely fails (Buelow, 2018).
Response time from an OEM is much quicker as they do not struggle to identify and produce parts, as they can access the original drawings (Howden, 2022).	OEMs are only loyal to their own business and not the client's business, which could cloud decisions and recommendations on-site OEMs make (Buelow, 2018).
The OEM support engineers have access to the design engineers of the product. Therefore, the client has access to a large variety of engineering and technical support (Howden, 2022).	Increase downtime on equipment due to the availability and travelling time of technicians and the availability of specialized repair tools during an urgent breakdown of equipment (Buelow, 2018).
Genuine OEM parts are designed to optimize performance and ensure an identical replica of the part, known as a like-for-like part (Howden, 2022).	

OEM parts come with a manufacturer's warranty, allowing the replacement of defective or premature failed parts (GES Repairs, 2022; Howden, 2022; Peterkin, 2019).	
OEM supplies aftersales support such as specialized parts, training, technical advice, and parts history (Peterkin, 2019).	
The OEM provides a service program with purchased equipment, allowing for a reliable maintenance service as the technicians know the equipment inside and out (GES Repairs, 2022).	
With an OEM maintenance team on site, the technician can manage stock levels accurately according to the demand on site (Buelow, 2018).	
OEM companies invest in research and development as they are expected to deliver solutions and not only products (Fessehaie, 2014:5; Leeuw, 2012:58).	
OEM services are essential to reduce the total cost of ownership of the mining companies (Fessehaie, 2014:5).	

2.7 SUMMARY

Chapter 2 has provided the literature on the history and origin of the mining industry in South Africa, as well as the financial contribution the mining industry makes to the country's GDP. The literature describes the different types and stages of mining in South Africa and the different equipment the mining industry uses in its daily operations. Emphasis was also placed on the importance of maintenance of these mining equipment and how it affects the productivity and profitability of the mining company.

This chapter explained the importance of using OEMs for aftermarket spares and service delivery to the mining industry. Comparisons were made between the advantages and challenges of using the mine's in-house maintenance teams to conduct maintenance tasks and repairs on mining equipment.

Comparisons were also made between the advantages and challenges of using OEMs to supply OEM spares to the mining industry in South Africa and the mining industry's outsourcing of maintenance and repair tasks to the OEMs. The advantages and challenges of third-party, non-OEM engineering companies and labour brokers to provide spares and maintenance services to the mining industry were also highlighted in this chapter.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

During this study, an interpretive paradigm and qualitative study method were performed. Primary data was collected and used during this study. For primary data collection for the study, in-depth interviews were conducted with participants in both the mining industry and OEMs in South Africa.

Phase 1 of the research methodology is a literature review. The function of the literature review was to acquaint the reader with the mining industry and the OEMs in the mining industry, the history and collaboration between these two entities, how these entities contribute to one another, and how they contribute to the economy of South Africa.

The study emphasises the need for the mining industry and the OEMs to understand the benefits and to form partnerships to improve the efficiency, safety, and productivity of the mining industry in South Africa. Furthermore, the literature review gives a background on the challenges the mining industry faces and will face if technology and innovation are not improved and implemented in the mining sector.

Google and Google Scholar were used to obtain the information for the literature review. The sources include the following:

- Books
- Electronic newsletter and internet articles
- Theses and dissertations
- Journal articles

3.2 EMPIRICAL STUDY

3.2.1 Research paradigm

According to Saunders *et al.* (2019:160), interpretivism is a research paradigm or subjectivist philosophy that emphasises humans being different from physical phenomena because human beings create meanings. The focus of interpretivism is

placed on the individual's lived experience and the individual's interpretation of the research phenomena (Saunders *et al*., 2019:160).

The subjective experience was used to understand human behaviour. Therefore, the research philosophy used for this study is interpretivism, as the personal view of the participants was used to develop a theory.

3.2.2 Research approach

Untested conclusions are generated using known premises when using an inductive approach to theory development (Saunders *et al.*, 2019:153). During induction, the researcher moves from the data collected to the theory (Saunders *et al.*, 2019:155).

The research approach that was used for this study is an inductive approach. The researcher collected a substantial amount of data relevant to the research topic. Once the data was collected, the researcher looked for patterns in the raw data and then developed a theory to explain the patterns.

3.2.3 Methodological choice

The study was conducted in two phases. The first phase was a literature review of the mining industry and the OEMs and the relationship between the two entities. This phase was followed by a mono-method qualitative study that examined the advantages and challenges to the mining industry using the OEMs for aftermarket services. The researcher conducted interviews with both the mining industry and the OEM participants. Therefore, a mono-method qualitative study was selected to conduct research.

3.2.4 Research strategy

Interviews are often used during qualitative studies. The strategy used during this study was one-on-one, semi-structured interviews. Open-ended questions were used to uncover thoughts, trends, and opinions. The interviews collected the true opinions and challenges faced by the OEM companies and the mining industry.

The questions used during the one-on-one interviews were structured to collect data that assists in fulfilling the primary and secondary objectives. The questionnaire was also drawn up from the literature review.

3.2.5 Time horizon

According to the research onion of Saunders *et al.* (2019:155), there are two types of time horizons: cross-sectional and longitudinal. A cross-sectional study examines data obtained during a single moment in time occurring over a short term. In contrast, longitudinal study participants are questioned multiple times over an extended period (Collis & Hussey, 2014:63,64).

A cross-sectional study was conducted as the study was a once-off study that took place over a short period.

3.2.6 Study population and sampling

The following guideline was used to develop the study population and sampling criteria:

- Defining the population.
- Determining the sampling frame.
- Selection of sampling techniques.
- Determining the size of the sample.

In this study, the following participants formed part of the study population:

1. OEMs supplying equipment to the mining industry: Site managers and maintenance managers that perform aftermarket services to the mining industry, as well as chief operating officers of OEM companies applying for mine tenders.
2. Mining industry in South Africa: Engineering managers, section engineers, and maintenance specialists in charge of on-site mining and plant equipment.

The following inclusion criteria were applied:

- Only on-site mining personnel and the supply chain department will be interviewed, as they are the participants working directly with the equipment and contracts.
- Only mining companies within the borders of South Africa will be used for the study.
- Only OEM companies supplying equipment, parts, and aftermarket services to the mining industry will be used for the study.
- Only OEM companies supplying equipment, parts, and aftermarket services to the mining industry within the borders of South Africa will be used for the study.

The following exclusion criteria were applied:

- No duplication of sample OEM companies will be allowed.
- OEM managers not directly involved with equipment, parts, and aftermarket services will be excluded.
- All illegal mining companies or activities will be excluded from the study.
- No sample will be collected from an OEM or mining industry participant without at least two years of practical experience.

Participants who assisted with the study also assisted in reaching additional potential participants. The Protection of Personal Information (POPI) Act was adhered to regarding contact details. The sampling, therefore, relied on chance, and the guarantee of equal opportunities for all population members is not guaranteed. The sampling method employed during this study is a non-probability snowball method due to time constraints and the complexity associated with accessing all mining and OEM companies in South Africa.

Due to the connections, networks and relationships the researcher had with participants in the gold and platinum mines in the Limpopo and Gauteng provinces in

South Africa, those two mining groups were mainly targeted. The snowball method allowed the research to spread to other mining groups.

It is recommended by many research books that data gathering should take place until the addition of participants will not yield any new information for the study, also referred to as saturation of data (Saunders *et al.*, 2019:315). For this study, targets of ten participants from the mining industry and ten from the OEM companies were selected to be interviewed. The target was reached, and data saturation was also reached during the interview process.

The researcher is an OEM contract manager on one of the mining companies' sites. The OEM company conducts business with mining companies all over South Africa, where some participants were interviewed. The conflicts of interest by the researcher are very low as multiple OEM companies deliver aftermarket services to those specific mines. The participants were required to answer questions regarding the OEM companies in general and did not give answers and opinions on an individual OEM company.

3.2.7 Designing the measuring instrument

As indicated in section 3.2.3, the research study adopted a mono-qualitative method. Data was obtained through one-on-one interviews with both participants from the mining industry and the OEM companies in South Africa. Raw data was collected through the interviewing process from the participants, which assisted the researcher in conducting the study.

The researcher used a semi-structured interview guide to manage the interviews. In preparation for the interviews, the researcher prepared two separate lists of questions from the literature review. One set of questions focused on the perspective of the mining industry, while the other set focused on the perspective of the OEM companies. The questionnaires used during the interviews were formulated to assist in answering the primary and secondary research questions.

Two different sets of questions were used during this study. One set was aimed at gathering data and information from the mining industry, and one aimed at gathering data and information from the OEMs.

The following will be questions aimed at gathering data and information from the mining industry:

- What is your experience level of interaction with the OEM suppliers?
- What are the advantages of using the OEM for aftermarket spares and maintenance services in the mining industry?
- What are the challenges of using the OEM for aftermarket spares and maintenance services in the mining industry?
- How likely are you to use OEM spares when repairing plant and mining equipment?
- How likely are you to use the OEM maintenance team to maintain plant and mining equipment?
- What alternatives does the mine use for aftermarket spares and maintenance services?
- What do you see as the future role of the OEMs in the mining industry?
- How can the OEMs improve service delivery to the mining industry?

The following will be questions aimed at gathering data and information from the OEM industry :

- What is your experience level of interaction with the mining industry?
- What are the advantages of using the OEM for aftermarket spares and maintenance services in the mining industry?
- What are the challenges of supplying OEM aftermarket spares and maintenance services in the mining industry?
- What are the challenges for the OEM if the mines do not use OEM spares and OEM maintenance services during repairs on equipment?
- What are the risks to the mining industry if modifications are made to OEM equipment without consulting or involving the OEM?
- What do you see as the future role of the OEMs in the mining industry?

- How can the mining industry improve to be more accessible to the OEMs to provide service delivery and spares to the mining industry?
- What is your perception of why the mining industry refrains from using OEMs for aftermarket spares and services?

3.2.8 Collection of data

To collect the data required for the research, the researcher conducted one-on-one interviews with both participants from the mining industry and the OEM companies in South Africa. These interviews were conducted using only face-to-face interviewing. Online platforms were not used during the interviewing process.

The researcher consistently adhered to the POPI Act regarding the integrity and confidentiality of the potential participants' contact details. As such, participants were not asked for the details of secondary participants but were asked to contact such secondary participants to request participation. The researcher took accountability and ensured that the contact details of the potential participants were only used for the lawful purpose of the research. The researcher informed the participants that their identity would be safeguarded and that any information and data collected during the interview were used for the sole purpose of the study.

Before asking the participant the research questions, the researcher greeted the participant, explained the study's purpose, and informed them that participation is optional and that they can withdraw at any time. The researcher also obtained permission to record the session from the participant. The researcher used a high-quality recording device to record the interviewing session, and notes were taken during the sessions.

3.2.9 Data analysis

The qualitative data is coded during thematic analysis to identify trends and themes linked to the research questionnaire for future analysis (Saunders *et al.,* 2019:651). Aunders *et al.* (2019:651) stated that thematic analysis allows for a systematic yet flexible data analysis approach. Qualitative analysis software such as Atlas.ti was used.

Saunders *et al.* (2019:652) also stated that the thematic analysis approach involves four elements:

- The researcher must code the data.
- The researcher must become familiar with the data collected.
- The researcher must recognise relationships and identify themes within the data.
- The researcher must test propositions and clarify themes.

During this study, thematic analysis was used to analyse the data. After all the one-on-one, semi-structured interviews were completed and the researcher was satisfied that saturation had been reached, the data was transcribed from the original voice recordings. Written consent was obtained by the researcher from the participants in this regard.

The data was then analysed via coding. Notes were kept on names, titles, actual answers, and dates, and the researcher ensured that the mining industry and OEM companies' transcripts were separated.

The data in the transcripts was coded and categorised to identify different similarities, themes, patterns, or dimensions of information. This was done to ensure that the researcher made sense of the data.

3.2.10 Trustworthiness

Trustworthiness consists of four criteria: transferability, credibility, dependability, and confirmability (Bryman *t al.*, 2015:44,45).

Transferability, according to Bryman *et al.* (2015:44), is when the study results are transferred to another setting. To achieve this, the reader must be able to compare similarities between the cases by studying the original research in depth (Bryman *et al.*, 2015:44). During this study, once saturation was reached, transferability was achieved in the mining sectors where data was obtained from.

According to Bryman *et al.* (2015:44), credibility can also be referred to as the validation of the respondent. One of the questions during the interview was to determine the level of experience of interaction with the OEM or mining industry. After the data was transcribed from the original voice recordings obtained from the

one-on-one interviews, the researcher shared the transcripts with the participants to confirm whether the results were interoperated correctly. The participants were allowed to rectify or add information to the transcripts.

According to Bryman *et al.* (2015:45), dependability can be reached when a research study demonstrates trustworthiness for its approach to be audited. The researcher ensured the research process was adequately documented, observable, and logical to achieve reliability. Only knowledgeable and experienced participants were involved in the collection of data.

Confirmability, according to Bryman *et al.* (2015:45), is a measurement placed on the researcher to ensure that personal values will not influence the research and that the findings and interpretation will be derived strictly from the data collected by the researcher. During this study, confirmability was reached when the researcher reached dependability, credibility, and transferability. The study leader, an expert in qualitative research, was consulted to ensure that the researcher had reached confirmability. The one-on-one interviews also continued until saturation was reached and beyond to ensure saturation.

3.3 ETHICAL CONSIDERATIONS

The selection of an unworthy research topic, failure to access participants, and failure to gain access to OEM and mine premises to conduct interviews were ethical issues anticipated before starting the proposed study.

Failure to obtain informed consent from the research participants, non-compliance to the POPI Act, the researcher stopping research before obtaining data saturation, and collecting data from incompetent and inexperienced participants were ethical issues anticipated during the data collection phase.

Incompetence, lack of experience of the researcher and inaccurate capturing of data were ethical issues anticipated during the data analysis phase of the study.

The unsafe data storage, sharing and reporting of data without the participants' consent, and non-compliance to the POPI Act were all ethical issues anticipated when reporting, sharing, and storing research data obtained.

Ethical clearance was obtained through the ethical clearance board of the Nort-West University (NWU) before the research was conducted, and the executability and access to required research participants were confirmed before obtaining ethical clearance. This assisted in resolving ethical issues anticipated before starting the proposed study.

The researcher drew up a consent form to inform the participants of the reason behind the study, as well as to ensure the participants that compliance with the POPI Act was ensured. The consent form was approved by the researcher's study leader and supplied by the NWU Business School. The one-on-one interviews were also continued until saturation was reached and beyond to ensure saturation. The participants were also required to inform the researcher of their total experience, and a minimum of two years was required to participate in the research study. This assisted in resolving ethical issues anticipated during the data collection phase.

Interviews between the researcher and the participants were recorded, and data was transcribed from the original voice recordings obtained from the one-on-one interviews. The researcher shared the transcripts with the participants to confirm whether the results were interoperated correctly. The participants were allowed to rectify or add information to the transcripts. Qualitative analysis software such as Atlas.ti was used to analyse the data obtained. Data analysis took place and was approved by the study leader of the researcher for the NWU Business School. This assisted in resolving ethical issues anticipated during the data analysis phase of the study.

Data obtained during the research phase was stored on a private laptop with a security code only the researcher knows. A consent form was completed by all the participants before the sharing and reporting of research data. Permission was granted by the participants before the sharing and publishing of data. This assisted in resolving ethical issues anticipated when reporting, sharing, and storing research data obtained.

To ensure compliance with the POPI Act, the researcher obtained special written permission using a consent form completed by all the participants. The consent form ensured that the participants gave permission to be recorded, gave permission that the data was collected, and that the data will be used for research purposes. The

participants also gave written consent that the information obtained during the research would be shared and published. No personal information of the participants was published, shared, or made publicly available, and the participants acknowledged, in writing, that he/she understood all the terms and conditions as stated on the consent form. Permission to contact additional potential participants was first granted before the researcher made contact.

3.4 CONTRIBUTION OF THE STUDY

Theoretical contribution: The research will add value to the body of knowledge related to operations management within the spares and service delivery industry in the mining and OEM sectors in South Africa. Data obtained will assist in investigating the relationship between the OEM and the mining industry, the future roles and responsibilities of the OEMs in the mining industry, as well as the advantages and challenges faced by both industries with specific reference to after-market services provided to the mining sector by the OEMs in South Africa.

Industry contribution: This research could assist in identifying and breaking down the barriers between the mining industry and the OEMs. This could allow for better collaboration and partnerships between the two entities, resulting in:

- improved technology through increased investment in R&D
- improved profitability and contribution to the GDP of South Africa
- improved safety, health, and environmental conditions
- increased life of mine
- job creation
- reduction in financial pressure

3.5 SUMMARY

This chapter highlights that the empirical study conducted in this research follows an interpretive research paradigm, emphasising the importance of human interpretation and subjective experiences. The inductive research approach involves data collection followed by theory development based on patterns observed in the data.

The study employs one-on-one semi-structured interviews as a research strategy, focusing on participants from OEMs supplying equipment to the mining industry and the mining industry in South Africa. The study uses a cross-sectional time horizon, taking place over a short period. Due to practical constraints, sampling involves a non-probability snowball method and aims to reach data saturation with ten participants from each sector.

Thematic analysis is used for data analysis, and the study ensures trustworthiness through criteria such as transferability, credibility, dependability, and confirmability. Ethical considerations are addressed through informed consent, compliance with data privacy laws, and secure data handling.

The study contributes to the understanding of operations management in the mining and OEM sectors in South Africa, aiming to improve collaboration between the two industries.

CHAPTER 4: EMPIRICAL STUDY AND FINDINGS

4.1 INTRODUCTION

The results obtained from the qualitative study are represented in this chapter, along with a detailed discussion and comparison of the data obtained from the study. The data was analysed using Atlas.ti where codes were identified and associated code groupings were detected.

Comparisons are also made between the results of the data obtained by the mining industry interviews and the OEM representatives' interviews. This is done to accomplish the following secondary objectives:

- To determine the advantages and disadvantages of using OEM spares through a qualitative study.
- To determine the service-level requirements by the mining industry for the OEMs.
- To determine the quality, technology, and availability perceptions of mining companies in South Africa towards the OEMs.
- To make recommendations about areas of improvement to increase collaboration between the mining industry and the OEMs.

The advantages and challenges identified in Chapter 2 were also correlated and compared to the results obtained in the qualitative study. This was done to confirm the primary objective to explore the advantages and challenges of aftermarket services of the OEMs in the South African mining industry. Advantages and challenges not obtained in the literature review of Chapter 2 are also highlighted in this chapter.

4.2 Qualitative results

The qualitative results are divided into three sub-divisions. The first analysis represents the different code groupings and the correlation that these codes indicate. These codes were analysed in Atlas.ti, and the main themes were identified.

The second sub-division compares the advantages and challenges identified by both the mining and the OEM representatives on the advantages and challenges of OEM spares and aftermarket service delivery.

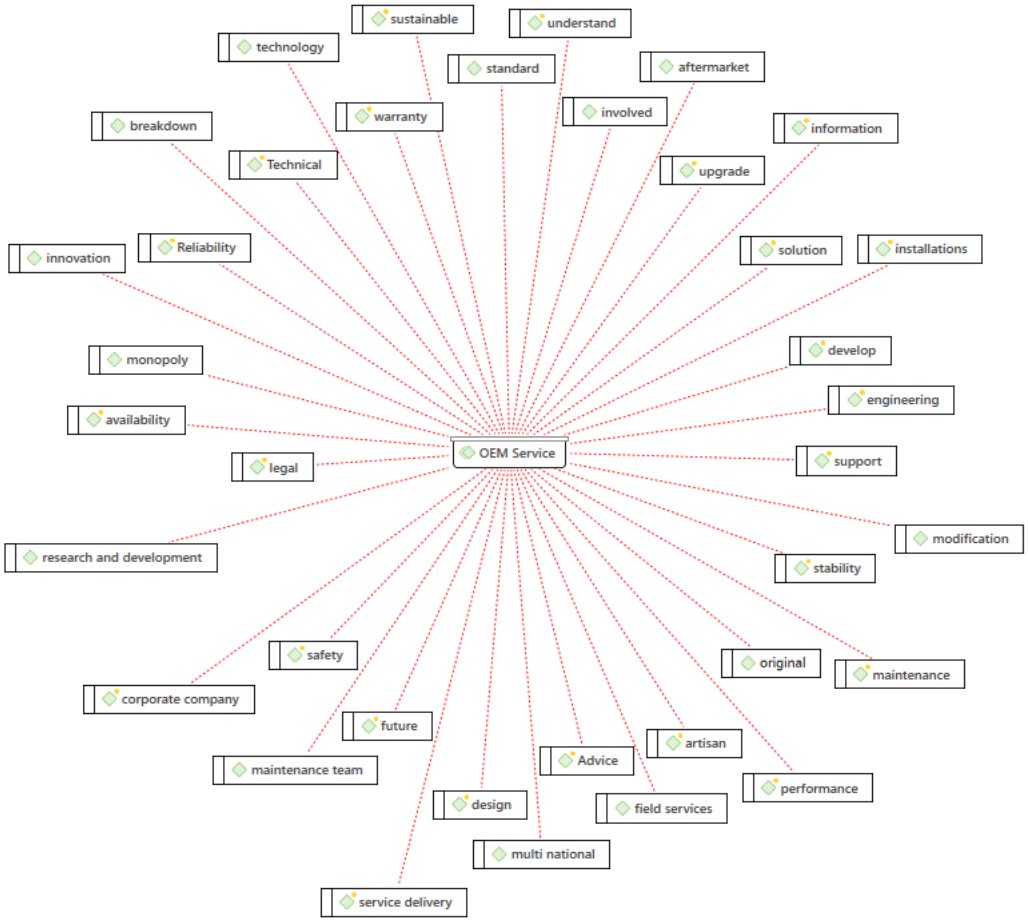
The third sub-division compares the future role of the OEM in the mining industry identified by both the mining and the OEM representatives. The third sub-division also contains recommendations from the OEM representatives on how the mining industry can improve to become more accessible for spares and service delivery.

4.2.1 Themes identified

After transcribing the interviews and analysing the data in Atlas.ti, a total of 127 codes were identified, and seven distinctive themes were identified.

Figure 4.1 represents the OEM service group network diagram. The codes selected relate primarily to the activities describing the service delivery provided by the OEMs in the mining industry. Figure 4.1 shows all the different service activities and services that the OEM provides to the mining industry and the advantages to the mining industry if they use the OEMs for aftermarket service.

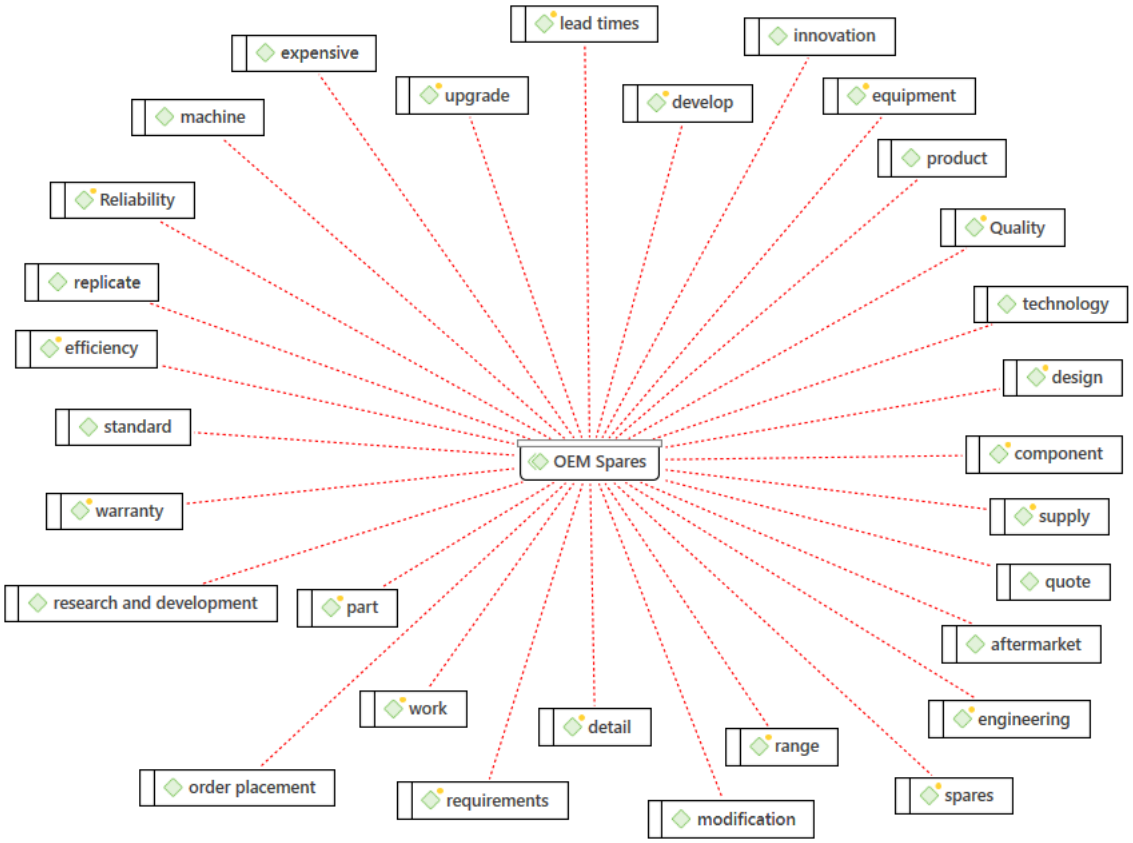
Figure 4-1: OEM service group network diagram



Source: Atlas.ti

Figure 4.2 represents the OEM spares group network diagram. The codes selected relate primarily to the activities describing the spares provided by the OEMs in the mining industry. This figure shows all the advantages and challenges the mining industry faces when using OEM spares. It also indicates the OEM's challenges in providing these spares to the mining industry.

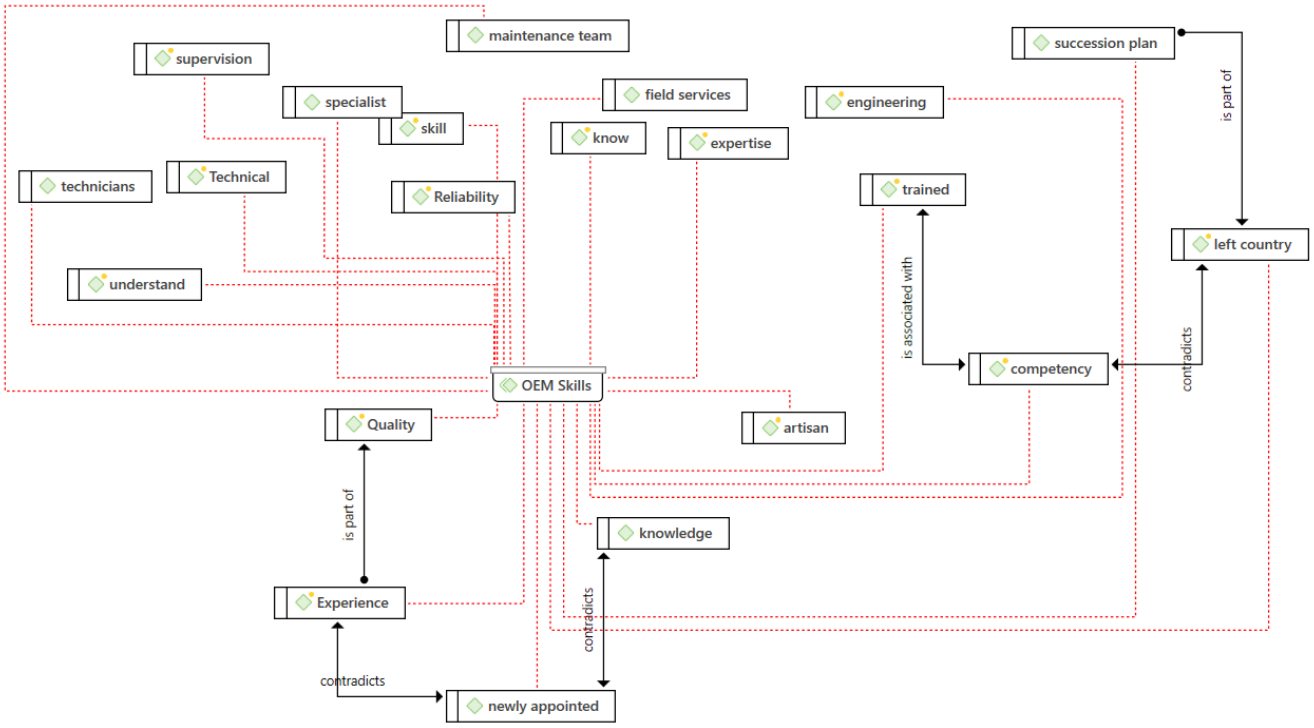
Figure 4-2: OEM spares group network diagram



Source: Atlas.ti

Figure 4.3 represents the OEM skills group network diagram. The codes selected relate primarily to the activities describing the service delivery skills provided by the mining industry OEMs. This figure shows all the skills that the OEM provides to the mining industry and the challenges the OEM faces with the new employment of employees. The figure also indicates the challenge the OEMs face in South Africa with skill drainage and highly skilled employees leaving the country.

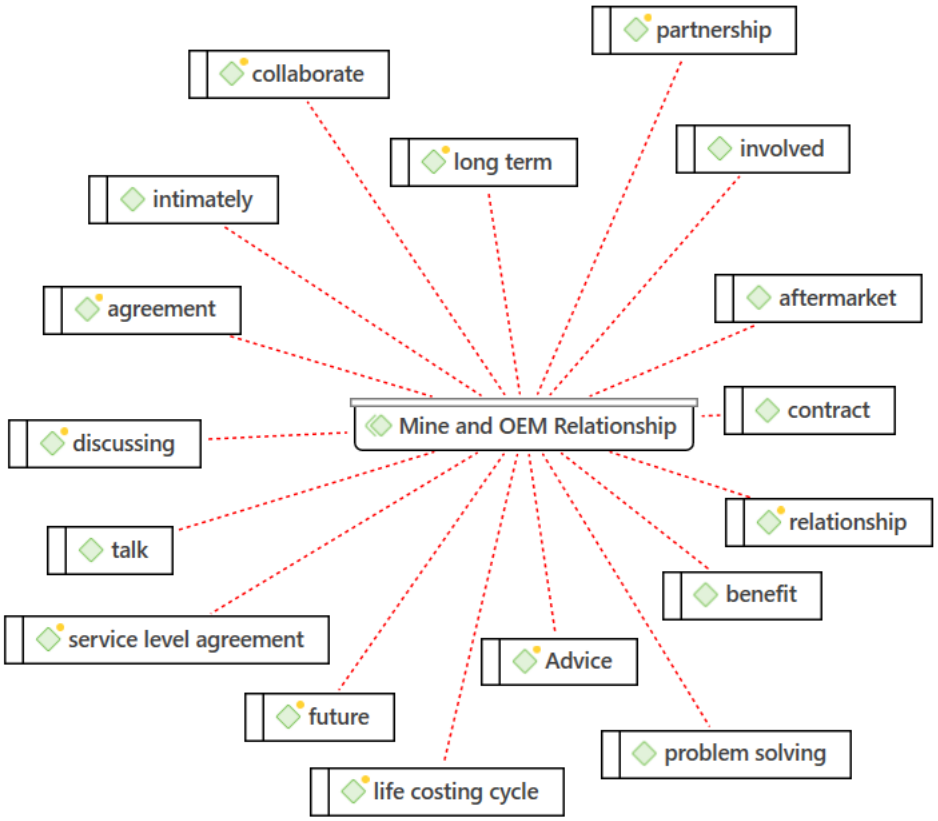
Figure 4-3: OEM skills group network diagram



Source: Atlas.ti

Figure 4.4 represents the OEM and mine relationship group network diagram. The codes selected relate primarily to the relationship between the OEMs and the mining industry. This figure shows the demand and desire for a long-term service-level agreement between the two entities and the advantages that collaboration and partnerships between the two entities will provide in the mining industry. The figure also indicates the requirements to create these service-level agreements.

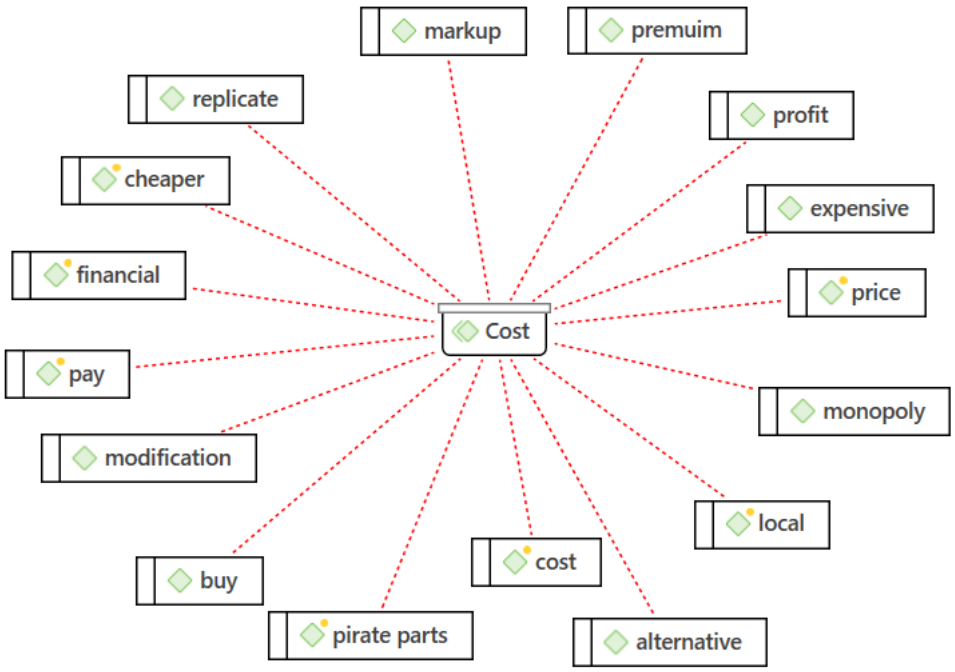
Figure 4-4: OEM and mine relationship group network diagram



Source: Atlas.ti

Figure 4.5 represents the cost group network diagram. The codes selected relate primarily to the costs associated with parts and services provided by the OEM to the mining industry. This figure shows the challenges that the mine faces with the high prices of spares and service delivery provided by the OEM. The diagram also indicates that the mining industry is seeking alternative, cheaper options for spares and service delivery, which provides its own challenges. The issue of local community development is also highlighted in the network diagram.

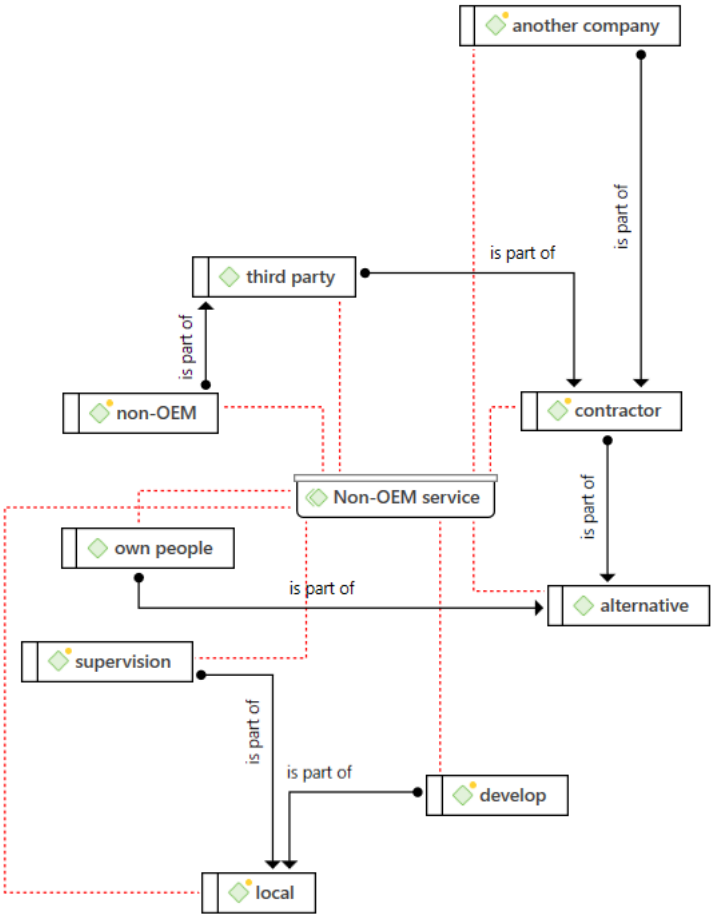
Figure 4-5: Cost group network diagram



Source: Atlas.ti

Figure 4.6 represents the non-OEM network diagram. The codes selected relate primarily to the services and spares provided to the mining industry by non-OEM companies. This figure indicates the use of alternative service providers in the mining industry not represented by the OEM. The mining industry uses alternative service providers to lower costs, availability of spares, availability of people, and the obligation to BEE and local community development.

Figure 4-6: Non-OEM network diagram



Source: Atlas.ti

4.2.2 Comparison of advantages and challenges of OEM spares

When referring to the advantages of the spares provided by the OEM to the mining industry, Table 4.1 below compares the advantages mentioned by both the mining industry and the OEMs.

Table 4-1: Advantages comparison of OEM spares

OEM spares advantages	
According to the mining industry	**According to the OEM**
Correct spares are delivered by the OEM.	The OEM products come with a warranty.
The spare of the OEM is of high quality.	Stable, reliable equipment. Spares can be relied on.
The OEM implements quality control systems.	Components achieve their life.
OEM spares increases the reliability of the equipment.	If the mine makes use of OEM parts, the OEM will defend the company.
The OEM spare parts last longer.	OEM supplies the correct spares for the proper application.
The OEM products come with a warranty.	OEM supplies a highly engineered piece of equipment.
The OEM parts provide insurance.	OEM does research and development on the machines.
The OEM spares can be trusted.	Components are designed to withstand specific forces, tensions, and strengths.
Cut out the middleman when dealing directly with the OEM.	Equipment goes through a full engineering cycle to ensure that it will work and perform well under the circumstances.
The OEM provides accountability on its parts.	High-quality products. Very high-quality standards. Quality materials, quality workmanship.
Drawings and spares availability.	OEMs are conservative in their design; spares generally tend to be over-designed.
Parts are difficult to replicate.	Preferential procurement plans and pricing.

There are multiple similarities in advantages mentioned by both the mining industry and the OEMs in providing OEM spares. These advantages refer to the quality and reliability of the products, the warranty of the products, accountability of the OEM for their spare parts, the durability of the spares, and the supply of the correct spares.

There are, however, some unique advantages of OEM spares mentioned by the mining industry that are not mentioned by the OEM. Those advantages are:

- Drawing and spares availability.
- The OEM parts are difficult to replicate.
- OEM parts provide insurance.
- The middle man is cut out when dealing directly with the OEM.
- The OEM implements quality control systems to ensure the quality of their products.

The OEM also mentions some unique advantages of spares provided by OEMs that are not mentioned by the mining industry. Those advantages are:

- Preferential procurement plans and pricing.
- Equipment goes through a full engineering cycle to ensure that it will work and perform well under the circumstances.
- OEM does research and development on the machines.

When referring to the challenges of the spares provided by the OEM to the mining industry, Table 4.2 below compares the challenges mentioned by both the mining industry and the OEMs.

Table 4-2: Challenges comparison of OEM spares

OEM spares' challenges	
Mine	**OEM**
Spares have long lead times.	Spares from the OEMs are more expensive.
OEM spares come with high prices.	Parts are not always available from the OEMs.
A limited number of spares are available.	The mining industry is slow compared to other industries, embracing concepts such as total cost of ownership or lifecycle management.
Repairs are done substandard.	Long lead times on spares from OEMs.
Warranties are not held up as much.	Limited visibility of the mean time between failures and forecasting of replacement parts.
Does not always have an aftermarket team.	Data forthcoming from customers about their needs regarding ware parts not up to standard.
	The speed of response of multinational OEM companies is slow.
	OEMs in South Africa currently face challenges with BEE regulation. Opening the market for third-party and pirate part suppliers.

There are multiple similarities in challenges mentioned by both the mining industry and the OEMs in providing OEM spares. These challenges refer to long lead times, availability of spares, and higher prices.

There are, however, some unique challenges on OEM spares mentioned by the mining industry that are not mentioned by the OEM. Those challenges are:

- The availability of aftermarket support from the OEM on spares is lacking.
- Repairs on OEM spares by the OEM are done substandard.
- Warranties from the OEM on spares are not really honoured as much.

The OEM also mentions some unique challenges on spares provided by OEMs that are not mentioned by the mining industry. These include challenges that the OEMs

face within their own companies as well as challenges the OEMs face with the mining industry. These challenges are:

- The mining industry is slow compared to other industries, embracing concepts such as total cost of ownership or lifecycle management.
- Limited visibility of the mean time to failure of the OEM equipment on the premises of the mines. This impacts the forecasting of replacement parts.
- Data forthcoming from customers about their needs regarding ware parts not up to standard.
- The speed of response of multinational OEM companies is slow.
- OEMs in South Africa currently face challenges with BEE regulation. Opening the market for third-party and pirate part suppliers.

According to some of the OEMs, in the past three years, especially with COVID, there was a great deal of cutback from mining companies, cutting back on purchasing OEM parts and components and sweating the assets. That resulted in a significant impact on supply and demand in the plants, and when the demand was not there, the OEMs had to cut back on personnel and the purchase of raw materials to produce parts and components. The net effect is that there was and still is a major increase in parts supplied and demanded after the COVID period. There is, however, not enough raw material or personnel available to manufacture and develop these parts and components.

4.2.3 Comparison of advantages and challenges of OEM services

When referring to the advantages of the services provided by the OEM to the mining industry, Table 4.3 below provides a comparison of the advantages mentioned by both the mining industry and the OEMs.

Table 4-3: Advantages comparison of OEM services

OEM service advantages	
Mine	**OEM**
The OEM provides backup services.	Advances product knowledge.
The OEM provides technical advice.	Provides a good service and value.
OEMs are trained and specialise in the particular machines.	Knows all the procedures from initiation up until decommissioning.
OEMs assist with route cause analysis.	Provides solutions to problems.
Lower risk of injury to people.	Keeps equipment as original as possible.
Accountability of work performed by the OEM.	OEM actually carries the guarantee.
Planning is better from the OEMs.	OEMs make use of OEM specifications.
Resources to assist them from head office.	Product improvement service letters from the factory are implemented on the equipment.
OEM gets the equipment up to standard.	Advises and supports the customers on how to maintain components.
OEMs provide product support.	OEMs consider the actual design.
OEMs assist with troubleshooting.	OEMs actively use the learnings from their services to develop or improve their products for future customers.
OEMs assist with the commissioning of installations.	OEMs have a global footprint.
OEMs support product development.	Experience from the OEM services team would also know of all the equipment on other sites.
Great deal of experience and know the equipment intimately.	The services are provided with the workmanship guarantee that it will be done correctly.
	Direct or indirect input to a level of design engineer. OEM artisan/engineer training has been developed or informed by the design process.
	Experience helps to get the solution quicker.
	OEM technicians or artisans are up to date with training.

There are multiple similarities in advantages mentioned by both the mining industry and the OEMs on service delivery by the OEM. These advantages include backup services, trained and competent personnel, experienced personnel, assistance with product development, OEMs getting support from head office, and the equipment being kept to OEM standards.

There are, however, some unique advantages of OEM services mentioned by the mining industry that are not mentioned by the OEM. Those advantages are:

- OEM service teams assist with the commissioning of installations.
- OEM service teams assist with fault finding on equipment.
- OEM service teams assist with root cause analysis on breakdowns on OEM equipment.
- Planning is better by the OEM service providers.
- There is a lower risk of injury to people when using the OEMs for aftermarket services.

There are also some unique advantages mentioned by the OEM on services provided by OEMs that are not mentioned by the mining industry. Those advantages are:

- OEMs provide good service and value.
- OEM services actually carry a guarantee.
- OEMs use OEM specifications when performing services and consider the actual design.
- Product improvement service letters from the factory are implemented on the equipment.
- OEMs actively use the learnings from their services to develop or improve their products for future customers.
- Experience with products on multiple sites and customers helps to get the solution quicker.

When referring to the challenges of the services provided by the OEMs to the mining industry, Table 4.4 below compares the challenges mentioned by both the mining industry and the OEMs.

Table 4-4: Challenges comparison of OEM services

OEM service challenge	
Mine	**OEM**
OEMs do not appoint the best quality people.	OEMs are forced to use a local contractor so that the mines can improve community development.
The competency of OEM service teams is an issue.	OEM charges more for the services than local contractors do.
OEM is not always involved.	OEM is only called in to assist when there is a breakdown. In the meantime, they need to carry the cost.
Lack of experience of OEM service personnel.	Modifications are made to equipment without consulting or involving the OEM.
Mine does not specify requirements from their side to the OEMs.	Equipment maintenance falls behind if the mine does not use the OEM to perform maintenance on equipment.
OEMs are not always reachable or available.	Mines are deviating from the original specifications.
OEMs perceive their scope towards the mine.	If the mine does not follow OEM maintenance, there will be numerous failures on their equipment, and they will have more cost into the equipment due to not using the OEM parts by modifications inside their systems.
OEMs are not involved in asset care.	The mine forces the OEM to use local communities and companies to do the physical maintenance work under the supervision of the OEM.
OEMs are not setting up lifecycle plans.	Onboarding OEM people and getting

	people on site are unnecessarily complicated in the mines.
OEMs are not setting up quality control plans.	South African skills drainage affects the quality of work by OEMs.
OEMs are not aligned with the requirements of the mine.	Dilution in the skillset of a multinational OEM company with a large product portfolio. Jack of all trades, but master of none.
Pricing of OEM services is expensive.	
OEMs need to utilise more local hands.	
Mines do not get what you pay for from the OEMs. Mine is paying quite a high rate for people who are still learning.	
OEMs are not always site compliant.	
OEMs have subcontractors helping them and doing the majority of the work.	
Skill drain where employees of the OEM either left South Africa or moved to another company.	
Succession planning by the OEMs is not done correctly.	
Globalisation causes the OEMs to become much less intimately attached to their customers.	
OEMs are not involved or visible on the ground level.	

There are multiple similarities in challenges mentioned by both the mining industry and the OEMs on service delivery by the OEM. These challenges involve the high cost of OEM services, the demand to use local labour, and the skill drainage taking place in South Africa, where the OEM is losing highly skilled employees to different countries.

There are, however, some unique challenges on OEM services mentioned by the mining industry that are not mentioned by the OEM. Those challenges are:

- OEMs do not appoint the best quality people.
- The competency of OEM service teams is an issue.
- OEM is not always involved.
- Lack of experience of OEM service personnel.
- The mine does not specify requirements from their side to the OEMs.
- OEMs perceive their scope towards the mine.
- OEMs are not always reachable or available.
- OEMs are not involved in asset care.
- OEMs are not setting up lifecycle plans.
- OEMs are not aligned with the requirements of the mine.
- Mines do not get what you pay for from the OEMs. Mine is paying quite a high rate for people who are still learning.
- OEMs are not always site-compliant.
- OEM has subcontractors helping them, doing the majority of the work.
- Succession planning by the OEMs is not done correctly.
- Globalisation causes the OEM to become much less intimately attached to their customers.
- OEMs are not involved or visible on the ground level.

There are also some unique challenges mentioned by the OEM on services provided by OEMs that are not mentioned by the mining industry. These include challenges that the OEMs face within their own companies as well as challenges the OEMs face with the mining industry. These challenges are:

- The OEM is only called in to assist when there is a breakdown. In the meantime, they need to carry the cost of the employees.

- Modifications are made to equipment without consulting or involving the OEM.
- Equipment maintenance falls behind if the mine does not use the OEM to perform maintenance on equipment.
- Mines are deviating from the original specifications of the OEMs. If the mine does not follow OEM maintenance, there will be numerous failures on their equipment, and they will have more cost into the equipment due to not using the OEM parts by modifications inside their systems.
- The mine forces the OEM to use local communities and companies to do the physical maintenance work under the supervision of the OEM.
- Onboarding OEM people and getting people on site are unnecessarily complicated in the mines.
- Dilution in the skillset of a multinational OEM company with a large product portfolio. Jack of all trades, but master of none.

4.2.4 Future role improvements and recommendations

When referring to the future role of OEMs in the mining industry, Table 4.5 below compares the expected and foreseen future roles mentioned by both the mining industry and the OEMs.

Table 4-5: Future role of OEMs in the mining industry

The future role of OEMs	
Mine	**OEM**
OEMs will assist with reliability and stability.	OEMs will take part in on-site services of the clients and provide insight.
OEMs will provide relevant technical expertise.	OEMs will provide solutions and improve equipment.
OEMs will assist with research and development.	OEMs will supply the shortage of skills in South Africa. Customers are becoming more and more reliant on our skillset.
OEMs will provide more of an advisory and less of an execution role.	OEMs will drive innovation and the development of new solutions.
OEMs will provide aftermarket support on equipment.	OEMs will assist in reducing the carbon footprint of their equipment.
	OEMs will step away from being a reactive type of repair to a more proactive repair to improve reliability.
	OEMs will be more strategic when working with their customers to ensure their plants are available and have the correct spares.
	OEMs will bring new technology to the market that assists their customers to be more energy efficient and perform better.

There are multiple similarities in future roles mentioned by both the mining industry and the OEMs. These future roles of the OEMs involve assisting the mining industry with the reliability and stability of equipment, providing clients with insight and technical expertise, providing aftermarket support, and research and development on mining equipment.

The mining industry stated that the OEMs will provide more of an advisory role and less of an execution role in the future. The following future roles were uniquely mentioned by the OEMs:

- OEMs will take part in the on-site services of the clients.
- OEMs will supply the shortage of skills in South Africa. Customers are becoming more and more reliant on our skillset.
- OEMs will assist in reducing the carbon footprint of their equipment.
- OEMs will step away from being a reactive type of repair to a more proactive repair to improve reliability.
- OEMs will bring new technology to the market that assists their customers to be more energy efficient and perform better.

When asked how the mining industry can improve to allow the OEMs to improve spares and service delivery in the mining industry, the following recommendations were made by the OEMs:

- The mining industry should be more open to SLAs and long-term contracts.
- There should be more collaboration between mining companies and the OEMs to solve problems.
- The mining industry must put maintenance and repair contracts in place with the OEMs. These contracts will allow the OEMs to give their clients a specific discount.
- Technical departments of the mining industry, such as the end users and site engineering managers, should have input on what components to purchase. Currently, these decisions are made by the cost-driven commercial

department, which does not have the technical background to make a decision.

- A gap between the purchase request and the order placement impacts the validity of quotes and the agreement on prices. The mining industry needs to reduce the duration between the quoting of spares and services and the ordering thereof.
- Monthly meetings need to be held between the OEMs and the mining industry to discuss the challenges between the OEMs and the mine.
- The mining industry is process-heavy and bureaucratic to get anything done, and the mines tend to dictate the rules. The mining industry needs to be more open about what their requirements are.
- The process of order placement on quoted items needs to be much quicker. Early placement of orders will assist the OEMs in booking service teams to be available for specific timeframes and allow sufficient time to make the team's site compliant.
- Closer collaboration and more openness from the mining industry towards the OEM suppliers. There needs to be a more collaborative relationship between the two entities rather than a transactional relationship.
- BEE contract reviews, especially when it comes to OEMs that are owned abroad and signing preferential procurement agreements.

4.3 SUMMARY

This chapter contains the analysed results from the qualitative study to determine the advantages and challenges OEMs face in delivering spares and services to the mining industry in South Africa. The results were divided into three sub-divisions.

One hundred twenty-seven (127) codes were identified using Atlas.ti, and seven distinctive themes were identified. Network diagrams were drawn up for every theme and were then analysed. The codes were obtained and combined from both the OEM representative interviews and the mining industry representative interviews.

Comparisons were made between the advantages and challenges of spares and service delivery mentioned by the OEMs and the mining industry. The unique advantages and challenges mentioned by only one of the two entities were also highlighted in this chapter. This was done to highlight the difference in perception between the OEMs and the mining industry in South Africa.

The future role of the OEMs in the mining industry was also compared and discussed in detail. The chapter concluded with the views from the OEMs on how the mining industry can improve to allow the OEMs to deliver a better service to the industry.

The OEMs demonstrated maturity during the interview phase of the study, as they mentioned shortcomings and challenges they face with delivering spares and services within their own companies.

In the next and final chapter, the data obtained in the study will be used to draw conclusions and recommendations. The attainment of the primary and secondary objectives and the study's limitations will be discussed. A list of future fields of study will also be included in the final chapter.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The data from the qualitative research study was presented and analysed in the previous chapter. In Chapter 5, the data obtained from the study will be used along with the theory obtained in Chapter 2 to determine whether the primary and secondary objectives have been met.

Conclusions will be drawn from the comparisons between the theory of Chapter 2 and the data obtained from the qualitative study in Chapter 4. These conclusions will also place focus on the significant issues identified in the qualitative research study in Chapter 4 to highlight the main challenges between the OEMs and the mining industry of South Africa.

Recommendations will be made in this chapter to address issues identified in the qualitative research study with specific reference to spares and service delivery from the OEMs to the mining industry in South Africa. These recommendations will be aimed at breaking down the barriers between the OEMs and the mining industry of South Africa to allow for a better relationship between the two entities.

Finally, the study's limitations and recommendations for possible future fields of study will be discussed in the chapter. This will assist in further developing the study to include possible alternative sectors and commodities to address the significant issues identified during the qualitative research study.

5.2 RESEARCH OBJECTIVES

The achievement of the primary and secondary research objectives of the study will be discussed in the following section. The primary objective of the research study was to explore the advantages and challenges of aftermarket services of OEMs in the South African mining industry. Although multiple challenges were identified during the research study, most of them can be resolved if the OEMs and mining industry work together to break down the barriers between them.

The study will assist the mining industry and the OEM companies in South Africa to understand better the needs and challenges both parties face. The study will also

provide insight and guidance to eliminate perceptions formed and allow for a more sustainable business environment.

5.2.1 Research objective 1: Explore the advantages and challenges of aftermarket services of the OEMs in the South African mining industry.

Research objective 1, which was also the study's primary objective, was met during the study. Research analysis and a literature review were executed to understand the problem statement. A practical application of the qualitative study method and the evaluation of the data obtained was used to conduct the study.

5.2.2 Research objective 2: Determine the advantages and disadvantages of using OEM spares.

The major advantages mentioned by both the mining industry and the OEMs in South Africa refer to the quality and reliability of the products, the warranty of the products, the accountability of the OEM for their spare parts, the durability of the spares, and the supply of the correct spares.

The major disadvantages of using OEM spares in the mining industry are long lead times, availability of spares, and higher-than-normal prices. OEMs in South Africa currently face challenges with BEE regulation, and this is opening up the market for third-party and pirate-part suppliers. Warranties from the OEM on spares are not really held up as much.

5.2.3 Research objective 3: Determine the service-level requirements by the mining industry for the OEMs.

The OEM companies are expected to deliver backup services and to provide the mine with trained and competent personnel. The OEM must consist of experienced personnel who assist their clients with product development and are expected to keep the equipment to the standards of the OEM, as original as possible.

The future role of OEMs in the mining industry will be to assist the mining industry with the reliability and stability of equipment, provide clients with insight and technical

expertise, provide aftermarket support, and research and development on mining equipment.

The mining industry will also rely less on their in-house employees to provide these high skills and competencies in South Africa and more on the OEMs to provide these services. They will also rely on the OEMs to assist them with local community development.

5.2.4 Research objective 4: Determine the quality, technology, and availability perceptions of mining companies in South Africa towards the OEMs.

The perception from the mining industry is that the OEMs are not appointing the best quality employees and that they lack experience. The mining industry stated that they do not believe the OEMs have very good succession plans. The OEMs are not always involved and visible from the ground level, and the OEMs perceive their scope of work towards the mine.

The mining industry stated that the OEMs are not always available and are not involved in asset care. The mining industry stated that globalisation causes the OEM to become much less intimately attached to their customers. The mining industry stated that the OEMs will provide more of an advisory role and less of an execution role in the future.

5.2.5 Research objective 5: Recommendations about areas of improvement to increase the collaboration between the mining industry and the OEMs.

During the research study, there were multiple demands from the mining industry and the OEM companies for long-term contracts and service-level agreements. Poor communication leads to perceptions and a lack of long-term planning. Implementing these contracts will create clarity and direction, assist in a better relationship between the two entities, and improve the mining industry’s sustainability.

The mining industry mentioned that the OEMs are not involved on the ground level and are not always available or accessible to get hold of. The presence of an on-site skilled and competent OEM representative will eliminate a majority of the challenges

mentioned by the mining industry and the OEM companies. The representative will act as the primary source of communication between the two entities and will bridge the gap between them.

The OEMs listed multiple areas where the mining industry can improve to allow them to deliver better services than in the previous chapter. The main improvements include monthly meetings, the need to be more open on their requirements, closer collaboration and the placement of orders on quoted spares and services must be quicker. The OEMs also requested BEE contract reviews, especially when it comes to OEMs that are owned abroad.

5.3 CONCLUSIONS

There are multiple similarities when comparing the research results from Chapter 4 with the theoretical information obtained from Chapter 2. High financial costs were by far one of the major topics when it came to spares and service delivery by the OEMs to the mining industry. The theory and results from the qualitative research study acknowledge the OEMs' high skills and quality of spares, the advantages of warranties, and the challenge of spares' availability and long lead times of spares delivered by the OEMs.

There were, however, multiple explanations and justifications for the higher-than-normal pricing of the OEM spares and service deliveries. The major issues identified in the qualitative research study were the following:

- The skills drainage in South Africa and its effect on the quality of work, the reputation of OEM companies, and the cost of services.
- The mining industry in South Africa requires local community development, forcing the OEMs to use local companies for spares manufacturing and local labour brokers for labour purposes.
- The demand for long-term contracts and service-level agreements from both the OEMs and mining industry in South Africa.

5.3.1 Skills drainage in South Africa

Skills drainage is a major issue in South Africa, significantly affecting OEMs and the mining industry. The high demand for qualified and competent artisans and engineers comes at a price. This is one of the most significant contributors to the higher-than-normal prices the OEMs charge the mining industry for service delivery.

It was mentioned multiple times by the mining industry that the skill and competency levels of the OEMs are deteriorating and that they are losing old and experienced employees. This results in more extended downtimes of the mining equipment as the duration of fault finding increases and the mean repair times also increase.

The mining industry is, however, still paying a premium price for less experienced OEM service providers due to successor plans not being in place from the OEMs. The mining industry is, therefore, questioning the prices from the OEMs as they are not receiving the full value for the money they are paying for service delivery.

According to the research results, the mining industry will rely less on their in-house employees to provide these high skills and competencies in South Africa and more on the OEMs to provide these services.

This skills drainage is causing a snowball effect in the mining industry of South Africa. For the OEMs to retain these highly skilled employees in their companies, they are forced to increase the benefits and salaries of these employees. The OEMs are then forced to increase their clients' high rates. The mining industry must then cut costs in other vital sectors such as exploration, training, long-term projects, and R&D to fund the OEM services.

5.3.2 Local community and non-OEM spares and services

The mining industry faces many challenges with the requirement to improve local community development in South Africa. These responsibilities are then handed over and forced onto the OEMs to use local community companies to repair and manufacture spares. The mining industry is moving towards a system where they will provide the OEMs with labour from the local community, and they will only rely on the OEMs for supervision and high-skill inputs.

The risks involved are substandard work and safety issues when referring to the local community members for labour services. These community members did not receive the training from the OEMs. Therefore, they cannot deliver the highly skilled labour required by OEM to ensure the quality and availability of the equipment. It is also difficult for the OEMs to train the local community members, as they will not be guaranteed to receive the same people every time to perform maintenance under their supervision.

There are many risks involved in the use of local community companies to repair and manufacture spares. These risks involve the quality of work, materials used, and the duration it takes to repair and manufacture the components. The design and manufacturing of the OEM spares are considered to be a highly advanced piece of engineering, which is difficult to replicate. The drawings, designs, and manufacturing processes are the intellectual property of the OEMs that they will not share with any other business. These local companies are also not trained or competent to manufacture the highly designed spares of the OEMs.

Because the mines are forced to use the local communities to provide specific spares, the risk of premature failure of the parts leads to more frequent breakdowns and longer downtime of equipment, a reduction in machine availability, and safety risks to employees. The mines indicated in the study that they will seldom use providers other than OEMs for spares on critical, high-value equipment for these reasons.

If the mining industry made modifications using non-OEM spares, and the OEMs were not informed or involved, the duration of downtime would increase according to the OEMs. This is due to increased difficulty in performing fault finding, and the spares must first be ordered to convert the equipment back to the original OEM design.

The procurement department also has the final say in purchasing spares in the mining industry. This is a challenge for the end-users in the mining industry as they do not involve the foreman who will use and install the spares. The procurement department is usually cost-driven when it comes to the purchasing of spares and the hiring of labour for maintenance and repairs, and this has an impact on machine availability and product quality. The OEM spares and labour teams will likely not be

procured by the procurement department as they tend to be more expensive than a third-party or local community spares and labour provider.

5.3.3 Demand for service-level agreements

There is a demand from both the mining industry and the OEMs for long-term service-level agreements and contracts. The mining industry and the OEM representatives mentioned the need for better communication multiple times in the research study.

Issues such as long lead times on spare delivery, spares' availability, labour services' availability, fluctuation in prices, and miscommunication of the client requirements and specifications result from a lack of communication and planning from both entities. The industry lacks clear guidelines and communication for required short- and long-term spares and services.

The late acceptance and payment of quotations from the mining industry to the OEMs are causing financial loss to the OEM companies. A transactional relationship between the two entities is causing damage to the relationship between mining houses and the OEMs. It prevents negotiation, communication, and the ability to work together to find solutions.

5.4 RECOMMENDATIONS

Multiple practical recommendations are identified to address the skills drainage in South Africa, the use of local community members to provide labour during maintenance tasks, and the implementation of SLAs in the mining industry. Implementing these recommendations will resolve most of the challenges faced and improve the relationship and service delivery by the OEMs in the mining industry.

The improved relationship will allow for improved technology through increased investment in R&D, improved profitability and contribution to the GDP of South Africa, improved safety, health, and environmental conditions, and increased life of mine, job creation, and a reduction in financial pressure.

To overcome the issue of inexperienced and incompetent employees, created by skills drainage from the OEM companies in South Africa, the OEMs should focus on

and invest in OEM training facilities. The training facilities should be able to upskill the employees of the OEM company to the point where they are competent to perform their tasks and are able to know the OEM equipment intimately. This will reduce the downtime on the machinery, and the customer will receive the professional service they are paying for. If the employee is still in training and requires practical experience, the employee should be accompanied by an experienced and competent representative of the OEM.

OEMs must focus on succession planning to mitigate the risk of skills drainage in South Africa. This investment will allow the OEMs to build depth in their skills and deliver a professional service to the mining industry with competent employees. The skills and knowledge of the experienced employees must be transferred to the new and inexperienced employees. This investment will justify the higher-than-normal rates that the OEMs charge for service delivery.

The OEMs must provide their clients with an on-site OEM representative to improve communication, establish the meantime to equipment failure, and improve the visibility of running data obtained from the equipment. This will improve the planning of spare orders and reduce the lead time of spare delivery. The payment of the OEM representative must be determined in the service-level agreement between the two entities. The representative will also be able to follow up on orders placed and will act as the middleman between the two entities.

The representative of the OEM on the client's premises will benefit both the OEMs and the mining industry, as an increase in production and machine availability will improve. This will increase the reputation of the OEMs and improve the relationship between the mining industry and the OEMs.

The presence of a skilled, trained, and competent OEM representative on the premises of the client will resolve issues such as site compliance and fault finding on equipment, and the OEM representative can provide the client with technical advice. The OEM representative can also assist with the training and upskilling of mine in-house employees and local community members. This will assist in resolving the issue of using unskilled local community employees and should be considered an investment of the mining industry in local community development.

The maintenance model for maintenance services conducted in the mining industry should consist of local labour companies that provide the labour and highly skilled OEM employees in a supervision role to oversee the work being conducted. This will ensure the quality of work and improve local community development. The local community members must be trained and competent to carry out their duties safely and professionally.

To improve spares and service delivery by the OEMs to the mining industry, the OEMs need to focus on what the mining industry deems to be vital to them. The mining industry is the client, and the OEMs need to focus on the client's priorities, requirements, and specifications. This will prevent miscommunication and perceptions between the two entities. However, the industry must move from a transactional relationship to a more collaborative one. This will improve communication and create a platform to raise concerns and provide better solutions.

A focus must be placed on negotiating and implementing long-term contracts and service-level agreements. This will assist with proper planning on spares, improving availability and prices.

Many issues can be resolved if the communication between the mining industry and the OEMs improves. Regular meetings between the two entities can achieve this, and clear guidelines and scopes of work need to be drawn up in writing and agreed upon, including a description of what services need to be provided. The duration of the tasks, pricing, date required, and the required resources such as tools, skilled personnel, spares, and onboarding requirements must be specified. This must be done well in advance to ensure enough time for payment and availability of resources.

The procurement department must involve the end-users in the process of purchasing spares to fully understand the reason for using OEM spares. This will prevent the purchase of incorrect spares and will increase the availability of the machines, thereby improving profitability in the long term.

The OEMs must also consider improving the service delivery to the mining industry to justify the higher-than-normal prices of the OEM spares. This can include assisting the mining industry with aftermarket asset care and setting up OEM equipment

lifecycle costs. The OEMs can also implement the total cost of ownership, including the purchase price and the operating cost over the asset's life span.

5.5 FUTURE RESEARCH AND LIMITATIONS

The geographical demarcation is considered a limitation of this study due to the networks and relationships the researcher has with participants in the Gauteng and Limpopo Provinces in South Africa. Due to time and budget constraints, the research did not take place in the remaining provinces in South Africa and can, therefore, not be considered a true reflection of the entire South Africa. This will provide the opportunity for future research in alternative provinces in South Africa.

The mining industry was considered a limitation in this study due to the researcher's networks and relationships with participants in the gold and platinum mining industries. Therefore, the research might not accurately represent all types of mining industries in South Africa, and industries such as coal mines, iron ore mines, and diamond mines, just to name a few, were not included in the study. This will provide the opportunity for further future research in alternative mining sectors and commodities in South Africa.

The mining processes were considered a limitation foreseen for this study due to the networks and relationships the researcher has with participants in specific mining processes. The processes the researcher mainly had access to are the mining process (drilling, blasting, loading, and hauling) and the concentrator plants on the mine premises (crushing, milling, floatation, and filtering). Therefore, the research might not be a true representation of all types of mining processes in South Africa and processes and plants such as smelting, purification, and refining, to name just a few, were not included in the study. This provides the opportunity for further future research into alternative mining processes in South Africa.

Another limitation was the sampling type, which was a non-probability sampling method because the researcher used participants from his networks and relationships at work, and a snowball method was used to obtain alternative participants to the study.

The following research topics will contribute to this research topic and the field of study. These future studies can also address particular critical challenges identified in

the research study, thereby further improving the relationship between the OEMs and mining industries in South Africa. Future research topics and factors to be considered are:

- Future research on different mining processes, such as processing and smelting plants.
- Future research on OEM services in different commodities and areas, such as iron ore and diamond mines in the Northern Cape or coal mines in Mpumalanga.
- Research on the impact of local community development in the mining industry in South Africa.
- Research on the impact of skills drainage on the OEMs and mining industry in South Africa.
- Research on the impact of service-level agreements in the mining industry of South Africa.

5.6 SUMMARY

The mining industry's direct GDP contribution in South Africa was 8.7% in 2021 while employing 370 000 people. Maintenance is crucial in ensuring equipment reliability and competitiveness. Mining organisations consider outsourcing maintenance, but factors such as process understanding and the choice between internal or external maintenance play a critical role. OEMs are essential for innovation, energy efficiency, and environmental impact reduction. The study's problem statement highlights challenges in maintaining OEM relationships and the impact it has on the costs, safety, and the environment. This calls for improved collaboration and communication between OEMs and mining companies to maximise equipment efficiency and industry contributions.

The study consists of two phases. The first phase was a literature review of the mining industry of South Africa, mainly focused on the maintenance services provided by different entities, and the second phase was a qualitative research study to determine the advantages and challenges of OEM services in the mining industry of South Africa. The mining industry and the OEM representatives were interviewed

using open-ended questions to compare the perceptions between the two entities. The results indicated the unique advantages and challenges mentioned by both the mining industry and the OEMs. Recommendations were also made on how service delivery can be improved.

The study highlights high financial costs as a significant concern regarding spares and service delivery by OEMs to the mining industry. Both theory and research acknowledge the high quality of OEM spares, the advantages of warranties, and the challenges related to spares' availability and long lead times. However, explanations and justifications are provided for the higher-than-normal pricing of OEM spares and services.

The qualitative research identifies significant issues, including skills drainage in South Africa, the mining industry's requirement for local community development, and the demand for long-term contracts and service-level agreements from both OEMs and the mining industry. Skills drainage is identified as a significant problem affecting quality, reputation, and service costs, leading to higher prices for OEM services. The mining industry's emphasis on local community development forces OEMs to engage local companies, which poses quality and safety risks.

The need for improved communication and long-term agreements is highlighted as a way to address various issues, including long lead times, spares' availability, fluctuating prices, and late acceptance of quotations, all of which have financial implications for OEM companies. The findings and recommendations in this document emphasise the demand for improved communication and collaboration between the mining industry and the OEM companies in South Africa, as the one cannot exist without the other. This will allow for better growth and sustainability in the mining sector in South Africa.

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APPENDICES
Appendix 1 – Proof of Language Editing Letter

To whom it may concern

Cecile van Zyl
Language editing and translation
Cell: 072 389 3450
Email: Cecile.vanZyl@nwu.ac.za

19 October 2023

Dear Mr / Ms

Re: Language editing of mini-dissertation (Exploring the impact of original equipment manufacturer aftermarket services in the mining industry in South Africa)

I hereby declare that I language edited the above-mentioned mini-dissertation by Dawid De Ridder (student number: 21627495).

Please feel free to contact me should you have any enquiries.

Kind regards

Cecile van Zyl

Language practitioner

BA (PU for CHE); BA honours (NWU); MA (NWU)
SATI number: 1002391

Appendix 2 – Ethics Approval Letter

Private Bag X1290, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Fax: 018 299-4910
Web: http://www.nwu.ac.za

Senate Committee for Research Ethics
Tel: 018 299-484
Feziwe.Mseleni@nwu.ac.za

28 February 2023

ETHICS APPROVAL LETTER OF STUDY

Based on approval by the **Economic and Management Sciences Research Ethics Committee (EMS-REC)** on 24/02/2023, the Economic and Management Sciences Research Ethics Committee hereby **approves** your study as indicated below. This implies that the North-West University Senate Committee for Research Ethics (NWU-REC) grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: Exploring the impact of original equipment manufacturer aftermarket services in the mining industry in South Africa

Study Leader/Supervisor (Principal Investigator)/Researcher): Dr J Jordaan – MBA
Student: de Ridder, DH (21627495)

N	W	U	-	0	0	5	8	0	-	2	3	-	A	4
Institution				Study Number						Year			Status	

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Application Type:
Commencement date: 1/2/2023 **Risk:** Low
Expiry date: 1/2/2024
Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.

Special in process conditions of the research for approval (if applicable):

•

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply:

- *The study leader/supervisor (principle investigator)/researcher must report in the prescribed format to the EMS-REC:*
  - *annually (or as otherwise requested) on the monitoring of the study, whereby a letter of continuation will be provided, and upon completion of the study; and*
  - *without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.*
- *The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the study leader/researcher must apply for approval of these amendments at the EMS-REC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.*
- *Annually a number of studies may be randomly selected for an external audit.*
- *The date of approval indicates the first date that the study may be started.*

n the interest of ethical responsibility, the NWU-SCRE and EMS-REC reserves the right to:

- *request access to any information or data at any time during the course or after completion of the study;*
  to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process;
- *withdraw or postpone approval if:*
  - *any unethical principles or practices of the study are revealed or suspected;*
  - *it becomes apparent that any relevant information was withheld from the EMS-REC or that information has been false or misrepresented;*
  - *submission of the annual (or otherwise stipulated) monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and / or*
  - *new institutional rules, national legislation or international conventions deem it necessary.*

The EMS-REC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the EMS-REC or the NWU-SCRE for any further enquiries or requests for assistance.

Yours sincerely,

Mark Rathbone

Digitally signed by Mark Rathbone
DN: cn=Mark Rathbone, o=North-West University, ou=Business management, email=mark.rathbone@nwu.ac.za, c=ZA
Date: 2023.02.28 09:10:21 +02'00'

Prof Mark Rathbone
Chairperson: NWU Economic and Management Sciences Research Ethics Committee

Appendix 3 – Informed Consent Letter

Informed consent letter

Exploring the impact of original equipment manufacturer aftermarket services in the mining industry in South Africa.

CONSENT TO TAKE PART IN RESEARCH

I hereby confirm that:

- I agree to participate in this research study voluntarily.
- I understand that I can withdraw from the interview at any time and can refuse to answer any question even though I agreed to participate without consequences.
- I understand that I can withdraw permission to use the data obtained from me in the interview at any time, in which case the data will be deleted.
- I agree that the nature and purpose of the study were explained to me and I was granted the opportunity to ask questions regarding the study before the interview.
- I understand that the data obtained will be used as part of the research study of the MBA program.
- I understand that open-ended questions will be asked during the interview and that the session will be recorded on an audio recording device.
- I understand that the information that I provide will be treated confidentially and that my identity will remain anonymous.
- I Understand that I will be able to contact any person involved in the research to seek further information and clarification.
- I understand that I will have access at any time to the information I provided during the study.

Student Name: Dawid Hermanus de Ridder Contact/cell.: 066 288 8468

Degree: Master in Business Administration Affiliation: North West University

_____ _____

Signature of participant Date

Appendix 4 – Mining Question List

Exploring the impact of original equipment manufacturer aftermarket services in the mining industry in South Africa

Interview Questions – Mining Industry

1. What is your experience level of interaction with the OEM suppliers?
2. What are the advantages of using the OEM for aftermarket spares and maintenance services in the mining industry?
3. What are the challenges of using the OEM for aftermarket spares and maintenance services in the mining industry?
4. How likely are you to use OEM spares when repairing plant and mining equipment?
5. How likely are you to use the OEM maintenance team to maintain plant and mining equipment?
6. What alternatives does the mine use for aftermarket spares and maintenance services?
7. What do you see as the future role of the OEMs in the mining industry?
8. How can the OEMs improve service delivery to the mining industry?

Appendix 5 – OEM Question List

Exploring the impact of original equipment manufacturer aftermarket services in the mining industry in South Africa

Interview Questions - OEM

1. What is your experience level of interaction with the mining industry?
2. What are the advantages of using the OEM for aftermarket spares and maintenance services in the mining industry?
3. What are the challenges of supplying OEM aftermarket spares and maintenance services in the mining industry?
4. What are the challenges for the OEM if the mines do not use OEM spares and OEM maintenance services during repairs on equipment?
5. What are the risks to the mining industry if modifications are made to OEM equipment without consulting or involving the OEM?
6. What do you see as the future role of the OEMs in the mining industry?
7. How can the mining industry improve to be more accessible to the OEMs to provide service delivery and spares to the mining industry?
8. What is your perception of why the mining industry refrains from using the OEMs for aftermarket spares and services?