IDENTIFYING BARRIERS FACED BY KEY ROLE PLAYERS IN THE SOUTH AFRICAN MANGANESE INDUSTRY

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ABSTRACT

South Africa has abundant manganese ore deposits. Yet, it fails to capitalize on this resource and reach possible levels of economic benefit in this commodity's industry. This paper aims to identify the barriers to economic growth for key role players in the manganese industry. The manganese value chain is mapped out to determine the different manufacturing processes, role player dependencies and factors shaping the value chain. Representatives from the various sectors in the value chain were interviewed in order to identify, categorise and rank the barriers according to their impact on economic growth. This enables areas for improvement to be identified in order to promote the development of the local manganese industry.

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1. INTRODUCTION

The manganese industry is an integral part of South Africa's well-established mineral and commodity sector. It is well endowed with natural reserves and has developed local technical expertise in producing value-added products i.e. manganese ferroalloys since 1937 [1]. Together with many other well-established mineral industries in South Africa, the manganese industry has served as a catalyst for the advancement of an extensive physical infrastructure in the country and similarly made significant contributions to research and development, technologic advancements and market relationships throughout the various sectors in the manganese value chain.

South Africa's vast mineral wealth has long served as an attractive option for large capital investments. This natural wealth is the driving force for the development of an integrated mining industry, due to the sharing of infrastructure and the overlap of shareholder interests. The mining industry has formed a dominant part of the country's economy and is responsible for revenues earned through trade in global markets [2]. The establishment of mining-related activities, together with the promotion of downstream beneficiation by government through various policies and strategies, has placed focus on unlocking economic value further downstream from mining to other activities, such as further processing, refining and fabrication of high value products [2]–[4].

The steel and manganese industries are closely related and regularly influence each other. The outlook of the steel industry is essential for manganese for the following four reasons:

1. Manganese is primarily used in steel manufacturing, which accounts for approximately 90 % of the total manganese demand [5]–[8].
2. It is used as an alloying material.
3. There are no suitable alternatives for manganese in steel production [5], [8], [9].
4. Vertical integration in the global manganese value chain (which means leading steel companies are to some degree involved in manganese production) [5], [10].

South Africa is a leading player in the international manganese ore and manganese ferroalloys industry. It is the largest producer and exporter of manganese ore and a major role player in ferromanganese production and global trade of these alloys [1], [11]. The abundance of natural resources, relatively low electricity costs and cheap labour are historical factors that have contributed to this dominant position in the manganese value chain [1], [12].

There are numerous factors that have progressively grown during the past couple of years which has had detrimental effects on the manganese industry and threatened the country's dominant position. These factors include [1], [12]:

1) New legislation affecting the mining and minerals industry;
2) A shortage of local suitable reductants;
3) Depletion of surplus electricity generation capacity with resultant threat of escalation of electricity prices, and;
4) Pressure resulting from the recent fall in the manganese commodity market.

Furthermore, the manganese ore and alloy production capacity added during the commodity boom cycle (between 2001 and 2007 when the manganese commodity cycle was at a peak [13]) has declined, resulting in the current market remaining oversaturated and in ample overcapacity of manganese ore and alloys [14]. As a repercussion, manganese is presently one of the worst performing commodities with prices at its lowest point, not seen since the 90's [14].

It is evident that the manganese industry like so many other metal and mineral industries, has entered an extremely difficult period. This has led to the industry shifting focus to address challenges not only in terms of short term gain, but to ensure long-term viability [1]. These measures include appealing for a review of specific legislative policies in the mining and mineral market to improve support from government, improvement of operational efficiency, development of port and rail infrastructure, as well as initiatives to expand electricity generation and coke production capacity [1].

1.1 Research objective

The aim of this study is to establish the importance of various factors that impede economic growth throughout the value chain in the South African manganese industry. This aim is supported by three research objectives, namely:

1. Determine the different stages and branches of the South African manganese value chain;
2. Identify the barriers faced by the role players within each of these stages and branches with regards to economic growth, and;
3. Rank these barriers according to their impeding effect on economic growth.

1.2 Literature gap to be addressed

The published literature pertaining to the South African manganese industry provides a detailed layout of the manganese value chain and how the country relates to the global market [1], [5], [10], [12]. Much of the literature, however, is slightly outdated, relying on sources published before the sharp rise in electricity tariffs were implemented, the regular occurrence of unreliable power supply, the manganese commodity cycle facing a record low point, increased labour disputes in the mining sector, and government policies implemented to support beneficiation initiatives. All of which gained traction in the mid to late 2000's.

Furthermore, there is a void in this research pertaining to the major problems and constraints faced by the different role players in this industry with regards to economic growth and the impact that these constraints have on their businesses. There also is a lack of information pertaining to the impact that these role players exert one another and how these constraints affect their relationships. At present, there is no research available where the main barriers to economic growth of individual role players in the manganese value chain is identified and ranked according to their impact on the business. This paper addresses these issues by providing an update of the current state of affairs of the South African manganese industry and its position in the global value chain, as well as identifying the current constraints faced by the various local role players and the impact these constraints have on their economic growth.

2. INDUSTRY BACKGROUND

South Africa hosts about 75 to 80 percent of the world's identified manganese resources and approximately 24 per cent of the world's reserves [12], [15]. Over 90 per cent of the reserves are located in the Kalahari Manganese Fields (KMF) which is situated in the Northern Cape and has an estimated 4 billion tons of manganese reserves [12]. There are two main types of manganese ore present in the Kalahari deposit, namely low-grade primary sedimentary Mamatwan-type ore and high-grade Wessels-type ore [12], [13]. The Mamatwan type contains between 20 to 38 per cent (less than 40%) of manganese in its ores, while the Wessels type, which only makes up 3 per cent of the total ore body, contains 45 to 60 per cent manganese [16], [17]. The manganese ores of the KMF are characterized by their low phosphorus content, which makes it a suitable feedstock for the steel industry.

The country produces high-grade ore, features increasing mining operations and is a significant producer of manganese alloys. The manganese supply and demand closely follows the iron and steel market trends due to manganese's primary use in steel manufacturing, but is also used in numerous other applications. Manganese is the 12th most abundant element in the earth's crust and the 4th most abundant of the metals in commercial use [9].

Manganese ore is obtained in the form of manganese oxide and must undergo numerous forms of processing in order to be converted into alloys. The most important manganese alloys are high carbon ferromanganese (HC FeMn), refined ferromanganese (RF FeMn) and silicomanganese (SiMn) alloys [5], [9], [12]. Manganese has properties which makes it an ideal input for alloy manufacturing and thus plays a significant role in the steelmaking process as an alloying element [7]. Therefore the three industries of manganese, iron and steel are intricately linked [5]. There is no adequate substitute for manganese in steel which contains all of its technical benefits and its relatively low cost [9]. The second most important application of manganese is portable dry cell batteries [7].

2.1 The manganese value chain

It is clear that the world demand for manganese and ferromanganese products have a direct dependence on the outlook of the steel industry, which in turn is driven by housing construction, the automobile industry and general infrastructural constructions [5]. To understand South Africa's position in this industry, the context of the country's role, where the barriers lie to economic growth, the global value chain of manganese, and manganese related products are examined. According to Gereffi [18], for many countries, especially low-income countries, the ability to effectively insert themselves into the global value chain is a vital condition for their development. The manganese value chain is closely related to the beneficiation process. According to Maia [2], beneficiation can be defined as the transformation of minerals, through chemical or metallurgical processes, to higher value added products for domestic or export markets. Different stages in the value chain are defined in Table 1, using examples applicable to the manganese value chain.

Through inspection of the manganese global value chain, it is evident how the industry is organized by examining the structure and dynamics of the different role players involved. Since this mineral commodity, like so many others, is globally integrated with complex industry interactions, examining the value chain is a useful tool to trace the shifting patterns of global production. It is also convenient for associating geographically dispersed activities and role players, and to determine the role they fulfill [18]. The global value chain focuses on the

sequences of value addition within the industry and examines the technologies, standards, regulations, products, processes, and markets which provide a holistic view of the global industry.

Table 1: The different stages of beneficiation, as defined by Maia [2]**, with examples applicable to the manganese value chain**

Stages	Raw material	Stage 1	Stage 2	Stage 3	Stage 4
Metals	Ore	Smelted or refined products	Fabrication alloys and metals	Semi manufactured articles	Fabricated articles
Example	Manganese ore	Ferromanganese	Stainless steel	Long and flat products	White goods, pumps, valves

2.2 South African manganese industry

The first two stages of Maia's beneficiation process are dominant in the South African manganese industry namely, the mining and procurement of the manganese ore and the fabrication of alloys, metals and other intermediate products. The manganese value chain does, of course, stretch much further than only these two sectors (see Figure 1); but these are the main aspects directly pertaining to the current South African manganese production activities. South Africa's position in the global production and consumption of these manganese products are summarised in Table 2.

Table 2: South Africa's global production and consumption of manganese products [11]

Product	Production			Consumption		
	Global rank	Volume (mt)	% of Total	Global rank	Volume (mt)	% of Total
Mn Ore	1	4,640	24.9	9	325	1.8
HC FeMn	3	457	10.1	28	27	0.56
Ref FeMn	5	102	5.9	31	10	0.59
SiMn	14	134	1.0	30	30	0.22
Steel	21	7,220	0.45	-	-	-

Where Vol = Volume (000 mt Mn Units), % = Percentage of global total, Rank = Global ranking

2.3 Local role players of the manganese industry

It is evident from Figure 1 that the manganese industry consists of various sectors, each utilizing specific types of ore, intermediate products, processes, upstream inputs and role players. This summary was created to provide the reader with a better understanding of the context of the production scale of the various manganese products and to present the different sectors of the manganese value chain. There are currently five major manganese mining companies in South Africa, namely [5], [19]: South32 (formerly BHP Billiton/Samancor Manganese), Assmang Limited, Kalagadi Manganese, Tshipi Manganese and United Manganese of the Kalahari (UMK). BHP Billiton is the world's largest manganese producer while Assmang Limited is fourth. Together these two companies dominate the local manganese production market in South Africa [5]. Smaller producers include Kudumane, Metmin and National Manganese Mines, as well as many other BBBEE companies that have entered the market [19].

The country has four manganese alloy producers that are classified as stage 2 role players in Maia's beneficiation process. These ferroalloy producers are: Metalloys (South32), Assmang, Transalloys and Mogale Alloys [12], [19]. Of these four, Transalloys is the largest producer of silicomanganese (SiMn) in Africa. Mogale Alloys a smaller producer of SiMn and the other two producers supply ferromanganese. With the increase in electricity tariffs and unreliable supply thereof in recent years, together with the oversaturated market, many of these suppliers have drastically slowed down production or halted their operations altogether [20]. South Africa also has producers of electrolytic manganese dioxide (EMD) and electrolytic manganese metal (EMM).

The latter generally accounts for between 6% to 10% of the total manganese ore usage [21]. All of South Africa's manganese resources are located in the Northern Cape Province in a zone stretching northwards over a distance of 150km, from south of Postmasburg to the Wessels and Black Rock Mines north of Hotazel, known as the Kalahari Manganese Field (KMF) [10]. It is the largest single manganese depository in the world and accommodates all of the country's manganese mines. The manufacturers of manganese related products, present higher in the value chain, however, are situated closer to the eastern coast in industrial areas in the Mpumalanga, Gauteng and Kwa-Zulu Natal provinces.

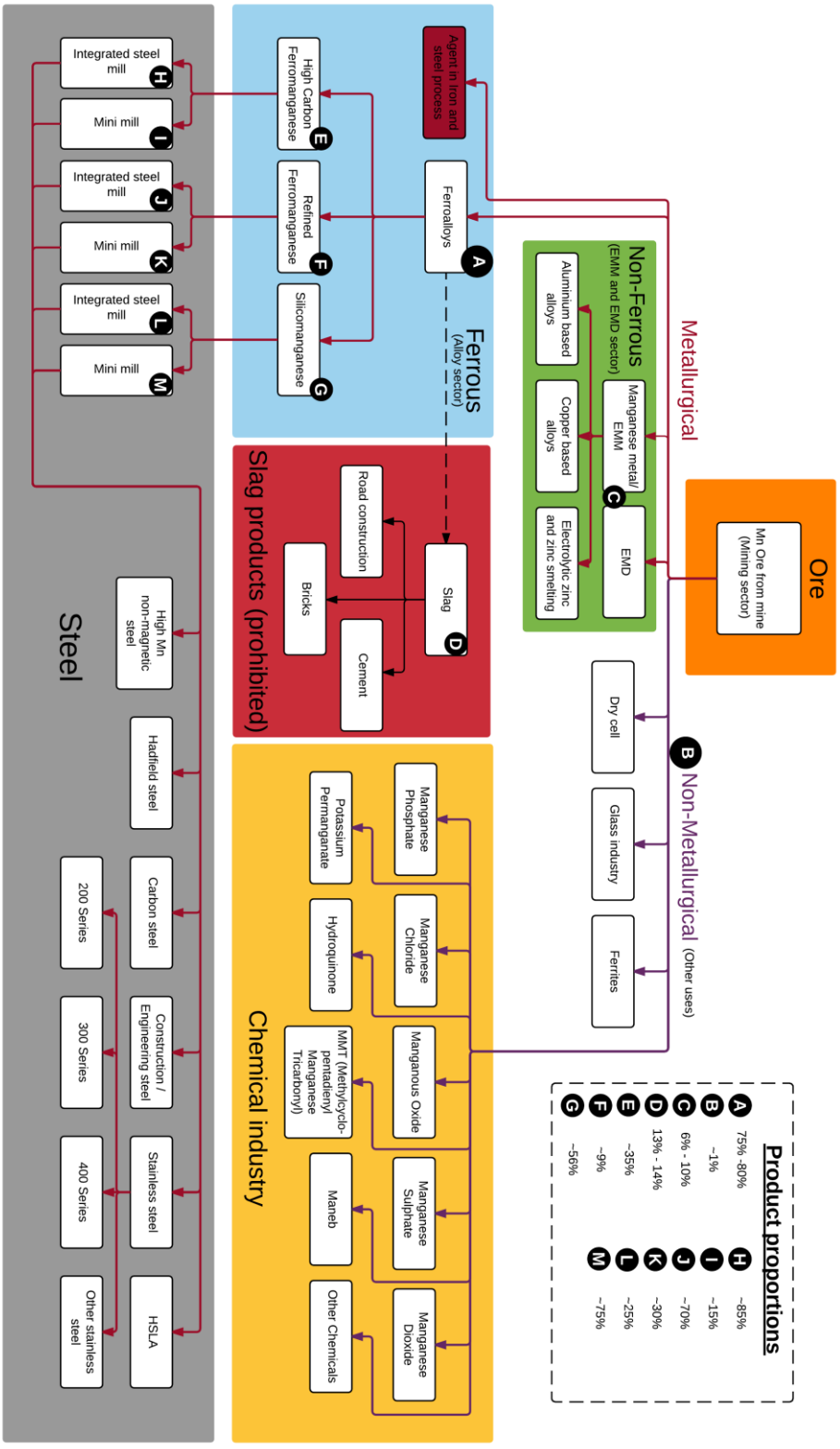

Figure 1: South African manganese value chain [5], [8], [21], [22]

3. RESEARCH METHODOLOGY

Due to the exploratory and descriptive nature of the study, a qualitative research approach was followed as shown in **Error! Reference source not found.**. A qualitative approach predominantly affirms an inductive approach to the relationship between theory and research, in which the emphasis is placed on information generation [23]. Since the focus of the study is on providing insight on the multiple role players in the manganese value chain and the various barriers that they face to economic growth, a qualitative study, is suitable for this research.

3.1 Research Approach

The principle data required for this study, is the ranking of the main barriers that different role players in the South African manganese industry face to economic growth. The research methodology followed for this study consists of 3 phases, with the first entailing the identification of data sources and method sampling. This phase addresses research objective 1 by providing an in-depth overview of the local value chain. The second phase is data collection, which includes drafting an interview guide, conducting interviews with relevant company's respondents, and reviewing reports and other forms of secondary data. This phase addresses research objective 2 and 3 through the identification of barriers by industry experts and ranking the barriers according to their responses. The final phase is the analysis and validation of the collected data and results. The phases and underlying activities are shown in Figure 2.

3.2 Data collection method

Multiple data collection techniques were used in the research methodology to reinforce the triangulation of data and therefore establishing the qualitative outcomes of the research. Various forms of data triangulation are employed through the use of qualitative research, the collection of specific operational data (such as electricity usage, when operational delays occur, productivity of the workforce, etc.) to corroborate the qualitative data gathered from the barrier discussions in the interviews. Furthermore, it supports the credibility, reliability and validity of the findings through cross verification of information [24]. This study incorporates triangulation with the following two approaches:

1) **Data source triangulation:** Evidence from different data sources (primary and secondary research) was collected. This includes interviews with relevant companies' respondents, questionnaires, company documents, public records, literature review and observations.
2) **Methodology triangulation:** Multiple methods to gather data was combined and utilised. This included conducting both conversational interviewing and semi-structured question interviewing to determine the barriers faced by companies. The results are compared with barriers gathered during company reports, news articles and relevant publications on the manganese industry.

The applied data collection tools for primary data collection includes document reviews and semi-structured interviews with the help of an interview guide which allowed for specific topics to be covered, yet allowed for questions to be added in accordance with responses provided by the interviewees. Open questions were used to ensure that the interviewee had leeway in how to reply and to allow for the interviewee's levels of knowledge and understanding to be tapped in order to explore new areas of research which has previously been limited [23]. The questions were exploratory in nature, prompting the interviewee to identify barriers that specifically affect them and which potentially have not yet been mentioned in public records. The interviews gave stakeholders the opportunity to voice their opinion on the level of interaction between different industry players. The questions also allowed for their perspectives to be shared on the future of the industry and where they believe the major barriers for economic growth lie.

Secondary data was also collected in the form of literature reviewed throughout the study, company publications such as annual and other reports, and publicly available data which is relevant to role players and barriers in the manganese value chain. In order to obtain a broader opinion on the various constraints faced by the role players, a questionnaire was prepared and emailed to numerous experts in the fields of mining, ferroalloy production and other production of manganese products (see Table 3).

The interview and questionnaire covered issues including current operations, logistics, technology, electricity and energy usage, raw materials and pre-treatment thereof, environmental issues, relevant legislation and policies, by-products, economic aspects of operations, exports and sale of products. An interview guide was sent to the respondents before the interview was conducted, presenting an overview of the various aspects that will be covered. It also explicitly requested the biggest barriers that they face in terms of economic growth. After the interview was conducted, a follow-up questionnaire was sent for soliciting specific information on content areas in order to identify and elaborate underlining barriers from the respondents.

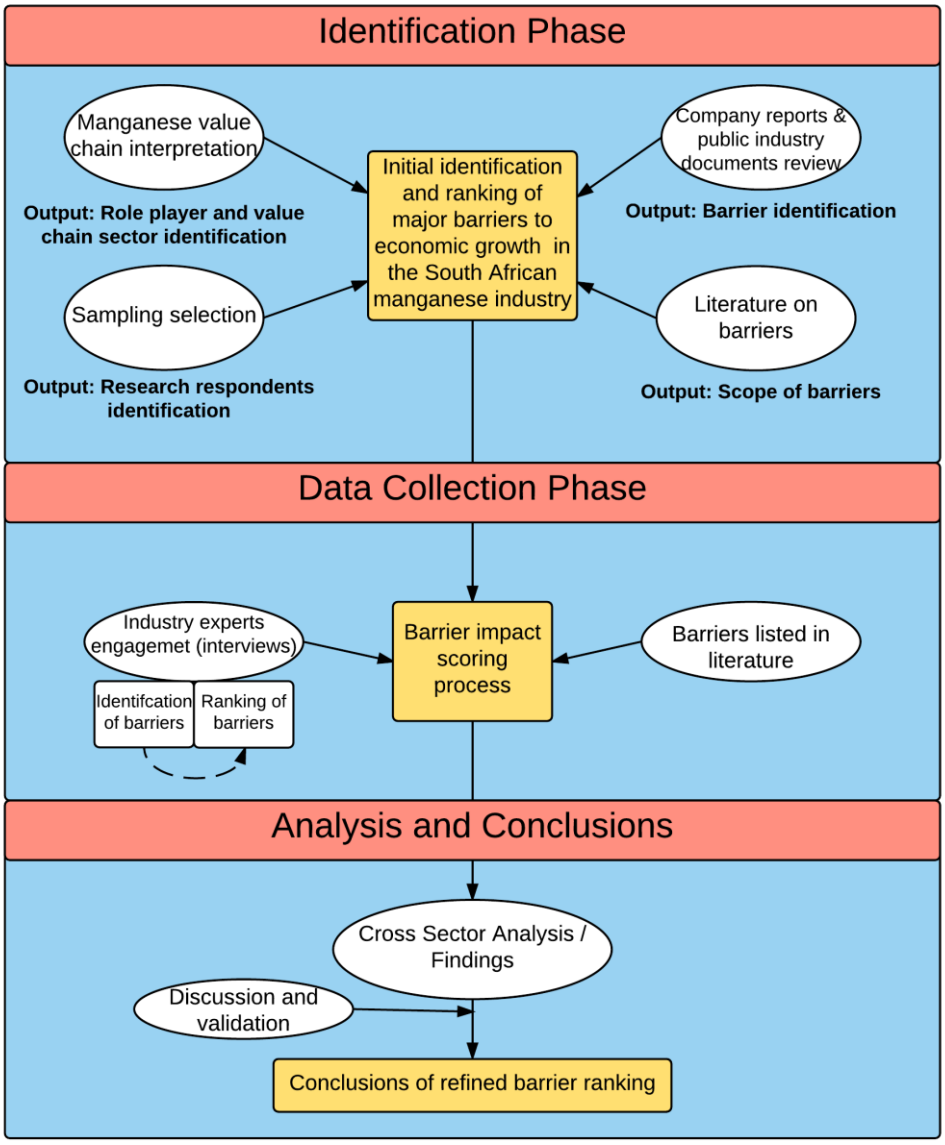

Figure 2: Research phases of the study

3.3 Sampling method

Semi-structured interviews were conducted with the aim of gaining comparable views of the most pressing issues in the industry faced by various role players in different sectors of the manganese value chain. It was thus necessary that potential respondents from the different sectors in the value chain were approached for the study. The input from these various industry experts have allowed for the constraints to be ranked according to severity which in turn makes it possible to assign a level of priority to each constraint. All interview responses were used to identify major operational barriers and the scope of its impact.

The list provided by the DMR [19] of manganese mining companies and manganese-related product manufacturers, as well as relevant companies listed in literature [5], [12], [25], identified 23 companies in the South African manganese value chain. Seven of these companies were disregarded, since their operational focus on manganese were negligible or they could not be reached for comments nor were any of their company documentation available. The remaining role players varied in business size, operation field, time in market and size of their market share. From the relevant candidates, three types of role players could be identified, namely those in mining, alloy production and lastly manganese related product manufacturers such as EMM and EMD producers. In order to cover the majority of the local value chain, it was important to have representatives from each sector participating in the study. Smaller sectors such as the specialized usage of manganese in chemical applications, which only accounts for approximately 1% of manganese usage, is not as crucial for this research purposes and were therefore excluded from the study.

Interviews were conducted with representatives of two of the largest manganese mining companies in the world, two of the four South African manganese alloy producers, gaining perspectives in both ferromanganese and silicomanganese alloys operations, and the world's only non-China based producer of electrolytic manganese metal and Africa's only producer of premium-quality electrolytic manganese dioxide.

Table 3: Sampling and sourcing of data

Role player Type	Interview	Questionnaire	Public records	Could not reach	Identified role players in sector
Mining	2	2	6	10	**16**
Alloy production	2	2	4	0	**4**
Other	2	2	2	1	**3**
Total sources	**6**	**6**	**12**	**11**	

Table 4: Companies from which the respondents were surveyed

Company	Role / Sector	Operation phase	Interaction type
1	Mine	Running	Interview / Questionnaire / Publications
2	Mine	Running	Publications
3	Mine	Running	Publications
4	Mine	Running	Interview / Questionnaire / Publications
5	Mine	Running	Publications
6	Mine	Running	Publications
7	Alloy	Production decreased	Publications
8	Alloy	Production decreased	Publications
9	Alloy	Production decreased	Interview / Questionnaire / Publications
10	Alloy	Production decreased	Interview / Questionnaire / Publications
11	EMM	Running	Interview / Questionnaire / Publications
12	EMD	Process of closing	Interview / Questionnaire / Publications

3.4 Data analysis techniques and interpretations

Barriers are initially identified through observations in company reports and other literature. It was accepted and elaborated upon further through primary sourcing in the form of questionnaires and interviews conducted with experts in the manganese field. The barriers were ranked according to the sectors they occurred in the value chain by the respondents' feedback on each barrier's respective impact on economic growth. A score was assigned to each ranking as follows:

- Ranked 1st = 5 points
- Ranked 2nd = 3 points
- Ranked 3rd = 2 points
- Mentioned = 1 point

The barriers are ranked according to the highest accumulative score between the respondents in the same sector in order to identify the major barriers faced by role players in the manganese mining, alloy production and other related product manufacturing.

Examining the results can help determine how the barriers influence each business and where bottlenecks occur which hinders progression. This analysis thus reveals which barriers cause the greatest restriction on economic growth. The results from the respondents were compared to secondary data from published company reports to determine if there is a degree of consensus. The literature corroborated the findings.

4. RESULTS

Through primary and secondary sourcing, numerous barriers in the manganese industry were identified, stretching from lack of proper infrastructure and energy supply to labour issues and the implementation of new policies by the government. It is also clear that the barriers provided by role players in the same sector had a strong correlation, but sometimes differed from role players in other sectors. An example is the unreliable energy

supply identified in the energy-intensive alloy, EMD and EMM production sector, but does not have as a significant impact in the mining sector. In some instances, some barriers were ranked together by the respondents (such as both the unreliable supply and rising cost of electricity), in which case these barriers shared the respective ranking. From the responses and literature review, a total of 31 barriers were identified. In order to protect the anonymity of the various companies and their representatives, the barriers are not explicitly linked to specific individuals.

Table 5: Scoring of barriers

MINING SECTOR					
Ranked barriers	**1st**	**2nd**	**3rd**	**Other**	**SCORE**
1) Low market price	1	1			8
2) Industry fragmentation	1				5
3) Lack of rail capacity			2		4
4) Electricity (unreliable supply)		1			3
4) Electricity (rising cost)		1			3
MANGANESE ALLOY SECTOR					
Ranked barriers	**1st**	**2nd**	**3rd**	**Other**	**SCORE**
1) Low market price	2				10
2) Electricity (unreliable supply)		2			6
2) Electricity (rising cost)		2			6
3) Low productivity of workforce			1	1	3
4) Volatility of workforce			1		2
5) Cost of labour				1	1
EMD SECTOR					
Ranked barriers	**1st**	**2nd**	**3rd**	**Other**	**SCORE**
1) Oversupply of product	1				5
2) Anti-dumping duty		1			3
3) Electricity (unreliable supply)			1		2
3) Electricity (rising cost)			1		2
EMM SECTOR					
Ranked barriers	**1st**	**2nd**	**3rd**	**Other**	**SCORE**
1) Electricity (unreliable supply)	1				5
1) Electricity (rising cost)	1				5
2) Lack of rail capacity		1			3
3) Lack of government support			1		2

4.1 Identified barriers in the manganese value chain according to sector

The top three barriers of each sector is ranked according to the impact it has on the economic growth of the role players in the respective sector.

4.1.1 Barriers in the manganese mining sector

1) Low market price

Commodity prices are often affected by external factors which many times cannot be controlled by producers. All commodities are subject to wide fluctuation, especially minerals used for alloy and steel manufacturing. Manganese supply and demand are closely dependent on the iron and steel market with all manganese products following a similar trend to these resources. Price volatility has an adverse effect on a company's operating results, asset values and cash flows. If commodity prices remain weak for sustained periods, it can lead to growth projects no longer being perceived as viable options. China's dominance in the steel market also determines many trends in the industry.

The added manganese ore and alloy capacity during the commodity boom years is now in the market, resulting in considerable overcapacity in the market. As a consequence, manganese is one of the worst performing commodities today [14]. Companies in some instances have rejected additional rail capacity to transport their ore when prices were too low for export. The weak market conditions for manganese products, has caused mining companies to lower production and only consider the cheapest forms of transport or risk making a loss.

2) Fragmentation / rise in internal competition

The fragmentation of the local industry structure has lead to a significant rise in internal competion. The barriers to entry in the manganese ore market have traditionally been relatively high, which allowed for a limited number of players in this sector, but this changed after the government started issuing

new mining licenses to numerous companies. This has caused the mining sector to be condensed with numerous companies all competing for the same resources in the same market.
When the market consisted of less ore producers, rivalry was contained and the price could be regulated by these few entities. At present, many mines are situated together competing for the same rail and port capacity, customers and other resources. The rise in competition between mining companies which is constantly on the rise, has lead to decreased profit margins in order to remain in the market and attract customers. The market conditions are thus becoming less attractive for ore producing companies.

3) Rail capacity

Ports and the freight system in South Africa is currently suffering from inefficiencies rendering most of the manganese ore incapable of being optimally distributed to domestic and international markets. Since the country's transport infrastructure has been found inadequate of supporting higher export volumes to the international market, greater efforts are to be made to improve the efficiency of South Africa's ports and rail utilities. Accelerated economic growth and lack of adequate maintenance and upgrading, however, have rendered the transport system in urgent need of corrective measures.

In both interviewed cases, the mining company's production rate is higher than what can be transported via rail to its various destinations, causing a bottleneck to occur. When the market price for manganese ore was still high, it was profitable to transport the ore via road transport such as trucks, but with the current weak economic position the commodity faces, this is no longer the case. Many mining companies, situated in close proximity to one another, have to vie for rail allocation to transport their ore. If enough rail capacity cannot be provided, then mining production is lowered. The logistic costs of transporting ore to ports for export, as well as from the ports to the final customer, are the highest expenditure for these companies. All interviewed mining companies have scaled down production in order to match their rail allocation. If more is produced, the ore needs to be transported via trucks on the road, which greatly increases the cost per ton and will lead to a loss of profit.

4.1.2 Barriers in the manganese alloy sector

1) Weak market conditions

Currently all manganese ferroalloy producers are shutting down or are in the process of shutting down production, primarily due to the weak market conditions. The market demand is too low to justify operating the energy-intensive furnaces. There was a time when a bottleneck occurred between the mines and the smelters where the supply of ore did not fulfil the demand, but this is no longer the case.

The current commodity recession has consequently lead to a downward trend in the demand for manganese ore and alloys. Steel manufacturing is inherently a primary economy which drives the demand for alloys and is currently in decline. It was not expected that this commodity slump would have continued for so long, which resulted in many producers having continued with operations while hoping for the conditions to change. All along enduring the difficult economic conditions that it entailed.

2) Unreliable electricity supply and rising cost (ranked together)

The second major constraint faced by alloy producers is electricity availability and rising cost. With production lowering due to the weak mineral economy, the supply has become sufficient, but at normal production rate the interrupted supply causes many operational setbacks and the rising tariffs are cutting into profits. Where South Africa used to have very inexpensive electricity, the country has lost its international competitive advantage in this regard. Furthermore, it seems that these prices may still be on the rise in the coming years, while other countries prices remain relatively consistent [26]. In recent years, power has seen a massive jump in price which had a significant impact on operation costs of all alloy producers.

Energy-intensive alloy producers also regularly experience power containments where energy consumption in the company must be lowered for a duration of time in order to lighten the burden on the national electricity grid as per agreement with Eskom. Consistency is key for these producers and their furnaces need to remain continuously running for as long as possible to attain ideal operating conditions. Power containment and interrupted supply, drastically decreases efficiency and increases the operating costs of the furnaces.

3) Volatile and unproductive labour force

South Africa's weak economic growth, rising costs, high unemployment and numerous socio-economic challenges have resulted in many problems and unrest in labour cost and efficiency. This extreme financial pressure has been evident in extended strikes in metal industries. Unrest among workers has led to decreased labour productivity which undermines companies' profitability and threaten the sustainability of the business.

Strikes also regularly occur with employees demanding larger wages, which further decrease productivity. According to respondents, similar facilities abroad are operated by a workforce much smaller in size than locally, with the same work being done by a smaller group of people. This is due to better qualified staff, as well higher productivity of workers abroad. Labour costs are on the increase, adding to the already large operational costs.

4.1.3 Barriers in the EMD sector

1) ***Oversupply in EMD market***
EMD is a niche market with various producers all over the world. Due to the large number of EMD producers and a reduction in demand, especially local demand in Africa, and the market is in oversupply. It is thus likely that a global producer must close down operations. Since local demand is much smaller than abroad, it is likely that South African producers' market share will shrink. This was the case for Delta EMD.

2) ***Anti-dumping duty***
South African producers have not always found it economic to exploit rising demand for manganese products due to its distance from the markets, despite the existing excess production capacity to do so. Competitors that are located closer to the markets have traditionally had a competitive advantage over producers from abroad. Anti-dumping claims have been made against South Africa by companies in Europe stating that South Africa is dumping EMD products abroad and selling it for less than the production cost. This to the South African company being forced to pay a 20% duty fee in order to export its products to Europe which was not a viable option. The same company lost its share in American markets, when the USA decided to terminate its contract and rather support a local producer.

3) ***Unreliable electricity supply and rising cost (ranked together)***
Electricity was another major barrier for this industry. Load-shedding which unpredictably took place and halted operations is a major concern. Many of the machinery had to be prepared more than two hours in advance to ensure that no damages occur to the equipment and the product. If the necessary precautions were not made beforehand, the entire batch being prepared was ruined and ended up as waste. Since an electrolytic process is used, a constant electricity supply is required for optimal working conditions. The sharp annual increases in electricity tariffs in recent years, has placed immense pressure on these companies and drastically increased their overall production costs.

4.1.4 Barriers in the EMM sector

1) ***Unreliable electricity supply and rising cost (ranked together)***
(See *Barriers in the EMD sector*)

2) ***Lack of rail capacity***
The freight system and ports in South Africa are currently suffering from inefficiencies rendering most of the manganese products incapable of being optimally distributed to domestic and international markets. Since the country's transport infrastructure has been found inadequate of supporting higher export volumes to the international market, greater efforts are to be made to improve the efficiency of South Africa's ports and rail utilities. Accelerated economic growth and lack of adequate maintenance and upgrading, however, have rendered the transport system in urgent need of corrective measures.

3) ***Government support***
Companies are making substantial changes to align their businesses with new policies implemented by the government to promote beneficiation, yet these companies do not receive the support or advantages, such as subsidies, as they expected by the government. Furthermore, the constant delays in national infrastructure developments adds to the mismanagement factor constraining economic growth of the businesses involved.

5. CONCLUSIONS AND RECOMMENDATIONS

This study has affirmed the current state of affairs of each sector which comprises the manganese industry of South Africa. An in-depth overview of the manganese value chain was presented, which provides context to how South Africa's local industry fits in with the global market. Furthermore, first-hand data was collected in order to identify the current major barriers faced by role players in different sectors of the value chain, as well as ranking the top three barriers in each sector. The results provide the barriers to economic growth that cause the greatest impedance on the various role players in the mining, alloy manufacturing and EMD and EMM production sectors.

These barriers were up to now, not explicitly identified and ranked according to severity by various role players in different sectors of the South African value chain. This provides significant insight by experts in the field of mining, alloy manufacturing, as well as the production of other manganese related products such as EMM and EMD on where operational bottlenecks in the manganese industry occurs. This study allows for further investigation as to how these major barriers to economic growth can optimally be addressed in South Africa, as well as forecasting the possible risks that these barriers could have on the different role players in the value chain.

Despite all of the research objectives being met, there are still some recommendations for future related work, including expanding the list of identified barriers to include more barriers. A severity score for each barrier could also be added, in order to quantify the extent of the impact of each of the barriers as experienced by each of the respondents.

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