CCRED
CENTRE FOR COMPETITION, REGULATION AND ECONOMIC DEVELOPMENT

**CCRED Working Paper 3/2020**

# MINING EQUIPMENT INDUSTRY IN SOUTH AFRICA: GLOBAL CONTEXT, INDUSTRIAL ECOSYSTEM AND PATHWAYS FOR FEASIBLE SECTORAL REFORMS

**Antonio Andreoni[1] and Sofia Torreggiani[2]**

**September 2020**

**Abstract**

[1] UCL Institute for Innovation and Public Purpose
[2] SOAS University of London

**Contents**

## Executive summary

The South African Government has acknowledged the importance of developing its mining equipment industry and that to do so a mining equipment masterplan would provide the right framework for policy action. This background paper is an input to the mining equipment masterplan development process led by CCRED at the University of Johannesburg. Against the background provided by the Situational Analysis Paper produced by CCRED, in this background paper we focus on four main issues.

First, we conduct an analysis of the global mining equipment industry aimed at positioning the mining equipment industry in South Africa against the global scenario. We provide a review of the main actors, product segments and global value chain structure of the industry as well as the industry-specific parameters of competitiveness. The adoption of a value chain perspective allows us to emphasize the key role played by supply chain and procurement business strategies in shaping global industry trends, both on the demand and supply sides. We find that the sourcing strategies of global players can reinforce concentration trends and competitiveness gaps in the industry, both in terms of value creation and capture. South Africa is mapped out against other major countries and markets to highlight the importance of the masterplan, especially given South Africa's cross-roads positioning in the global landscape. The mining master plan is a key instrument to steer the South African mining equipment industry towards both domestic industry and export markets development.

Second, building on field work interviews and ongoing research work, we conduct an in-depth analysis of the South African mining equipment sectoral value chain and cluster. This section complements the Situational Analysis Paper by focusing on dynamics leading to differentiated value creation and capture along the mining life cycles and across product/industry segments in South Africa. We find that linkages in the local production systems play a key role in determining these value dynamics. A number of country and sector-specific binding constraints and leveraging points are highlighted as focus areas for policy intervention.

Third, building on the previous two sections, we introduce an industrial ecosystem and policy package framework aimed at guiding the existing set of policies and institutions which have an impact on the development of the mining equipment industry. We highlight the importance of distinguishing different policy forms and functions, and reaching an alignment across the entire spectrum of industry-relevant policies in South Africa. The gap analysis revealed a number of areas were interventions are urgently needed, while other areas were policy goals are already partially met. For each policy gaps, we propose a number of potential instruments – both institutions and policies – partially building on a number of international experiences in the mining industry and across other sectors. We find that all countries reviewed relied on a mix of different instruments – including incentives, procurement and ownership rules, and technology services – as well as different policy enforcement mechanisms. The effectiveness of these instruments in terms of their implementation is context specific and must be reviewed in light of the specific South African sector-specific regulatory and policy context. Annex 1 provides descriptive information on this context.

| Policies | **Assessment** Extent the policy address constraints and meet parameters | **Binding constraints and competitiveness parameters determining best total life cycle cost** (Detailed in sections 1 and 2) | **Policy gaps and potential instruments** |
|---|---|---|---|
| **Local procurement and content** | **PARTIAL** | Pre-existing buyer-supplier relations and risk aversion | |
| | **GAP** | Early engagement in procurement. | **Pre-feasibility engagement**<br>**Dynamic incentives and linking local content and export** |
| | **PARTIAL** | Location of decision-making with respect to procurement strategies | |
| | **GAP** | Lack of contact with (and knowledge of) local markets and suppliers | **Catalogue of competencies**<br>**Mission-oriented specialized institutes & networks** |
| **Collaborative R&D initiatives and technology services** | **PARTIAL** | Appropriate functional and performance specifications. | |
| | **PARTIAL** | Appropriate technical specifications. | |
| | **PARTIAL** | Appropriate operational and maintenance provisions. | |
| | **GAP** | Scalability | **Mission-oriented specialized institutes & networks**<br>**Joint ventures, consortia, and export cartels** |
| | **PARTIAL** | Standardization | |
| | **PARTIAL** | After-market support facilities | |
| | **GAP** | Cooperation between mining houses and equipment suppliers | **Joint Ventures**<br>**Consortia development with incentives & joint licenses** |
| **Skills development** | **GAP** | Appropriate technical specifications. | **Mission-oriented specialized institutes & networks** |
| | **GAP** | Appropriate operational and maintenance provisions. | |
| **Exports finance and support** | **PARTIAL** | Customized equipment financing solutions | |
| | **GAP** | Attractive commercial propositions and financing solutions. | **Affordable/tailored export finance and guarantee scheme** |

| | | | |
|---|---|---|---|
| | **PARTIAL** | After-market support facilities | |
| | **GAP** | Scalability | **Affordable/tailored export finance and guarantee scheme** |
| | **GAP** | Longevity | **Affordable/tailored export finance and guarantee scheme** |
| | **GAP** | Cooperation between project houses and equipment suppliers for international projects. | **Affordable/tailored export finance and guarantee scheme Joint ventures, consortia, and export cartels** |
| **Trade policies** | **PARTIAL** | Pre-existing buyer-supplier relations and risk aversion | |
| | **GAP** | Scalability | **Reverting incentives to protect domestic final products** |

Fourth, against the global and national background, we engage with the analysis and design of a number of policy actions for feasible reforms in the mining industry in South Africa. We envision five policy actions for the mining equipment masterplan and we sketch policy design directions:

a) Reforming local procurement content and linking it to export promotion

b) Reforming tariff schedules selectively

c) Promoting technology innovation with a focus on scalability and collaborations via a specialized institute

d) Promoting related diversification with a challenge competition fund

e) Export finance, credit guarantee consortia, hybrid incentives and procurement

A number of policy forms to achieve these policy functions have been proposed, however policy forms shall remain flexible and pass the feasibility tests before any inclusion in the master plan. The master plan document provides a synthesis and selection of these proposals, integrating the two main background papers and the results of stakeholder engagement across the mining equipment industry in South Africa.

# 1 The global mining equipment industry

## *1.1 Setting the scene*

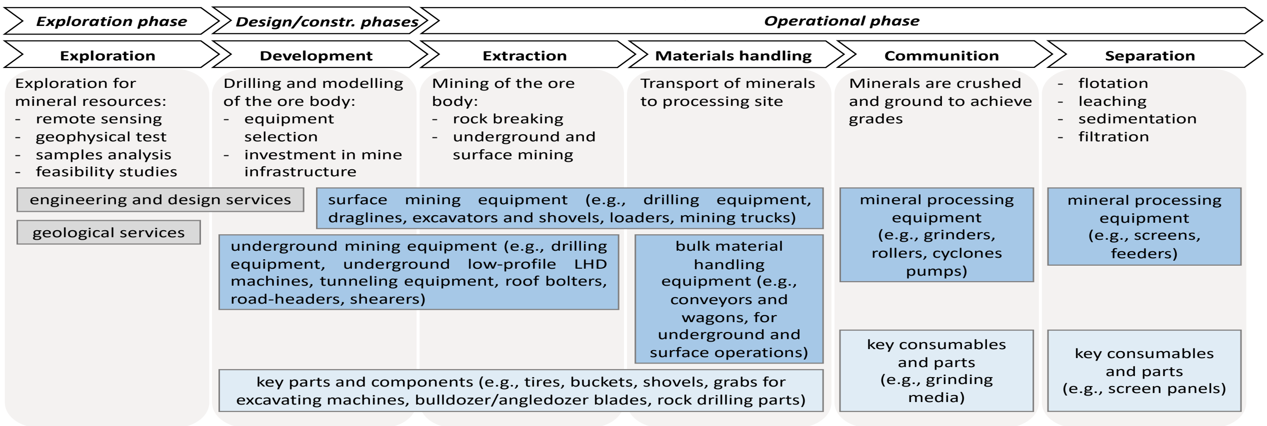
### *1.1.1 Main product segments*

The mining machinery industry includes a wide spectrum of equipment used along the different stages of a mine's lifecycle (e.g., from exploration to refining). For the purpose of the present work, the mining equipment industry can be segmented into four main product categories:

1. ***Underground mining equipment*** (e.g., drilling equipment, underground low-profile load-haul-dump machines, tunneling equipment, hydraulic roof supports, roof bolters, road-headers, and shearers)
2. ***Surface mining equipment*** (e.g., drilling equipment, draglines, excavators and shovels, loaders, mining trucks)
3. ***Mineral processing equipment*** (e.g., crushers, cyclones, feeders, screens, grinders)[3]
4. ***Bulk material handling equipment*** (e.g., conveyors and wagons)

Each of these categories includes a vast range of inputs used in the various stages of a mine's life, from relatively less to relatively more complex, customized, innovation intensive equipment and spare parts to be regularly replaced due to abrasion during the usage. Figure 1 below plots this product segmentation against the key stages of mining development under consideration in the present analysis. [4]

**Figure 1 – Mining equipment and machines operated on-site along the different stages of a mine's lifecycle**




*Source:* own elaboration based on relevant secondary literature and engagement with industry representatives.

---

[3] This category only includes equipment used for *on-site* material communition, separation and refining. Other mineral processing and beneficiation equipment mainly operated off-site is not included here.

[4] Unfortunately, publicly available trade and production classifications do not allow to obtain specific data on those product segments, at least for two reasons: first of all, underground and surface equipment are not disaggregated in the official trade and production databases; secondly many earthmoving equipment used for surface mining might also be employed in the construction industry. However, for the purpose of this background paper, this product segmentation seemed the most reasonable to follow in order to select the main actors to be interviewed. Its appropriateness has been confirmed by industry's representatives and minor variants of such product segmentation are used in many other industry's reports and studies. See also CCRED (2019) on this.

*1.1.2 Global patterns in demand and supply*

Analyzing demand and supply patterns of mining machinery across countries, four key country clusters emerge (see figure 2 below for a summary):

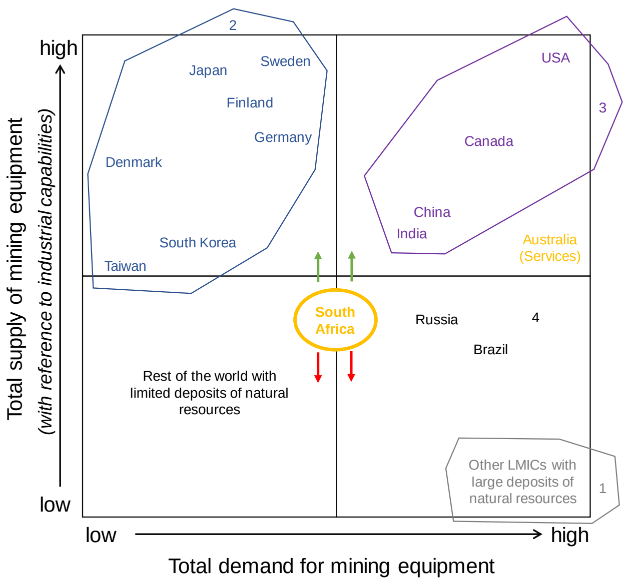
- A **first cluster** is formed by many mid-sized low- and middle-income economies in Africa, Asia and Pacific and South America that rely on extraction and export of non-refined natural resources. These countries constitute a growing end-market for mining operations and, consequently, mining machines, but they do not have the capabilities for producing sophisticated equipment.

- A **second cluster** encompasses advanced economies in Western Europe (mainly Scandinavian countries and Germany), Japan, and, to a much less extent some 1st tier Newly Industrialized Countries like South Korea and Taiwan. These countries have limited mineral and metal resources, and mining operations, but they produce high-end, sophisticated mining equipment which is mainly exported.

- The **third cluster** includes countries like USA, Canada, China and India that have significant mineral and metal resources, and mining operations and also produce advanced equipment for both the domestic and the foreign market. A distinction can be made here between two sub-clusters since China and India still lag behind Canada, and the USA in terms of supply of advanced machinery.

- Finally, countries in the **fourth cluster** are Russia and Brazil. They have large deposits of mineral and metal resources, but they are still not able to produce high-end and sophisticated equipment and, consequently, to join the third cluster.

**Figure 2 – Mapping key country clusters of supply and demand patterns for mining equipment**



*Source:* own elaboration based on rough estimates of demand-supply in selected countries, using trade and production data, and information from interviews and industry reports on the relative quality of the equipment supplied.

India's, and especially, China's emergence as exporters of machinery and equipment within this specific sector has been driven by a confluence of factors:

1. The rising domestic demand for mining equipment, driven by the massive increase in the number of domestic mining operations, and, in parallel, the huge investments in manufacturing capabilities' upgrading within the broader machinery and equipment sector (e.g. with special reference to the construction equipment industry).

2. The offshoring and global supply chain strategies of mining equipment multinational companies, locating production and assembling facilities in China.

3. Global sourcing strategies of big blue-chip mining houses for less strategic types of equipment and consumables and their willingness to minimize costs by maximizing, in certain specific periods, the share of Chinese procurement also through parts and components of strategic equipment supplied by global Original Equipment Manufacturers (henceforth referred to as OEMs).

4. Increasing global presence of Chinese companies within the extractive sector and the consequent shifts in procurement strategies by mining houses majority-owned by Chinese investors (e.g., particularly in Australia and sub-Saharan Africa).[5]

5. The emergence of Chinese OEMs as new, key players alongside those from Australia, Europe, North America, and South Africa, as part of the Chinese "Going Out" policy strategy.

6. Gradual lateral migration from construction equipment to mining equipment of Chinese OEMs (e.g., mainly small and medium-size off-road "yellow metal" vehicles for open cast mining operations).

### *1.1.3 Main global players*

In 2009, it has been estimated that the leading six global mining machinery manufacturers accounted for about one-fourth of total production: Atlas Copco[6] and Sandvik from Sweden; Bucyrus International, Joy Global, Terex Corp from USA; and, Metso from Japan (Deneen and Gross, 2009). Since then, the sector has undergone a tremendous consolidation process: large and well-funded multinational companies have continued to grow through a large number of mergers and acquisitions (M&A), building up production and distribution networks around the globe. As an example, in 2011, the mining equipment lines of Terex Corp and Bucyrus International have been acquired by Caterpillar, while more recently, in 2017, Joy Global has become a Komatsu's subsidiary (together with P&H and Montabert). Moreover, on July 4th, 2019, Outotec and Metso, two key mineral processing multinationals, have announced their transformational combination in order to build a

---

[5] National ownership dynamics along extractive value chains might indeed shape procurement strategies of end-clients. (Bridge, 2008; Fessehaie, 2012).

[6] Now the group is subdivided in two listed entities: Atlas Copco with focus on industrial customers and Epiroc with focus on customers in mining, infrastructure and natural resource segments.

leading company in process technology, equipment and services supplying the minerals, metals and aggregates industries.

The main motives behind such acquisitions have been: (i) increasing production capacity especially, but not only, during the commodity boom (ii) entering new product segments in order to offer a full suite of equipment and services to mining houses eager to rationalize and standardize their supply chain, with fewer and far more strategic first-tier suppliers (iii) entering new growing emerging markets, especially in the Far East (iv) building a global supply chain structure and (v) acquiring complementary intellectual property (IP) and technologies (e.g., battery electric vehicle solutions for underground mining, autonomous vehicles solutions) to meet the stricter safety and environmental standards and to discover and exploit more marginal resources at a greater depth and under more extreme circumstances.

The underground mining equipment market is globally dominated by Sandvik and Epiroc (e.g., Atlas Copco) and to a lesser extent by Joy Global[7] (now owned by Komatsu), Bucyrus International and Terex (both currently owned by Caterpillar). The key players in the surface mining equipment market are Caterpillar and Komatsu. In the mineral processing equipment sub-sector, Outotec, Metso (now combined), FLSmidth and Weir Minerals are the most dominant multinational companies.

For what concerns emerging Chinese OEMs, industry reports and information gathered from specialized periodicals and own interviews show that they are becoming increasingly competitive on a global scale in specific sub-segments of the surface mining equipment market (e.g., mainly small and medium-size off-road "yellow metal" vehicles for open cast mining operations) and the mineral processing market. For example, North Hauler, Tayuan Heavy, XEMC, Liugong, Sany and XCMG are major producers of mining trucks: they are very active and competitive in the construction sector, however they already have significant export sales of mining units. CITIC Heavy Industries is a renowned supplier of mining crushers, grinding mills, mine winders.[8]

## *1.2 A sectoral value chain perspective*

### *1.2.1 Actors, functions and governance structures*

The mining equipment value chain encompasses a large number of *functions* ranging from research and product development to post-sales services. A number of *actors* are involved in the different stages of the value chain, according to their respective tasks. Both, actors and functions characterizing a typical mining equipment value chain are reviewed below and summarized in figure 3.

*Actors*

Key actors along the chain encompasses the end-clients (mining houses or contractors managing the extraction and processing operations), project or engineering houses (EPCs or EPCMs), the

---

[7] Mainly specialized in soft rock mining equipment (e.g., coal).

[8] According to our interviews, CITIC Heavy Industries is currently one of the three companies in the world that are able to supply a 40 feet diameter grinding mill. Moreover, according to our data, it is among the preferred suppliers of steel grinding media and ball mills of major South African EPCM companies.

OEMs producing, supplying and servicing machinery and equipment and, finally, the OEMs' supply chain providing components and raw materials.

1. **Mining houses.** This group of actors consists of both mines' owners and mining contractors. From interviews it has emerged that size and nationality of ownership are the two key factors shaping procurement strategies and supply chain governance patterns of mining companies (e.g., what we refer to as $1^{st}$ level procurement in figure 3). Thus, in what follows we will make reference to this two-fold segmentation of the end-market (reported in figure 3).

   *By size.* With tier 1 client we refer to large blue-chip mining houses (also referred to as the *majors*) that own, manage and operate numerous assets globally (e.g., Anglo American, BHP, Glencore, Rio Tinto). These global companies have interests in many different commodities. Tier 2 (e.g., mid-tier) companies are medium-sized international mining houses focusing on one or two key commodities: these firms have grown significantly over the last decades and they currently manage and operate larger projects (e.g., Sibanye Stillwater, ERO Copper). Finally, with tier 3 we mainly refer to a large group of smaller companies with only one or two mining assets, with a predominantly national range of operations.

   *By nationality of ownership.* On the one hand, we define "traditional investors or buyers" those mining companies with a North American, European, Australian, South African majority ownership. On the other hand, with "emerging investors or buyers", we mainly refer to lead mining houses with Indian and especially Chinese majority ownership. The relevance of such distinction with respect to procurement strategies and supply chain governance patterns has been confirmed during interviews by industry's representatives. Other empirical evidence has underlined the appropriateness of such differentiation in practice (Fessehaie, 2012).

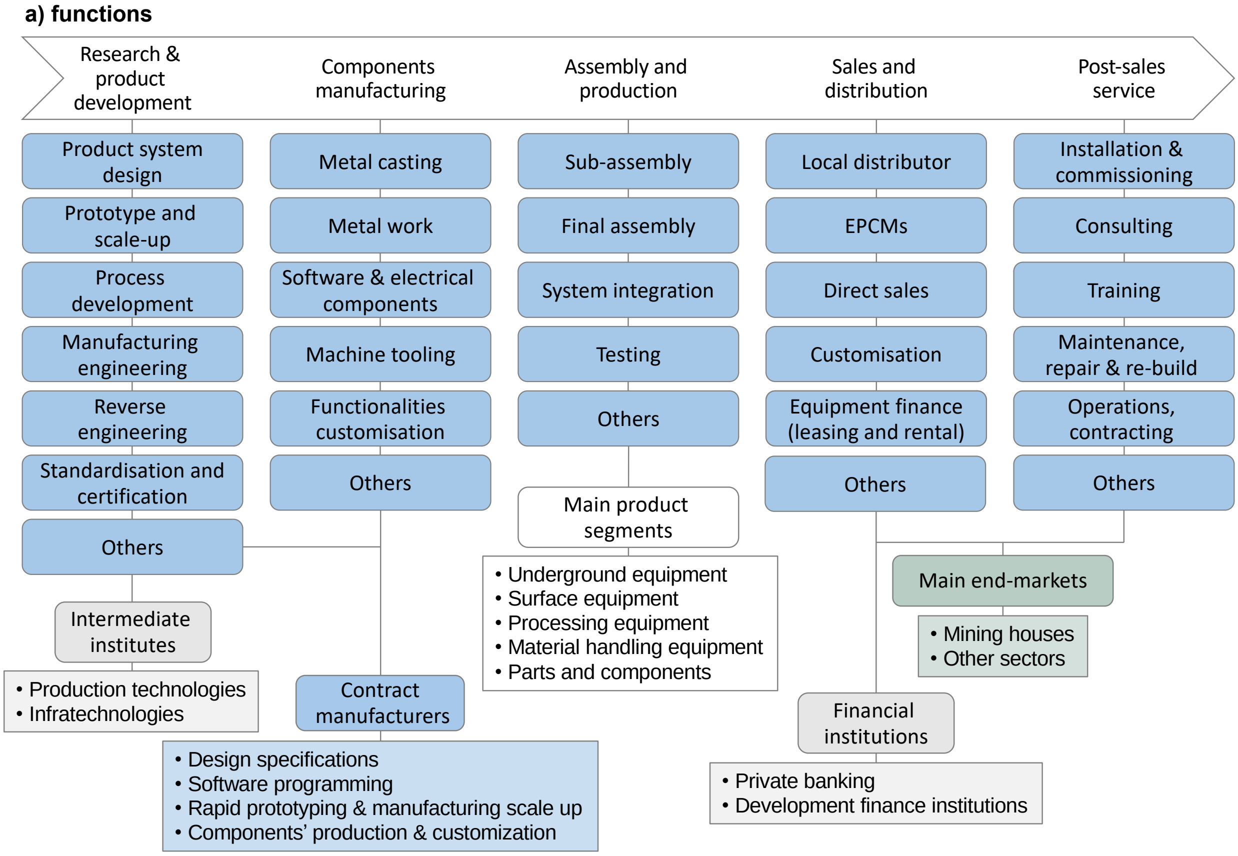
2. **Engineering contractors and project houses.** These firms can be contracted by the end-client to manage the planning, design and development phases of a mine. They can act as EPCM companies (Engineering, Procurement and Construction Management) or as EPC companies (Engineering, Procurement and Construction), and their responsibilities in terms of equipment procurement vary according to the specific contracting model in place with the end-client (see next section for further details). However, regardless the specific contractual model in place, they play a central role in specifying and selecting equipment suppliers, either as decisions-influencers or decisions-makers.

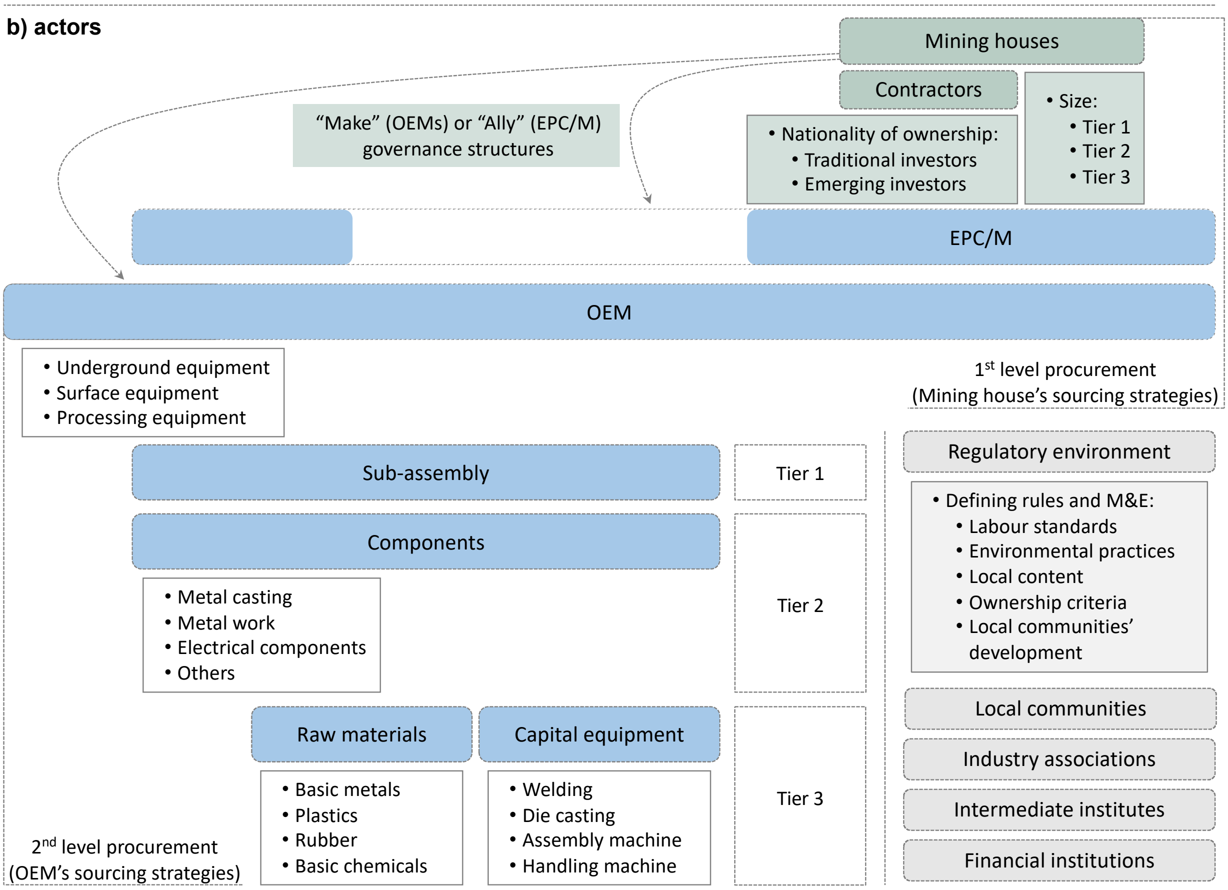
3. **OEMs.** These companies design, manufacture and provide after-sales support for mining equipment and machines. They might outsource different stages of research and product development, manufacturing, distribution and after-sales service to other actors, or perform some of these tasks in close collaboration with end-clients and engineering contractors.

4. **OEMs' supply chain.** Mining equipment companies generally outsource sub-assembly and manufacturing components fabrication stages to tier 1 and tier 2 suppliers. Tier 3 suppliers mainly focus on providing raw materials (e.g. steel, non-ferrous metals and alloys, basic plastics and chemicals) and capital equipment used in the fabrication of components (e.g., all these stages form what we refer to as $2^{nd}$ level procurement in figure 3). Certain raw materials should present very specific technical criteria because of the strict durability and resistance requirements associated with many mining machines operating under extreme conditions.

5. **Other stakeholders.** This group of actors includes governments and public sector institutions, local communities, industry associations, intermediate institutes (e.g., research and technical education institutes), financial institutions. The regulatory framework, in particular, defines the rules and the standards under which exploration, extraction and production of natural resources is to take place. They are responsible for granting mining concessions and monitoring how mining companies deal with issues of local content, ownership requirements, environmental impact, human risk, safety, and labor standards. Collaboration and coordination among private and public actors along the mining equipment supply chain is essential to fully understand the needs of the industry in each specific context and develop a medium- to long-term sector strategy.

**Figure 3 – A detailed representation of the mining equipment value chain: functions (a) and actors (b).**






*Source: own elaboration based on information gathered through interviews with industry’s representatives.*

*Functions*

1. **Research and product development**. This functional stage encompasses a wide range of activities from R&D to standardization and certification, including product design, prototyping and scaling up, process development and engineering tasks. Recently, such R&D activities have been directed to the development of solutions to address the new challenges faced by the industry such as improving mines’ productivity and efficiency, meeting the stricter safety and environmental standards, discovering and exploiting more marginal resources at a greater depth and in more extreme circumstances. This functional stage is generally managed by multinational OEMs in their headquarters, although for certain product lines leading foreign firms might opt for R&D localization in emerging economies (e.g., as in the case of FLSmidth’s *Buffalo* products – feeders, feeder breakers, sizers – for which R&D and engineering design are carried out in South Africa). These companies devote significant resources to R&D activities, investing in support infrastructures like test mines (e.g., like the Sandvik’s test mine in Tempere or the NORCAT’s Underground Centre of Atlas Copco). Often, such activities are managed in close collaboration with mining houses, engineering contractors (EPCM companies) and intermediate government-funded institutions. Smaller and medium-size OEMs in emerging economies have far less resources to invest in formal R&D activities and proprietary supporting and testing infrastructures of the type referred above. As far as the South African case is concerned, the Mandela Precinct and the industry cluster of Mining Equipment Manufacturers of South Africa (MEMSA) have recently tried to fill this gap building up an experimental test mine that will provide a protected environment for South African OEMs to learn and innovate. It is hoped that these coalition-

building efforts would result in collaborative forms of R&D among South African companies and, eventually, in the development of new marketable technologies.

2. **Manufacturing.** For each product segment, this functional stage might be further broken down into different phases, including raw material supply (e.g., tier 3 suppliers), components manufacturing (e.g., tier 2 suppliers), sub-assembly and contract manufacturing (e.g., tier 1 suppliers) and assembly and system integration (e.g., OEMs). The degree of vertical integration of leading OEMs with respect of the production sub-stages of the value chain, as well as their procurement strategies, varies across the sector. According to our interviews, both, multinational lead companies and local OEMs would retain certain key strategic manufacturing and assembling stages in-house, in order to protect the associated IP.[9]

3. **Sales and distribution**. Domestic sales are generally managed either directly by the OEMs (e.g., this is mainly the case for local OEMs and international OEMs with significant local production facilities), by owned subsidiaries (e.g., Komatsu's model), or by independent dealers (e.g., Caterpillar's model). Proximity to the end-client is crucial, and this is why sales and distribution centers are generally geographically located close to, or even inside, mining operations (e.g., many OEMs, indeed, have established a network of local sales and support offices). Thus, it follows that in order to be able to operate in export markets on a permanent basis, companies should establish sales, distribution and support centers in those countries. From the end-client perspective, there are different equipment procuring procedures, encompassing outright purchase agreements, leasing and rental purchase contracts that give mining houses greater assets flexibility. These financing options are particularly attractive for junior miners with limited access to funding and only few operations (e.g., some mid-tier and, especially, tier 3 end-clients in figure 3), often characterized by relatively short time horizons (e.g., 7 years). Leasing and rental contracts constitute effective ways to change the distribution of investments between capital and operating expenses in the clients' financial model, allowing them to easily move resources from CapEx to OpEx. Another widely used scheme is the "fleet leasing": where off-road fleet for underground or surface use is on hiring or on contract mining. Large international OEMs, like Caterpillar, Komatsu, Sandvick, Epiroc and FLSmidth, offer favorable equipment financing options in order to facilitate the purchase of equipment, including low-interest loans. According to our interviews, also Chinese OEMs have the ability to offer different equipment selling models, tailored to the specific needs of tier 2 and, especially, tier 3 mining houses, offering leasing agreement with payment on a per-hour or per-ton basis.[10] Local OEMs in emerging economies are often not in the position of offering competitive rental and leasing agreement, mainly because of higher interest rates faced domestically and limited balance sheets.

4. **Post-sales service.** This stage refers to all after-sales service activities, encompassing installation, training of machines' operators, provision of spare parts, maintenance, repairing,

[9] This is also the reason behind the fact that some of the local OEMs interviewed have refrained to open up facilities in China and are cautious about supplying Chinese or Indian mining operations, in order to avoid, or at least contain, reverse engineering of their equipment.

[10] Pumps, for example, can be sold on hourly basis: this means that for every hour that the pump is in service the customer would pay a certain amount. For mobile crushing stations, payment can be based on the throughput: thus, for every tons of material that goes in, the customer would pay a certain amount. Simple counters mounted on the equipment can easily control for those metrics. These type of funding schemes can provide relatively smaller junior miners with enough flexibility and with the possibility to prove to potential shareholders their ability to service debt.

refurbishing and re-building. Moreover, in certain cases, OEMs might also directly operate the machines and the equipment as external contractors, on behalf of the end-client, as in the case of Joy Global for example. When considering an investment on equipment, mining companies or contractors, will rather look at the total life-cycle cost of that machine than the initial capital cost of purchasing it. Total life-cycle cost includes the initial capital cost of purchasing, the life-time operating costs and the life-time maintenance costs. Thus, OEMs and mining companies engage in 10-15 years contracts, where manufacturers are required to provide not only the necessary equipment but a whole range of after-sales service: warranties, spare parts provision, maintenance, operator support and training among others. As in the case of sale and distribution networks, geographical proximity to mining operations is crucial to be able to secure these types of long-term contracts with end-clients. And indeed, many multinational companies have established global logistics operations with regional and local support offices allowing for next-day delivery of many components and spare parts, and on-site maintenance and training provision. Geographical remoteness of mining operations also increases the benefits of adopting predictive maintenance solutions rather than time-based maintenance programs, since it allows for performing maintenance only when needed but before unplanned breakdowns can occur on-site. Machines of large international OEMs are equipped with monitory technologies (e.g., see for example Joy Connect and PreVail used by Komatsu), providing timely and efficient machine health and performance information, and recognizing familiar patterns and deviation from normal control limits. Our interviews reveal that the margins for the initial capital sale of the machine can be really low (4 to 5 percent), while the life-cost revenues arising from after-sale services can be extremely high. It is by far the most profitable part of the business for OEMs in this mature and highly competitive sector, accounting for between 40 and 70 percent of their total revenues generated (see table 1, below). Moreover, it is also one the most employment-absorbing stages for many OEMs: during our interviews, representatives of a leading South African manufacturer of hydropower underground equipment have reported that three quarters of total employees are directly involved in after-market support activities.

**Table 1 – % of revenues and profits generated from capital project and after-market service (selected equipment).**

| Product line | Measures of value capture | Stage | |
|---|---|---|---|
| | | Capital project | After-sale |
| Hydropower underground machines | Revenues (%) | 50 | 50 |
| | Profits (%) | - | - |
| Vibrating screens | Revenues (%) | 50 | 50 |
| | Profits (%) | 10 | 90 |
| Feeders, feeder breakers, sizers | Revenues (%) | 30 | 70 |
| | Profits (%) | 15 | 85 |

*Source: own elaboration based on information gathered through interviews with industry's representatives.*

Indeed, emerging companies from Far East are still not so competitive in countries like South Africa and especially with respect to strategic pieces of equipment for tier 1 and tier 2 mining companies, precisely because they provide no or only limited after-sale support, despite the fact that the initial cost of their equipment might be extremely low and convenient. This might also open up the possibility for local companies in emerging economies like South Africa, both manufacturers and traders, to partner with and represent Chinese OEMs in the domestic and regional market, providing spare parts, maintenance and training support on behalf of the overseas producer (e.g., see, as an interesting example, the case of Roytec in South Africa). Maintenance, repairing and re-building activities are also of primary importance because all the information on equipment efficiency, including customers' feedback, can become useful inputs into the R&D process and, eventually, lead to revised design for current machines or to development of new products.[11]

*Governance structures*

The mining industry is predominantly characterized by a hierarchical and modular governance structure, globally dominated by a handful of large multinationals across the different stages of the value chain (e.g., mining houses, engineering contractors and OEMs). All these key actors populating the mining equipment value chain might act as lead firms, to a certain extent, but the power configuration will vary according to the specific circumstances and the specific relations in place between them.

Figure 4 provides a schematic diagram with the key three alternative governance structures, involving all the leading actors, and giving rise to different implications for equipment procurement and supply chain management.

1. In the *"make" governance structure*, the mining house (or the mining contractor) chooses not to make use of an engineering contractor or project house for the design and development phases of the mine. Within this model, the supply chain office of the mining house will handle all procurement operations, dealing directly with equipment suppliers, without any intermediary intervention. Thus, the project delivery is managed internally by the mine-project-owner, and, often, in close collaboration with key strategic OEMs which have developed, over time, the capabilities to design and execute large projects as much as specialized engineering contractors are able to do.[12]

2. In the *"ally" governance structure*, the mining house (or the mining contractor) will manage the design and development phases of a mine by appointing a specialized engineering contractor. Two types of contracting arrangements are widely used into the industry and they differ mainly with respect to the specific actor which is in charge of the procurement process (e.g., deciding what to buy and from who).

    2.1 *EPCM* (Engineering, Procurement and Construction Management) contracts. Under this contract, the specialized engineering contractor acts as an agent for the end-client, carrying out engineering, designing and procurement specifications on behalf of the mining house. It is also in charge of supervising the mine's construction and the overall management of the project to ensure the work is executed according to the design criteria and the required standards defined by the end-client. However, the mining house will be directly responsible

[11] A very interesting case in this respect is the one of JA Engineering (JAE), a South African company established in 1987 to provide alternative after-market support for the equipment of multinational companies, through exceptional reverse engineering solutions. Over time, JAE has established itself as an OEM, and, in close collaboration with clients, it has started to design and engineer original equipment, like for example the Wildcat: an underground machine for the global coal industry.

[12] According to our interviews, a number of international mineral processing OEMs, like FLSmidth and Metso, have started to offer specialized engineering contractors' services.

of awarding and signing contracts with selected suppliers, taking into account the EPCM's recommendations. The specialized engineering contractor is generally paid on a cost-plus basis (e.g., costs reimbursement plus a fee) and it is not responsible for cost overruns and project delays. The EPCM contract are becoming the most commonly adopted ones within the industry.[13]

2.2 *EPC* (Engineering, Procurement and Construction) contracts. Under this contracting model, the end-client appoints the specialized engineering contractor to design, procure and deliver the final project. Thus, within an EPC agreement, once the test-work has been done, the process has been designed and the float sheet has been determined (e.g., the process up until that point is exactly the same as in the EPCM model), then, the procurement phase is directly managed by the engineering contractor, which will award and manage all contracts with selected suppliers. The EPC is generally paid on fixed price basis (e.g., under a Lump Sum Turnkey – LSTK – contract), and it bears the risk of cost overruns and project delays. The EPC contracts flourished during the commodity boom, when the market's demand for risk shifting from mining companies to engineering contractors was extremely high.

However, a recent key trend in the industry, is the increasing demand among mine-project-owners for hybrid delivery models that can provide an alternative to the traditional EPCM and EPC contracting agreements and can be designed to clearly define those specific areas over which the owner may wish to take control, while minimizing the risk exposure in other areas. In general, it might be said that relatively larger mining houses (e.g., tier 1 and some tier 2) would mainly contract on an EPCM basis, because they understand risk, they can easily secure funding and they have the internal structure and capabilities to manage multiple projects in different contexts and environments. Smaller companies (e.g., some tier 2 and especially tier 3) with limited capabilities and access to funding, would prefer to fix costs and transfer risk to the specialized engineering contractor. Moreover, the choice between the EPCM and EPC contracting model will also depend on the specific commodity to be extracted and/or processed and the specific market where the mining site is located.[14] However, also under an EPCM contract, the degree of procurement power of the specialized engineering contractor will depend on the capabilities and experience of the end-client. A number of factors and considerations will indeed influence the sourcing strategies of mining houses.

By simplify, we might say that the mine-project-owner is the lead firm in terms of procurement operations especially:

1. Within the context of the "make" governance structure, when no external engineering contractor is appointed and the mining house manages internally the project delivery, often in close collaboration with few key strategic global OEMs that, over the years, have developed in-house the capabilities to design and execute large mining projects.

---

[13] During an interview, a major South African EPC/M has estimated that the 90% of their current projects is undertaken under EPCM contracts, also confirming that this is a broader tendency in the industry.

[14] During interviews, the representatives of a major South African EPC/M have stressed that for some commodities (e.g., diamond) in which they have a substantial experience, they would be prepared to act as an EPC. Similar considerations will apply to the specific market under analysis: managing a project in Botswana, DRC or Russia is, again, very different and the risk tolerance of the engineering contractor would vary accordingly.

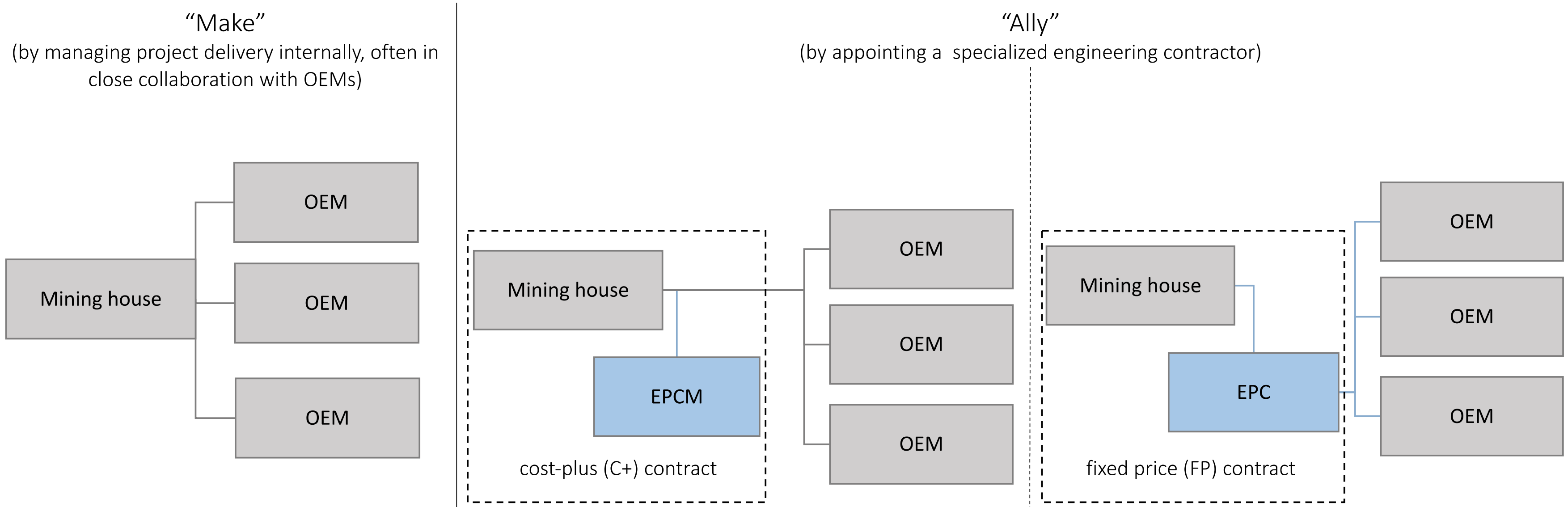
2. Within the context of the “ally” governance structure, when an external engineering contractor is appointed under an EPCM delivery agreement, and the mine-project-owner has stringent procurement requirements and regulations, and the experience, the internal resources and capabilities to effectively enforce those specific contractual terms on the provision of products and services.

3. During the operational phase, if the project-owner is also operating the mine.

4. When its procurement operations are centralized, with stringent procurement requirements and regulations enforced across all mining sites.

In addition to mining houses, specialized engineering contractors and OEMs, also governments in countries hosting mining operations are increasingly perceived as key actors, influencing governance patterns along mining supply chains. The particular nature of the mining industry in developing countries (often (*i*) an enclave sector, (*ii*) with mining operations of limited lifespan) creates incentives for the host countries to set up stringent resource management regulations for commodity producing firms, in order to maximize socio-economic benefits and to reduce dependency on mining activities in the long run. In particular, such norms and protocols target local procurement and recruitment, suppliers and skills development programs and infrastructure development projects. Moreover, also local communities are increasingly perceived as key actors providing the mining companies with a sort of *social license to operate*. This, in turn, translates into a rise of the bargaining power of local communities *vis-à-vis* mining companies concerning issues of resource management.

**Figure 4 – Governance structures for the exploration-development (or expansion) phases of a mining projects.**




- the engineering contractor provides services (project management expertise) to the mining house;
- it develops and manages the project on behalf of the mining house;
- it is not directly responsible for project costs or for subcontracting directly with trade and building contractors (including OEMs);
- the mining house directly subcontracts with trade and building contractors based on the terms negotiated with the EPCM and its recommendations;
- the EPCM company is paid on a cost-plus basis: reimbursement for the hours worked plus a fee;
- the mining company bears the risk of cost overruns or project delays.

- the engineering contractor is responsible for the delivery of design and project construction;
- it is directly responsible for project costs and for subcontracting directly with trade and building contractors (including OEMs);
- the mining house facilitates the project execution, but it is much less involved in coordinating the design and construction details;
- the EPC company is paid on a fixed price basis;
- the EPC company bears the risk of cost overruns or project delays.

*Source:* own elaboration based on information gathered through interviews with industry's representatives.

*1.2.2 Procurement strategies and supply chain management*

In the previous section we have described the specific functions characterizing the mining equipment value chain, and the different actors performing those functions. We have also highlighted which stages allow for greater value capture opportunities (e.g., after-sales service) and the alternative governance structures characterizing the sector. The purpose of the present section is to understand how inter-firm linkages might promote or limit the emergence, growth and consolidation of local OEMs in emerging economies. Specifically, we will underline how procurement decisions are taken and by whom, under different governance structures. This is obviously extremely relevant in order to fully identify opportunities and challenges for local OEMs in emerging economies willing to enter and upgrade through such supply chains.

In analyzing the sourcing process along the mining equipment value chain, we distinguish between 1st and 2nd level procurement (as reported in figure 3). The former refers to the sourcing strategies of the mining houses when specifying, selecting and buying mining equipment and machines from OEMs, while the latter refers to the sourcing decisions of the OEMs themselves with respect to their own supply chain (e.g., from tier 1 to tier 3). In the first case, the key buyer and decision-maker is the mining-project-owner (or the mining contractor), while other decision-influencers might include the specialized engineering contractors. In the second case, the key buyer and decision-maker is the OEM, while other decision-influencers might include both the specialized engineering contractors and the mining companies. For both procurement's levels, the key objective of this section is to highlight how different criteria, companies and inter-company power configurations directly influence sourcing decisions along the value chain, unlocking opportunities or creating barriers for local suppliers to entry, upgrade and consolidate in the industry.

*a. Sourcing strategies of mining-project-owners (1st level procurement)*

In this sub-section we will analyze the key factors that influence procurement decisions of mining houses,[15] throughout the life cycle of a mine and the critical success factors for equipment suppliers, looking at the various reasons behind the dominant position, globally, of multinational OEMs in this industry and, along with it, at how high barriers arise for local suppliers from emerging countries.

*Buyers' procurement decisions through the mining project lifecycle*

In analyzing the critical aspects influencing sourcing and procurement strategies in the mining industry it is crucial to understand how a typical mining project lifecycle develops. The key decisions made during each phase of a mining project lifecycle might indeed directly opening or limiting opportunities for local suppliers. The actual decision by the mining-owner-project of the specific type (and brand) of capital equipment to be employed for commodities' extraction and processing is generally taken well before the start of the operational phase. Following the exploration, there are three key phases within a typical mining project lifecycle in which critical decisions are taken,

[15] In what follows we will make reference mainly to the procurement strategies of tier 1 and mid-tier mining houses majority-owned by traditional investors. As already briefly introduced, sourcing decisions of mining houses majority-owned by emerging investors and by tier 3 end-clients, with limited access to funding and only few operations often characterized by relatively short time horizons, might differ and follow alternative strategies (e.g., Chinese or Indian content maximization strategies in the first case, or initial capital cost-minimization strategies in the second case).

influencing procurement strategies. These include the technical and financial evaluation (or design) phase, the construction phase and, eventually the operational phase.

Far from being a comprehensive representation of a typical mining project lifecycle, the information reported below illustrate the process flow of procurement decision making through these different phases, underlining the role of the actors involved and the influence of different governance structures in shaping their relations and sourcing strategies.

1. **Technical and financial evaluation (or design).** This is an iterative process that follows the exploration phase, in which more detailed design, planning and financial models are developed as the confidence in the feasibility of the project grows.

    1.1. **The scoping / conceptual study.** It consists of an analysis of the nature of the reef to be mined. Test work covers metallurgical (e.g., the specific properties of the ore), and geotechnical studies. Key outputs of this step include an evaluation of the reef and the definition of a general mining approach to extract and process the commodity, as well as a preliminary conceptual mine plan.

    1.2. **Prefeasibility study.** During this step, a more rigorous analysis of the underlying geology is undertaken. A conceptual outline of the mine's time-life and a high-level financial model are realized to verify the *prima-facie* business conditions for the project's development.

    1.3. **Feasibility study**. During this step, the appropriate mining system is identified, including key technologies required, their main functional requirements, and the fundamental infrastructure needed for these technologies to operate. In addition, the evaluation process requires the development of a detailed financial model leading to a bankable feasibility analysis. Already during this phase, an external engineering contractor might be appointed, and certain commercial relations put in place with strategic suppliers to further consolidate the feasibility plan. Despite the appointment of an external engineering contractor, these preliminary procurement decisions are generally heavily influenced by the mining-project-owners, especially when stringent guidelines, requirements and regulations are in place, requiring that the design is standardized, whenever possible, with their other operations (either new projects, or project's expansions). In particular, standardization allows to minimize risk exposure and to maximize production efficiency, ensuring economies of scale in maintenance activities. Hence, well before any procurement process takes place, many local and regional suppliers can be excluded based on technical and functional specifications, nature of the enabling infrastructure that will be used, but, mostly, pre-existing commercial relations of the buyers (e.g., mining-project owners, engineering contractors) with entrusted suppliers (e.g., OEMs). Differing preferences for equipment suppliers can lead to frictions between mining companies and engineering contractors, already in this phase, especially when centralized stringent procurement guidelines are not issued by mining-project-owners.

2. **Construction.** After the feasibility study is completed and the decision to proceed with the project is taken, a detailed and site-specific engineering plan will be developed. Depending on the

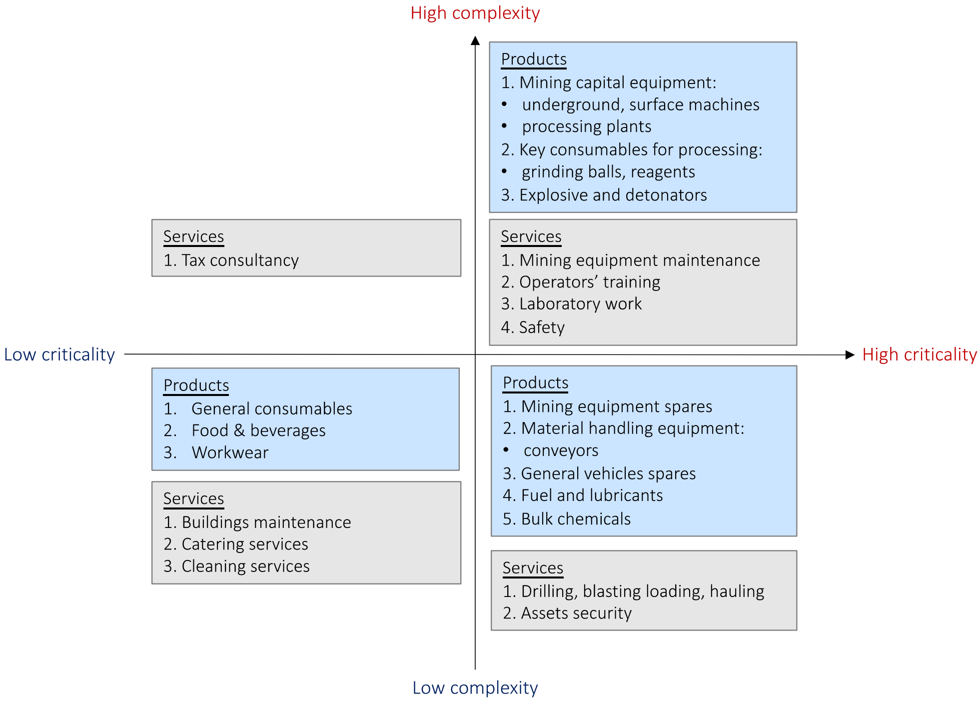
capabilities of the mining company, the complexity of the project and the external risks, the construction's implementation may take place under different governance structures, with the appointment of an engineering contractor (on a cost-plus EPCM contract or on a turnkey EPC contract), or simply involving a more direct and closer collaboration between the mining-project-owner and the OEMs.

3. **Operations.** By the time the mine has reached its operational phase, the fundamental design decisions are in place and they are very difficult, and costly, to change. Similarly, the functional and technical specifications for the key operational equipment have largely been defined based on the mine infrastructure and the mining system. Attempts to change the mining system once operations have started have often proven to be disastrous, given the complementarities and the inter-dependencies between the underlying mine design and the choice of operational equipment. During this phase the mining plan may be continuously updated and tweaked, based on new knowledge about the reef. In terms of operational equipment, the key objective on the part of the mining-owner-project is to maximize reliability and production efficiency and minimize maintenance costs of the existing equipment. Given the benefits of standardization, once specific buyer-vendor relations are in place for strategic operational equipment, it is extremely difficult to substitute the whole fleet of machines or processing plants. However, despite the advantages of standardization, in the absence of specific centralized sourcing recommendations, procurement decisions might be driven by other actors (e.g., site-engineers, engineering consultants), resulting in loss of standardization and proliferation of suppliers.

*Suppliers' critical success factors*

Procurement strategies will vary significantly in relation to the characteristics of the products and services sourced by mining companies. The strategic nature or otherwise of certain products and services can be defined by two dimensions: their *criticality* and *complexity* (see figure 5 below). Products and services can be defined critical if their functional failure or breakdown would directly compromise the productivity, efficiency, safety, regulatory and standard requirements of the mining operations. The complexity associated with mining products and services refers to the increasing sophistication of their functional and technical specifications. Higher margins are also a characteristic of more complex products and services, which typically require more advanced product, process and training standards.

**Figure 5 – The procurement matrix for products and services sourced by mining-project-owners.**




*Source:* adapted from Östensson (2017) and Mjimba (2011), based on own interviews with industry's representatives.

The key concern for mining companies in the procurement of the most critical and complex pieces of equipment is to secure the best total life-cycle cost at the lowest possible risk, while maximizing productivity. The total life-cycle cost is measured against all the costs associated with the equipment (e.g. initial capital costs, running and operational costs, maintenance and repairment costs, including operators' training). This cost is then compared to the likely productivity of the equipment (e.g. tons moved during the life of the equipment, hours of continuous operations), taking into account the risks and costs associated with lost efficiency and productivity due to unreliability and unplanned breakdowns. To this purpose, the following features of the most critical and complex machines are particularly taken into considerations by mining companies and represent the critical success factors for equipment suppliers.

1. **Appropriate functional and performance specifications.** Such specifications will determine what the equipment needs to be able to do, rather than how the equipment should be designed. Hence, performance specifications are often included within functional specifications (e.g. minimum tons moved per hour, minimum hours of continuous operation, emissions requirements, maximum load among others). As already underlined, the importance of equipping the machines with monitory technologies is becoming increasingly a decisive factor when it comes to sourcing strategies, especially for tier 1 and some mid-tier mining companies.

2. **Appropriate technical specifications.** Such specifications will define certain elements that need to be taken into consideration in the design of the equipment. This is often to ensure that the equipment is compatible with the specific mining conditions and infrastructure (e.g. power supply, size of equipment, maximum weight, the strength of steel components among others).

Information technology integration requirements with the broader mine planning system are becoming increasingly critical, especially for tier 1 and some mid-tier mining companies.

3. **Appropriate operational and maintenance provisions.** Such requirements include a number of specifications broadly related to the equipment total-lifecycle cost, performance and risk management processes. These include the establishment of on-site workshop and support facilities, the availability and delivery-on-time of spares and components, the provision of operator training to maximize the efficiency of the equipment as well as artisan and technical training to maintain and repair it. The ability to standardize entire fleets and suites of equipment, obviously, plays a key role in the context of operational and maintenance provisions.

4. **Attractive commercial propositions and financing solutions.** The nature of the commercial proposition offered by the equipment manufacturer to its buyer (e.g. the mining company) can dramatically impact the competitiveness of different equipment in the marketplace, altering significantly the risk exposures of the mining company and the equipment supplier (see box 1 for a detailed assessment of this point).

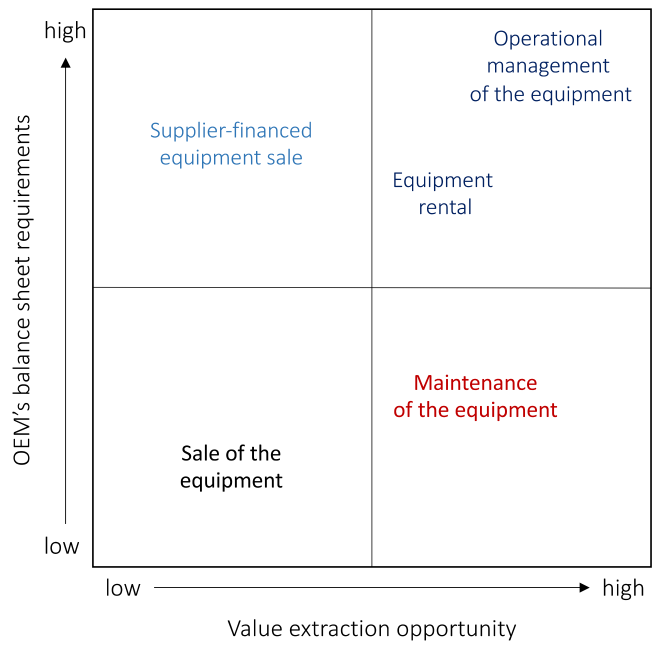
**Box 1 – Different commercial propositions offered by mining OEMs to their buyers.**

Commercial models and propositions may differ substantially, being highly customized to specific customer requirements. Far from being a comprehensive catalogue, the following list reports the most widely used equipment financing solutions in the mining industry (also summarized in figure 6).

1. **Sale of equipment with a performance guarantees for a limited period of time.** This is the classic "arm's-length" transaction, whereby the mining company procures the equipment using its own funds, takes operational responsibility for the use of the equipment and is directly responsible for the repairing and maintenance activities over the life-time of the equipment, in the context of a limited-period warranty, covering all functional aspects. The supplier will only receive payment for the initial sale of the equipment. Within this model, the size limitation of supplier's balance sheet is a key concern of the buyer only in case of large-scale procurement.
2. **Sale of equipment with a long-term equipment maintenance agreement.** This contract provides the OEM with a lump sum payment for the sale of the equipment plus profitable annuity streams. In this context, the margins for the initial capital sale of the machine can be really low, but they are fundamental to secure the more lucrative, longer-term maintenance agreement. The control of the equipment's maintenance will provide the OEM with higher margins from servicing the machine and selling spare parts. Global OEMs might outsource the sale and servicing contract to a specialized large OEM agent. Smaller local OEMs may also secure contracts from mining companies to service global OEMs' equipment after the warranty has expired, lowering the costs borne by the customer and associated with the procurement of original OEMs' parts.
3. **Rental of equipment with an intrinsic maintenance agreement.** In this case, the mining company can pay for the use of the equipment entirely through operational cash flows and the OEM will have an exclusive right to service and repair the equipment. Depending on the nature and the duration of the contract, the OEM may include a liability or a contingent liability in its balance sheet. To be able to offer equipment rental agreements, the OEM will require either a significant balance sheet, or a partnership with a financial institution.
4. **Sale of a service based on the productivity / output of the equipment.** This contract provides that the OEM is paid based on an equipment performance metric, such as the amount of tons mined or processed, the amount of hours the equipment has been in service, or, in the most sophisticated agreements, the amount of saleable output processed. This is the highest value contract for the OEM through which it creates an exclusive relationship with the mining company and secure margins on the equipment servicing and operations, provided that the OEM is able to ensure the delivery of an output which secures these margins. Obviously, this also means that these machines should be equipped with monitory technologies providing timely performance information. Consequently, the entire operational risk is borne by the OEM, and this aspect obviously requires that it has the proper financial means and the balance sheet size to fund the operations and to deal with contractual under-performance.

*Source:* adapted from CCRED (2019), based on relevant secondary literature and own interviews.

**Figure 6 – Equipment financing models: balance sheet requirements and value extraction opportunities for OEMs.**




*Source:* adapted from CCRED (2019), based on information gathered through interviews with industry's representatives.

*Barriers to entry for local suppliers in emerging economies*

A confluence of factors, both on the part of the demand (e.g., the sourcing process through the lifecycle of the mining project of either tier 1 or mid-tier mining houses) and the supply (e.g., critical success factors for mining equipment suppliers) directly influence the barriers to entry and expansion for local suppliers in emerging economies.

On the demand side, as already briefly underlined, certain conditions might influence mining houses procurement strategies' and push them to opt for global OEMs, building simultaneously barrier to entry and upgrading for local OEMs in emerging economies. These conditions can be summarized as follows.

1. **Pre-existing buyer-supplier relations and risk aversion.** As already underlined, many local and regional suppliers can be excluded from procurement process also based on the pre-existing commercial relations among buyers (e.g., mining-project owners, engineering contractors) and entrusted suppliers (e.g., often global OEMs), with proven experience and track record in the industry. These pre-existing relations can be extremely deep and complex, often to the point of constituting truly global alliances and partnerships that facilitate standardization of entire fleets and suites of equipment across different global mining operations. This, in turn, allows to minimize risk exposure of end-clients, maximizing their production efficiency and ensuring economies of scale in maintenance activities. Once an OEM has secured a contract for supplying equipment and related services, it is far simpler and less risky to maintain the *status quo* than to

move to another contractor. According to our interviews with end-client representatives, a very strong strategic intent of the top-level management would be needed to change entire suites of mining equipment, shifting to alternative, maybe local, suppliers, especially for brownfield operations.

2. **Location of decision-making with respect to procurement strategies.** The increasing adoption, especially by tier 1 mining houses, of centralized procurement arrangements that incorporate value-based control mechanisms has key implications for the local embeddedness of their supply chain. The strengthening of the value-based management's approaches and conventions in the procurement departments of the majors is designed to facilitate and enhance a global approach to supplier relations, favoring the prioritization of cost minimization strategies and the disruption of deeper, longer-term relations between mine site managers and local engineering and technology suppliers, especially in emerging economies. The practice of enriching central procurement divisions has also spread along the value chain to other actors playing a key role with respect to sourcing strategies, like engineering contractors and project houses.

3. **Lack of contact with (and knowledge of) local markets and suppliers.** Even if strategic sourcing functions are located on-site, procurement officers are often expatriate employees and might have little interaction with the local economy, especially in less developed countries. They might often prefer to approach local representatives or distributors of global OEMs. This might be related to the geographical remoteness and the "enclave" nature of many mining sites. The lack of exposure to the domestic ecosystem might lead to a lack of awareness of what can be successfully sourced from local suppliers. This is probably less of a problem in countries like South Africa, where especially site-engineers are generally aware of local capabilities and quite supportive of domestic OEMs' solutions (Reynders, 2018).

The evidence suggests that especially large mining companies rely mostly on foreign multinational OEMs for key, knowledge-intensive, sensitive solutions. Looking at the supply side, indeed, these global companies have at least three major competitive advantages, namely, brand, scale and a strong balance sheet, that allow them to differentiate from local OEMs in emerging economies with respect to the following aspects.

1. **Early engagement.** They are able to engage with major mining companies already in the early phases of the mine's design. This is the results of being perceived by major blue-chip mining houses as technology leaders in their specific product space. Moreover, the pre-existing commercial (or even personal, in certain instances) relations of the buyers (e.g., mining-project owners, engineering contractors) with specific entrusted global OEMs can be deep and complex often to the point of constituting truly global alliances and partnerships, further strengthening multinational OEMs' market position. This provides these companies with the ability to influence the functional and technical specifications associated with the mining system conceptualized during the technical and financial evaluation stages of the project, giving their equipment a significant competitive advantage during the tender phase.

2. **Scalability.** They can rely on an established network of production facilities and on a truly global and flexible supply chain structure that can be managed and optimized according to the specific circumstances and project's locations. This provides major mining companies with a guarantee that large-scale orders can be delivered on-time, without compromising the quality.

3. **Standardization.** They have the ability to offer the full suite of mining machines, in one or more product segments, needed by the end-clients in new or existing mining operations, resulting in a one-stop source of equipment and related services for their customers. This allows mining companies to standardize sub-systems and components across different pieces of equipment and across different operations, optimizing the provision of operator, artisan and technical training to operate, maintain and repair the machines.

4. **After-market support facilities.** They offer a global network of support facilities for the equipment, located in proximity or even inside mining sites, ranging from fully equipped workshops to training hubs for engineers, operators, artisans and technicians.

5. **Longevity.** Given the long lifetime of a large mining project, and the related long service life of equipment and machines employed on-site, the proven longevity and financial stability of global suppliers guarantees the reliability and the quality of their products and services.

6. **Customized equipment financing solutions.** They are able to offer a broad range of value propositions, from product sales to outsourced services, with customized financial packages to properly fund these propositions for different end-customers. In certain instances, the relationship between leading OEMs and their home countries ensures that they have special access to development finance institutions and are able to influence the national research and development agenda.

Thus, although the global OEMs might not produce the best piece of equipment in a certain range or sell their equipment at the most competitive quality to life-cycle-cost ratio, the leading OEMs are in a dominant market position. Such convergence of demand and supply side constraints influencing the procurement process of major mining companies, places domestic OEMs in emerging economies, often focusing on niche technologies and highly customized solutions particularly suitable for the local geological conditions, in a very difficult competitive situation.

*b. Sourcing strategies of OEMs (2nd level procurement)*

Mining equipment companies might outsource different stages of research and product development, manufacturing, distribution and after-sales service to other actors, or perform some of these tasks in close collaboration with (and under the influence of) end-clients and engineering contractors. The sourcing strategies of different OEMs (e.g., 2nd level procurement) rely partly on relatively more diversified and context-specific logics, compared with those followed by mining houses. In what follows we will briefly introduce some general observations, but a more detailed analysis in this respect will be provided in the next section with special reference to the specific case of South Africa.

*Sub-assembly and components*

With respect to the manufacturing stage of the value chain, OEMs generally outsource sub-assembly and manufacturing components fabrication stages to tier 1 and tier 2 suppliers. Production and supply chain models vary widely, however, according to our interviews, both multinational lead companies and local OEMs in emerging economies would retain some key strategic manufacturing and assembling stages in-house, in order to protect the associated IP. International OEMs can rely on their structured supply chain consisting of a global network of manufacturing facilities located both in their home-countries and abroad (e.g., especially in China and India). This provides them with the flexibility to assess from time to time, on a landed-cost basis, where it is convenient to do the fabrication for different product lines, also in consideration of the geographical location of the specific mining project and the requirements imposed by the customers (e.g., minimum local or regional content, price criteria, specific preferences over components' brand or origin). In many developing countries, electrical components like engines and batteries for underground and surface machines, or unbalance motors and magnetic vibrators for vibrating processing equipment are imported from tier 2 foreign suppliers or sourced from their local representatives. The same applies to other components, like tires and track systems for heavy earthmoving equipment used in the mining industry. Relatively less complex and key components can usually be sourced locally (e.g., hoses, lights, paintwork, welding equipment, lubricants, fuel). For some kind of items (e.g., motors and engines), especially local OEMs maintain a certain supply chain flexibility and allow the customers (e.g., mining houses or engineering contractors) to specify whatever type and brand of motor they want.

*Raw materials*

Tier 3 suppliers mainly focus on providing raw materials (e.g. steel, non-ferrous metals and alloys, basic plastics and chemicals) and capital equipment used in the fabrication of components (e.g., all these stages form what we refer to as 2$^{nd}$ level procurement in figure 2). Certain raw materials (e.g., specialized types of steel like duplex stainless steel) should present very specific technical criteria because of the strict durability and resistance requirements associated with many mining machines operating under extreme conditions. In many developing countries such materials are generally imported for different reasons: (*i*) the lack of local capabilities to manufacture them domestically, (*ii*) the lack of sufficient domestic demand to keep (*iii*) prices competitive. For other raw materials (e.g., basic steel or plastic) price competitiveness of China and other South Asian countries (e.g., Malaysia) is driving increasing imports in other emerging economies producing mining equipment and machines.

*c. The role of local content policies*

Many resources-rich economies have set up over time specific policy instruments aimed at increasing the use by their mining sector of locally available products and services, with the main goal of securing increased socio-economic benefits from their mineral endowments. These policy measures are specific to and pervasive in extractive industries, including in OECD economies and in countries open to trade. One of the key objectives of local content and capacity building policies in countries hosting mining operations is the development of upstream supply chains at the domestic level to respond to procurement needs of mining companies in core and non-core products and services.[16] Local content requirements obviously influence procurement strategies of both mining companies (e.g., 1$^{st}$ level procurement) and OEMs (e.g., 2$^{nd}$ level procurement) and might lower barriers for local companies to entry, upgrade and consolidate along the mining equipment supply chain. If properly formulated, implemented and monitored, they can effectively reduce competitive pressure from imported inputs for local suppliers and create immediate employment opportunities. Otherwise, the risk is that they can potentially undermine these objectives in the long-run: on the one hand, if poorly designed and enforced, they might lead to potential distortions penalizing many

[16] Other related key objectives include workforce development, technology transfer, research ad development and innovation and downstream value addition or beneficiation.

leading local companies and creating pockets of unproductive rents-capture for a small group of players; on the other hand, if their enforcement along the entire supply chain is not properly monitored, they can prove simply ineffective. A more detailed analysis in this respect will be provided in the next section with special reference to the specific case of South Africa, where local content measures aim primarily (*i*) to provide better access for historically disadvantage groups within the society to the gains from mining companies and (*ii*) to strengthen local linkages with the mining sector in order to increase value-addition and employment-absorption within the economy.

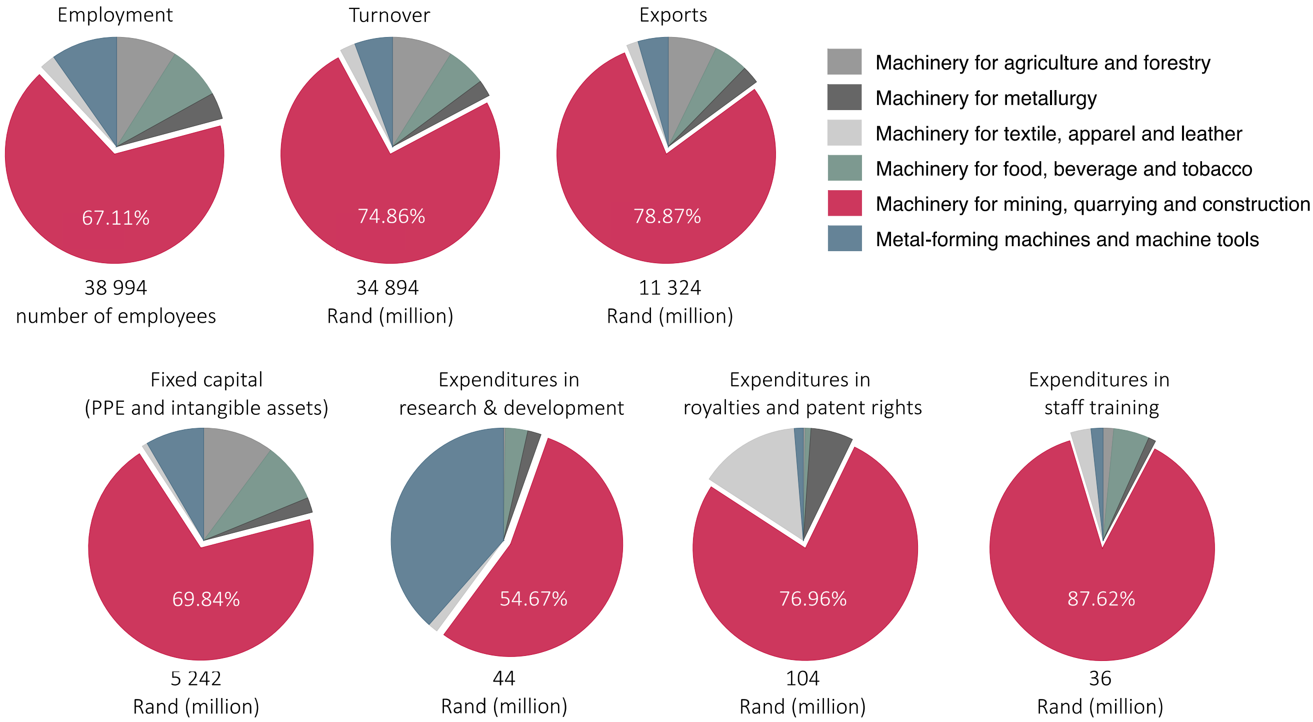
## 2 The South African mining equipment sectoral value chain and cluster

### *2.1 Mapping out the mining equipment national value chain and cluster*

Mining equipment production and services are the today's most relevant and technologically advanced segments of the broader special purpose machinery industry in South Africa. Specifically, the mining machinery and equipment sector represents the largest contributor to employment, turnover and exports of the special purpose machinery industry, and it also stands out with respect to total plant, property, equipment (henceforth referred to as PPE) and intangible assets, expenditures in R&D, royalties and patent rights, and staff training. According to SARS data, in 2017, South Africa-registered companies producing equipment and machines for mining, quarrying and construction, contributed to more than 67% of the total employment in the special purpose machinery sector (e.g., around 39 000 employees), and to around three fourth of its total turnover (75%) and exports (79%), accounting to around 35 000 million Rand and 11 300 million Rand, respectively. The development of a mining equipment ecosystem in the Gauteng province – two thirds of the employment and turnover are concentrated there – has driven processes of technological capabilities development and diffusion. Indeed, this sub-sector also makes a hefty contribution to the total non-current assets (70%) and spending in capabilities development undertaken in the specialised machinery and equipment industry, as proxied by expenditures in R&D (55%), royalties and patent rights (77%) and spending in staff training (88%).[17]

[17] Further indications of the technological sophistication of the sub-sector are the quantity and quality of mining-related technology patents. Indeed, as reported by Kaplan (2012) these patents (*i*) constitute a much larger share of South Africa's total patenting activity at the United States Patents and Trademark Office (USPTO) than of other comparable countries that are technological leaders in mining-related technologies (e.g., USA, Canada, Australia) and (*ii*) they receive more citations with respect to other South African patents.

**Figure 7 – Relevance of the mining equipment sector within the South African specialized machinery industry in 2017.**




*Source:* own elaboration, based on SARS (2019) and AFS (2018).

The proximity to the mines, the demand for customized and niche technology solutions well-suited for the peculiar geological conditions of South Africa have been critical drivers of learning and, thus, global competitiveness for local companies that, over the years, have developed production and services operations across major extractive industries and countries, actively engaging with the technological race in the global mining value chain. However, although a number of these companies are large by local standards, they are still significantly smaller than the leading multinationals operating in South Africa and their expertise and competencies are particularly advanced and at the global frontier only in specific product segments (e.g., deep level mining and related areas).

During the last decade, South Africa's global competitiveness in the mining equipment sector has been on the decline due to a combination of factors including both domestic bottlenecks like the shrinking domestic mining industry among others, and global threats such the increasing foreign competition faced by local players. The country has experienced a decline in its export shares of mining machinery and equipment to traditional markets in the aftermath of the global financial crisis (CCRED, 2019) and it is losing its appeal for leading multinationals as a preferred and strategic location in which to undertake research, product development, engineering and production activities. In this section we will review the key companies operating in the sector, illustrating their production and distribution models and the regulatory environment they face.

*2.1.1 A general overview of the cluster*

The main criteria used in this report to provide an overall picture of the South African mining equipment and specialized services cluster are nationality of ownership (foreign or local), companies' size distribution, main product segments (whether they mainly produce underground, surface, handling or mineral processing equipment) and the nature of the business and key activities (whether they locally design, engineer, manufacture, export, import, distribute, maintain and service their products). Unfortunately, there is no publicly available dataset listing all entities registered in South Africa exclusively supplying the mining industry and accessible information, such as data from SARS, does not include all the relevant aspects mentioned above. In what follows, in order to formulate a reliable overview of the sector, we will build on the study by Walker and Minnitt (2006) based on data for 678 companies belonging to the mining equipment and specialized services cluster in the East Rand, gathered between 2000 and 2001, trying to complement and update this evidence using a more recent set of secondary and primary information (e.g., industry reports and data, and own interviews).

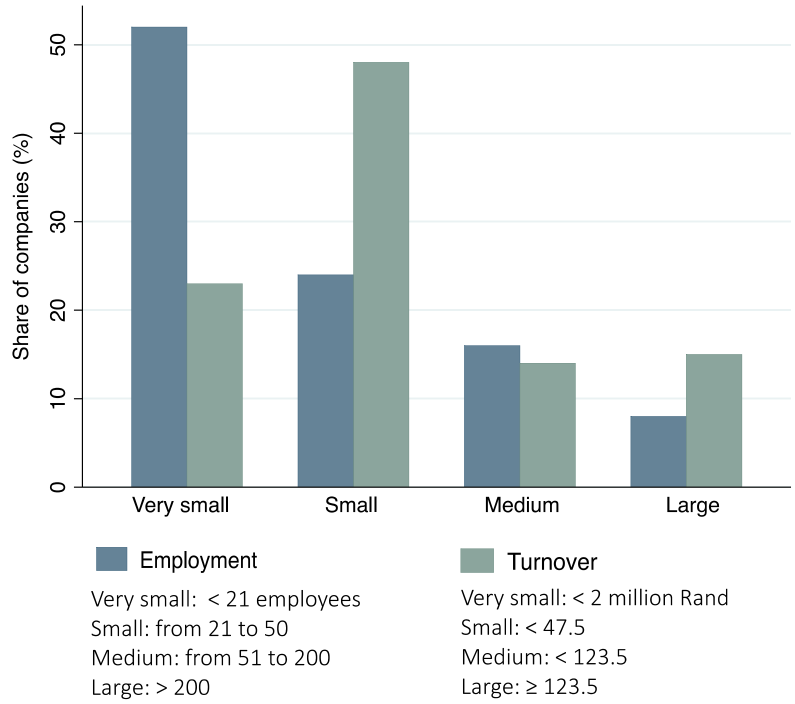
1. **Ownership**: over the years, the South African mining equipment and specialized services sector has attracted significant foreign investments by leading global multinationals, that selected the country as a preferred location in which to undertake mainly distribution and sales activities (e.g., market seeking investments), and to a lesser extent also research and product development. Indeed, according to Walker and Minnitt (2006), in 2001, 33% of the companies in this sector were foreign, while 67% local. Since then, this proportion might have slightly changed, however it still describes quite accurately the ownership pattern within the sector: according to the Who Owns Whom (2019) industry report foreign firms account for around 34% of total companies and 46% of total turnover in the sector. These global firms are specialized engineering contractors, OEMs and exclusive distributors and service providers for such OEMs. Local companies also include suppliers at any tier along the mining equipment supply chain (see figure 3).

2. **Size distribution**: according to the data gathered by Walker and Minnitt (2006), the average number of employees per company in the mining inputs cluster was 239 in 2001, with over three fourths of the firms employing between 1 and 150 people and only 17 employing over 1000 people and accounting for the 60% of total employment in the sample (many of the latter were foreign companies). More recent data exclusively on registered manufacturing firms[18], operating in the Gauteng province, reveals that in 2017 the mining equipment cluster was mainly composed by small companies, employing less than 51 people (76%), while medium (e.g., between 51 and 200 employees) and large companies (e.g., with more than 200 employees) accounted for the 16% and 8% respectively. In terms of turnover, 71% of companies were classified as small, 14% as medium and 15% as large.[19] Medium and large firms, regardless the specific classification used, account for the bulk of total employment, sales, exports, investments in fixed capital, expenditures in R&D, staff training and royalties and patent rights. Key foreign OEMs operating in South Africa are generally large companies with a number of employees per firm of around 1000 or more. Local OEMs generally fall into the medium-size class, with some notable exceptions (e.g., Bell Equipment, Multotec and Master Drilling among others). Several local suppliers, at any tier, are small and very small companies.

[18] Thus, excluding engineering contractors and companies providing only services. The work of Walker and Minnitt (2006) also includes those firms beside manufacturers.

[19] The official definitions of small, medium and large business used here, and based on full-time equivalent employment and turnover data, are provided by the dti (2016).

**Figure 8 – Size distribution of mining equipment manufacturing firms in 2017, by employment and turnover.**




*Source:* own elaboration, based on SARS (2019) using companies' size classifications provided by the dti (2016).

3. **Main product segments**: at the product-service level, over the years, South Africa-based companies has developed advanced competencies in certain specific areas. On the one hand, as far as products are concerned, these locally developed machines have generally been designed and fabricated by South African firms, sometimes in partnership with foreign companies or entities, and include spirals for washing coal, vibrating equipment for mineral processing, mining pumps for deep level mines, hydropower equipment, tracked mining equipment, underground locomotives and ventilation equipment, drilling solutions and small- and medium-sized mining trucks for open-cast mines. On the other hand, with respect to services, local companies have also specialized in shaft sinking, geological advice, turnkey solutions for designing greenfield mining sites, operation and maintenance services. Hence, South Africa has strong and particularly advanced capacities in offering products and services in certain fields, such as deep level mining and related areas, where customized and niche solutions well-suited for the peculiar geological conditions of South Africa can provide substantial added value for the end-client. As an example, South Africa is particularly well represented in drilling: 5% of the companies operating globally in such field are based in South Africa (Porter and Ramirez-Vallejo, 2010; Kaplan, 2012). However, for those products whose global success is strictly linked to large economies of scale and standardization, the competitive position of South African companies is much weaker. For instance, with respect to products like mining and haulage vehicles, including low-profile machines for underground operations, where scale economies and standardization are critical, large multinationals tend to dominate the market.

4. **Business models and main activities**: local OEMs undertake research, product development and system integration activities in-house, often outsourcing a number of fabrication stages to their local suppliers and importing components that are not available locally (e.g., engines, batteries, tires for earthmoving equipment). They are also directly involved in after-sales support activities, like maintenance and repair, refurbishment, staff training. Many of them export their products, but their ability to substantially increase their market presence abroad crucially depends on the possibility of setting up support facilities for the equipment, located in proximity or even inside mining sites, ranging from fully equipped workshops to training hubs for engineers, operators, artisans and technicians. Foreign OEMs have established a much more varied range of business models to operate in South African and in the broader region. Many of these companies exclusively undertake distribution and after-sales activities through an extensive network of local and regional branches providing sales and support services. Some of these multinational companies also offer customization services and outsource the fabrication of few minor components to local suppliers. A small number of these multinationals have set up extended manufacturing facilities in South Africa, where they fabricate and assemble selected product lines, nurturing and supporting a number of local suppliers. For some of these machines locally manufactured, multinationals' subsidiaries based in South Africa also undertake research and product development in-house (see section 2.1.2 for a more in-depth analysis of production and distribution models of key players operating in South Africa).

*2.1.2 Value chain and cluster segmentation: Key players, products and value distribution*

Table 9 in the in the situational analysis paper (CCRED, 2019) lists notable manufacturers of mining equipment operating in South Africa. Among them, we can distinguish between three main clusters of companies adopting different business models and controlling different capabilities:

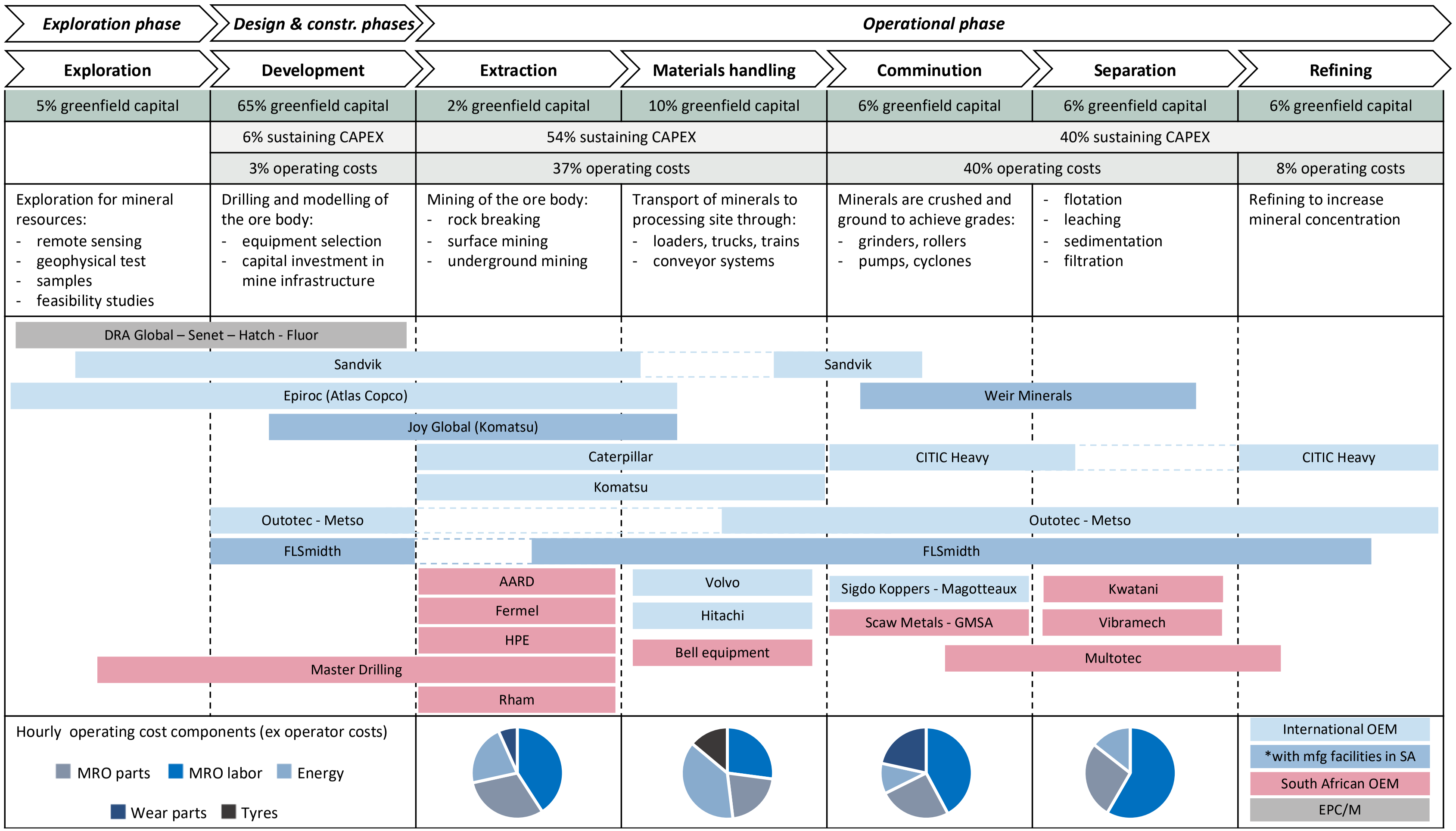
**(*a*) international OEMs mainly importing assembled machines from abroad with limited manufacturing facilities in the country and weak linkages with the local supply chain** (notable examples are Sandvick and Epiroc in the underground segment, Caterpillar and Komatsu in the surface equipment segment and Outotec and Metso (now combined) in mineral processing);

**(*b*) international OEMs with significant production and assembling activities in South Africa and relatively stronger relationships with local suppliers** (notable examples are Joy Global – recently acquired by Komatsu – in underground equipment and FLSmidth and Weir Minerals for mineral processing)

**(*c*) domestic OEMs and local suppliers with high local content and export capabilities** (notable examples are AARD, Rham and Fermel for underground equipment, Bell Equipment for surface equipment and Kwatani, Vibramech and Multotec for mineral processing).

These different clusters of companies operate across various stages of a mine's lifecycle and specialize on three main different product segments – i.e. underground equipment, surface equipment and mineral processing. Figure 9 below summarizes this configuration with a graphical representation of the key players operating in the South African mining equipment cluster, highlighting their product segment specialization, the nationality of their ownership and the relevance of their local manufacturing footprint.

## Figure 9 – Key mining machinery manufacturers operating in South Africa.




*Source:* adapted from Berenberg Equity Research (2013) and Zalk (2017), based on own interviews.

Based on different production and distribution models (for more details see situational analysis paper, CCRED 2019), we provide a list of selected key components along the mining equipment value chain, by their local and foreign content (see table 2).

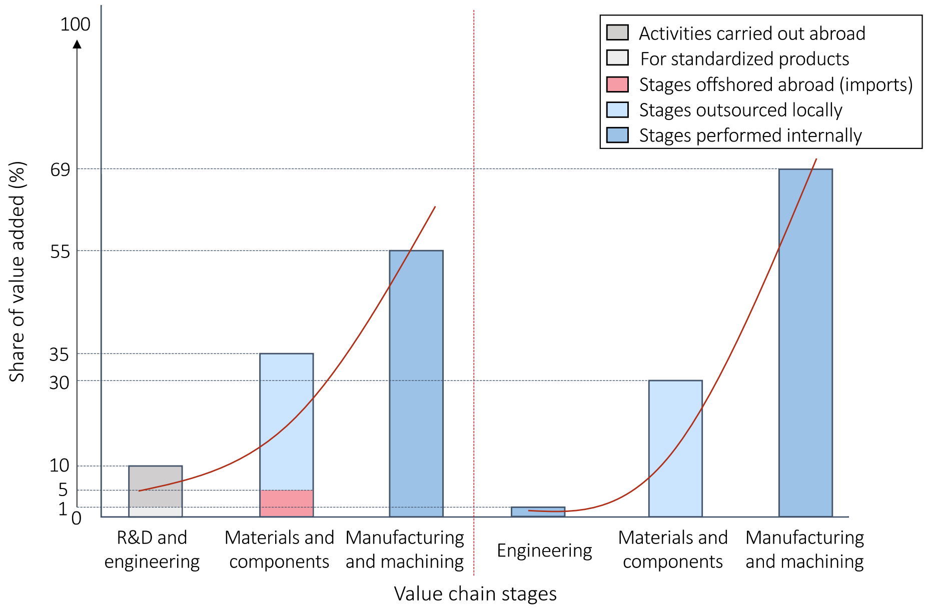
**Table 2 – Selected components along the mining equipment supply chain, by foreign and domestic content.**

| Component | Description |
|---|---|
| Engines | Not manufactured locally, generally sourced from established suppliers in the USA or Europe (or from their regional distributors located in South Africa). Key suppliers are Invicta and Italvibras for unbalance motors, and Zest for low and medium voltage electric motors. |
| Bogies, axles, frames, canopies, booms, ejector, buckets | Local content is around 50%-60%, according to the specific machine under consideration. Some local OEMs produce axels in-house, some international OEMs outsource the manufacture of bogies frames, rims, booms and ejector buckets to local fabricators. However, there is high import penetration for some frames, canopies and booms which require specific high-grade and specialized steel inputs that are not locally available. |
| Track systems | Non-trackless equipment (e.g. dozers) track manufacture is outsourced or procured internationally from suppliers such as Intertractor America Corporation. |
| Tires | There are some local manufacturers, but certain large tires and rim for mining trucks are often procured internationally from established suppliers. |
| Converters and transmission systems | High import content. |
| Valves, gears and hydraulic components | High import content. Suppliers used include Poclain Hydraulics and Bosch Rexroth. Some local OEMs have developed manufacturing capabilities related to hydraulic cylinders to be used in their equipment. |
| Control systems (on-board and remote) and instrumentation | Instrumentation has very high import content. Some local value-addition has occurred through the modification and simplification of control systems by South African OEMs. Foreign OEMs such as Sandvik and Epiroc employ their own specific automation and control systems in conjunction with inputs sourced from Parker and Nautilus International. |
| Others | Hoses, lights, paintwork, welding equipment, some basic grades of steel, lubricants, and fuel are sourced locally. |

*Source*: adapted from Mintek and Turgis (2008) and CCRED (2016), based on own interviews.

Companies' positioning along the various stages of a mine's lifecycle and their specialization in terms of their product segments have implications in terms of value distribution and capture opportunities. Figure 10 addresses this issue for the cluster of company including international OEM with significant local manufacturing footprint, with a specific reference to vibrating equipment. Two company cases are notable in South Africa - FLSmidth and Weir Minerals. They have large local production facilities and a strong commitment to increase the local content shares of their products. In particular, FLSmidth has three manufacturing facilities in South Africa: in Stormill, it focuses on assembling valves, cyclones (whose components are mainly imported) and pumps (whose local content mainly include the shafting and the high-chrome parts supplied by a South African foundry); the facility in Emalahleni manufactures products belonging to the BUFFALO brand (e.g., feeders, feeder breakers and sizers) with a very high local content, including R&D and product design activities that are undertaken in South Africa; the recently opened super-facility in Delmas focuses on vibrating equipment and special projects, with very a high local content component (e.g., as in the case of the vibrating screens and the REFLUX Classifier, where local content account for around 85% and 95%, respectively, of the total value of the capital project). The company is able to develop and bring to the market new technologies smartly packaged in mobile, scalable and modularized systems. As far as the demand side is concerned, FLSmidth deals with both mining houses and engineering contractors. Over years, through the implementation of an integrated "pit-to-port" strategy, it has developed the capabilities to plan, manage and execute large projects just as engineering contractors do, establishing peculiar EPS (Engineering, Procurement and Service), BOOM (Build, Own, Operate and Maintain) and BOOT (Build, Own, Operate and Transfer) models of delivery backed by innovative outcomes-based financing solutions.

**Figure 10 – Smile curves for vibrating equipment of an international OEM with significant local manufacturing footprint.**




| | Capital project | After-sales service |
|---|---|---|
| Revenues generated | 50 % | 50 % |
| Profits generated | 10 % | 90 % |

*Source:* own elaboration based on information gathered through interviews with industry's representatives.

Capturing value along the smile curves for different product segments depends on several strategic factors and capabilities. Among South African OEMs and local suppliers the following strategies have emerged.

1. **Underground equipment segment**:
   The most important local manufacturers of underground equipment (e.g., wheel loaders – LHDs –, mining trucks, crushers and breakers, roof bolters) are medium-sized companies like AARD, Rham and Fermel, that combined account for less than 30% of the market share in South Africa (Reynders, 2018). Over the years, they have developed customized and bespoke solutions well-suited for the specific geological conditions of South Africa, also increasing their exports and their presence abroad with subsidiaries in other Southern African countries (e.g., Botswana, Zambia, Zimbabwe). Other OEMs, like HPE, a leading local manufacturer of hydropower equipment, have specialized in niche technology solutions for deep level mining, The supply chain of these players is mainly local and for the most part composed by entrusted small and very small companies, with few significant exceptions (e.g., large basic steel suppliers). Many of these small domestic suppliers, especially the key ones, are extremely dependent on the local OEMs: indeed, their supply relations with the equipment manufacturer constitute a significant part of their total turnover (e.g., up to two thirds in some cases) and when it comes to investment decisions about the expansion and the improvement of their facilities, local OEMs act as lenders and/or co-investors. A number of key components, like engines, gearboxes, batteries, tires and specialized steel are imported, even when sourced locally. Finally, mention must be made of the significant scale and international footprint of Master Drilling which is a leading South Africa-based provider of drilling solutions, with manufacturing facilities in both South Africa and China and training centers in South Africa, Chile and Peru. It employs slightly less than 2000 people and manages complete projects from exploration phase to the production stage for major and mid-tier mining companies across Africa, North and Latin America, India, Turkey and China. Through the current focus on the organizational and systematic implementation of company's core capacity, it is also developing as a niche supplier of EPCM services. However, its supply chain mainly relies on a number of strategic components suppliers located in China.

2. **Surface equipment segment:**
   Bell Equipment is the national champion with respect to above ground earthmoving vehicles for mining operations. It is a large company, employing over 2700 people in South Africa (more than 3200 worldwide), globally competitive in a specific range of products (e.g., mainly small-to-medium sized dump trucks, with capacity ranging of 12 tons up to 60 tons) where around 90% of the total R&D spending of the company is concentrated. Contrary to their large competitors, like Komatsu and Caterpillar, producing a full suite of products, Bell Equipment has strategically specialized in a specific product sub-segment. With respect to the demand side, the company mainly deals with small and medium contractors operating mining sites, rather than mining-project-owners or engineering contractors. The 70% of its market is concentrated in the Northern Hemisphere, while Africa is not considered a promising area to be targeted, mainly because of its highly cyclicality and instability. As far as the supply side is concerned, Bell Equipment has around 250 international suppliers (e.g., mainly from Europe, USA, Japan and Australia), and 1050 domestic suppliers, 240 of which located in Richard Bay in the direct neighborhood of the company's headquarter providing painting services, sand blasting and some hydraulic components. However only the 40% of the most strategic suppliers of Bell are represented by South African companies. Some key components like engines, gearboxes and tires have to be imported, since they are not available locally, others like specialized steel are increasingly sourced overseas as a result of cost and quality considerations. The company has a relatively high internal value addition capacity, compared to other competitors (e.g., as an example, they produce internally their own axles), with manufacturing and assembling facilities in Richards Bay

and in Alsfeld (Germany). The recently opened German production site is part of an ongoing strategy of strengthening the European foothold of the company, also transferring the manufacture of certain core components from its Southern Hemisphere facility in Richards Bay. Such strategy signals the company's continuity and commitment to its Northern Hemisphere's clients, and at the same time, implicitly, a number of weaknesses of the South African mining equipment ecosystem, including the small size of the domestic market and the lack of an efficient support system for export finance in particular (see section 2.2.3 for a more in-depth analysis of the systemic binding constraints along the value chain).

3. **Mineral processing segment**:
Kwatani, Vibramech and Multotec are key local players in the mineral processing equipment space, holding significant local market shares for some of their product lines. The first two companies are medium-sized entities producing vibrating equipment employing slightly less than 200 people, while Multotec is a large group of companies manufacturing a wide range of mineral processing equipment and consumables, with over 1500 employees. Multotec is a key supplier of polyurethane panels for the vibrating screens manufactured by both Kwatani and Vibramech. These three players are all key suppliers to South African and international EPCMs operating in Southern Africa which specify and co-design products and solutions together with these OEMs. They also have significant export capabilities. Kwatani, for example, exports around 20% of their total sales, mainly to sub-Saharan countries, while only a 5% of exports is directed to other economies like Russia, Chile and North African ones. Vibramech has major exports in Europe, Australia, North and South America. Multotec exports around 50% of its total group turnover mainly to sub-Saharan Africa but also in Asia, Australia and South America, but for specific product lines, like screening media, this percentage is higher (e.g., around 60%) and on a rapid growth track in many target countries, except for Zambia where increasing import competition from China has slowed down such increase. In addition to supply the mining industry, they are also entering and expanding in other sectors like food processing, water treatment, chemicals and defense. They all have high local content and their key suppliers are mainly domestic players ranging from small and very small entities to very large companies. However, some key components (e.g., engines, magnetic vibrators, unbalanced motors) and raw materials (e.g., specialized steel) are imported even when sourced locally from domestic dealers and distributors.

## *2.2 Linkages and binding constraints: an assessment*

### *2.2.1 Quality of linkages along the value chain*

The South African mining equipment value chain faces issues of cooperation mainly related to its hierarchical governance structure, the high levels of concentration in a number of upstream industries (e.g., basic iron and steel and non-ferrous metals), and the historical lack of trust pervading the sector. In what follows we focus on a number of dynamics limiting collaboration among key actors along the mining equipment supply chain, constraining in particular the ability of local OEMs of upgrading (e.g., scaling up, developing new marketable technologies, entering new markets).

a) **Lack of cooperative attitude of mining houses towards equipment suppliers**. Although, in certain cases, the pre-existing relations between the majors and a limited number of entrusted multinational OEMs might lead to the formation of truly global alliances to manage and execute large mining projects, the establishment of technology partnerships and joint ventures between mining houses (especially tier 1 companies) and OEMs is an exception in this industry. According to our interviews with local and international OEMs with a significant manufacturing footprint in South Africa, this relates to the current low risk appetite, the excessive short-termism and the conservative attitude to the development and the adoption of new technologies of mining houses. They generally favor an approach that shift costs of developing new solutions onto the shoulders of the OEMs, some of which (mainly local ones) are too small to bear those risks and to offer new marketable and scalable technologies to their clients. Local OEMs have very strong and long-standing relations with project houses and their clients at the executive- and supervisor-level of individual mining sites in South Africa and to a lesser extent in the region,[20] but there exist high barriers of entry in other markets precisely because the international client base is extremely risk adverse and reluctant to try solutions and product lines they are not familiar with.

b) **Limited cooperation between project houses and equipment suppliers for international projects.** Given the conservatism and the risk-sharing reluctance characterizing the procurement and investing choices of international mining companies, project houses can effectively provide a getaway for local suppliers to open up or enter new markets. However, their current prevailing focus on EPCM projects and their technology agnosticism prevent them from playing this key intermediation role. According to our interviews, while engineering contractors generally start from specific vendor lists for equipment suppliers, they do not have any strong preference and maintain a substantial degree of flexibility to satisfy the end-client requirements, according to the specific project's conditions and locations. Another issue reported by OEMs is the excessive red tape and the sheer technicalities characterizing supply contracts between project houses and equipment suppliers. Furthermore, non-disclosure agreements signed between mining companies and EPCMs and more general information asymmetries often prevent local OEMs form engaging with mining houses at the early stages of projects development. EPCMs, in turn, complain about the limited support offered by local equipment suppliers, from both a risk and commercial point of view, when dealing with international mining projects financed by global financial institutions.

c) **Low trust and strong power relations along the OEMs' supply chains**. International OEMs with limited local manufacturing footprint underline the considerable difficulties in localizing at least part of their production activities in South Africa, often on the grounds of the limited business capabilities and the low-price transparency of domestic suppliers and a general lack of mutual trust. As far as price transparency is concerned, the dominance of few transnational corporations in the upstream industries (e.g., basic iron and steel and non-ferrous metals) and the resulting high concentration levels,[21] lead to frequent and sudden price increases imposed to equipment manufacturers on a "take-it-or-leave-it" basis.

### *2.2.2 Systemic binding constraints and leverage points along the value chain*

The analysis undertaken in the second chapter of this report has yielded a rather paradoxical picture. The South African mining equipment sector, indeed, still constitutes an advanced niche of excellence

---

[20] In particular for local projects, our respondents reported a number of cases in which equipment has been co-designed by OEMs, project houses and large first-tier suppliers of critical consumables and components to meet specific technical requirements due to the peculiar South African geological conditions.

[21] According to own estimates based on SARS (2019) data, the value of the Herfindahl-Hirschman index for the basic iron and steel sector (e.g., slightly higher than 2,500) reveal very high concentration levels.

characterized mainly by medium local companies highly specialized in certain specific areas, with significant productive and technological capabilities but limited financial muscles to effectively compete with global market leaders. A handful of international firms undertaking substantial manufacturing and, to a lesser extent, research and product development activities in the country completes the picture.

However, the domestic and regional market is mainly dominated by multinational companies from Europe, Japan and the USA with limited local R&D and manufacturing footprints and characterized by a significant level of imports along all stages of the value chain with an increasing amount of components and machines shipped from emerging economies like China and India. Moreover, the South African mining equipment sector is highly fragmented, characterized by cooperation issues and a pervasive lack of mutual trust among key actors along the value chain. Against this background in what follows we summarizes the key systemic binding constraints limiting the growth and upgrading opportunities of local companies and international OEMs with substantial manufacturing footprint in the country, highlighting a number of leverage points and opportunities along the value chain which, if properly exploited, might help these actors to strengthen their competitive position in the domestic and regional markets.

a) **Research and product development.** Medium-size OEMs characterizing the South African mining equipment ecosystem have far less resources to invest in formal R&D activities and proprietary supporting and testing infrastructures as compared to large international OEMs. On the one hand, they mainly focus on shop-floor incremental innovation and efficiency development, on the other hand when developing new technologies, they face serious constraints in transforming them into marketable products. The Mandela Mining Precinct and the industry cluster of Mining Equipment Manufacturers of South Africa (MEMSA) have recently tried to strengthen the weak industry-research linkages in the country through a number of initiatives, including the building up an experimental test mine that will provide a protected environment for South African OEMs to learn and innovate. It is hoped that these coalition-building efforts would result in collaborative forms of R&D among South African companies and, eventually, to the development of new marketable technologies for deep level mining.

b) **Manufacturing.** With respect to the competitiveness issues of locally manufactured machines and equipment, in what follows we analyze (*i*) the limitations of the prevailing business model adopted by local companies across the South Africa mining equipment sector, (*ii*) the difficulties in properly implementing and monitoring local content requirements and some of the unintended distortions it might create and finally (*iii*) the related issues around components' and raw materials' cost, quality and local availability.

**Escaping the niche trap.**

Most of the medium-sized local OEMs characterizing the South African mining equipment industry have specialized, over time, in the provision of small volumes of a large variety of bespoke, highly customized systems and niche technological solutions particularly well-suited to the specific geological conditions in the country. This business model – being a niche player in a relatively small market like South Africa with high barriers to entry with respect to the bespoke technologies developed – has allowed them to establish and maintain their market shares and, in many cases, to effectively respond to the increasing competition from emerging players (e.g., Chinese and Indian companies). However, such business choice implying limited scalability, modularization and standardization also constraint the growth (domestically and abroad) and upgrading potential of many of these South African companies. The risk for them is to remain locked in *niche traps*, following trajectories of diminishing returns driven by a constantly shrinking base of potential customers and increasing market power of dominant international OEMs in the industry. An area where the advanced production and technology capabilities of South African companies can be successfully deployed is in developing and packaging modular turnkey solutions particularly suitable for mid-tier and tier 3 mining companies in sub-Saharan Africa, trying to overcome the scalability constraint by moving away from the current silo mentality toward a more collaborative type of approach among different actors (e.g., sharing knowledge and outsourcing manufacturing of additional units to other local facilities), and by adopting new risk- and ownership-sharing delivery models (e.g., BOOM and BOOT), backed by innovative outcome-based financing solutions. Obviously, given the limited balance sheet of many of these local players, this would be possible only through the development of specific supporting funding programs and mechanisms allowing them to offer to the market competitive equipment finance deals and/or through the involvement of international OEMs with significant engineering and manufacturing footprint in the country, or at least a strong commitment to increase the local content shares of their products.

**Local content requirements: challenges and leveraging points**

Local content policies have been widely used across countries to promote domestic industrialisation. While the use of conditionalities introduce a constraint, it does so in view of leveraging businesses towards domestic value addition and linkage development. The design, implementation and enforcement of these conditionalities is therefore critical. The Mining Charter in South Africa establishes stringent requirements for procurements of mining products and services with very high level of local content (at least 60%). However, although mining companies have made good progress in increasing their share of local procurement (DMR, 2015), the compliance target may be very difficult to reach in practice because certain components are not available locally or their price and/or quality is not competitive with the overseas' alternatives. In particular, foreign multinationals operating in South Africa have expressed concerns over the possibility of aligning their (heterogeneous) business strategies with the stringent local content requirements contained in the Mining Charter. Many of these companies would rather be supportive of an approach moving beyond the strict compliance with the specific regulatory targets defined by the Mining Charter toward a revised system (e.g., that would take into account, for example, an export promotion element for the measurement of local content).

Moreover, it is also a common opinion within the private sector that the demanding local contents provisions of the Mining Charter increase substantially the cost of doing business also creating a number of unintended distortions and pockets of unproductive rents-capture for a small group of actors. In other cases, it has been observed that the procurement of inputs by mining houses has shifted from those that are locally produced (possibly by local manufactures that, however, do not qualify as historically disadvantaged with respect to their ownership) to imports that have been purchased abroad by local traders and distributors that qualify as historically disadvantaged. Indeed, a recent procurement analysis conducted by the dti and based on the work of Smeiman (2018) has shown that about 40% of all mining companies' transactions in the gold and the platinum group metals (PGMs) sectors, representing over the 65% of their total value, is "unidentified" or "free-text". The dti, SABS and other stakeholders (e.g., exports councils and industry associations) are currently working together to develop and facilitate the adoption of the GS1 coding system. In this regard, the active involvement of the private sector – of both locally-owned companies and foreign ones – in policy design and enforcement and in the adoption of proper monitoring mechanisms is crucial to overcome the weakness and the top-down nature of many policy initiatives characterizing this sectoral value chain.

**Components' and raw materials: costs, quality and local availability.**

As far as the domestic steel sector is concerned, we have already mentioned the frequent and sudden price increases imposed to equipment manufacturers on a "take-it-or-leave-it" basis by upstream actors. Furthermore, with respect to the foundry sector, poor policy implementation of the Price Preference System (PPS) has resulted in massive exports of scrap material, which is not reused domestically. As reported by Rustomjee et al. (2018), although local foundries are given first choice when procuring scrap material, scrap merchants are employing different tactics in order to directly export the scrap, earning higher profits. As a result, local foundries either have access to poor quality scrap or have to purchase scrap at very high prices. Therefore, the downstream machinery and equipment sub-sector directly experiences the consequences of the poor performance of the foundry. Especially the high cost and the poor quality of inputs produced in the foundry industry have led firms in downstream segments to increasingly rely on imported cast components. For certain steel-made consumables (e.g., finer wire screen panels), rubber's components (e.g., liners for cyclones) and other similar inputs, large-scale conditions prevent the profitable localization of their production: alternatives shipped from China and other emerging economies are far more convenient and their quality is increasing. Other components like engines and batteries for underground and surface machines, or unbalance motors and magnetic vibrators for vibrating processing equipment are imported from tier 2 foreign suppliers or sourced from their local representatives. The same applies to other components, like tires and track systems for heavy earthmoving equipment used in the mining industry (see table 2). Certain raw materials (e.g., specialized types of steel like duplex stainless steel) should present very specific technical criteria because of the strict durability and resistance requirements associated with many mining machines operating under extreme conditions. In South Africa these components and raw materials are generally imported for different reasons: (*i*) the lack of local capabilities to manufacture them domestically, (*ii*) the lack of sufficient domestic demand to keep (*iii*) prices competitive.  Furthermore, in certain cases the current tariff structure penalizes some leading local manufacturers importing key inputs (e.g., tires and certain steel components) *vis-à-vis* international players shipping to the country already- or ready-to-be-assembled machines.

**Sales and distribution & post-sales services.**

As already stressed in section 1.2.2, the actual decision by the mining-owner-project of the specific type (and brand) of capital equipment to be employed for commodities' extraction and processing is generally taken well before the start of the operational phase. Thus, the ability to engage in an early dialogue around machinery and equipment with end-clients (both domestically and abroad) especially for new projects development represent a key comparative advantage in this sector. To this purpose, local equipment manufacturers, especially those without a renowned brand, should try to (*i*) approach project houses already in the pre-feasibility stages providing details around their products and solutions, and (*ii*) develop and strengthen a tripartite system of collaboration with project houses and exploration companies, which are involved in mining projects from the very beginning. This collaborative approach that can be promoted through relevant export councils and industry associations, should be complemented by the offering of innovative risk and ownership sharing models of project delivery, like the already mentioned BOOM and BOOT schemes that might help to improve cooperation among all the actors involved. However, the limited balance sheets of many local manufacturers and the high interest rates they face in South Africa prevent them from offering competitive leasing and rental equipment solutions to their clients. As far as international projects are concerned, the ECIC, the dti and the IDC have established export credit and finance incentives in order to boost cross-border sales of mining equipment but in many cases companies have reported that going through these procedures is an extremely time consuming process. The red tape characterizing many of these schemes makes it difficult for local manufacturers to access incentives in an effective and timely manner, while the stringent requirements lead to the risk of excluding from trade grants certain international players with a significant manufacturing footprint in the country. EPCMs can again play a key role for export promotion of locally manufactured mining machines, providing a getaway for South African suppliers to open up or enter new markets. This is obviously conditional to the ability of these manufacturers of providing after-sale services to the international clients, establishing a network of local support centers located close or even inside mining sites. Attention should be also given to measures and programs facilitating the adoption of smart technologies for predictive maintenance by local OEMs in order to start reducing the gap with international multinationals in this field.

**Cross-cutting issues.** The gradual loss of competitiveness of the South Africa mining equipment cluster has also to do with a number of cross-cutting factors directly affecting the broader South African metal fabrication, machinery and capital equipment production system. These factors are both related to a contraction in domestic demand and capability gaps in energy, infrastructures and skills.

*Demand side.* Local firms in South Africa struggle to achieve economies of scale due to the small size of the local demand and their distance from major international markets. Furthermore, in addition to the fairly limited size of the internal market, the historical decrease in domestic mining production further exacerbates declining trends in local demand for machinery and capital equipment, and consequently for key inputs of metal works and castings. In this respect, diversification strategies, in both foreign markets and new sectors are of paramount importance to reduce sectoral vulnerability. A limited number of mining equipment companies has started to explore new field of applications for their technologies (e.g., food processing and agricultural machinery).

*Supply side.* Three cross-cutting factors deserve particular attention here: (*i*) energy cost and supply, (*ii*) poor state of infrastructures and (*iii*) skills shortage. First, cost and supply structure of electricity is biased toward high voltage customers compared to low voltage customers. Companies in high energy intensive upstream industries source energy directly from Eskom (at a lower tariff), while midstream (e.g., foundries) and downstream (e.g., machinery manufacturers) industries either access electricity from Eskom or municipalities depending on the manufacturing plants' location. Rustomjee et al. (2018) document that companies supplied directly by Eskom pay lower tariffs for electricity compared to municipalities (e.g., with a difference of about 29%). These price differentials not only affect how local firms compete amongst themselves, but also how they compete in the international market. Second, the availability of roads, rails and ports and their current state has been found to be insufficient, according to our own interviews with South Africa-based companies. Infrastructure play a key role in determining price competitiveness, especially in a sector aspiring to increase its footprint in both regional and global markets. Finally, most of the firms interviewed, both locally owned and foreign ones, have made reference to the lack of skills in the sector as one of the key binding constraints on their growth and as a major factor behind production relocation abroad, notably to

China. Skill shortages were said to be particularly severe with respect to highly qualified technical sales professionals, mechanical, structural and electrical engineers as well as artisans like welders and boilermakers. Skills pose a policy challenge which require targeted responses, both through existing institutions and potentially new one focusing on specialized apprenticeships schemes and technology services.

## 3 The South African institutional, regulatory and policy framework

### *3.1 Mapping out the national and sectoral framework*

The South African industrial ecosystem is composed by different firms, geographically clustered around a few industrial agglomerations, and organized around several sectoral value chains. These include resource-based sectors like food, agro-processing and metals; light and advanced manufacturing sectors like textile, machinery and automotive respectively; and services, including retail. Section 2 above has provided a detailed analysis of one of these sectoral value chains – that is, the mining equipment one and its cluster in South Africa. We have identified the different actors involved in the sector and the ways in which they interact with each other based on different business models and localization strategies. We have also identified the relevant 'competitiveness parameters' in this specific sectoral value chain – that is, what makes certain actors more competitive than others and why a number of national players are increasingly struggling to retain their market shares or gaining new ones in the regional markets. Competitiveness parameters are related both to broader changes in the South African industrial ecosystem as well as specific dynamics in the mining equipment industry. Industrial policies promoting the development of the mining industry sector must take both set of parameters into account.

Each one of these sectoral value chains, and the organisations operating within them, rely in their operations and innovations on a number of *cross-cutting technology platforms* as well as *sector-specific technology applications*. In the digital industrialisation era (UNIDO, 2019), many of these technologies are acquiring a digital character. This means that the new 'industrial competitiveness parameters' are defined by digitalization, as well as other key enabling technologies. In the mining equipment industry, the full spectrum of data-based technologies – including data processing for improving operations and their maintenance - are becoming major sources of value creation and capture.

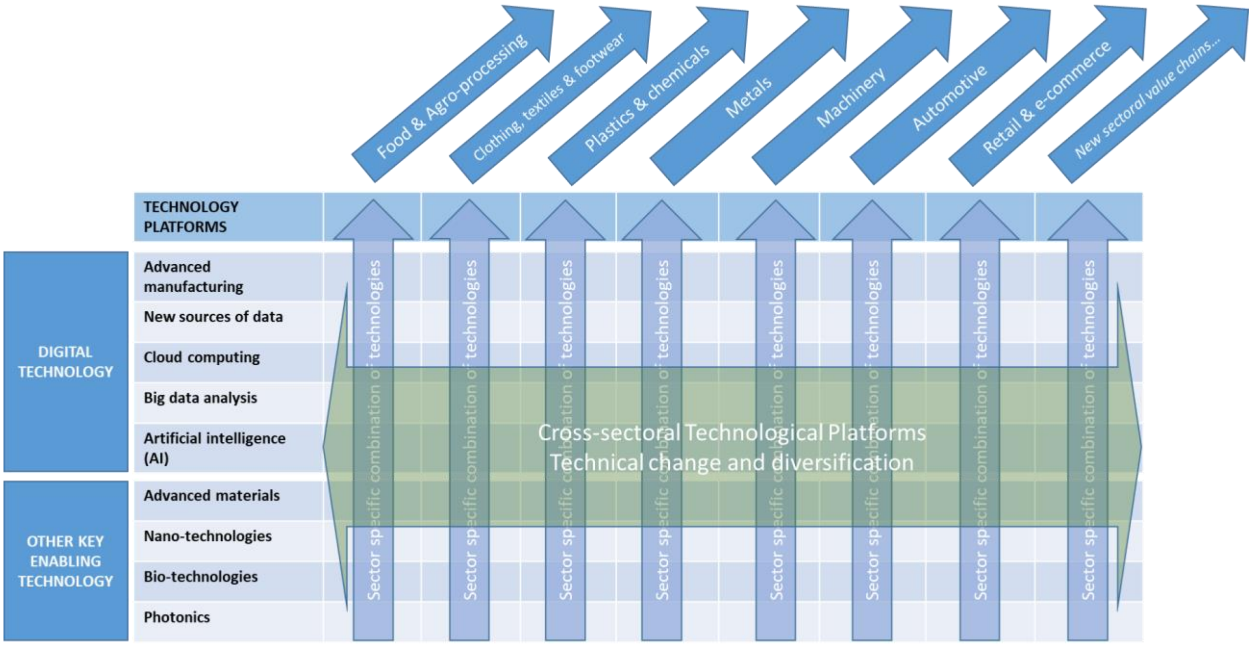
A number of companies in South Africa have started capturing a number of these digital opportunities for process and product innovation, including post-sale services. In the mining equipment industry, for example, we have seen how the digitalization of mines has started from an increasing investments in the 'sensorization' of machineries and the investment in predictive maintenance solutions. A limited number of companies are also diversifying their portfolio of products and activities by integrating their technological capabilities in advanced manufacturing and materials, and in doing so exploring new opportunities within and across other industries. These technological innovations and diversification dynamics will increasingly define the evolution of the South African overall industrial ecosystem, as well as transformations within each sectoral value chains such as the mining equipment industry. Specifically, with reference to the deployment of digital technologies, companies will face several opportunities:

a) improve products and their digital content, changing product system functionalities, move towards higher value product segments;

b) diversify products – goods and services – and activities by deploying digital industrial technologies transversally across sectoral value chains;
c) increase productivity via process upgrading along the value chain, from agricultural, mining and industrial raw materials processing, up to downstream logistics and services;
d) linking up with domestic and international companies, as well as diversify market access
e) enter and develop industrial competitiveness in new global sectors by leveraging South African resources

An industrial ecosystem is not simply made of its sectoral value chains and technologies, it is also defined by the existence of a set of institutional actors, policies and regulatory frameworks determining the way in which business organisations interact with each other and with the public sector institutions. This is why an ecosystem perspective – as depicted in Figure 12 provides an important framework in the definition of both sectoral value chain specific and cross-sectoral policies, regulations and institutional reforms (Andreoni, 2018 and 2020).

**Figure 12: Industrial ecosystem framework and South African overview**




*Source: Adapted from Andreoni, 2020*

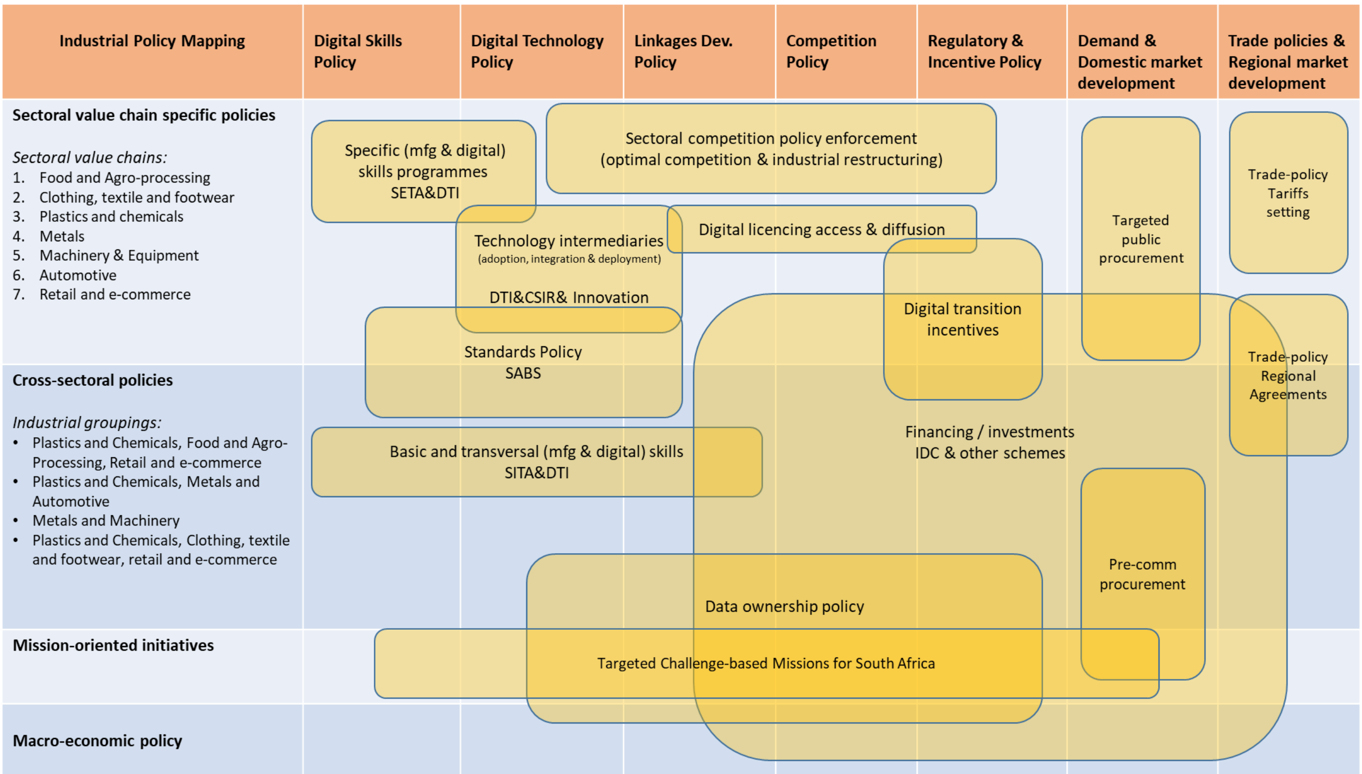
Navigating the complex set of institutional actors, policies and regulations of an industrial ecosystem calls for a three-staged approach. Figure 13 provides a schematic for South Africa.

The first step consists in the identification of national-level (thus, cross sectoral) institutional actors, policies and regulatory frameworks. The fact that these frameworks are set to operate at the national-level does not mean that they do not have different impact across different sectoral value chains. At this level, policies should focus on those opportunities and challenges that are faced by different firms across sectors, especially those related to broader foundational capabilities (e.g. basic and transversal digital skills; digital and manufacturing extension services); technology infrastructure (e.g. digital software licensing; connectivity; data quality and affordability); and broader financing, competition (including trade) and regulatory conditions in the country.

The second step is about identifying for each sectoral value chain, those institutional actors, policies and regulatory frameworks which are more relevant in determining value creation, capture and distribution dynamics in the selected sector. Sector specific interventions and reforms shall start from an assessment of the national value chain and cluster of each sector, and the capabilities and linkages of its main business and institutional actors.

The third step is about policy alignment and governance coordination. The effectiveness of sectoral and cross-sectoral interventions across sector-specific and cross-sectoral policy areas will depend on the extent to which the government is able to reach a strategic alignment among interventions and develop a governance framework beyond policy silos. Breaking out of policy silos is thus both a matter of what/how policy interventions are designed as well as how resources are allocated and governed. The introduction of mission-oriented initiatives is a way of linking sectoral and cross-sectoral policies around specific challenges.

**Figure 13: Industrial ecosystem framework and South African overview**




*Source:* authors

Figure 13 also highlights the three types of challenges policymakers face in the effective adoption of an industrial ecosystem perspective. These are respectively: i) the challenge of policy alignment across different policy areas; (ii) the challenge of governance coordination between different agencies in charge of different policy areas; iii) the challenge of tailoring policies at the sectoral level, at the cross sectoral level (both by industrial groupings and challenge driven mission-oriented interventions) and macroeconomic level.

The industrial ecosystem and policy framework sketched above offers three main insights in the process of designing a sector-specific policy such as the masterplan for the mining equipment sectoral value chain.

The first insight is that the masterplan will have to propose a number of reforms addressing institutional actors, policies and regulations across several policy areas – from skills to technology support, from competition to trade policies, from investments incentives to financing. And these reforms must be targeted while reinforcing each other towards improved industrial competitiveness outcomes in the sector.

The second insight is that the masterplan shall identify not only what to do for developing the mining equipment sectoral value chain, but also how the proposed sector-specific measures fit within the national industrial policy framework and initiatives. Alignment is important to make sure companies do not face contradictory policy incentives and regulations. It is also critical because alignment can lead to the identification of resources across policy areas (demand and supply side measures) and sectoral value chains. For example, leveraging procurement in digital technologies and infrastructures or designing a digital technology policy across sectors can help in reaching the scale of resources required in each one of them. In a nutshell, policy alignment is a way of pulling public resources and crowd-in investments at appropriate scale.

Finally, the third insight, is that the masterplan shall identify institutional arrangements that would make governance coordination and policy alignment possible in the implementation phase. Given that the mining equipment sector is made of different types of actors with different incentives and business models, it is critical to make sure policy proposals pass the test of 'feasibility'. As we will see in section 4, the challenge is to combine the sector-specific dynamics detailed in sections 1 and 2 and the review of policies and international lessons detailed in this section, towards feasible policy reforms.

In what follows we start from a review of the mining equipment sector-specific framework in South Africa and assess the extent to which it addresses binding constraints discussed in section .2. We move then to a review of other country experience in search for lessons for policy reforms (Section 3.3). Specific policy reforms will be highlighted in section 4.

### *3.2 Policy functions, policy forms: an assessment of the policy package and policy gaps*

Each policy reviewed in section 3.1 is aimed at achieving one or more *functions* by introducing policies and institutions taking specific *forms*. For example, the local procurement and local content policy within the Mining Charter aims at boosting the development of the local supply chain and value addition and, at the same time, promoting black social and economic empowerment. In order to achieve these two policy 'functions', the mining charter has developed into a specific policy 'form' – that is a set of conditionalities on local content, business ownership etc.. These are supposed to constraint certain business strategies so that important policy functions are enabled. While all policies perform this constraining and enabling roles, it is very important to remind three important issues in designing and implementing a policy.

First, **when the same policy is trying to achieve too many functions at the same time, managing potential trade-offs become critical**. Many policies in the South African context tend to fall short when we perform this test. While multiple policy functions are legitimate, if trade-offs are not seen and policy functions are not clearly defined, the risk is that the policy does not work or worst that it seems to work but it does not achieve the desired functions. So for example, while companies might be formally compliant, the local content or ownership conditionalities imposed by the policy may be by-passed by businesses simply because achieving all policy functions at the same time under a specific policy form is not feasible. This can happen also in public institutions context. For example, training and vocational institutions have de facto a twofold policy functions in developing and emerging economies like South Africa, that is, developing specialized skilled workers for specific sectors but also performing a social inclusion function. This raises a trade-off in terms of allocation of resources and training focus. Often training and vocational institutions have to fill quality education gaps from primary and secondary education among students – e.g. basic mathematical skills; if they do so they have to divert scare resources away from specialized training. Again, while these are both legitimate policy functions, the institutional or policy form used might not be adequate or make almost impossible to manage trade-offs at the implementation level.

Following on from the first point, the second issue to bear in mind is that **policy functions can be achieved by relying on very different policy forms**. Thus, while the government should make sure its policy functions are clearly stated, it should be also flexible in the identification of the most effective policy forms which would make possible to achieve the stated policy functions. The risk of government getting fixated with specific policy forms – i.e. a certain way of doing local content – more than focusing on the policy functions to achieve is detrimental. It might result in lack of compliance, it might discourage investments, ultimately it might undermine the policy function the government wants to achieve. Pragmatism in the definition of policy forms is critical in the design of a new masterplan for the mining equipment sector.

Third, **policy forms must be well specified and feasible given the policy function the government wants to achieve**. This means that government must take into account the capabilities and incentives of the players involved when certain policy forms are specified. Problems associated with businesses being compliant with local content parameters could result from two different factors. It might be because some actors do not want to follow the conditionalities imposed by the policy, in another cases it might be also because the specific policy form is not adequate to achieve the policy function, hence the business cannot comply with the conditionality without incurring in losses. If the government tries to enforce a local content conditionality without distinguishing these two types of businesses – those who do not want to comply from those who want to comply if the policy form allows them to do so, the risk is that no one in the business community will support the policy. A corollary to feasibility is also that policy forms must be designed to take into account incremental changes. Given that changes take time, policy forms must evolve alongside changes in the capabilities of the businesses involved.

Based on these three principles, and in view of the specific binding constraints highlighted in section 2 for the mining equipment sectoral value chain and cluster in South Africa, the following assessment of the existing policies for the mining equipment industry can be performed. Table 4 provides a summary of this assessment and points to policy gaps and alternative policy forms. These policy alternatives will be reviewed in light of other countries experiences (section 3.3) and developed in section 4 for the specific South African industrial ecosystem.

In South Africa the mining-related legislation is dense, complex and characterized by a number of different norms, and sectoral strategies. In the Annex 1 of the report we provide a descriptive review of regulations and institutions that directly influence the development trajectories of the South African mining equipment national value chain and cluster, including: (i) Local procurement and content (ii)

Collaborative R&D initiatives and technology services (iii) Skills development, and (iv) Exports finance and support; (v) Trade policies.

*Local procurement and content*

The local procurement and content policy attempts to perform several policy functions at the same time. In order to achieve these functions, the policy details a specific set of conditionalities operating both at the levels of business ownerships and local content requirements. This specific policy form partially addresses some of the binding constraints stressed above. Specifically, it influences procurement strategies and force mining house and EPC and EPCM companies in moving beyond pre-existing buyer-supplier relationships. A number of other related binding constraints remain unmet, however. In particular, there is no way to facilitate an early engagement of local OEMs in procurement processes, especially in the feasibility stage. Given the path-dependence, early engagement seems key for follow up contracts. Second, the lack of contact with (and knowledge of) local markets and suppliers is not supported. This means that even if mining houses and EPC/EPM were keen to engage local suppliers, lack of knowledge of their distinctive capabilities and value propositions might undermine their efforts.

In terms of the specific policy form and the plurality of policy functions it aims to achieve, the local procurement and content policy does not provide sufficient clarity in terms of managing trade-offs among conditionalities. Trade-offs in compliance and related potential rigidities are left to companies to be solved. This approach is detrimental as it induces non-voluntary non-compliance, that is, situations were business enterprises achieve compliance only formally without de facto contributing to the achievement of the policy function. For example, they increase the use of certain raw materials to increase their local content, or simply rely on chains of companies whose local content production is difficult to trace back (local content of local content of local content…). In these situations rethinking the policy form is also critical to make enforceability of the local content possible. Despite the critical effort that SABS is making in standardization and enforcement of trade policy tariff schedules, rule will become enforceable only when they will offer players who wants to be compliant a feasible way to do so.

Finally, while if we focus on one specific function of the local procurement and content policy – that is, increasing domestic value addition in the mining equipment industry – this can be achieved both by introducing sticks – local content conditionalities – but also carrots in the form of alternative ways to increase domestic value addition through increasing export. The local content conditionality insists on a given domestic market whose size has been shrinking. Increasing local content there might have a relatively small scope for development, and it might also not exploit an alternative pathway. This is developing value addition for the export market. Given the features of the global market described in section 1, this penetration will require some form of alliance with international OEMs. These are the same companies which are asked to comply with local content requirements. As we will see in section 4, there is thus an opportunity for re-aligning incentives here by reviewing the local content policy and integrating it with an export promotion element.

**Table 4 – Sector-specific policies, binding constraints and competitiveness parameters**

| **Policies** | **Assessment** Extent the policy address constraints and meet parameters | **Binding constraints and competitiveness parameters determining best total life cycle cost** (Detailed in sections 1 and 2) | **Policy gaps and potential instruments** |
|---|---|---|---|
| **Local procurement and content** | **PARTIAL** | Pre-existing buyer-supplier relations and risk aversion | |
| | **GAP** | Early engagement in procurement. | **Pre-feasibility engagement Dynamic incentives and linking local content and export** |
| | **PARTIAL** | Location of decision-making with respect to procurement strategies | |
| | **GAP** | Lack of contact with (and knowledge of) local markets and suppliers | **Catalogue of competencies Mission-oriented specialized institutes & networks** |
| **Collaborative R&D initiatives and technology services** | **PARTIAL** | Appropriate functional and performance specifications. | |
| | **PARTIAL** | Appropriate technical specifications. | |
| | **PARTIAL** | Appropriate operational and maintenance provisions. | |
| | **GAP** | Scalability | **Mission-oriented specialized institutes & networks Joint ventures, consortia, and export cartels** |
| | **PARTIAL** | Standardization | |
| | **PARTIAL** | After-market support facilities | |
| | **GAP** | Cooperation between mining houses and equipment suppliers | **Joint Ventures Consortia development with incentives & joint licenses** |

| | | | |
|---|---|---|---|
| **Skills development** | GAP | Appropriate technical specifications. | **Mission-oriented specialized institutes & networks** |
| | GAP | Appropriate operational and maintenance provisions. | |
| **Exports finance and support** | PARTIAL | Customized equipment financing solutions | |
| | GAP | Attractive commercial propositions and financing solutions. | **Affordable/tailored export finance and guarantee scheme** |
| | PARTIAL | After-market support facilities | |
| | GAP | Scalability | **Affordable/tailored export finance and guarantee scheme** |
| | GAP | Longevity | **Affordable/tailored export finance and guarantee scheme** |
| | GAP | Cooperation between project houses and equipment suppliers for international projects. | **Affordable/tailored export finance and guarantee scheme Joint ventures, consortia, and export cartels** |
| **Trade policies** | PARTIAL | Pre-existing buyer-supplier relations and risk aversion | |
| | GAP | Scalability | **Reverting incentives to protect domestic final products** |

*Source:* authors

*Collaborative R&D initiatives and technology services*

The South African Mining Extraction Research, Development and Innovation (SAMERDI) Strategy and the related Mining Phakisa project, have introduced two important institutional forms to address the challenges faced by local OEMs and their supply chain in R&D activities. First, the Mandela Mining Precinct provides an important institutional solution to some of the binding constraints pointed out above in terms of technological innovation and upgrading. An intermediate technology institute like the Precinct can support companies in achieving appropriate functional, technical and performance specifications, by innovating on several technologies and solutions offered by local OEMs. It can also provide support in the standardization process, also making sure local OEMs develop solutions to capture the value of post-sale services. Similarly, MEMSA can support the absorption and diffusion of these technologies and promote collaborations across local OEMs and their suppliers.

To perform these critical policy functions these institutions must be properly funded – at this stage funding are still relatively limited and fragmented. Funding is not sufficient, however. Other two conditions must be met. First, funding must be properly directed, especially in developing technology infrastructures supporting innovative market-ready solutions for mines. The development of an experimental test mine is indeed an initiative in the right direction. Second, researchers and personnel in these institutions must be properly incentivized and motivated in filling a critical intermediate functions between companies and basic research within universities. Improvements in both these areas are needed.

A policy gap in these two initiatives can be also identified. This is about the extent to which this policy form is addressing a key binding constraints among local OEMs, that is, scalability. As discussed above (section 2), local OEMs are quite well versed in indigenous technological experimentation and development of niche products, despite lacking a full-fledged public technology infrastructure. Companies however are relatively less capable in scaling up their production capacity and doing so in a cost-competitive manner. This means that while supporting technological experiment is a key function, there should be more services supporting companies in scaling up their operations and finding the cost-effective way to produce at scale their innovative solutions. Indeed, the latter is a specific capability that local companies tend to lack given their development trajectory and broader context.

*Skills development*

Challenges in developing sector-specific appropriate skills and lack of effective linkages between training institutions and companies are widespread phenomena in many countries, especially developing and emerging economies. There are several reasons why this is the case in South Africa, including the fact that many of TVET institutions are not well funded; the fact that they perform a social inclusion function, thus they have to focus on filling quality gaps in primary and secondary education, more than developing more advanced technical skills; finally, the fact that they have been increasingly focused on providing skills certificates, and less on employability. In the South African context, a number of technology-focused universities (such as VUT and CUT) are developing programmes in advanced skills such a additive manufacturing and robotics. These are important initiatives, especially because they can increase companies' technological applied capabilities. At the same time, however, this does not always compensate for lack of skilled supervisors or directors of operations capable to improve shop-floor level operations and increase overall organisational capabilities. Skills development is therefore better obtained by distinguishing at least these three figures – skilled artisans capable to operate effectively machinery and operations; supervisors and production directors capable to assure quality, consistency and coordination; technologists capable to engage with more advanced technology issues and design solutions. Some of these skills can only be acquired through on the job training schemes.

Recent initiatives led by companies are an attempt of addressing these problems and need for differentiation, hence a development in the right direction. Collaborations between private companies and public sector training facilities are critical. Given that reforms in the skills development sector require a major cross-sectoral reform across the South African industrial ecosystem, a sector specific response to the policy function gap should come from a bottom-up sectoral initiative linking all players along the value chain. Particular emphasis should be given to dedicated programmes supporting training among workers supervisors, production and operation directors. This could be done with a dedicated programme financed by the SETA metals chambers, providing already skilled workers or technologists with skills upgrading programmes to fill the gap in supervisors, production and operation directors. The development of these figures can have a significant impact on productivity increases, while requiring significant collaboration between companies and training centres. A strong coordination and alignment with the emerging intermediate technology and cluster initiatives would be necessary. Indeed, in many cases providing appropriate technical, operation and maintenance specifications is an R&D, a technological as much as a skills issue. As discussed in section 4, specialized institutes can integrate these policy functions by changing their institutional form or expanding the functions an institution performs.

*Exports finance and support*

The package of export finance and export support policies has developed in different directions over the last two decades. From a policy functions perspective, the different institutions and schemes are supposed to provide a full spectrum of financial services, from commercial guarantee to credit. In many cases, these schemes are linked to localization policies, such as in the case of the Export Credit Insurance Corporation. Overall the policy forms described above only partially meet the needs of companies in at least three respects.

First, with the exception of IDC's strategic business units, financial institutions do not have a sector-specific focus, hence their financial schemes and products not always meet sector-specific needs. In the case of the mining equipment industry, finance needs in export are related both to the capex and opex, that is, both to the capital investments needed to operate at scale in foreign markets, but also the financial solution needed to package the products in a specific market with a specific client. As discussed in section 2, in the mining industry business models have developed to manage risks associated with large fixed investments. Leasing and other type of payment contracts have become a major factor in determining sourcing decisions from mining houses, EPC and EPCM.

Second, to be effective, financial institutions must provide sector-specific products and solutions that are also affordable. The affordability problem has been raised by several companies as a major factor limiting their scaling up and export development. Improvements in this area will ultimately relies on a broader reform in the banking sector, promotion of competition and tailored industrial development finance. Dedicated initiative such as sector-tailored guarantee schemes backed up by the government could provide an initial relief for companies in terms of improved affordability.

Third, while posing some conditionalities on local content, the credit insurance scheme and the other financial support schemes do not sufficiently encourage the creation of collaborative arrangements providing similar functions of export cartels. Access to export finance could be tied or made preferential in case of companies developing joint initiatives to penetrate regional and international markets.

*Trade policy*

Trade policy is always intertwined with the local procurement and content policy. This is because trade policy alongside local content policy affect price and quantity respectively, hence it shapes the competitiveness in the domestic market between domestic and international players. In general, across developing and emerging countries, trade policies have performed two main functions. First, protecting domestic production from foreign competition, especially when sectors are still in an infant stage and are less capable to compete. Second, making access to foreign technologies – especially machinery and equipment – cheap so that certain industries can absorb these technologies and deploy them in production, especially assembling and processing activities.

In South Africa, however, where significant technological capabilities exist in the mining equipment industry such approach to trade policy is problematic and indeed presents dysfunctional results. Indeed, the current tariff schedules pushes the competition at the level of domestic OEMs who are not given any protection. At the same time, by protecting suppliers of local OEMs from international competition (e.g., producers of components such as tires and certain steel products), it makes local OEMs disadvantaged against international OEMs able to access inputs at a cheaper price. Depending on the specific policy function the government wants to achieve, it is critical to define what stages of the mining industry sectoral value chain shall be supported. This decision shall be part of a dynamic process whereby companies are provided protection for a limited period of time and in view of becoming competitive.

### *3.3 Learning from international policy experiences: Lessons for sectoral reforms*

Sector-specific as well as broader initiatives at the industrial ecosystem level from different countries can provide insightful examples of alternative policy and institutional forms which can be effectively used to achieve the policy functions described above for the South African mining industry.

*Lesson 1 Full, fair and reasonable procurement – Australia and Finland*
Australia is endowed with the largest demonstrated mining resources in diamond, gold, iron ore, lead, nickel, rutile, tantalum, uranium, zinc and zircon, and the second largest resources of bauxite, brown coal, copper, ilmenite, niobium, silver and tungsten. Australia`s resources of antimony, black coal, lithium, manganese ore, tin and vanadium are ranked in the top 4 countries. Over the last decade, this diversity of resources and mining investments has led to a boom in the Australian Mining Equipment, Technology and Services (METS) sector. METS contributes approximately A$90 billion annually to the economy with yearly exports of at least A$27 billion. R&D expenditures are estimated at around A$1 billion and the sector employs approximately 31,300[22]. Australian companies operate in the international markets providing mining equipment, equipment supply and consumables, contract mining and exploration, professional engineers and business services, software and digital solutions. Australia is also home to some of the world's biggest mining firms, including BHP Billiton, the British-Australian multinational Rio Tinto and Fortescue Metal Group (OECD, 2017).

Local content policies in the mining sector are defined at the national as well as the State level in Australia. Table 5 provides a summary of the different local content requirements.

**Table 5: Summary of Local Content Policies applicable in Australia**

| Type of Requirements | Details of requirements | Applicability in Australia | Relevant legal frameworks |
|---|---|---|---|
| | | **Legal requirements to give preference without specifying targets** | |
| Labour requirements | Provisions to encourage employment of local labour | Firms are encouraged to employ local labour (sometimes specific professional categories are identified) | State Agreements<br>ILUAs |
| Local procurement | Sourcing of goods and services | Firms need to ensure full, fair and reasonable access to opportunities for local suppliers<br>Firms need to ensure that their local contractors given local service suppliers opportunity to tender | Jobs Act<br>AIP<br>State Agreements |
| Information sharing | Firms are required to publish information on their website and in the press | Firms are required to consult local databases and to publish job vacancies and tenders on their websites | State Agreements;<br>ILUAs |
| Capacity building and training | Training and capacity building for Indigenous workforce and for local suppliers | Firms are encouraged to provide training to labour and suppliers (for Aboriginal communities) | ILUA<br>State Agreements |
| Reporting and justification | Requirement to report on implementation of various local content provisions. | All applicable projects, including in mining, must develop an Australian Industry Participation plan which details how they will give Australian entities a 'full, fair and reasonable' opportunity to participate in the supply of goods and services.<br>In some State Agreements, firms must report on expenditure on local service suppliers and labour as % of total;<br>name and number of local service providers;<br>proof of consultation of existing suppliers' databases;<br>reasons for sourcing labour and suppliers outside and opportunities given to locals. | Australian Jobs Act 2013;<br>State-level legislation and polices |

---

22 https://www.austrade.gov.au/australian/export/export-markets/industries/mining-equipment-technology-services

*Source: OECD, 2017: 20*

The overarching principle inspiring the local content policy framework is to offer 'full, fair and reasonable' access to employment and tendering opportunities to Australian firms and individuals. The implementation of this principle relies on specific ways of defining what is local content, and strong reporting requirement on the measures taken to recruit and procure locally. For example, at both the national and state levels, mining companies had to justify and provide evidence on why they were not successful in recruiting or using local suppliers.

Within the "Local Industry Policy – A fair go for local industry, Interim Update 2013 (LIP)" (S2, pp. 5-6; part of the Queensland Industry Participation Policy Act 2011), contestable goods and services are the goods and/or services included in, or may potentially be included in, contracts for an eligible project that can be potentially supplied from any of the following locations:
– Geographically close to the project;
– Queensland;
– Other locations within Australia or New Zealand; or
– Outside Australia and New Zealand (ANZ).
Goods and/or services which are highly likely to be supplied from sources geographically close to the project, or goods and/or services that are highly likely to be supplied from locations outside ANZ because they are not currently manufactured or provided by ANZ suppliers are excluded.

Full, fair and reasonable opportunity is the provision of equitable opportunity for capable local industry to participate in the procurement activity by ensuring (World Bank, 2015)[23]:
– Local industry has the same opportunity afforded to supply chain participants from elsewhere to participate in all aspects of a project, including front-end engineering and design, and project management;
– Expression of interest/tender documents should encourage local industry to collaborate in circumstances where the project delivery requirements are outside the capacity and capability of a single local business but could be delivered competitively by a number of capable local businesses through collaboration (including consortia);
– Tender documentation is free from technical requirements that might rule out local industry and is structured in such a way as to provide local industry the opportunity to participate in projects;
– For example, wherever it is practicable to do so, use ANZ standards and codes to ensure that local industry is not excluded from the market (if ANZ standards and codes are not able to be specified, and an equivalent to these standards and codes is used, then the reasons for adopting this approach must be explained in the Local Industry Participation Plan (LIPP))
– As part of value for money, that due consideration in the tender evaluation is given not only to price but also to environmental sustainability, quality and delivery, whole-of-life costs and/or administrative and risk mitigation advantages and the advancement of the priorities of Government arising from local sourcing

Local content includes all value-added activities undertaken by local industry and is accounted as substantial transformation of goods and a minimum of 50 per cent of production costs incurred in Queensland, Australia and/or New Zealand. A more hands-off approach to the implementation of local content, has however gone hand in hand with other hands-on measures implemented both at

[23] Local industries is defined as Australian or New Zealand small and medium enterprises (SMEs) Small to medium enterprise (SME) is defined as an Australian or New Zealand firm with fewer than 200 full time equivalent employees.

the national level and through state-specific agreements (e.g. Indigenous land use agreements, ILUAs). While some of them have been phased out over the last years, these schemes played an important role in building up of the local supply chain. Two schemes are worth mentioning (see OECD, 2017).

First, the Supplier Access to Major Projects (SAMP) started in 1997, provides funds “to work with project developers to identify supply opportunities for capable and competitive Australian firms” in major projects (with local SMEs given special treatment). In 2011, SAMP was extended to SAMP (Resources) as part of the Buy Australia at Home and Abroad programmes. An assessment of the scheme by ICN found that thanks to AUD 18.5 million has been provided to support 162 projects, Australian firms have won contracts valued at more than AUD 4 billion for work that could have gone to overseas competitors. The financing programme was also coupled with an institutional innovation aimed at linking suppliers and mines. A Resources Sector Supplier Envoy was appointed as the spokesperson of the domestic supplier industry and worked with a broader Resources Sector Supplier Advisory Forum "to raise awareness among project developers and their international agents of the benefit in considering Australian firms within their major projects".

Second, the Enhanced Project By-Law Scheme (EPBS), implemented from 2002 until 2016, offered duty-free tariff concessions for a list of eligible goods which were considered strategic in large projects development and were not produced in Australia, or more technologically advanced than the one produced domestically. However, to access these concessions project houses had to develop and implement an approved AIP (Australian Industry Participation) plan that “demonstrates how the project will provide full, fair and reasonable opportunity to Australian industry (especially small and medium enterprises) to supply goods and services to the project”.

A few lessons can be learned from these schemes and specific policy forms. First, policies were inspired by a pretty hands-on approach aimed at linking up suppliers and bringing them up to speed in industry tenders. The government also exercise significant influence in the decision of major mining companies to be listed in national or foreign stock markets. However, at the same time, unnecessary rigidities were avoided and the implementation of the local content policy responded to a quite pragmatic approach. Third, a strong monitoring component was also introduced a different government levels to ensuring public accountability.

Local content policies have been implemented in all countries with a major mining sector. Finland is today one of the countries at the fore front of green mining and one in which local content policies have been applied historically in a strategic manner with a significant steering role for the State. Thus, this is an example of a more hands-on approach to local content than Australia. Starting with the application for an exploration and a mining license, foreign companies must establish an affiliate in Finland, or if they belong to the EEA, they are to set up a branch in Finland as a minimum requirement. Access to funding from the public sector and relevant ministry (Tekes) is conditional on the firm being registered in Finland (branches cannot access Tekes funding).

Table 6 provides a detailed account of specific requirements based on numerical targets and on monetary value. It is interesting to note how specific categories of procurement are reserved exclusively for local suppliers, and as already discussed permits or licensing requirements tend to be stricter than other countries. Moreover, requirements based on monetary value perform several functions beyond increasing domestic value addition. It imposes spending requirements regarding technological transfer and local R&D spending. Finally, a preferential price premium is applied exclusively for local suppliers, thus increasing the amount. Similarly to Australia, reporting and accountability requirements are quite strict and cut across important dimensions including information sharing, R&D contribution and preferential treatment.

**Table 6: Summary of Local Content Policies applicable in Australia**

| Quantitative Requirements | | |
|---|---|---|
| Requirements based on numerical targets | Labour requirements | No specific numerical targets but needs and expertise of the labour market must be taken into account before granting permit to foreign employees |
| | Specific categories of procurement reserved for local suppliers | None |
| | Permits or licensing requirements | Foreign firms can apply for a licensing requirement provided they set up an affiliate in Finland |
| Requirements based on monetary value | Spending requirements regarding technological transfer | None but incentives are provided through dedicated investment programmes |
| | Requirements regarding R&D spending locally | None but investment in R&D and education is considered a priority and receives financial support from Tekes |
| | Value of wages paid to expats should not exceed a % of total payroll | None |
| | % of local procurement spending to be attributed to local suppliers | None |
| | Preferential price premium exclusively for local suppliers | None |
| | Registration requirement to access funding | Tekes funding can be made available if firms are registered in Finland |
| **Qualitative Requirements** | | |
| Reporting & justification | Mining firms to report and justify hiring foreign labour or sourcing inputs from abroad | None |
| Information sharing | Requirement to advertise job vacancies or publish tenders and procurement requirements | None |
| Capability & knowledge development | Requirement for the training of local labour or certification of local suppliers | None |
| R&D contribution and transfer of technology | Firms required to transfer technology to local firms; or<br>Firms required to carry out some levels of R&D locally | None |
| Preferential treatment | Firms to hire local labour or source inputs from domestic suppliers only if available on a competitive basis | None |

*Source: OECD, 2017: 46*

*Lesson 2 Incentives and procurement for suppliers development – Chile and Australia*

Countries have followed very different approaches to enabling domestic suppliers and OEMs to compete with more established international players. Some have relied on fiscal and monetary incentives, while others have focused on a service-based approach (see Lesson 3). The use of incentives is perhaps one of the most common policy tool. The advantage of this instrument is that its implementation is relatively simple, especially if compared with the setting up of institutions providing technology and other business services. In some cases, countries have used a combination of these instruments, that is, both incentives and services.

In 1995, CORFO (The Chilean Economic Development Agency) experimented a new incentive scheme in the Antofogasta region, whereby large companies that were prepared to participate in supplier development were granted financial incentives. This incentive scheme was later scaled up to support a collaborative effort across several stakeholders in the ecosystem, including ten large mines and two regional universities. With the establishment of the Antofagasta Industry Association (AIA), a a Vendor qualification System and supplier database – SICEP – was introduced in 2001 aimed at identifying existing capabilities among local suppliers as well as gaps. According to the World Bank (2015), by 2015 this vendor model was used by around 20 purchasing companies in the mining and oil & gas industries, including international suppliers and primary contractors and accounted for over 2,500 suppliers. To participate in this scheme, suppliers must register and pass a certification process assuring labour and social security compliance. Suppliers in need of business support are offered such capability enhancing services, which are funded through fees paid by suppliers to be part of the vendor scheme.

This PPP model was later further developed in Chile with the launch by BHP Billiton of the World Class Supplier Development Programme in 2009, in partnership with Fundacion Chile. The programme was later (2010) joined by the publicly-owned Codelco who also collaborated with BHP Billiton in assuring technical support to the companies participating in the programme. The programme is modelled around a hybrid incentive-procurement scheme whereby mining companies identify technical and operational challenges they face and advertise them to potential suppliers. As a starting point, the programme seeks tenders from local suppliers on problems or challenges, rather than prescribed solutions. Two to three local suppliers are then invited to form a cluster/collaboration to research the challenge and develop/pilot solutions for the mining house. The newly formed cluster can draw also from other actors in the ecosystem including Fundacion Chile and local universities in addressing the challenge. The programme has a twofold aim: first developing a scalable solution to the operational challenge identified by the mining firm, and second increasing in the process technological and organisational capabilities of local suppliers. Tenders focus on five areas, that is, water, energy, HSEC (health, safety, environment and community), human capital and operational efficiency. The cost of projects can range from US$100,000 to US$20m and have a typical project lifetime of 15-27 months from problem identification through to evaluation. Working with the government, BHP Billiton's investment in the programme during its first four years reached $50 million, and for the financial year 2013/14, the budget was just under $20 million. After 2011 the Chilean government also supported the programme with tax exemptions and the development of a supplier database listing the challenges firms were looking to resolve. As of 2017 the programme had facilitated the development of over 100 projects, and a number of companies started supplying BHP Billiton. This programme is working to create 250 world-class mining suppliers in Chile by 2020.

Countries with a more advanced mining industry like Australia have relied heavily on R&D tax incentives to boost investments, alongside national and state-based funding schemes targeting domestic SMEs and start-ups to support innovation and commercialization. Table 7 provides a summary as 2017.

**Table 7: Summary of Local Content Policies applicable in Australia**

| PROGRAM NAME | STATE | VALUE | PROJECT SME CONTRIBUTION | ELIGIBILITY / NOTES |
|---|---|---|---|---|
| Innovation Connections | All | < $50k | 1:1 cash | • $1.5m - $100m turnover, 3+ years in business.<br>• Grants available for researcher, business researcher and graduate placements. |
| CSIRO SIEF STEM+ Business | All | < $105k p.a. | 1:1 cash | • $1m - $100m turnover.<br>• Projects delivered by early-career researchers. |
| Accelerating Commercialisation | All | < $1 mil | 1:1 | • < $20m turnover.<br>• Funds commercialisation, not research and development. |
| ICon Proof of Technology grant | ACT | $5k-30k | 1:1 cash and/or in-kind | • < $2m turnover. |
| ICon Accelerating Innovation grant | ACT | $5k-10k | 1:1 cash and/or in-kind | • < $2m turnover. |
| TechVouchers | NSW | < $15k | 1:1 cash | • < $30m turnover, < 20 employees, 1+ years in business.<br>• Preference for companies not previously engaged in research. |
| BISI Innovation Voucher | NT | < $25k | 40% | • < 100 employees. |
| Knowledge Transfer Partnerships | QLD | < $50k | 1/3 cash | • < 200 employees, 2+ years in business.<br>• Research performed by KTP eligible graduates. |
| Innovation Voucher program | SA | $10k -$50k | 1:2 or 1:1 | • < $200m turnover, 1+ years in business.<br>• Contribution 1:2 for SMEs below $5m. |
| Business Transformation Voucher | SA | < $50k | 1:1 cash | • 1+ years in business.<br>• Can include developing new business models or R&D. |
| BioSA Industry Development program | SA | $50k-250k repayable | | • Early-stage/start-ups.<br>• Bioscience and related industry sectors. |
| SBDF Start-up business grant | SA | < $20k | 1:1 cash | • To contribute to starting a new business or buying a business. |
| SBDF Business Expansion grant | SA | $10k-100k | 1:1 cash | • < 20 employees, 1+ years in business. |
| Innovation Vouchers | WA | < $20k | At least 20% | • < $500k turnover, < 200 employees. |

*Source: CSIRO Futures, 2017*

*Lesson 3 Intermediate Technology Services, Opportunities Scouting and Skills Development – Australia and Italy (Emilia Romagna)*

Countries with advanced industrial ecosystems have relied on a number of service-based support schemes and institutions aimed at providing companies with those technology and business services which are essential for meeting industrial competitiveness parameters. These services have been mainly provided through ‘intermediate technology institutions’, that is, institutions operating at the interface between education and basic research in university on the one hand, and companies on the other. In the design of these institutions, a number of countries have followed a sector-based approach, while others have relied on a technology platform-based approach aimed at both developing specific sectoral value chains and promoting innovative diversification. Hybrid versions of these two models also exist, with countries increasingly moving towards hybrid institutional forms capable to address digitalization in the most effective way possible.

Australian industrial ecosystem is enriched by the presence of a network of intermediate technology service centres performing key technology, R&D, business and skills development functions. The Australian Government's Industry Growth Centres Initiative is a sector based approach to growing industries and creating jobs. The Initiative targets sectors of competitive strength and strategic priority through six Growth Centres:

• Advanced manufacturing, known as the Advanced Manufacturing Growth Centre (AMGC)
• Cyber security, known as AustCyber
• Food and agribusiness, known as Food Innovation Australia Ltd (FIAL)
• Medical technologies and pharmaceuticals, known as MTPConnect
• Mining equipment, technology and services, known METS Ignited
• Oil, gas and energy resources, known as National Energy Resources Australia (NERA).

METS Ignited was established to provide the Australian mining equipment industry with support and services towards more collaborative solutions and improved scaling up and commercialization of products and services. Activities range from hackathons to accelerators, from challenge platforms to cluster programs, and finally awards programs to recognise improved collaboration. METS Ignited has committed $7.3 million across 16 collaborative projects valued at over $20 million through the METS Ignited Project Fund. METS Ignited has leveraged $13.3 million in matched cash funding from industry. Among this projects, the development a prospectus for the Future Battery Industries Cooperative Research Centre (FBI CRC) to connect world class research capability with industry needs to build knowledge and develop processes and battery applications using Australia's new energy materials. The Shield-X Hackathon in 2017 challenged companies to develop an industry-wide Safe Stop personal safety device for autonomous systems at mine sites. Nineteen teams from nine different countries were involved, with the winners going on to develop a commercial version of their device which is now on the market.

Supporting the development of clear pathways from schools to vocational training or tertiary studies to industry, and upskilling existing workers is another of METS Ignited aims. In partnership with the Entrepreneurs' Programme, METS Ignited developed a series of Masterclasses to help attendees understand and benefit from the emergence of Industry 4.0, how to better leverage capital investment, the future of industry and workforce, and how to better pitch their offerings. METS Ignited also launched an internship programme in collaboration with the mining business association, Austmine. Together they established a STEM METS Career Pathway Program to increase the number of students seeking a career in the METS sector. At the core of the program is the opportunity for students to gain first-hand experience of the METS sector, through a paid 10-week internship with a METS company.

Another important function offered by METS Ignited is the launch of an exchange programme called METStech Passport between Australia and Chile. METS Ignited is sending three Australian METS companies to Chile, and three Chilean METS companies to Australia to take part in a two-week mining innovation ecosystem immersion. Austrade and METS Ignited run the program in partnership with Expande, a public-private organisation as part of Fundacion Chile, to give mining suppliers international exposure to cross-pollinate ideas and facilitate international expansion.

The model adopted in Australia for the mining industry combines both hard and soft services and promotes collaboration within the sector. With the increasing digitalization of the economy (Andreoni, 2020), a number of countries and regions have started relying on more cross-sectoral technology-platforms based initiatives. As detailed in Figure 12, these initiatives rely on the establishment of a network of public-private technology intermediate institutions capturing both sector-specific and cross-sectoral opportunities in the ecosystem. An example is offered by the High Technology Network (HTN) promoted by the Italian region, Emilia Romagna, and managed by a regional organisation called ARTER. The Emilia-Romagna HTN includes multiple and heterogeneous PTIs organised around 6 Thematic Platforms. Specifically, it includes 35 Research Laboratories and 66 Operating Groups spread on the regional territory. It is organised along two axes:

- Location: 10 Technopoles Technopoles are facilities dedicated to industrial research located and spread on the regional territory. They include multi-thematic competences (Equipment - Human Resources) and constitute a meeting place for research offerings and demand on behalf of enterprises
- Competence: 6 Regional Thematic Platforms: Agrifood, Constructions, Energy & Environment, ICT & Design, Mechanics & Materials, Life Science.

A Regional Thematic Platform (RTP) is a virtual network bringing together researchers, industry and industrial association, in a particular technological field in order to foster regional research and development in the concerned area.

The HTN performs three sets of key policy functions:

**Vision-setting for the regional industrial ecosystem**

- Defining medium-long term research and technology development objectives
- Keeping a close contact with the European Technological Platforms (Identify the most promising technology paths to which give priority in regional, national and European research programmes)

**Coordination and management of the PTIs network and international gatekeeper**

- Promoting and coordinating research initiatives related to areas of strategic interest for the regional manufacturing system in liason with Universities or other research centres, or in collaboration with single or associated enterprises, business associations, trade unions, as well as other bodies and authorities;
- Developing initiatives enabling companies to access and participate, together with regional Universities and research institutions, in industrial research programmes at national, European and international level;

**Industrial scaling up and matchmaker**

- Organising and managing physical infrastructure and technological facilities, also through the establishment of other companies, mainly public joint-stock companies;
- Developing initiatives to facilitate, promote and support the creation and development of new companies for the use of results and expertise derived from research activities;
- Setting up and managing integration tools, through the Research Catalogue database (internet portal), to use the scientific and technological skills existing in the Emilia Romagna Regional High Technology Network.

- Supporting the establishment of research and service contracts to augment the Network's collaborative research output.
- Giving support to industrial enterprises which upgrade theirlabs with the most suitable instrumental equipment and tooling
- Involving the entire economic value chain, making sure that the knowledge generated by research is readily converted into technologies and processes, and thus into commercially viable products and services

The specific production and technology functions offered by the HTN are organised around the 6 technology platforms. While some of these platforms are more critical for certain sectors than others, they are not sector-specific. The HTN provides opportunities for technology diffusion, innovation and renewal across sectors by organising an open technology and production service offering (centred around technologies) to different sectors.

The establishment of a regional web platform called 'Catalogue of Competencies' played an important role in mapping existing technology offerings and production services in the region. The technology offerings and services for the mechanics, materials and ICT platforms include a wide range of critical activities for high-value manufacturing sectors. These include embedded systems, automation and control, robotics, high performance and cloud computing, internet of things, software engineering, interoperability, protocols and standards, mechatronics applications, vibration and harshness analysis. Since its constitution leading firms and a number of their suppliers have established collaborations with the local universities, innovation centres and laboratories involved in the HTN.

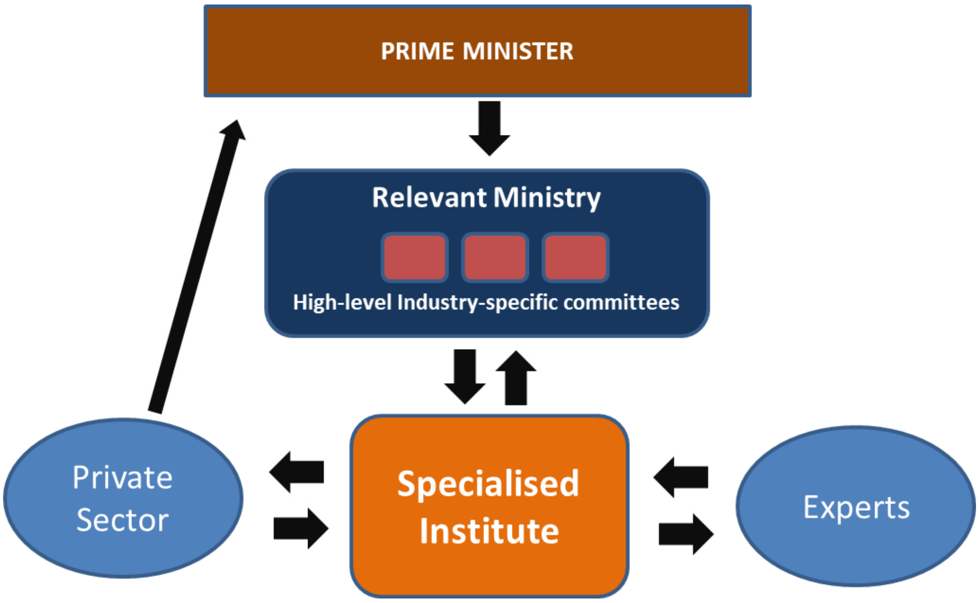
*Lesson 4 Sector-focused mission oriented institute – Thailand*
The implementation of a complex package of policies as detailed in Figure 13 above, requires the adoption of governance models favouring coordination and alignment. There are several governance models which have been successfully adopted to promote specific sectoral missions and implement sector-specific masterplans. The model of a specialized institute (or of a network of specialised institutes) operating as a policymaker and implementor is one of them (UNIDO, 2020). Within this model, the central government sets the industrial vision through a broader industrial policy. At a more disaggregate level the specialized institutes, on the other hand, draw on specialized sector knowledge and their local embeddedness to develop a detailed masterplan and engage with sectoral stakeholders. These institutes can also incorporate other bottom-up inputs, for example from academics or local communities, in the master plan. The specialized institutes are then mandated to implement the master plan.

This organisational model was used in Thailand for the successful development of the Automotive Industry[24]. Following the Asian financial crisis, the government formulated the Industrial Restructuring Plan under the leadership of the Ministry of Industry (MOI). MOI established ten specialized institutes to design sector-specific masterplans and implement the policy actions. Six of these were industry-specific institutes, four were thematic (for example covering technical training, management and certification, and SME development). Of these industry-specific institutes, the

[24] Other countries have used the specialized institute model to address governance challenges encountered in the use of other inter-Ministerial coordination models. For example, as part of the Ethiopian Agriculture-Led Industrial Development Vision, the government used autonomous specialized institutes (such as the Leather Industry Development Institute) to support export-oriented industries after several failed attempts to use directorates within the regular bureaucracy and the National Export Coordination Committee.

Thailand Automotive Institute (TAI) was one of the most successful. As shown in Figure 14, TAI relied on a tripartite structure (including government, companies and experts) and was in charge of designing and implementing the masterplan for the automotive sector (an approach later copied by other countries such as South Africa). As a specialized institute TAI cooperates with different Ministries, conducts joint research with universities, provides research and information services and manages a website for automotive part makers as a way of supporting backward linkages. Over the years, the provision of these services has also allowed TAI to become financially independent.

**Figure 14: Model for governing sectoral missions: specialised institutes and networks**




*Source: UNIDO, 2020*

Given the flexibility of the specialised institute model, other countries have relied on this approach to coordinate networks of institutes at the national and regional levels. When sectors are spread across different regions, such networks can provide critical coordination functions in the policy-making process, as well as supporting implementation, for example through the provision of technology services. In Germany, for example, the Fraunhofer-Gesellschaft is a network of specialized institutes organized around seven groups devoted to specific broad research areas. There is a complex organisational structure which aims to coordinate top-bottom and bottom-up policy making. Similarly, as discussed above, the Emilia Romagna region has developed a high technology network comprising 82 Industrial research laboratories and 14 Innovation centres. These three specialized institute models show how different organisational models can support very selective industrial policy, that is, policy instruments targeting specific industrial parameters at the sub-sectoral and product levels.

## 4 Pathways for feasible sectoral reforms: windows of opportunities and coalition of interests

### *4.1 Windows of opportunities: Analysis of private sector reforms proposals*

The development of a sectoral master plan relies critically on the identification of windows of opportunities in the sector and the broader South African industrial ecosystem. These opportunities should be assessed in light of the global and national sector-specific evidence presented in sections 1 and 2 (and complementary CCRED background paper). They should be also analysed against the existing policy and institutional landscape reviewed in section 3. Lessons from international experiences discussed in section 3 can be also used to support the design of specific policy actions in the South African context, provided that these policy actions are feasible. Policy feasibility is mainly determined by the capabilities and incentives of government actors which are supposed to implement and enforce the policy, and the capabilities and incentives of those private sector actors whose behaviors and business models will be either constrained or enabled by the policy.

Consultations with sectoral stakeholders have highlighted a number of windows of opportunities around which a new sectoral masterplan could develop. For example, the OEM Mining Supply Forum has advanced a number of potential solutions around three set of opportunities:

a) *Encouraging partnerships between the global OEMs and local OEMs to identify opportunities for working together, especially to expose the local OEMs to the export market.*
b) *Models for involving local entrepreneurs and the community in local mining operations.*
c) *Beyond Compliance initiatives, that go beyond the ticking of boxes to comply with the Mining Charter*

and has reflected upon several ways to leverage procurement and other policies to drive supply chain development, including:

- A strategic partnership with national and international Original Equipment Manufacturers (OEMs) around how the supply chain can be localised (and exports promoted).
- A strategic partnership with international OEMs and or their home governments around upgrading the competitiveness of national players in the OEM supply chain.
- Promoting a partnership between global and national OEMs and their supply chain to increase national value add and to increase exports of both systems and components.
- A partnership with South African OEMs around solving immediate and future production challenges.
- Localising components on the back of a critical mass of demand and the opening up of export market.
- The establishment and resourcing of a specialised agency to upgrade national suppliers.

A set of critical challenges and opportunities that the masterplan should focus on have been specified. They largely reflect some of the conclusions arising from the analyses in sections 2 and 3. These are:

- challenges in the quality of the domestic supply chain;
- challenges arising from a fixation with specific policy and institutional forms within the Mining Charter, more than a focus on policy functions and a collaborative logic;
- challenges in implementation, especially with respect to measurement of local content, assessment of OEM’s investment plans and effective implementation of tariff schedules;

- challenges arising from lack of 'design for differences', that is, a tailored approach recognizing that companies have different capabilities, business models and incentives, hence the same policy conditionalities might not be effective in achieving the stated policy functions;
- opportunity of leveraging a bigger market pie, by promoting exports to regional and international markets;
- opportunities arising from a digitalization of the mining sectoral value chain and the need for more technology investments and skills;
- opportunity of replicating business models aligning mining houses, OEMs and community-based operators.

The identification of these challenges and opportunities is an important recognition of the fact that OEMs are keen to engage the government towards the development of a productive coalition of interests. The lack of reflection and policy recommendations on a number of critical challenges raised in section 2, however, raise concerns about the willingness of the same industry actors to improve the quality of linkages along the supply chain. In particular, the lack of trust among companies along the value chain and the reluctance of some mining houses, EPC and EPCM companies in offering domestic OEMs and suppliers more space in their procurement decisions must be addressed. At the same time, the lack of recognition of local OEMs and suppliers of their challenges in meeting some competitiveness parameters is also something that calls for policy action. The challenge in providing scalable and modular solutions to mining houses, EPC and EPCMs, and the reluctance in establishing collaborations and joint ventures are not sufficiently recognised. As a result, while many proposed solutions might go in the right direction, they do not necessarily address the fragmentation and scalability challenge of domestic OEMs. This challenge must be addressed if both export market and new digital opportunities have to be captured. Finally, while important business models aligning mining houses, OEMs and community-based operators can provide quick wins and address social empowerment goals, these measures must be complemented with more strategic interventions along the ones discussed in section 3 with reference to international experiences.

### *4.2 Feasible sectoral reforms: five policy actions*

While policy instrument design and governance frameworks are critical, the effective implementation and enforcement of any industrial policy will depend on the extent to which the policy is able to promote the emergence of a new coalition of productive interests, or offer the existing powerful groups alternative and more productive ways to operate in the economy. This is the ultimate 'feasibility' test for the policy. There are a number of sectors in which the productive interests are predominant, while capabilities and power are relatively distributed. In these sectors, the political settlement structure might allow for quick wins and the emergence or consolidation of new coalitions for change. In other sectors, where interests have been more entrenched and even resulted in state capture, consolidated power structures are more difficult to change and open up to new actors and competition. Here, competition policy alongside other regulatory and incentive restructuring can force the emergence of new deals. These deals can open the way to transition pathways towards more productive and technologically dynamic sectors.

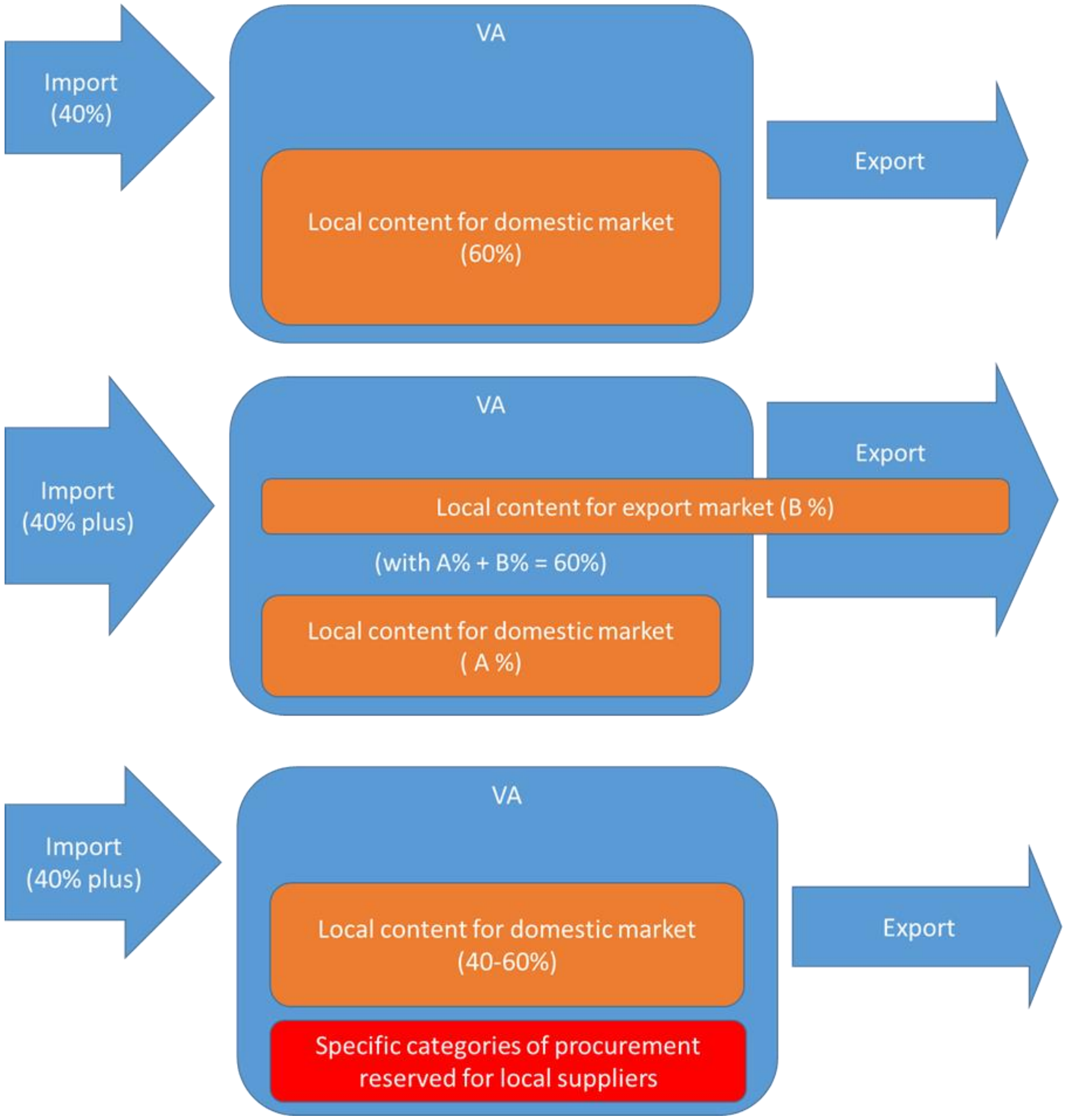
Based on the analyses conducted in sections 1 and 2 and in consideration of several solutions discussed within the business community in South Africa and other international experiences (see section 3), in what follows we propose five policy actions to be included in the master plan for the mining equipment industry in South Africa. These policy actions operate across a broad spectrum of policy areas and rely on different carrot and sticks. As discussed in section 3, their effectiveness will be also affected by the broader industrial policy package within which they operate and the evolution of the broader South African industrial ecosystem.

***Reforming local procurement content and linking it to export promotion***

The South African domestic market for mining equipment has shrunk over the last years. The local content requirements policy have played an important role, however they have also introduced in some cases unnecessary rigidities which have prevented alternative pathways to increase domestic value addition. The local procurement and content policy framework could be reformed along two main directions, as detailed in Figure 15.

The first one would consists in the introduction of a list of specific categories of procurement reserved for local suppliers, as in the Finnish case discussed in section 3. The definition of such list would require a thorough assessment of the products and services to target, and the extent to which these products and services meet quantity, quality and price competitiveness parameters.

**Figure 15: Local procurement and content, potential reforms**




Source: authors

A second option (also in combination with the former) could be introduced in view of linking compliance with local procurement and content requirements with export promotion. Specifically, this option would offer domestic companies the opportunity of contributing to increasing domestic value addition either by increasing the local content of their products and services in the domestic market OR by increasing the value of their products and services in the international export market. In a nutshell, companies would be allowed to import more of the products their need, to the extent that they also increase the local content value of the exported products. This policy could appeal several international OEMs with or without a local footprint as well as domestic OEMs who are affected by the local content requirements in their production expansion and price competitiveness. International OEMs willing to invest in South Africa would now have a new development pathway. They would be allowed to increase their import from their global supply chain for a number of products and services, to the extent that they link up local companies to their exclusive global supply chains and allow them to export internationally. By doing so, local companies would be opened enormous export market opportunities and would potentially become the main supplier of the international OEMs in other major mining countries such as Australia, Canada, Russia and Brazil[25]. The international OEMs could also link back the local company into their exclusive supply chains, thus 'powering' the local company. Of course, a limited number of domestic companies might be technologically and operationally ready to seize this opportunity. The development potential and growth scope however would be extremely significant. This measure would also create some competitive pressure in domestic backward industries. Local OEMs would have some alternative ways to reach local content requirement, that is, by increasing their export instead of accepting uncompetitive prices.

The masterplan should identify specific regulatory instruments that can incentivise OEMs to develop the local supply chain on the back of decreasing imports and increasing exports. There are two available policy levers:

- The mining charter can start measuring OEM performance in a more targeted and nuanced manner so as to incentivize localization and exports
- A tariff and rebate system can be introduced such that tariffs are imposed on selected imports, whilst rebates are achieved through achieving specified levels of national value addition through localization and / or through exports

Both the above instruments would incentive OEMs to integrate high performing South African suppliers into their supply chains, allowing these companies to increase both revenues and capabilities.

***Reforming tariff schedules selectively***

The existing tariff schedule presents a number of challenges, discussed in section 3, including the fact that final machinery and equipment products are offered more favourable tariffs than inputs and components. The reform of the tariff schedule for the mining equipment value chain should allow for two important policy functions.

First, tariff schedules should be reviewed in view of implementing an export promotion model as the one detailed above in conjunction with the local content requirement. Based on the main products identified, the local content of products across international and national OEMs, and the justifications for exclusions, we will identify:

- Products on which tariffs will apply for the purposes of a localisation / export policy
- Appropriate local content targets
- Incentives for prioritized capability development areas
- Benchmarking possible tariff rates against local content of SA firms
- Taking into account tariff limitations (ITAC considerations)
- Understanding how tariffs can be rebated by exports.

Second, a more targeted set of tariffs should be set based on an assessment of the local supply chain capabilities and specific product segments for which domestic producers have a chance to be competitive internationally. This assessment should start from the analysis of the additionality of the current tariff, that is, the identification of the real beneficiaries of tariffs along the extended metal, mining equipment value chain. In those cases in which the beneficiaries have benefitted from rents and have capture them in an unproductive way – that is, rents generated through tariff protection have not been reinvested – government should discipline the rents by removing tariffs protection.

[25] This model has been already implemented successfullt by Weir Minerals. The company uses specialised pumps produced by Curro Pumps as part of theie export range. Curro pumps on it's own would not have been able to access much o these export markets.

Following on from this first assessment, the master plan should prioritise those intermediate and final product segments in which existing companies have already developed distinctive capabilities and are close to the international price competitiveness benchmark. Those products whose price is determined mainly by scale and standardisation parameters should be reconsidered. In fact South Africa might not have a competitive advantage in these products for which a large backward industrial raw materials industry is needed. On the contrary there are several more sophisticated product segments and niche products which could be promoted with tariff protection in view of scaling up domestic capabilities and potentially enhance export capabilities.

***Promoting technology innovation with a focus on scalability and collaborations via a specialized institute***

The Mandela Mining Precinct should be elevated to a specialized intermediate technology institute housing and integrating fragmented initiatives across the mining industry; focusing on the opportunities offered by the global mining mega trends; addressing the challenge of scaling up national OEMs and their suppliers; promoting collaboration across domestic players.

The roadmap developed for the Australian mining equipment industry by CSIRO Futures (see Table 8), provides some detailed accounts of the global mining mega trends that will determine value creation, capture and distribution in the coming decades in the industry. A specialized intermediate technology institute should embrace these opportunities and challenges and set up a mission-oriented set of actions aimed at transforming the South African mining industry in key areas.

**Table 8: Global mining mega trends**


*Source: CSIRO Futures, 2017: iv*

The innovation imperative and the knowledge economy mega trends suggest the importance of supporting the development, absorption and diffusion of a number of key digital technologies. Data driven mining decisions will increasingly rely on the use of sensors and the Internet of Things; Analytics and optimization; Visualisation solutions; and Cyber security. The effective engagement with these technologies will require also specialized digital skills. The institute can provide this combined technology and skills development functions, focusing on the targeted training of task forces of specialized technicians and engineers in collaboration with Universities and TVETs. By relying on these technologies, companies will increasingly more towards 'advanced extraction' operations. Thus, the specialized institute should focus in developing technology services and skills in installing, operating and manufacturing advanced extraction technologies as well as advanced drilling, sensing, sorting and processing technologies. Advanced extraction will also result in increasing use of autonomous and robotic equipment, and pervasive advancements in material sciences and nanotechnology. Support development of regulatory frameworks for advanced extraction technologies, including standards for interoperability of technologies will become another key area of intervention for such a specialized institute. Finally, expanding exploration knowledge and processes will be increasingly needed given that high-quality and accessible ores are declining. In addressing this challenge, the specialized institute should develop geophysical and geochemical knowledge, data analysis, modelling and geographic information system (GIS) capabilities and infrastructures.

Capturing the opportunities offered by the global technology and industry megatrends is conditional in increasing the scaling-up capability of the domestic OEMs and suppliers. As discussed in sections 2 and 3, while South African mining equipment companies show relatively high level of technological capabilities, they lack a number of strategic, operational and organisational capabilities needed to compete internationally. Producing an advanced technology solution at scale and under specific price competitiveness parameters is much more than being technologically innovative, it is about addressing manufacturability challenges. These scaling up challenges can be addressed by providing dedicated technology services as well as providing companies with access to quasi-public good technologies such as data systems, testing facilities and pilot lines for virtual design and prototyping of mining solutions. In some cases these initiatives might not be sufficient. The specialized institute should promote joint ventures, consortia and collaborative arrangements. There are several arrangements within the South African regulatory framework which could be promoted, including arrangements for experimenting new collaborative business models. Following the model pursued in Australia of a Resources Sector Supplier Envoy, the specialized institute could break a number of deals among domestic and international players, and provide some form of supervision and accountability.

***Promoting related diversification with a challenge competition fund***

The master plan should explicitly promote related diversification for mining equipment producers, focusing in particular towards those closely related sectors where domestic players could redeploy their capabilities. Figure 12 above provides a tool for identifying related diversification opportunities[26]. These sectors include the agro-industrial value chain – both harvesting and sorting/processing machineries – the construction sector and off-road transport sectors. The government could promote the launch of a challenge competition fund in partnership with private companies in these related sectors. The challenge competition fund should work as a market

[26] See Andreoni (2018) for an analytical discussion and application of the methods.

creation tool, based on specific procurement needs and specifications from private companies operating in related sectors. Companies in the mining industry willing to capture this market and provide a technology valuable solution would be given a commission from the private company matched by a government fund supporting the diversification effort of the company.

***Export finance, credit guarantee consortia, hybrid incentives and procurement***
The master plan should engage with the major challenges faced by mining equipment companies – as well as other manufacturers in South Africa. The affordability of export finance schemes and the extent to which these schemes are or not tailored on the specific needs of the sector has been discussed in section 3. We think the master plan should promote the introduction of the following three sets of instruments:

a. Export finance focusing on the provision of leasing contracts for domestic mining equipment companies exporting their products in the regional and international markets. As discussed in section 2, leasing contracts are becoming a major non-technological competitive factor, especially in regional markets. IDC should explore financial options available to support domestic companies with proven capabilities to further enhance their product value proposition with a financial product package.

b. Promotion of a credit guarantee consortia offering mutualistic guarantees among MEMSA companies aimed at alleviating financial constraints on their small or medium-sized (SMEs) shareholding or syndicated enterprises. Known as 'Confidi', these credit guarantee consortia have played a major role in Italy and reduced the pressing conditions posed by banks on enterprises. Alternative versions could be introduced with government providing second-level guarantee to these credit guarantee consortia. This public guarantee could be used to further de-risk the investment and thus lower the cost of capital

c. Hybrid incentives and procurement policies can be important instruments to foster domestic supply chains development and collaborations across mining houses, OEMs and broader actors in the industrial ecosystem. Drawing from the experiences of the incentive schemes in Chile and Finland (section 3), and alongside the promotion of a challenge competition fund, hybrid incentives and procurement could be used to overcome reluctance of trust and willingness to collaborate among domestic players. These incentives should be aligned with measures supporting scaling up capabilities (see above) and should promote innovative collaborations involving universities and potentially international partners for technology transfers (see also section 3 on lessons from international experiences).

### *4.3 Conclusions*

Building on the industrial ecosystem and policy package framework, as well as the assessment of policy gaps in the existing policy and institutions, developed in section 3, we have then moved to the discussion and design of a number of policy actions for feasible reforms in the mining industry in South Africa. The feasibility of these measures is supported by the analyses conducted in sections 1 and 2, and inspired by a number of international experiences discussed in section 3.
In sum we envision five policy actions for the mining equipment masterplan:

a) Reforming local procurement content and linking it to export promotion
b) Reforming tariff schedules selectively

c) Promoting technology innovation with a focus on scalability and collaborations via a specialized institute
d) Promoting related diversification with a challenge competition fund
e) Export finance, credit guarantee consortia, hybrid incentives and procurement

A number of policy forms to achieve these policy functions have been proposed, however policy forms shall remain flexible and pass the feasibility tests before any inclusion in the master plan.

**References**


AFS (2014), "Annual Financial Statistics, 2014", SSA, available at: http://www.statssa.gov.za.

AFS (2017), "Annual Financial Statistics, 2017", SSA, available at: http://www.statssa.gov.za.

AFS (2018), "Annual Financial Statistics, 2018", SSA, available at: http://www.statssa.gov.za.

Andreoni, A. (2018) 'The Architecture and Dynamics of Industrial Ecosystems: Diversification and Innovative Industrial Renewal in Emilia Romagna', *Cambridge Journal of Economics*, vol. 42, no. 6, pp. 1613–1642.

Andreoni, A. (2020) 'Technical change, the Shifting Terrain of the 'Industrial' and Digital Industrial Policy', forthcoming in: Chang, H-J., Cramer, C., Kozul-Wright, R. and A. Oqubay (eds.) The Oxford Handbook of Industrial Policy, Oxford: Oxford University Press.

Andreoni, A. and F. Tregenna (2018) 'Stuck in the middle: Premature deindustrialization and industrial policy', CCRED Working paper 11/2018.

Bamber, P., Fernandez-Stark, K. and Gereffi, G. (2016), "Peru in the Mining Equipment Global Value Chain", Technical Report for the World Bank, Duke University Center on Globalization, Governance and Competitiveness (CGGC).

Bridge, G. (2008), "Global production networks and the extractive sector: governing resource-based development", *Journal of Economic Geography*, 8(3): 389-419.

CSIRO Futures (2017) *Mining Equipment, Technology and Services A Roadmap for unlocking future growth opportunities for Australia*, CSIRO Futures.

Deenen, M. A. and Gross, A. C. (2009), "World Mining Machinery", *Business Economics*, 44(3): 169-176.

Deloitte (2019), "2018 Mining Charter Analysis", April 2019.

DMR (2004), "Broad-Based Socio-Economic Empowerment Charter for the South African Mining Industry", The Department of Mineral Resources of South Africa, Government Gazette, 2004.

DMR (2010) "Broad-Based Socio-Economic Empowerment Charter for the South African Mining Industry", The Department of Mineral Resources of South Africa, Government Gazette, 2010.

DMR (2017) "Broad-Based Socio-Economic Empowerment Charter for the South African Mining Industry", The Department of Mineral Resources of South Africa, Government Gazette, 2017.

DMR (2018) "Broad-Based Socio-Economic Empowerment Charter for the South African Mining Industry", The Department of Mineral Resources of South Africa, Government Gazette, 2018.

Dti (2016), "Annual review of small business in South Africa 2015-2016", The Department of Trade and Industry of South Africa – Bureau of Small and Medium Enterprise Development, Pretoria.

Fessehaie, J. (2012a), "What determines the breadth and depth of Zambia's backward linkages to copper mining? The role of public policy and value chain dynamics.", *Resources Policy*, 37(4): 443-451.

Fessehaie, J. and Morris, M. (2013), "Value Chain Dynamics of Chinese Copper Mining in Zambia: Enclave or Linkage Development?", *The European Journal of Development Research*, 25: 537-556.

Kaplan, D. (2012), "South African mining equipment and specialist services: technological capacity, export performance and policy.", *Resources Policy*, 37(4): 425-433.

Lydall, M. (2009), "Backward linkage development in the South African PGM industry: a case study.", *Resources Policy*, 34(3): 112–120.

Mjimba, V. (2011), "The Nature and Determinants of Linkages in Emerging Minerals Commodity Sectors: A Case Study of Gold Mining in Tanzania", Making the Most of Commodities Programme (MMCP), Discussion Paper No. 7, March.

OECD (2017) Local Content Policies in Minerals-Exporting Countries. Case Studies. OECD Working Party of the Trade Committee. TAD/TC/WP(2016)3/PART2/FINAL

Östensson, O. (2017), "Local content, supply chains, and shared infrastructure", WIDER Working Paper, No. 2017/96, The United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki.

Quantec (2020), "EasyData", Quantec, available at: https://www.quantec.co.za/easydata/.

Reynders, K. (2018), "Determining customer needs for a niche supplier in the mining industry", MBA Dissertation, North-West University, South Africa.

Rustomjee, Z., Kaziboni, L., and Steuart, I. (2018). "Structural Transformation along Metals, Machinery and Equipment Value Chain - Developing Capabilities in the Metals and Machinery Segments", CCRED Working Paper, 2018/7.

SARS (2017), "South African Revenue Service firms and employment data", South African Revenue Service.

Toreggiani, S. and Andreoni, A. (2019) 'Dancing with dragons. Chinese import penetration and the performances of manufacturing firms in South Africa', WIDER Working Paper 63/2019, UNU-WIDER.

UNIDO (2019) *Industrializing in the digital age*, Industrial Development Report 2020. Vienna: UNIDO.

UNIDO (2020) *Industrialization as the Driver of Sustained Prosperity*, Edited by Li-Yong and co-authored by Antonio Andreoni and Nobuya Haraguchi.

Walker, M.I. and Minnitt, R.C.A. (2006), "Understanding the dynamics and competitiveness of the South African minerals inputs cluster.", *Resources Policy*, 31(1): 12–26.

World Bank (2015) 'A practical guide to increasing mining local procurement in West Africa', World Bank, KAISER EDPI and Australian Government.

WOW (2019), “Manufacture and wholesale of machinery for mining, quarrying and construction”, Who Owns Whom Industry Reports.

**Annex 1**

***Sector-specific institutional actors, policies and regulatory framework***

*Local procurement and content*

The Broad-Based Black Socio-Economic Empowerment Charter for the South African Mining and Minerals Industry, commonly known as the *Mining Charter*, was first released in 2004, amended in 2010 to quantify minimum thresholds and targets, and then revised in 2017 and 2018. The Charter was developed, following the Minerals and Petroleum Resources Development Act (MPRDA), as the key policy tool to drive transformation in the industry. It has introduced a scorecard system for mining right holders, which is currently based on the following six criteria:

a. Ownership participation by Historically Disadvantaged Persons (HDP) in mineral resources industries.
b. Employment Equity (EE), promoting fair treatment and equal opportunities in the workplace.
c. Human Resources Development (HRD) and capacity building for employees and local communities.
d. Inclusive Procurement, Suppliers and Enterprise Development (IPSED) to procure from and develop of local empowered businesses.
e. Mine Community Development (MCD) to contribute to the socioeconomic wellbeing of the communities hosting mining operations.
f. Decent housing and living conditions for mine employees.

The non-compliance with one of the above obligations can lead to the withdrawn (or the suspension) of the mining permit. However, existing mining rights holders are granted a transition period, with progressive implementation, to reach the compliance targets. The IPSED requirement, in particular, constitutes the highest weighted contributor to the overall compliance scorecard of the 2018 Charter (40% out of the 100%) and it establishes the following provisions for mining right holders:

a. Sourcing 70% locally manufactured mining goods, including both capital equipment and consumables, with a 60% local content, and 80% locally provided services with preferential procurement from HDP entities, firms owned or controlled by women and youth and BEE compliant companies.
b. A minimum of 70% of total R&D budget to be spent on South Africa based R&D entities.
c. Mineral sample analysis across the entire mining value chain must be conducted exclusively in South Africa-based facilities or companies.
d. Investing in enterprise and supplier development (also through the engagement of OEMs) permits mining right holders to offset some of their procurement element obligations.[27]

Table 1A traces changes over time of the procurement-related provisions contained in the Mining Charter. The most recent revisions of the document have also introduced a procurement monitoring and evaluating mechanism in the form of a verification of local content by the South African Bureau of Standards (SABS), for capital and consumer goods sourced by mining rights holders and by their suppliers along the mining value chain.

---

[27] The 2018 Mining Charter is relatively more aligned, although not fully, with the dti B-BBEE Codes, especially with respect to procurement provisions.

**Table 1A3 – The evolution of procurement provisions of the Mining Charter (2004-2018).**

| Key dimension | Charter 2004 | Charter 2010 | Charter 2017 | Charter 2018 |
|---|---|---|---|---|
| Procurement | • Mining rights holders must commit to procure capital goods, consumables, and also services from Historically Disadvantaged South African (HDSA) companies. | • Mining rights holders must procure 40% of capital equipment from Black Economic Empowerment (BEE) entities by 2014;<br>• Foreign multinational firms supplying capital equipment to the mining sector must devote the 0.5% of annual income generated from local mining firms to socioeconomic development programs;<br>• Mining rights holders must procure 70% of services and 50% of consumer goods from BEE entities by 2014. | • Mining rights holders must spend 70% of total procurement spending for mining products, on South African manufactured products (with 60% of local content), broken down as follows:<br>a. 21% of South African manufactured goods must be sourced from Black Owned companies;<br>b. 5% South African manufactured products must be sourced from female Black Owned and/or youth Black Owned companies;<br>c. 44% South African manufactured goods must be sourced by BEE compliant companies;<br>• Mining rights holders must procure 100% of services from South African based firms, broken down as follows:<br>a. 65% must be sourced from Black Owned companies;<br>b. 10% from Black Owned female companies;<br>c. 5% from Black Owned youth firms;<br>• Mining rights holders must use South African companies to perform 100% of sample analysis locally;<br>• Mining rights holders must provide proof of local content in the form of certification from SABS – suppliers of goods and services must provide local content certification. | • 70% of total mining goods must be locally procured (with at least 60% of local content), broken down as follows:<br>a. 21% on goods manufactured by Black entrepreneurs;<br>b. 5% on goods manufactured by BEE woman entrepreneurs or 51% on goods manufactured by youth owned enterprises, and<br>c. 44% on goods on a BEE compliant companies;<br>• 80% of total spend must be services from South African companies which in turn is broken down into sub-categories:<br>a. 60% on BEE entrepreneurs;<br>b. 10% on BEE women or 51% youth owned enterprises;<br>c. 10% on BEE compliant companies.<br>• 5% of a procurement budget and 10% of a services budget may be offset by investing in enterprise and supplier development programs;<br>• 100% of samples must be analysed locally;<br>• 70% of rights holders' R&D budget must be spent in South Africa;<br>• Foreign suppliers must contribute 0.5% of local turnover to Mandela Mining Equipment Precinct;<br>• Rights holders must provide annual proof of local content verification. |

*Source:* own summary based on DMR (2004, 2010, 2017, 2018) and Deloitte (2018).

*Collaborative R&D initiatives and technology services*

The post-apartheid South African mining-related research system mainly consists of three public institutions: (*i*) the Council for Scientific and Industrial Research (CSIR), which inherited the research mandate of the Chamber of Mines Research Organization (COMRO) after their merge in 1992, (*ii*) Mintek, and (*iii*) universities. From early 1990s COMRO/CSIR started to experience a severe downsizing: while up to the 1980s the co-investment between the Chamber and member companies amounted to around R400 million (around USD 27 million) a year, the available funding has declined substantially up until 2014, when only R5 million was allocated for mining-related R&D initiatives. In 2015, the Mining Phakisa initiative, led by the Presidency, has signaled a renewed interest and commitment for the mining sector in the country gathering together many key stakeholders into a "lab", with the primary objective of identifying constraints and building a common vision for the long-term development and transformation of the sector, including the inputs cluster. It was only with the launching of the Mining Phakisa initiative, that the CSIR was given a new key role for policy implementation (Fessehaie et al., 2016).

In close collaboration with the Department of Science and Technology (DST) and the Department of Mineral Resources (DMR), the CSIR has been appointed to draft the South African Mining Extraction Research, Development and Innovation (SAMERDI) Strategy (Sing, 2017), which called for the institution of a dedicated mining sector R&D fund aligned to the government's target for the entire economy (e.g., 1.5% of GDP). More specifically, the SAMERDI strategy, together with the outcomes of the Mining Phakisa project, has served as the starting point for the development of two key focus areas: (*i*) the first one is the Mandela Mining Precinct aims at building up a collaborative R&D model with a focus on core technologies for deep level mining operations and the (*ii*) the second deals with the establishment of the industry cluster of the mining equipment manufacturers of South Africa (MEMSA), with the objective of ensuring that development requirements are translated into appropriate R&D programs (Singh, 2017).

a. Guided by the outcome of the Mining Phakisa, the Mandela Mining Precinct was established as central hub for sectoral R&D initiatives with research and administrative functions and with the primary objective of being the key vehicle for a healthy, safe, transformative, innovative and economically viable mining industry. In particular with respect to innovation and R&D initiatives, it is already serving as a collective learning and testing lab specifically for rock engineering, support systems and ventilation solutions. The establishment of the Precinct has led to a substantial increase of mining-related R&D public funding: for the three-years from 2017/18 to 2020/21, the DST has allocated R210 million (around USD 14 million) specifically for hard-rock, narrow-reef and metalliferous underground mining, while in 2015 those contributions only amounted to R750.000 (around USD 50000). Furthermore, the Minerals Council has pledged R33 million (around USD 2 million) for 2018 with a public-private contribution mechanism following the ratio of R1 for every R2 provided by the government (Creamer, 2018).

b. The Mandela Mining Precinct was launched together with the Mining Equipment Manufacturers of South Africa (MEMSA), which has a key role in (*i*) assessing technology readiness levels, aligning companies' initiatives to the key points identified by the SAMERDI Strategy and in (*ii*) supporting the development of new technologies, providing access to learning and testing facilities to its members. With respect to the first point, a Technology

Availability and Readiness Atlas (TARA) has been developed to map technologies developed by South African OEMs, assessing to what extent they are employed by end-clients. As for the second point, in close collaboration with the Mandela Mining Precinct, MEMSA is currently building up an experimental test mine that will provide a protected environment for South African OEMs to learn and innovate. It is hoped that these coalition-building efforts would result in collaborative forms of R&D among South African companies and, eventually, to the development of new marketable technologies. More broadly, MEMSA's objective is to help positioning the South African mining equipment (mainly underground and surface machines, excluding mineral processing solutions[28]) as world class high quality, innovative and cost competitive not only locally, but on regional and global markets.

At the very heart of these funding allocation initiatives is the need of developing local solutions for local technical challenges, primarily related to the specific characteristics of the South African mineral deposits (e.g., steep angles of orebodies and narrow width of the reef). To this purpose, through dedicated work-streams and cross-cutting initiatives, the Mandela Mining Precinct is pursuing six focus areas including the longevity of current mines, mechanized drilling and blasting programs, non-explosive rock breaking, advanced orebody knowledge, real-time information management systems the successful application of technology centered around people.

*Skills development*

In 1994 the Government of South Africa embarked on a comprehensive reform process for skills development, involving legislation, structures and organisations. The aim was to change the cultural and institutional landscape for skills development and vocational training at all levels, including the introduction of a National Qualifications Framework (NQF). In 1998 Parliament ratified the Skills Development Act, which defined a new Sector Training and Education Authority (SETA) system. In 2000, 23 SETAs, each with its own clearly defined sector and sub-sector, were established (reduced to 21 with the new National Skills Development Strategy in 2011).

SETAs are the key implementation agencies for establishing and maintaining quality in workplace-based training and learning. They are responsible for overseeing training and skills development in a specific national economic sector (including learnerships, internships, unit-based skills programmes and apprenticeships), and for developing Sector Skills Plans (SSPs) to outline the strengths and challenges of a sector in terms of employment and skills development. SETAs are governed by the Skills Development Act and Skills Development Levies Act of 1999.

The Skills Development Levies Act (SDLA) (No. 9 of 1999) established a compulsory levy scheme for the purpose of funding education and training as envisaged in the Skills Development Act (No. 97 of 1998). The Skills Development Levy (SDL) became payable with effect from 1 April 2000. The Department of Higher Education and Training, in conjunction with the various SETAs, is responsible for administering the Act, while the South African Revenue Service (SARS) is responsible for the collection of levies. The SDL is intended to encourage learning and development in South Africa and is determined by an employer's salary bill. The SDL is 1% of the total amount paid in salaries to employees, including overtime payments, leave pay, bonuses, commissions and lump sum payments. Employers are required to pay the levy every month if they have registered their

[28] The South African Mineral Processing Equipment Cluster (SAMPEC) is in charge of identifying research and development requirements for mineral processing operations and solutions, facilitating interface and collaboration between equipment producers and research facilities.

employees with SARS for tax purposes (Pay As You Earn (PAYE)), and if the employer pays over 500 000 South African Rand a year in salaries and wages to employees (even if they're not registered for PAYE with SARS). SARS uses the funds from the SDL to develop and improve the skills of employees. The primary focus of the business is determined by analysing what approximately 60% of employees do. The levies are put in a special fund and are divided with 80% distributed to the different SETAs and 20% paid into the National Skills Fund.

In accordance with the SETA Grant Regulations, SETAs pay mandatory grants to employers that are equivalent to 20% of the levies paid by the employer. The following conditions must be met: the employer must be employing 50 or more employees and must submit an application for a mandatory grant within six months of registration, supported by a Work Skills Plan (WSP) and an Annual Training Report (ATR). Mandatory grants are then used by employers to train their employees.

Mining-related skills development is primarily regulated by the Skill Development Act 97 of 1998 and the Mine Health and Safety Act 29 of 1996. Moreover, also the Mining Charter establishes a number of criteria for mining rights holders who are required to (*i*) invest 5% of annual leviable payrolls to skills development programs and, (*ii*) 1% as skill development levy. In order to demonstrate their compliance to the Mining Charter and to maintain their rights, mining companies are also required to submit their skills development plan to the Mining Qualification Authority (mqaSETA). According to the Minerals Council (2019) in 2018 about R6 million has been invested in skills development programs by mining companies, from 2013 to 2018 around 13,000 tertiary education learners have been supported by the sector and more than 10,000 artisans have been enrolled in training and development programs.

With respect to skills development programs, two training initiatives are particularly relevant: (*i*) the Sector Education and Training Authorities and, (*iii*) the Technical Vocational Education and Training (TVET) colleges. As the input cluster is concerned, the competent Sector Education and Training Authority (SETA) is the Manufacturing, Engineering and Related Services Authority (merSETA), and, more specifically, the Metal Chamber of merSETA. It is in charge of quantifying occupational shortages, identifying skill gaps, determining skills priorities and developing an appropriate educational offer for specific clusters of sub-sectors. Other government-funded training initiatives launched over years offering vocational education programs also in mining-related areas, include public Technical Vocational Education and Training (TVET) colleges.

Alongside government-funded programs, some industry clusters like MEMSA, SAMPEC, the Valve and Actuator Manufacturers Cluster of South Africa (VAMCOSA) and the South African Capital Equipment Export Council (SACEEC) are autonomously undertaking a thorough skills needs assessment and, in certain cases, have also launched their own endeavors in response to the sector-specific training requirements. In particular, SACEEC, has recently established a school of excellence in collaboration with the National Tooling Initiative Program (NTIP) and the Gauteng Growth and Development Agency (GGDA) to increase the number of artisans entering the industry and to prepare them for the challenges and opportunities associated with the introduction of new technologies.

*Exports finance and support*

Although not exclusively related to the mining equipment sector, but instead applying to the whole range of South African industries, a number of key export finance and promotion initiatives affect development and export capacity of mining equipment manufacturers. Here we focus on the following institutions offering relevant programs: (*i*) the Export Credit Insurance Corporation (ECIC), (*ii*) the Industrial Development Corporation, (*iii*) the Export Marketing and Investment Assistance (EMIA) scheme of the dti and, (*iv*) SACEEC.

a. Export Credit Insurance Corporation. Established in 2001, under the Export Credit and Foreign Investment Insurance Act, it is a 100% state owned insurance company with the mandate of facilitating exports trade and cross-border investments between South Africa and the rest of the world, providing political and commercial risk insurance. In order to be eligible for ECIC support ranging from investment cover to buyer and supplier credit, companies must fulfill the following criteria:
    i. A minimum of 15% of the export contract value must be paid to the exporter by the buyer and only the 85% of the export contract value is eligible for ECIC backed finance and insurance support.
    ii. Loan eligible for ECIC support must be backed by at least 50% South African content for projects in Africa (20% content may come from other African countries or the host country).
    iii. For projects outside of Africa, the minimum South African content is 70%.
    iv. For investment insurance, there must be a cross-border investment and the equity investment must be made through a South African registered entity.
    v. Cover for performance guarantees, bid bonds and others must be linked to an existing or potential export contract by a South African company.

Following the ECIC investment into the African Export and Import Bank (Afreximbank), South African became the 47$^{th}$ African country to join the bank as a participating member. The partnership between the two entities resulted in a program launched in June 2018 for an initial amount of USD 1 billion, the South Africa – Africa Trade and Investment Promotion Program (SATIPP), which is aimed at identifying and supporting large South African companies with selected interventions, including:

i. Supporting South African company operations and their subsidiaries through pre-approved credit lines to fulfil their financing needs.
ii. Investment in industrial parks and special economic zone where Afreximbank is financing or developing.
iii. Financing the importation of equipment needed by South African export manufacturers to upgrade and retool their equipment for improved competitiveness.
iv. Support efforts at improving the skills of South African exporters in export marketing through capacity building initiatives in order to improve foreign market access for South African exporters.
v. Deploying project finance to support the construction of trade enabling infrastructure such as power plants and transport infrastructure, including warehouses.

b. Industrial Development Corporation. It is the South African largest development finance institution providing funding for industry growth across key industrial sectors, including the mining and metal value chain. In terms of export support programs, the IDC manages a specific fund to facilitate exports trade by South African manufacturers and the size of the fund varies case-by-case.

c. Export Marketing and Investment Assistance. It is an incentive scheme developed by the dti offering a number of group and individual initiatives to South African manufacturers and services companies, export councils and trading houses, including those operating in the capital equipment and allied services. Among the former: the organization of national pavilions at international trade fairs, outward investment and selling missions, inward buying and investing missions. Among the latter: the organization of individual exhibitions, drafting of foreign direct investment and primary market research and individual inward buying and investment missions.

d. SACEEC. Acknowledging the importance to become global leaders and linking up in high value segment of global value chains, SACEEC provides a platform for capital equipment exporters, supplying information and services to promote exports. It facilitates the sharing of export related facilities, it conducts analysis on new foreign markets disseminating export leads and it encourages the development of export consortia.

*Trade policy*

The design and implementation of the trade policy is critical in setting price competitiveness parameters in the country, hence determining sourcing decisions by mining houses, EPC and EPCM. Import penetration in South Africa has increased dramatically over the last decade, partially reflecting increasing competitiveness of foreign companies in countries like China (Torreggiani and Andreoni, 2019), but also widespread signs of premature de-industrialisation across several sectors in South Africa (Andreoni and Tregenna, 2018). Table 2A presents the tariff schedule that the South African government has negotiated for equipment and components used in mining operations. With respect to the South African mining industry, tariff schedules tend to protect a number of key industrial materials which are used as components for domestic OEMs (e.g., tires and certain steel components). In doing so, trade policy aims at protecting backward industries in the extended metals, machinery and equipment value chain. Final products – such as assembled machinery and equipment are on the contrary given access to the domestic market at zero or very low tariffs.

**Table 2A – Custom tariffs on selected items (equipment and components) used in mining operations.**

| **HS Code** | **Surface and Underground** | **Tariffs** | | | | |
|---|---|---|---|---|---|---|
| **HS Code** | **Description** | **General** | **EU** | **EFTA** | **SADC** | **MERCOSUR** |
| 820713 | Rock drilling or earth boring tools: With working part of cermets | | | | | |
| | Bits (excluding those of a diameter exceeding 100 mm but not exceeding 385 mm incorporating hemispherical shaped inserts of tungsten carbide, those of a kind used for raise boring and chisel blanks for rock drills) | 15% | Free | 15% | Free | 13.50% |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Other | Free | Free | Free | Free | Free |
| 842911 | Bulldozers and angledozers :-- Track laying | Free | Free | Free | Free | Free |
| 842919 | Bulldozers and angledozers :-- Other | Free | Free | Free | Free | Free |
| 842920 | Graders and levellers | Free | Free | Free | Free | Free |
| 842930 | Scrapers | Free | Free | Free | Free | Free |
| 842940 | Tamping machines and road rollers | Free | Free | Free | Free | Free |
| 842951 | Mechanical shovels, excavators and shovel loaders :- Frontend shovel loaders | Free | Free | Free | Free | Free |
| 842952 | Mechanical shovels, excavators and shovel loaders :-- Machinery with a 360 revolving superstructure | Free | Free | Free | Free | Free |
| 842959 | Mechanical shovels, excavators and shovel loaders :-- Other | Free | Free | Free | Free | Free |
| 843010 | Pile-drivers and pile-extractors | 10% | Free | Free | Free | 10% |
| 843031 | Coal or rock cutters and tunnelling machinery :-- Self-propelled | Free | Free | Free | Free | Free |
| 843039 | Coal or rock cutters and tunnelling machinery :- Other | Free | Free | Free | Free | Free |
| 843041 | Other boring or sinking machinery :-- Self-propelled | Free | Free | Free | Free | Free |
| 843049 | Other boring or sinking machinery :-- Other | Free | Free | Free | Free | Free |
| 843050 | Other machinery, self-propelled | Free | Free | Free | Free | Free |
| 843061 | Other machinery, not self-propelled :-- Tamping or compacting machinery | Free | Free | Free | Free | Free |
| 843062 | Other machinery, not self-propelled :- Scrapers | No Data | | | | |
| 843069 | Other machinery, not self-propelled :- Other | Free | Free | Free | Free | Free |
| 845910 | Way-type unit head machines | Free | Free | Free | Free | Free |
| 845940 | Other boring machines | Free | Free | Free | Free | Free |
| 845970 | Other threading or tapping machines | Free | Free | Free | Free | Free |
| 870130 | Track-laying tractors | Free | Free | Free | Free | Free |
| 870410 | Motor vehicles for the transport of goods: Dumpers designed for off-highway use: | 10% | Free | Free | Free | 10% |
| 870421 | Diesel powered trucks - G.V.M. not exceeding 5 t | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Other (excluding double-cab), of a vehicle mass not exceeding 2 000 kg or a G.V.M. not exceeding 3 500 kg, or of a mass not exceeding 1 600 kg or a G.V.M. not exceeding 3 500 kg per chassis fitted with a cab | 25% | 18% | 20% | Free | 25% |
| | Other | 20% | 12% | 15% | Free | 20% |
| 870422 | Diesel powered trucks - G.V.M. exceeding 5t but not exceeding 20 t | | | | | |
| | Shuttle cars for use in underground mines; low construction flameproof vehicles, equipped with control mechanisms both in the front and at the rear, for use in underground mines | Free | Free | Free | Free | Free |
| | Other | 20% | 12% | 15% | Free | 20% |
| 870423 | Diesel powered trucks - G.V.M. exceeding 20 t | | | | | |
| | Shuttle cars for use in underground mines; low construction flameproof vehicles, equipped with control mechanisms both in the front and at the rear, for use in underground mines | 10% | Free | Free | Free | 10% |
| | Other | 20% | 12% | 15% | Free | 20% |

*Source:* South African Tariff Book, Schedules to the Customs and Excise Act of 1964 (2018).