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Regional Industrialisation Research Project: Case Study on the Mining Capital Equipment Value Chain in South Africa and Zambia

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10 December 2014

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Acronyms

B-BBEE	Broad-based Black Economic Empowerment
CAGR	Compounded growth annual rate
CAPEX	Capital expenditures
COMRO	Chamber of Mines Research Organisation
CSFs	Critical success factors
DAs	Development Agreements
DMR	Department of Mineral Resources
DRC	Democratic Republic of Congo
DTI	Department of Trade and Industry
ECIC	Export Credit and Insurance Company
EPC	Engineering, Procurement and Construction
EPCM	Engineering, Procurement, Construction and Management
FDI	Foreign Direct Investment
GVC	Global value chain
HDSA	Historically Disadvantaged South Africans
ISO	International Standard Organisation
JV	Joint Venture
LHDs	Load Haul Dumps
LME	London Metals Exchange
LSTK	Lump Sum Turnkey
M&As	Mergers and acquisitions
NDP	National Development Plan
NSI	National system of innovation
OEM	Original Equipment Manufacturer
PGMs	Platinum Group Metals
R&D	Research and development
RMG	Raw Materials Group
SABS	South Africa Bureau of Standards
SADC	Southern African Development Community
SARS	South African Revenue Services
SIB	Stay-in-business investment
TCO	Total cost of ownership
TNCs	Transnational Corporations
ZABS	Zambia Bureau of Standards
ZCCM	Zambia Consolidated Copper Mines
ZCCZ	Chambishi Zambia-China Economic and Trade Cooperation Zone
ZMLCI	Zambia Mining Local Content Initiative

Executive Summary

The mineral commodity price boom has led to a significant expansion of the demand for mining capital equipment. Equipment requirements vary significantly by stage of mining operation, type of mining (open pit/underground) and mineral. Global mining houses have focused their procurement strategies on reducing Total Cost of Ownership (TCO) and require suppliers to help them reduce operational costs, increase productivity, and improve worker health, mine safety and environmental management. The implications for the equipment industry are many-fold. Original Equipment Manufacturers (OEMs) are expected to offer 'solutions' rather than simply products, hence they have entered into partnerships with the mining houses to find innovative technologies and are investing continuously R&D and product improvement. OEMs are also acquiring startups and established firms for a variety of reasons: to enter new markets, reduce competition and broaden product portfolio. Lastly, as greenfield investment is slowing down, aftermarket services have become critical in order to reduce TCO for buyers and to increase/stabilise revenues for the OEMs.

South Africa's mining inputs cluster has historically developed on the back of strong demand from the mining sector for technological solutions to deep level hard rock mining, and has been characterised by high levels of investment in R&D and human capital. Notwithstanding changes post-1994 to the mining industry and the macro-economic environment, South African OEMs have found niche markets in which they are globally competitive. Indeed, mining capital goods are the most dynamic section of the capital goods sector and represent more than 50% of total capital goods exports. Erosion of R&D and skills base constitutes the most pressing challenges for the long-term competitiveness of the sector.

From the 1990s onward, following the end of nationalisation and import substitution policies, Zambia's mining inputs cluster shrank significantly in size and value added content. Whilst the entry of new investors, including from Asia, injected much needed capital into its copper mining sector, only few local suppliers managed to seize new market access opportunities. Without the support of interventionist industrial policies and faced with competition from imports, most manufacturers struggled and exited the supply chain. Many suppliers turned into importers of capital equipment as subsidiaries, agents and traders. The challenges to supply firms include weak firm technological competencies, low skills base, costly access to finance and a very high cost production structure.

South Africa exported R 32 billion worth of mining capital equipment in 2013. The regional market is very important, in particular Zambia is South Africa's largest export market and South Africa is Zambia's largest source of capital equipment. Zambia's imports from South Africa are concentrated on few products: from structures to earth moving equipment, from mineral processing equipment to excavating machinery, to pumps and conveyor belts. For both South African and international OEMs, South Africa is a platform to operate in the regional market.

From a policy perspective, both Zambia and South Africa are increasingly committed to increase local content in the mining sector. In Zambia, local content measures were put place when the mines were privatised, but these were hardy implemented. More recently, though, suppliers, under the umbrella of their business association, have been spearheading a more ambitious local content initiative which is receiving support from the mining companies, the government and donors. South Africa's industrial policy is facilitating some categories of suppliers through skills development, credit facilities, etc. Moreover, its export credit agency has linked its financing to local content requirements. The country is also in the process of implementing the local content provisions of the Mining Charter, which conflagrate local value addition and BEE ownership issues. In both Zambia and South Africa, the private sector has to play a major role if local content policies are to succeed. Indeed the suppliers' business associations are actively involved in these processes. Exploring the scope of their role in the

national and regional industrialisation projects would be important in formulating policy recommendations for the case study.

The study is based on interview data collected across suppliers and OEMs, ECPM firms and institutional actors in South Africa and Zambia. The research focused on four product clusters: mineral processing equipment, offroad special vehicle, conveyor systems, and pumps and valves. The findings highlighted that in South Africa new entrants may struggle to enter the regional mining supply chain given the size and competitiveness of incumbents, but there could be significant opportunities for lateral migration of technologies, hence for OEMs currently active in other resource and non-resource sectors to enter the mining value chain, and for mining OEMs to expand their markets beyond mining. In Zambia, barriers to entry were somehow lower because most suppliers were traders and faced low capital and skills entry barriers.

EPCM firms coordinated entry into the regional mining supply chain, especially for mineral processing equipment. They largely tapped into the South African mining inputs cluster for national and regional projects, with no preference given to South African OEMs. There was some evidence that OEMs supplying directly to the mining companies were finding it easier to offer more innovative products. Zambian suppliers were largely cut out from the EPCM firms' procurement strategy.

In general, South Africa-based OEMs were characterised by significant degrees of local content, value addition and upgrading efforts. Nevertheless, international OEMs had externalised considerable levels of R&D and manufacturing high-IP content components to their parent companies, and relied on low cost global suppliers for manufacturing of generic components. South African OEMs had higher degree of value addition, but devised various strategies to cope with import competition, including distributing foreign products and importing components. Zambian suppliers were positioned at the bottom of the regional value chain in terms of specialisation, local content and value addition.

As expected, the regional value chain for mining capital equipment was driven by quality and TCO market parameters. Aftermarket services and full package capabilities were increasingly important and were found to be important elements in shaping the trajectory of the industry. Because they focused on TCO and quality, South Africa-based OEMs were able to withstand Chinese low-cost competition. For valves, however, which was a cost-driven value chain, cost reduction strategies were more important. Lead times for aftermarket services in the Copperbelt were critical.

Localisation requirements in Zambia were becoming increasingly stringent and there was evidence that employment requirements were already shaping the human resource strategies of OEMs in the Copperbelt. Localisation requirements in South Africa were discouraging some South African players to move into the regional markets.

As pointed out in the literature review, South Africa was a hub for the regional value chain for mining capital equipment. The OEMs' internationalisation strategies in the Copperbelt showed two patterns. Firstly, there was a considerable amount of trial and error in selecting modes of entry; secondly, there was a progression from direct exports, to working with an agent or setting up a JV, to establishing a subsidiary. The study found that South Africa-based OEMs supported their subsidiaries in multiple ways: back up services, training of local staff in the region and abroad, joint marketing, and access to credit lines. Zambia-based subsidiaries provided aftermarket services, but relied on the South Africa-based OEM for complex services. The OEMs which selected other entry modes, such as agents, JVs and direct exports, provided very little support to upgrade local capabilities in Zambia.

Manufacturing and R&D linkages were weaker for any type of firm. There was very little sub-contracting and for very simple inputs, there was no joint product development and no R&D budget for the Zambian operations. Even in cases where the South Africa-based OEMs cooperated with the mining companies in the Copperbelt to innovate or customise products, there was no significant involvement of local subsidiaries or agents.

Suppliers in the region faced a range of constraints at national level, from poor infrastructure and policy inconsistency in Zambia, to skills constraints and scarce resource for regional marketing in South Africa. At regional level, two constraints stood out: inconsistency between local content policies in South Africa and Zambia, which made it difficult for firms to create a coherent strategy for investment and value addition, and difficult access to the DRC mining supply chain. The DRC was particularly important because Zambia was seen as a sub-regional hub for Central Africa.

The findings of this study suggest that there is significant scope for cooperation at regional level in the mining capital equipment value chain. A regional strategy to increase value addition in South Africa and Zambia should rest on two pillars:

1) Building a regional market across South Africa-Zambian Copperbelt-DRC Copperbelt.
2) Intensifying linkages between South African and Zambian mining inputs clusters.

Zambian and South African suppliers are already using the Copperbelt as a basis to participate in the DRC mining supply chain. OEMs find the DRC too risky to invest in a solid market presence there. The DRC Copperbelt therefore offers an opportunity for Zambian suppliers to acquire larger economies of scale. This in turn implies that South Africa-based OEMs have more incentives to increase the value added content of their activities in the Zambian Copperbelt. This strategy however requires removal of barriers between South Africa, Zambia and the DRC. Such barriers include high transportation costs, and tariffs imposed by the DRC as a non-SADC FTA member. Lowering transportation costs requires regional cooperation in road and railways investment as well as on trade facilitation issues. Zambia and South Africa should facilitate the establishment of bonded warehouses. The latter would allow South Africa-based OEMs to move larger stock of equipment and spares to the Zambian Copperbelt to supply the regional market. It would lower transport costs thanks to bulk transport, and shorten lead times in supplying clients.

Linkages between South Africa-based OEMs and Zambian suppliers played an important role in supporting firm upgrading in the Copperbelt. A regional value chain strategy should leverage on this, and provide incentives to South Africa-based OEMs to build their market presence in the Copperbelt. Elements of this strategy should include cluster initiatives in South Africa and in Zambia to address constraints to firm upgrading, and establishing a regional approach to local content requirements which reduces conflicts in national local content incentives and support a win-win outcome. South African established OEMs and startup companies should be supported by DTI in establishing their Copperbelt subsidiaries and increasing their local value added content. This would be mutually advantageous: OEMs would become more competitive in terms of aftermarket services and lead times, and Zambia would benefit in terms of, among others, employment, skills development, knowledge transfer, and sub-contracting opportunities. On the Zambian side, this strategy requires that local content policies are part and parcel of a broader industrialisation strategy. Multiple stakeholders, in particular the mining companies and the OEMs, need to be involved. Employment localisation requirements need to be complemented by an aggressive skills development strategy through technical and vocation schools and apprenticeship programmes. Particular support should be given to manufacturing companies to become Tier 2 suppliers to the OEMs, even if for simple, low value added components and spares initially. South Africa should have a forward looking policy and support Zambia's strategy in these areas. In the longer term, regional cooperation

could target cooperation in technology innovation and R&D and higher value added activities in South Africa and the Copperbelt.

1 Introduction

This study is part of a research project on regional industrialisation commissioned by South Africa's National Department of Trade and Industry and TIPS and has been undertaken by the Centre for Competition, Regulation and Economic Development (CCRED) - University of Johannesburg.

This study investigates the regional value chain for mining capital equipment in South Africa and Zambia. In particular, it focuses on the following specific research questions:

- What is driving South African Original Equipment Manufacturers (OEMs) competitiveness in the Zambian market?
- Mapping regional linkages: how do South African and other foreign OEMs with a regional presence internationalise in Zambia? What is driving their strategies? What are the implications for Zambia?
- Is the regional supply chain supporting knowledge intensification and local value addition processes in Zambia? How?
- What role do the Engineering, Procurement, Construction and Management (EPCM) firms play in the regional supply chain?
- What are the opportunities to deepen and expand regional linkages?
- What is the role of industrial policy in South Africa and Zambia?

The study is firmly situated within a Global Value Chain (GVC) analytical framework. Developed from the 1990s onwards, GVC literature has focused on changes in the organisation of production of goods and services and on the impact of such changes on developing countries' industrialisation processes. In other words, the literature has sought to understand the globalisation of the world economy, a fast-changing process which began in the 1960s and accelerated in the 1980s, in which geographically dispersed activities have been functionally integrated and organised within complex transnational production networks, inclusive of both visible and invisible trade (Gereffi, 1994). In this respect, understanding linkages between firms and countries becomes important to understand how global value chains arise and change.

Upgrading at the firm, regional and country level is critical to allow firms and regions to move into more sustainable, remunerative stages of the global value chain (Kaplinsky and Morris, 2001). Upgrading should be understood as improvements in the production process, for example through re-organisation of the production systems or new technologies (process upgrading); moving into higher more sophisticated product lines (product upgrading); moving into higher-skills content functions (functional upgrading), and moving into new production activities (inter-sectoral or chain upgrading) (Humphrey and Schmitz, 2002).

A fundamental proposition of GVC research is that opportunities for upgrading are shaped by the characteristics of the sector (technological intensity, product cycle, entry barriers, etc), by the industrial strategies of developing and industrialised countries and by value chain governance by lead firms (Bair, 2009). Value chain governance becomes an important analytical tool to understand how global value chains operate: the nature of linkages and how they are governed opens up or shuts down specific opportunities for growth and upgrading to firms and countries. Gereffi (1994; 1999) identified two types of governance structures: *producer-driven* and *buyer-driven* value chains. In producer-driven value chains, manufacturers controlled the organisation of the value chain, backwards, with large networks of components suppliers, and forward, into distribution and retail. These value chains were found in capital- and technology- intensive industries, such as automobiles and computers. Buyer-driven value chains, typical of labour-intensive, consumer goods industries, were dominated by retailers and trading companies, which coordinated vast, decentralised production and trade networks, largely based in low-cost developing countries. Whilst in

producer-driven value chains, profits were generated by economies of scale and R&D, in buyer-driven value chains, these accrued from design and marketing activities that met the demand of fast-changing consumer markets. Whilst this dichotomy is somehow dated, as new and more complex relationships between firms have emerged, the governance function exerted by lead firms in a GVC remains important for analytical purposes: deciding what is to be produced, selecting participants in the value chain and determining their roles, determining how to handle the flow of products and services along the chain, setting key performance standards, monitoring and, in case of failure, sanctioning or assisting suppliers. The lead firms' strategies not only determine how value and rent is distributed in the GVC, but also whether the upgrading process of suppliers will be supported.

With few exceptions (Bridge, 2008; Fessehaie, 2012; Morris et al., 2011), the GVC for extractive industries remain under-researched. Hence, this study on the mining capital equipment value chain in South Africa and Zambia contributes to the empirical literature on GVC on extractive industries.

The study is divided in two sections. Section one provides a background on the global and regional value chains for mining capital equipment and draws on literature review (academic publications as well as grey literature) and analysis of trade and industry data. In particular, chapter two discusses the dynamics of the global value chain for mining capital equipment, while chapter three turns to its regional dimension, including analysing trade flows between the two countries, and a preliminary mapping of inter-firm linkages across the two countries. Chapter four presents the policy frameworks concerning upstream linkage development in South Africa and Zambia.

Section two is based on interview data and presents the findings of the study. In particular, chapter six analyses issues related to entry into the supply chain, value addition and firm upgrading. In chapter seven, the study turns to the competitiveness of South Africa and Zambia-based supply firms and the dynamics which will shape tomorrow's firm competitiveness. Chapter eight focuses on intra-regional linkages, in particular looking at the internationalisation strategies of South Africa-based OEMs in the Copperbelt province, their relationships with Zambia-based suppliers and the impact on local value addition and knowledge intensification in Zambia. Chapter nine discusses national and regional level constraints faced by mining suppliers. Chapter ten concludes and elaborates on the policy implications.

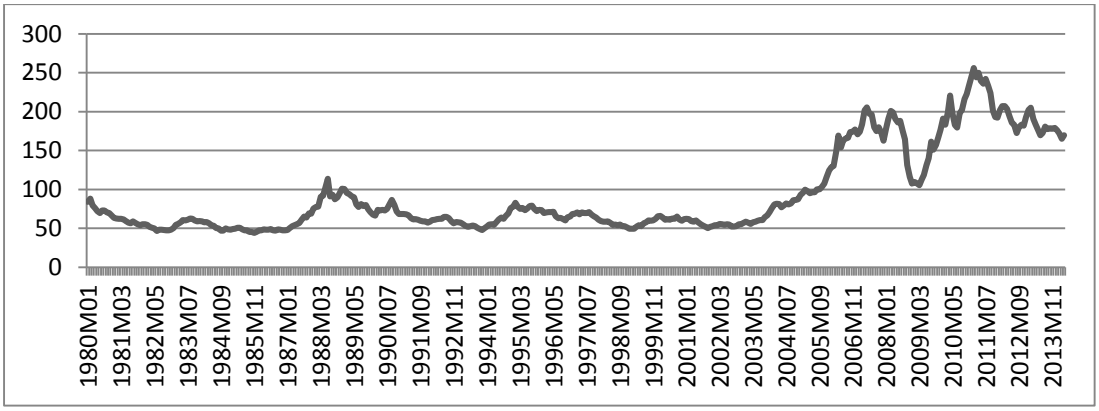
SECTION 1: BACKGROUND

2 The global mining value chain

2.1 Global context

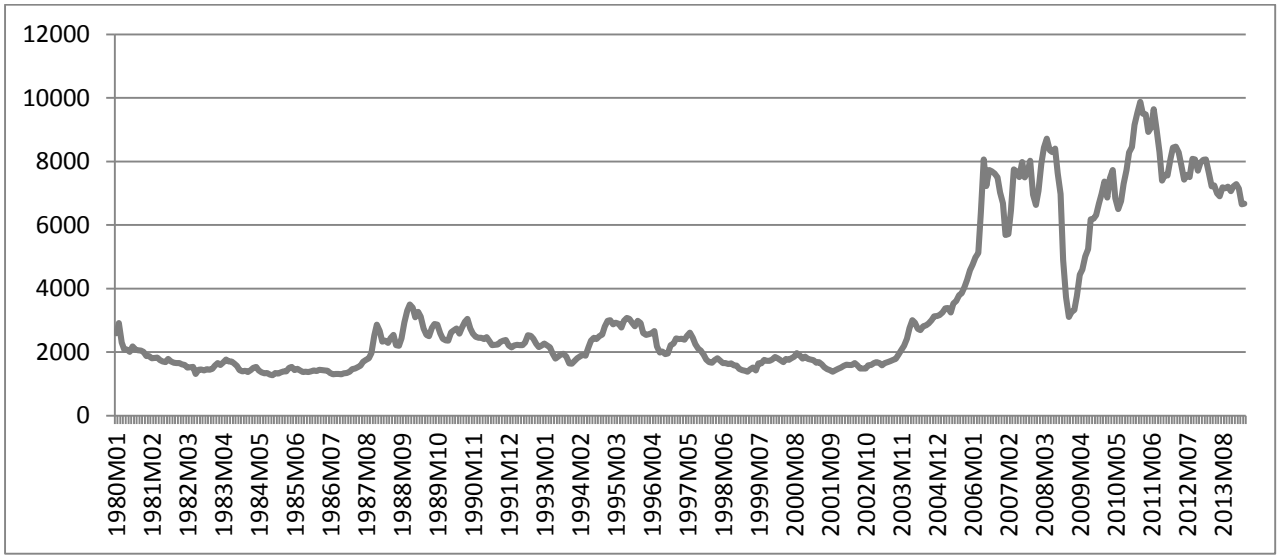
The price boom for mineral and energy commodities in the early 2000s has underlined major changes in the global mining industry. Following a decade of relatively depressed prices in the 1990s, 2003 marked the beginning of a steep rise in world prices. Between 2003 and 2007, the IMF metals price index trebled from 61 to 183 (Figure 1). The price crisis between the last quarter of 2008 and the first quarter of 2009 was short-lived, and by 2010, metal prices had recovered above pre-crisis levels. Since 2012, world prices have weakened but are still substantially above the 1990s annual averages. Turning to a metal of particular importance to this case study, copper, Figure 2 shows the LME spot price since the 1980s. Copper prices followed the general pattern discussed above, with a surge from 1,779 US$/t in 2003, to 7,132 US$/t in 2007. Even after 2009, world prices did not fall below 7,000 US$/t. The world copper market experienced the lowest price volatility and one of the highest price surges amongst hard commodities.

Figure 1: IMF Metals price index, Jan 1980-April 2014



Note. Index based on 2005 (average of 2005 = 100). Group indices are weighted averages of individual commodity price indices. Source: IMF Primary Commodity Price Data retrieved from http://www.imf.org/external/np/res/commod/index.aspx in May 2014.

Figure 2: Copper prices, Jan 1980-April 2014



Note: Copper, grade A cathode, LME spot price, CIF European ports, US$ per metric ton. Source: IMF Primary Commodity Price Data retrieved from http://www.imf.org/external/np/res/commod/index.aspx in May 2014.

The hard commodity price boom has spurred an investment surge in Africa's extractive industries, which has prompted significant debate among African policy makers on the role of their extractive industries in promoting broader-based economic development. This led, among other initiatives, to the adoption of the Africa Mining Vision in 2009. Within this context, upstream linkage development strategies are seen as increasingly attractive platforms to promote industrialisation. Policy makers and researchers are interested in understanding the extent to which TNCs procure locally manufactured capital goods, consumables and inputs, and on strategies to increase local value added content. The regional dimension of upstream linkage development then becomes critical. In the Southern African region, harnessing regional value chains offer the opportunity to develop complementary industrial capabilities, promote technology and skills transfer, and create integrated markets which provide the economies of scale and scope required for a thriving manufacturing sector.

2.2 Market dynamics in mining capital equipment

The mining value chain requires a broad range of capital equipment, with variations according to stage of mining operation (exploration, mine development, extraction, processing), type of mining (open pit/underground) and mineral (Table 1).

Table 1: Capital equipment requirements across the mining value chain

Stage of the GVC/ Type of mine	Capital equipment
Exploration	Exploration drilling equipment
Development	Development drills and rigs Shafts Loaders, trucks Electrical equipment Pneumatic and hydraulic equipment
Open-pit mining	Drills and rigs Conveyors Excavators

	Loaders, trucks, trains Rolling stock Draglines Hoists, winders, cages Coal cutters Power shovels Wall and roof bolting systems
Underground mining	Drilling equipment Bulk materials handling (conveyors, locomotives, scrapers) Pumps and valves Head gear (motors, chains, cables) Ventilation equipment
Minerals processing	Crushing and grinding equipment, storage tanks, chemicals and reagents, liquid-solid separation equipment, materials handling (conveyors, pumps) Crushers, screens, mill balls Grinders, rollers Storage tanks Materials handling (conveyors, pumps) Agitators Power generation systems Tanks Vessels Silos, bins
Smelting	Furnaces Dryers Refractories Classifiers, thickeners Mixers, filters flotation tanks, washers, scrubbers Separators Dewatering systems, water purification systems Pumps Electronic process control systems
Refining	Thickeners Conveyor belts Filters Tanks Dryers

Source: Various sources

While most of South Africa's output originates from underground mining, Zambia's mines are both open pit and underground. Underground mining is more expensive than open pit mining hence expenditures on capital equipment are higher. Moreover, the share of mining equipment in total CAPEX if often higher in underground mines, in coal mining for example this share doubles compared to open pit (Virgo, Armstrong and Alftan, 2013).

In GVC analysis, studying market requirements is important to understand what makes some firms more competitive than others and how industrial policies should be designed in order to promote value chain upgrading. Market requirements are defined as critical success factors (CSFs), which are sub-categorised as order-qualifying and order-winning criteria (Kaplinsky and Morris, 2001). "Qualifiers are those criteria that a company must meet for a customer to even consider it as a possible supplier" (Hill, 2000, p. 36), whilst order-winner criteria make it possible for suppliers to succeed by out-performing the competition, maintaining market share and growing. Both sets of criteria are market and time specific (Kaplinsky and Morris, 2001).

As a general trend, global mining houses have been under pressure to reduce costs and increase productivity. In order to do that, they have rationalised their supply chains by reducing the number of suppliers and developing more intense buyer-supplier relationships with fewer, more capable suppliers. With these suppliers, which tend to be OEMs and technology suppliers with a global reach, the mining companies have stipulated alliances which assist them in finding solutions to their mining requirements across different environments. The mining companies' procurement strategies focus on Total Cost of Ownership (TCO) that is inclusive of capital, maintenance and operational expenses. As a result, Original Equipment Manufacturers (OEMs) face the following order-qualifying CSFs: cost competitiveness, product quality to ensure durability and performance, quality of after-market products and services, and lead times.

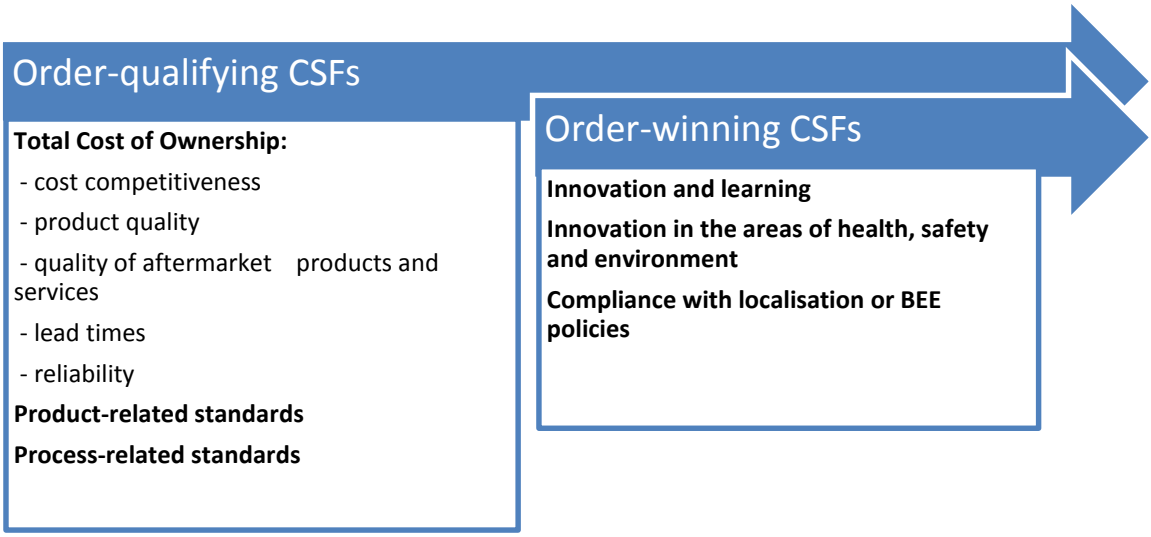
Because suppliers are expected to provide 'solutions' to increase productivity of the mining operations, rather than merely sell products, firm dynamic capabilities in terms of innovation and learning have become order-winning CSFs. Moreover the mining houses are under pressure to improve the health, safety and environmental conditions of their operations. Hence, competition among suppliers focuses on innovations to make safer equipment, including solutions for autonomous operations, and energy saving and environmentally friendly equipment and processes.

International standards, both mandatory and voluntary, have been found to be important in other GVCs in determining entry barriers for local suppliers and their competitiveness in global markets. In critical supply links such as mining capital equipment, ISO certification for the products is often a requirement. Compliance with process-related standards in terms of quality assurance, environmental and occupational health and safety management systems is also required in most instances. The relevant international standards are ISO 9001.2008, concerning quality management standards; ISO 14001.2004, concerning environmental management; OHSAS 18001 concerning occupational health and safety management.

The capital equipment market is also influenced by non-market parameters, such as local content policies. In Zambia, the local content provisions in the Development Agreements (see chapter 4.1) have been barely enforced. There has been however political pressure to grant some level of market access to small local businesses which has influenced to some extent the sourcing decisions of some mining houses. This however has had little impact on the procurement of high cost, critical supplies such as most capital equipment. In South Africa, the mining houses have to comply with the Mining Charter requirement to give B-BBEE companies preferred supplier status, but a review in 2009 showed very little progress in this respect.

Figure 3 summarises at the conceptual level the CSFs for the capital equipment supply chain. In section two of this study, the interview data has been analysed to corroborate whether these CSFs were aligned to those of buyers in South Africa and Zambia.

Figure 3: Conceptualisation of Critical Success Factors in the mining capital equipment supply chain



Source. Author's analysis

The mining capital equipment industry is characterised by the increasing importance of three strategic factors: technological innovation, aftermarket segment, and mergers and acquisitions.

Technological innovation

As the mining houses focus on their core business, equipment manufacturers have become the key source of innovation in the industry, mainly in the form of incremental product innovation (Bartos, 2007). Investment in R&D is dominated by OEMs and engineering firms, public institutions and various private-public partnerships, rather than the mining houses (Walker and Minnitt, 2006).

Therefore global OEMs allocate very large budgets to R&D.[2] Moreover, they have internationalised their R&D activities across the globe in order acquire new technological capabilities and to tap into local knowledge.[3] OEMs R&D target energy efficiency, enhanced operational productivity, increased worker safety and health, and lower environmental impact, often in cooperation with the largest mining conglomerates.

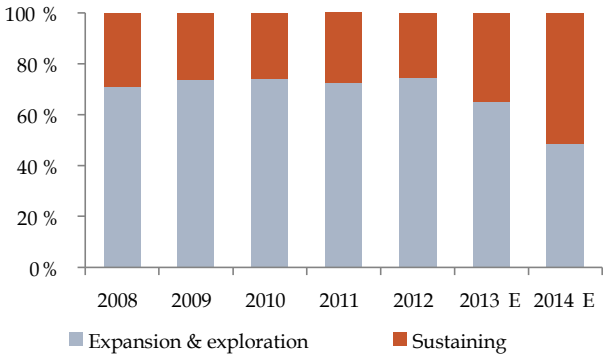
[2] Sandvik invests over US$ 400 million each year in R&D and quality assurance and employs 2,700 people in this area. It has 8,000 patents and intellectual property rights. Atlas Copco spends more than 2% of revenues on R&D; in 2012 this amounted to more than US$ 300 million. There are around 2,500 employees conducting research, design and development. Caterpillar invested around US$ 2 billion in R&D in 2013, employs more than 8,000 engineers holds more than 4,000 active patents (Company Reports 2012).

[3] Sandvik's largest R&D centres are based in Finland, Austria, Germany, the UK and the US, but it has opened new centres in India and China. Atlas Copco has also expanded its R&D hubs beyond Sweden and Europe into India, China, Brazil, and North America. Caterpillar has research centres in the US, Japan, China and India.

After-market sales

2012 estimates of the value of greenfield projects put them at US$ 124 billion, of which US$20 billion worth of underground mining project (RMG and Parker Bay Mining, 2012). Increasing greenfield, brownfield and Stay-in-business (SIB) investment will drive aftermarket sales (Virgo, Armstrong and Alftan, 2013). The CAPEX component of SIB investment is bound to increase because there are larger equipment fleets purchased in previous periods of expansion – a 30% CAGR in CAPEX in the 2009-2012 period.

Figure 4: Mining CAPEX composition, 2008-2014



Source. Virgo, Armstrong and Alftan, 2013

Table 2 compares the SIB expenditures/initial capital investment ratio per unit for a range of capital equipment items.[4] These figures provide a snapshot of the size of after-market revenues compared to the initial capital cost of the equipment. Processing plants offer overall the highest aftermarket opportunities in particular for grinding mills, cyclones and pumps (because of large numbers of units installed) and crushing plants. In mining, LHDs and continuous mining machines have the highest SIB/initial capital ratio.

Table 2: Mining and processing operations: SIB capital vs. initial capital

Mining equipment	Initial	Total SIB	Ratio SIB:initial	Processing equipment	Initial	Total SIB	Ratio SIB:initial
Underground loaders (LHDs)	1.9	27.0	14 :1	Grinding mill, rod & ball	5.5	197.6	35 :1
Shovels, hydraulic	15.9	179.3	11 :1	Cone crushers	4.0	65.0	16 :1
Continuous miners, u/ground	3.2	35.9	11 :1	Mobile crushing plants	1.2	17.7	15 :1
Roof bolters	1.4	16.5	11 :1	Gyratory crushers	13.0	170.0	13 :1

[4] Assumptions as follows: SIB capital calculated as sustaining capital cost and operating capital cost on a per unit basis. Mining operations of 350-360 days per year, two shifts of 12 hours each, with 80% utilisation rates and 85% equipment availability, resulting in c5,700 hours of operation per year, or 171,000 over a 30-year LoM. Processing operations of 365 days per year, two shifts of 12 hours each, 90% utilisation rates and 95% equipment availability, resulting in c7,500 hours per year and c225,000 hours over a 30-year LoM.

Tunnel boring machines	19.0	210.9	11 :1	Grinding mill, SAG	13.5	181.7	13 :1
Rotary blasthole drill rigs	3.0	30.3	10 :1	Stackers, conveyor	20.5	120.4	5 :1
Continuous miners, surface	4.9	49.7	10 :1	Mill drives, gearless	18.8	97.0	5 :1
Backhoes, hydraulic	17.0	164.9	9 :1		$, 000s		
Bucketwheel excavators	7.1	56.1	7 :1	Cyclones	26	1.0	39 :1
Wheel loaders	7.7	58.9	7 :1	Slurry pumps	84	2.1	25 :1
Shovels, cable	23.0	127.5	5 :1	Electric motors	185	3.6	19 :1
Underground ore & coal haulers	1.6	8.4	5 :1	Screens	403	5.4	13 :1
Draglines, crawler	5.5	24.5	4 :1				
Trucks, rear-dump (40t-400t)	6.5	29.6	4 :1				
Draglines, walking	184.5	523.5	2 :1				

Source. Virgo, Armstrong and Alftan, 2013

Mergers and acquisitions

The mining capital equipment industry is highly concentrated, with few players dominating several product markets at global level. For example, Sandvik, Atlas Copco, and Caterpillar dominate the market for Load Haul Dumps (LHDs), trucks, drills and bolters (RMG and Parker Bay, 2012).[5]

Global OEMs have pursued M&As as an avenue to acquire new intellectual property and innovation capabilities, expand their range of products, complement their pre-existing offering, access regional markets and reduce competition. This is illustrated by the examples of Atlas Copco's significant market presence in North America, through the acquisition of US-based Wagner, and Caterpillar market presence in Australia through the acquisition of Elphinstone.

3 The regional value chain for mining capital equipment

3.1 Historical profile of the mining inputs clusters

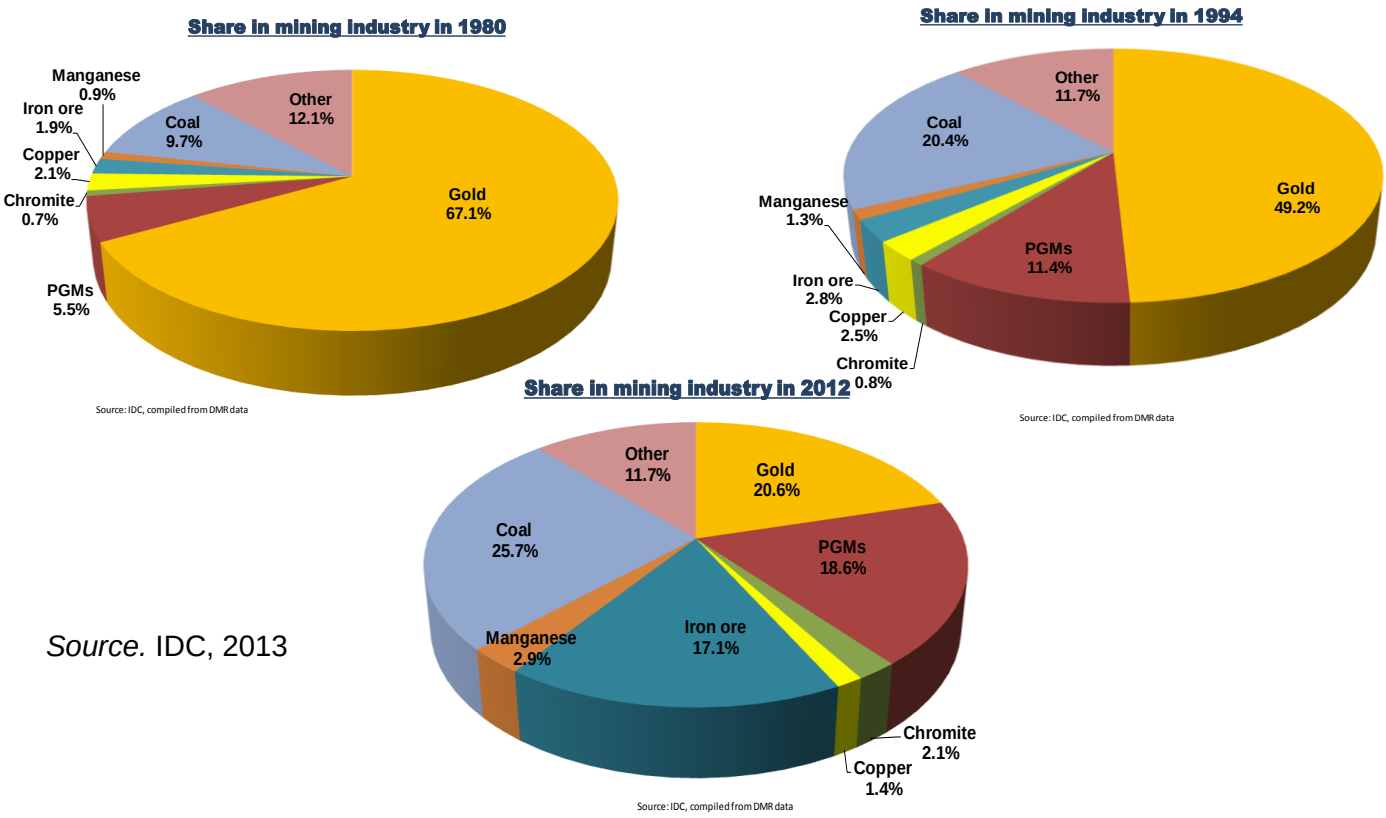
South Africa is the mining supply hub for Southern Africa. Its mining inputs cluster has over time developed high levels of technological competencies and in some areas has become globally competitive. This has been the result of a relatively long history of mining, during

[5] Other important global players in mining and processing equipment are Furukawa (underground and surface drilling equipment), Joy Global (open-pit mining equipment), Komatsu (mining extraction and haulage equipment), Boart Longyear (underground and exploration drilling equipment, rock drilling tools), Metso (grinding mills), Weir Minerals (pumps and liners), Outotec and FLSmidth (grinding mills).

which suppliers had to find innovative solutions to the geological and metallurgical challenges of hard rock, deep level mining which characterised the South African mines. Such innovative efforts were driven by the Chamber of Mines Research Organisation (COMRO), which undertook significant levels of 'blue sky' R&D. A very dynamic national system of innovation (NSI), with strong linkages between mining companies, suppliers, research centres, universities and technical and artisanal schools, underpinned the cluster. Intense cooperation was accompanied by fierce competition at the supplier level.

The gold sector spurred the initial technological innovations in mineral processing (dry versus wet crushing, outside versus inside amalgamation, chlorination versus cyanidation, and electrolytic versus zinc precipitation), and deep mining (rock mechanics, shaft sinking, refrigeration, ventilation, pumping and hoisting systems, drilling and blasting) (Walker and Minnitt, 2006). With the decline of gold in South Africa's mining sector, supplier firms' technological capabilities subsequently migrated to other mineral commodities, such as coal and chrome, and more recently to PGMs.

Figure 5: South Africa's composition of mining industry, selected years (%)

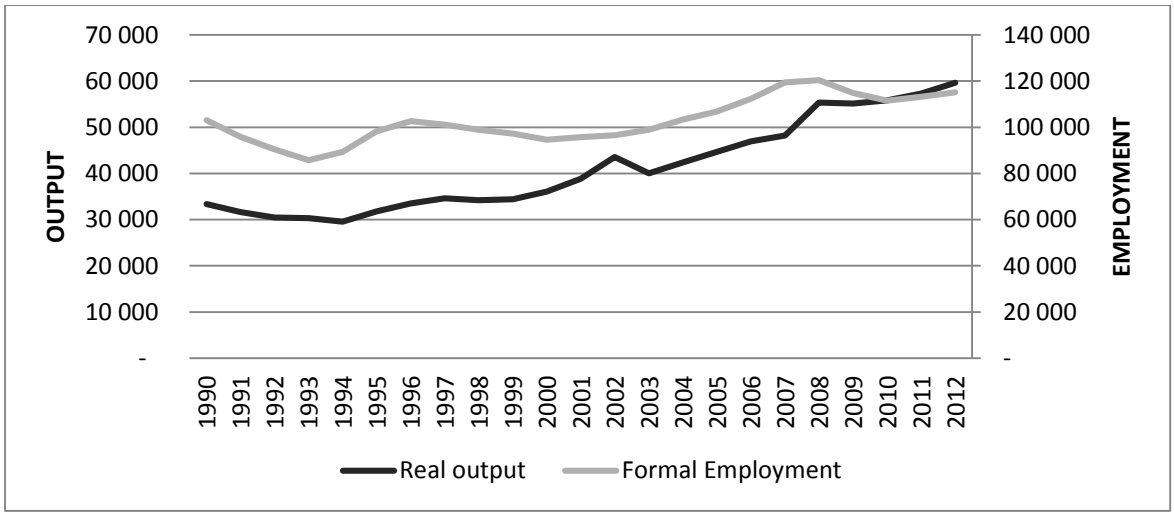


Source. IDC, 2013

After 1994, domestic demand for mining inputs rose but trade and investment liberalisation increased stiffened competition for the local supply cluster. South Africa witnessed a decline of the NSI, with the demise of COMRO, which was first moved within government and then saw its research capacity undercut (Altman, 2007). The result has been a considerable reduction in the level of sectoral R&D undertaken domestically, and a shift from long-term, 'blue sky' R&D and pure innovation to short-term product development (Walker and Minnitt, 2006). While South Africa retains a comparative advantage in mining-related innovation, the declining NSI is eroding its capacity to sustain such competitiveness in the future (Kaplan, 2011).

In 2012, real output for the South African machinery and equipment sub-sector reached R 60 billion, after a decade of significant growth which slowed down in 2009-2010 (Figure 6). Employment levels, which had been growing since 2000 and reached a peak of 120,000 employees in 2008, declined in 2009-2010 but have been slowing recovering. Mining absorbs around 17% of machinery and equipment output. Mining capital goods are the most dynamic section of the capital goods sector and represent more than 50% of total capital goods exports (Kuriakose, Kaplan, and Tuomi, 2011). Mining machinery, in particular, is the tenth highest manufacturing export sector (IDC, 2013).

Figure 6: South Africa's machinery and equipment sub-sector: Real output (R million) and formal employment, 1970-2012



Notes. Output at constant 2005 prices. Quantec data is modelled data and not census or survey data hence it may not provide a completely accurate picture. *Source.* Quantec Database. Retrieved from http://www.quantec.co.za/ (February 2014)

The areas of excellence for South Africa's inputs cluster include: mine design and development, construction and structural engineering, ventilation and cooling, contract mining, shaft sinking, mineral processing, tailings treatment, process control, metallurgical testing, smelting and refining, niche systems and components (hoisting, winding, hydropower drills, filters, pumps, pinch valves) and strategic consumables (cement, shotcrete, explosives, grinding balls) (Lydall, 2009).

Notwithstanding a relatively long history of mining also in Zambia, its inputs cluster followed a very different trajectory from South Africa's one. Following the nationalisation of mining assets by the Zambian government in 1969, upstream linkage development became a critical component of Zambia's industrialisation strategy (Fessehaie, 2012). This was pursued through a combination of direct state ownership of some large-scale supply firms, preferential procurement from the state-owned Zambia Consolidated Copper Mines (ZCCM), import substitution industrialisation and intense linkages between ZCCM, its suppliers and public research and training institutions. These policies were partially successful: they supported the development of a thriving manufacturing sector populated by large state-owned entities, family-run businesses established by European and Indian migrants, and OEM subsidiaries, such as Chloride (batteries), Dunlop (tires) and Boart Longyear (drilling equipment). Unlike South Africa, nevertheless, the Zambian inputs cluster did not find niche markets where it operated at the global technological frontier.

In the 1990s, Zambia privatised its mining assets and adopted swift trade and investment liberalisation measures as part of its Structural Adjustment Programme. The ownership structure of Zambia's copper sector became more heterogeneous, with the entry of mining

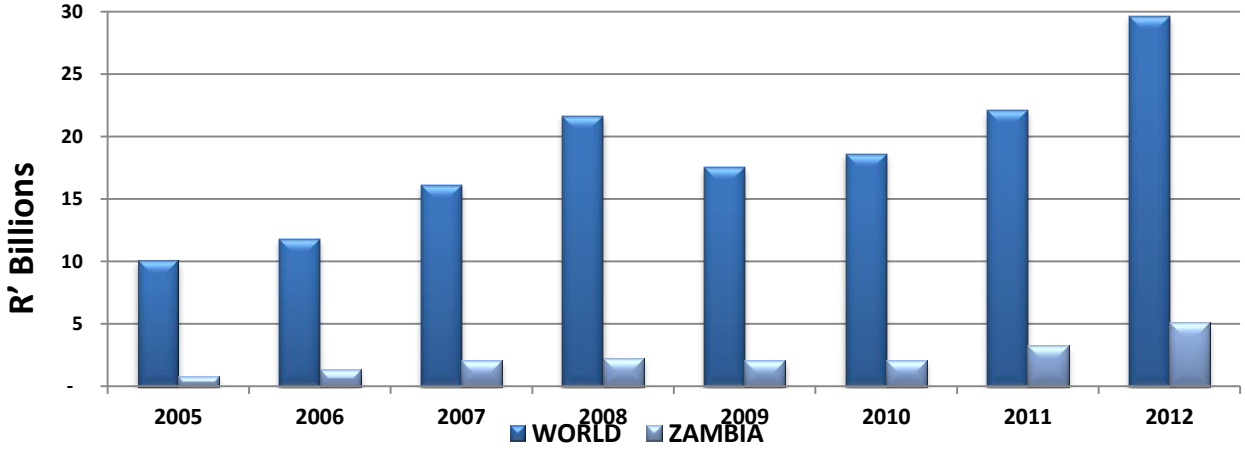
houses from Canada, Europe, Australia as well as China and India (Fessehaie, 2013; Haglund, 2010).[6] South Africa was involved in Zambia's copper mining sector with two mining companies, Anglo American until 2002, and Metorex Limited until 2011.[7]

In this new economic environment, supplier firms were faced with a two-fold challenge: on the one hand, past protectionist policies were dismantled very quickly with little time for suppliers to adjust, and on the other hand, the mining companies, freed from preferential procurement requirements, relied on a global network of suppliers (Fessehaie, 2012). Some local firms have been able to seize the opportunities of a larger customer base by upgrading their products and processes, expanding capacity, and specialising. Overall, nevertheless this process has been very selective, a large part of Zambia's manufacturing capacity was lost and many firms exited the mining value chain. In their place, a fast-growing number of importers have emerged, comprising specialized, value-added service providers, as well as ad hoc traders.

3.2 South Africa- Zambia trade flows

According to South Africa Capital Equipment Exports Council (SACEEC) data, South Africa's exports of mining capital equipment increased from R 10 billion in 2005 to R 29 billion in 2010 (Figure 7). In 2013, exports of mining capital equipment reached R32 billion. The region, in particular Zambia followed by Zimbabwe, Mozambique and DRC, is the largest market for South Africa's mining capital equipment exports (Table 3). Zambia's importance for South African exporters has grown over the years: the percentage of South Africa's mining capital equipment exports destined to the Zambian market doubled from 8% in 2005 to 17% in 2012 (Figure 7).

Figure 7: South Africa's capital equipment exports to the world and Zambia, 2005-2012



Source. SACEEC (2013)

[6] NFCA from China, in particular, although relatively small in terms of copper output, has been fast-growing and has invested in the Chambishi Zambia-China Economic and Trade Cooperation Zone (ZCCZ), a US$ 800 million-worth investment, inclusive of the Chambishi Copper Smelter, acid plants, as well as a copper semi-fabricates manufacturing plant.

[7] Zambian-based suppliers had developed good supplier/buyer relationships with both AA and Metorex (Fessehaie, 2012). Both mining companies had developed trust-based relationships with local suppliers. In particular AA was involved in cooperation on quality management and joint product development, adopted practices such as open books accounting and open door policies, and promoted linkages between South African manufacturers and local firms. AA also set up the first supplier development programme in the Copperbelt.

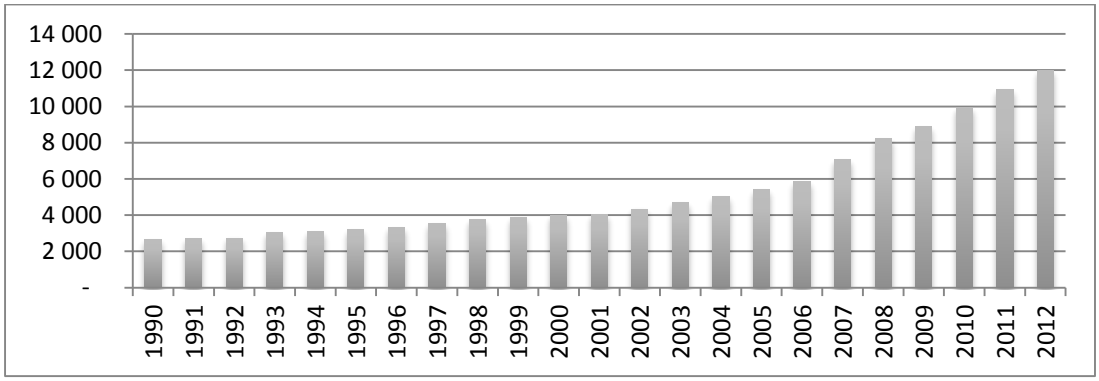
Table 3: Top ten export markets for South Africa's mining capital equipment industry, 2012 (R and %)

Export market	Export values	% of total mining capital equipment exports
Zambia	5,129,921,654	17%
DRC	3,923,324,693	13%
Mozambique	2,710,415,460	9%
Zimbabwe	2,678,387,481	9%
United States	1,466,979,403	5%
Australia	1,354,402,795	5%
Tanzania	829,451,707	3%
Germany	781,831,748	3%
Angola	748,637,887	3%
Ghana	694,512,135	2%

Source. SACEEC (2013)

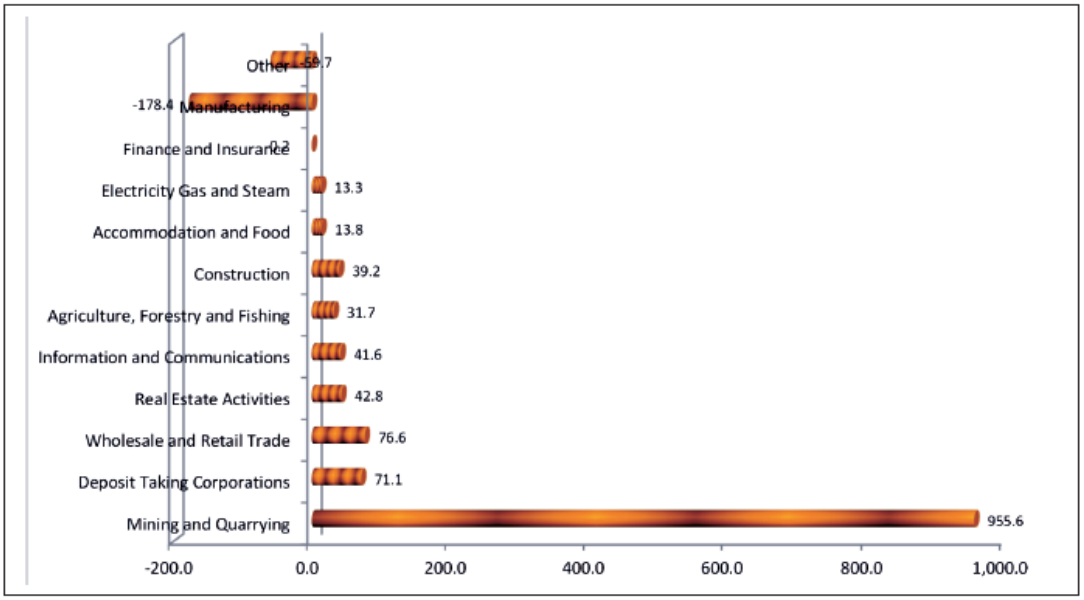
The mining sector has been driving Zambia's imports of capital equipment. Within a decade, the mining industry invested very high levels of CAPEX to re-capitalise the mining assets and complete greenfield projects (Lumwana Mines). Whilst annual copper output fell from 750,000 tonnes in 1973 to 257,000 tonnes in 2000 (Chamber of Mines, 2005), by 2011, copper exports amounted to more than 600,000 tonnes. As shown in Figure 8, FDI stock into Zambia increased from approx. US$ 4 billion in 2000 to US$ 12 billion in 2012. The mining sector has absorbed the lion's share of Zambia's inward FDI (Bank of Zambia, 2012). In 2011, mining received US$ 955.6 million in FDI flows, that is 86.2% of total FDI that year (see Figure 9), bringing the total of FDI stock into the mining sector to US$ 7.8 billion. In comparison, FDI stock into the manufacturing sector was only US$ 805.7 million in 2011.

Figure 8: Zambia's inward FDI stock (1990-2012, US$ millions)



Source. UNCTADSTAT database retrieved from http://unctad.org/en/pages/Statistics.aspx in May 2014. Note: US$ at current prices and current exchange rates

Figure 9: Sectoral distribution of Zambia's inward FDI flows, 2011



Source. Bank of Zambia, 2012

South Africa is Zambia's main source of imports for mining capital equipment. According to COMTRADE data,[8] Zambia's top imports of mining capital equipment from South Africa consist of the following: structures, diesel powered trucks with a gross vehicle weight not exceeding five tonnes, dump trucks, parts of mineral processing equipment (sorting, screening, mixing crushing, grinding, washing and agglomerating machineries), parts of cranes, work-trucks, shovels, and other construction machinery, self-propelled excavating machinery, pumps and parts.

In terms of capital equipment, four clusters of products have been identified for in-depth analysis in section two of this study: 1. mineral processing equipment; 2. off-road specialised equipment; 3. pumps and valves; and 4. conveyor systems. These product clusters feature among the top Zambian imports from South Africa, and existing literature and anecdotal evidence suggest that South African firms are globally competitive and have developed high levels of in-house technological capabilities.

Tables 4 to 6 show the export performance of South Africa in the Zambian market and globally in relation to the four product clusters during the period 2006-2013. Among the four product clusters, mineral processing equipment[9] shows the highest growth rate in terms of absolute export values: exports to Zambia rose from US$ 24.8 million to US$ 84.5 million in the seven years period. The aftermarket business is very important, parts accounted for ¾ of total sales to Zambia in 2013, and increased, following the expansion of installed plants, from US$ 18 million in 2006 to US$ 64 million in 2013. Zambia absorbed on average 16% of South African exports, but these have grown faster than South African exports to the rest of the world (241% vs 106% between 2006 and 2013). This reflects South Africa's competitiveness in Zambia, where its market share averaged almost 40%, and grew at an annual average of 19%.

[8] COMTRADE data have been collected at the HS 6 digit level. For specific tariff lines, COMTRADE data may overestimate trade values compared to SACEEC data, which have been collected at the HS 8 digit level.

[9] All products under heading HS 8474 'Machinery for sorting, screening, washing, agglomerating, shaping mineral products'.

Table 4: Zambia's import from South Africa in selected product clusters, US$ '000

Product Cluster	2006	2007	2008	2009	2010	2011	2012	2013
Mineral Processing	24,773	53,780	57,563	38,733	42,906	80,135	71,191	84,548
Off-road special vehicles	64,486	77,129	99,149	46,113	87,811	116,397	195,671	157,562
Pumps and Valves	33,979	46,691	47,492	38,443	57,003	74,362	68,524	77,588
Conveyor systems	5,418	7,491	8,759	5,464	6,549	13,411	9,905	17,599

Source. COMTRADE database, retrieved from http://comtrade.un.org/ in July 2014.

Table 5: South Africa's market share in Zambia for selected product clusters (%)

Product Cluster	2006	2007	2008	2009	2010	2011	2012	2013
Mineral Processing	14.7%	27.0%	52.4%	49.5%	44.5%	40.5%	50.1%	28.2%
Off-road special vehicles	60.6%	69.3%	63.3%	57.3%	68.0%	50.6%	61.3%	57.4%
Pumps and Valves	79.6%	79.0%	72.0%	79.0%	79.4%	73.3%	65.8%	58.0%
Conveyor systems	68.5%	65.2%	65.4%	63.3%	66.3%	59.2%	60.8%	70.0%

Source. COMTRADE database, retrieved from http://comtrade.un.org/ in July 2014.

Table 6: South Africa's exports to the rest of the world for selected product clusters (US$ '000)

Product Cluster	2006	2007	2008	2009	2010	2011	2012	2013
Mineral Processing	212,207	222,968	276,085	214,740	289,501	327,603	405,354	436,408
Off-road special vehicles	886,508	1,085,221	1,343,517	668,225	939,873	1,414,818	2,229,855	2,364,936
Pumps and Valves	97,240	135,294	171,949	182,893	195,262	259,117	331,966	348,531
Conveyor systems	35,479	50,141	43,214	28,280	49,469	67,566	74,953	101,719

Notes. South Africa's mining capital equipment total exports minus exports to Zambia. *Source.* COMTRADE database, retrieved from http://comtrade.un.org/ in July 2014.

South Africa's exports of off-road special vehicles[10] are dominated by two products: diesel powered trucks (HS870421) and dump trucks (HS870410). South Africa's exports to Zambia grew from US$ 64.5 million in 2006 to US$ 157.6 million in 2013. South Africa's market share in Zambia is very significant and has been relatively stable, 61% on average and a 10% annual

[10] Products under headings HS 870421 'Diesel powered trucks with a GVW not exceeding five tonnes' and HS 870410 'Dump trucks designed for off-highway use'.

growth rate on average in the period under examination. Zambia is however a relatively small destination market, on average only 7% of South African exports reach Zambia, and exports to the rest of the world have grown faster than exports to Zambia (167% vs 144% between 2006 and 2013).

South Africa's exports of pumps and valves[11] grew from US$34 million in 2006 to US$ 77.6 million in 2013 (on average pumps made over 4/5 of the total value). Aftermarket sales are an important part of the pumps business, indeed spares accounted on average for 45% of pumps sales to Zambia in the period under examination. Whilst Zambia absorbs on average 21% of South Africa's exports of pumps and valves, South Africa's market share in Zambia has decreased (-4% on average per year), from almost 80% in 2006 to 58% in 2013, and exports to the rest of the world have grown faster than to Zambia (258% vs 128% between 2006 and 2013).

Exports of conveyor systems[12] increased three-fold between 2006 and 2013, from US$ 5.4 million to US$ 17.6 million. South Africa's market share in Zambia has remained relatively steady, on average 65% during the period under examination. Whilst Zambia absorbs on average only 14% of South African conveyor systems exports, exports to Zambia have grown faster than to the rest of the world (225% vs 187% between 2006 and 2013).

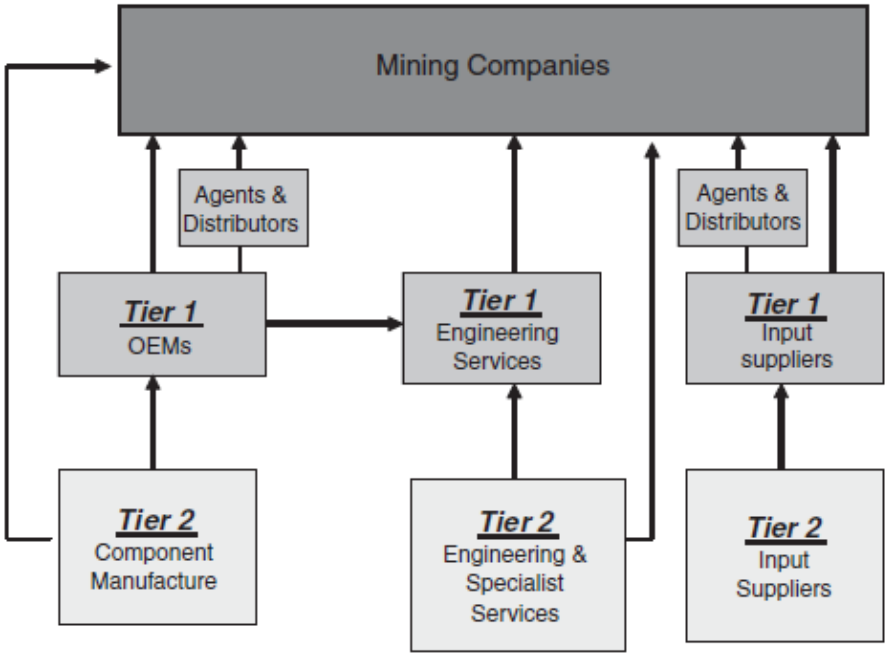
3.3 Mapping the regional supply chain

The mining supply chain is sketched in Figure 10. Mining companies can source capital equipment directly from OEMs, or indirectly through their agents and distributors. In South Africa, there are both South African and international OEMs. OEMs are the main source of borehole drilling, radar processing, remote sensing, geological assaying, drilling consumables and replacement items, opencast and underground bulk materials handling and haulage equipment, electrical equipment, comminution (crushers, mills, cyclones) and concentration equipment (flotation cells, filters, pumps), metallurgical testing, chemicals and reagents, driers, converting equipment, smelting and tapping equipment, environmental/gas-treatment and refining equipment (Lydall, 2009). South Africa also has a relatively well developed network of Tier 2 suppliers of standard (idlers, cables) or specialised components (hoisting hooks, valves) and foundries, with varying degrees of competitiveness. The largest OEMs operate in Zambia through subsidiaries: it is estimated that up to 80% of capital equipment is procured by the mining houses via local subsidiaries (Kasanga, 2012).

[11] Products under the following headings: HS 848180 'Taps, cocks, valves and similar appliances, nes'; HS 848190 'Parts of taps, cocks, valves or similar appliances'; HS 841391 'Parts of pumps for liquid whether or not fitted with a measuring device'; HS 841381 'Pumps nes'; HS 841370 'Centrifugal pumps nes'

[12] Products under the following headings: HS 401011 'Conveyor belt metal reinforced vulcanised rubber'; HS 401012 'Conveyor belt textile reinforced vulcanised rubber'; HS 401019 'Conveyor belts of vulcanised rubber nes'; HS 591000 'Transmission or conveyor belts or belting of textile material'; HS 842320 'Scales for continuous weighing of goods on conveyors'; HS 842820 'Pneumatic elevators and conveyors'; HS 842820 Pneumatic elevators and conveyors; 'HS 842831 'Continuous action elevators/conveyors f goods/mat spec design f u/grd nes'; HS 842833 'Continuous action elevators/conveyors for goods/mat, belt type nes'; HS 842839 'Continuous action elevators/conveyors for goods/mat nes'; HS 842890 'Lifting, handling, loading or unloading machinery nes'

Figure 10: Regional mining supply chain



Source. Walker and Minnitt (2006)

Consumables suppliers include manufacturers and/or distributors of explosives, reagents, chemicals and fuel. In this category, Zambia has some manufacturing capacity: local firms produce galvanized pipes, PVC products, engineering bolts and nuts, metal fabrication, rubber lining services, and personal protection equipment (Kasanga, 2012). The largest number of firms based in the Copperbelt however consists of agents and distributors. Whilst some agents provide value added services such as stock-holding, repair and maintenance services, the majority is involved in very low value added content activities, characterised by low barriers to entry and exit, high-profits and low-risk. These agents are known as *briefcase businessmen* because they operate *out of a briefcase*, and there were an estimated 5000 firms in operation before 2009 (Fessehaie, 2012). With very few exceptions, their trajectory has not led to specialisation or upgrading processes. After the 2008/09 crisis, the mining companies have re-organised their supply chains with a view to focus on few, selected capable suppliers and exclude briefcase businessmen.

Engineering companies provide the mining companies with a broad range of services, often sub-contracting specialised service providers. These engineering companies are particularly relevant for the capital equipment industry when they are Engineering, Procurement, Construction and Management (EPCM) companies operating under Lump Sum Turnkey (LSTK) or EPCM arrangements. Under these arrangements, they are responsible for the procurement of capital equipment which is then integrated into complete systems. In Zambia, there is a small group of engineering companies providing repair and maintenance services to the mines which has done relatively well thanks to strong locational advantages and high skills-related entry barriers for competing firms.

Estimates of local procurement of goods and services in Zambia vary. A recent study prepared for the Zambia Mining Local Content Initiative (ZMLCI) estimates local sourcing to amount to approximately US$ 2.5 billion, comprised of equipment and mining services (35% of total expenditures), consumables, parts and components, maintenance (40%), low tech manufactured goods (5%), and basic services (20%) (Table 7). Presumably, this figure includes fuel and contract labour. Suppliers include locally-based international suppliers of

goods and services (80% of total value of procurement), overseas suppliers (16%), and locally-based Zambian suppliers (4%).

Table 7: Estimated composition of Zambia's mining procurement expenditure, 2012 (US$ '000 and %)

CATEGORY OF SUPPLIER	MAIN PRODUCTS & SERVICES	PROPORTION OF MINING SPEND		SHARE OF MINING BUSINESS BY NATIONALITY OF SUPPLIERS		
		Value (US $,000)	%	Foreign Owned With Local Base (1) (US $,000)	Overseas Based (2)	Wholly Local (3)
1	Mining services (production and technical)	875,000	35	700,000 (80%)	157,500 (18%)	17,500 (2%)
2	Chemicals, explosives, fuel, oils, plant and equipment parts supply installation and maintenance services	1,000,000	40	850,000 (85%)	100,000 (10%)	50,000 (5%)
3	Basic (low tech) manufactured goods supply and engineering services	125,000	5	46,250 (37%)	62,500 (50%)	16,250 (13%)
4	Security, cleaning, catering and transportation services	500,000	20	400,000 (80%)	75,000 (15%)	25,000 (5%)
	Total	**2,500,000**	**100**	**1,996,250**	**395,000**	**108,750**
	Per cent of Total	*100*		*79.8*	*15.8*	*4.4*

Notes. (1) Locally registered subsidiaries of foreign companies; (2) Not locally registered; (3) Ownership by registered residents and Zambian citizens. *Source.* Kasanga, 2012

Both South Africa and Zambia's inputs clusters are characterised by crucial competitiveness bottlenecks. In South Africa these include the following:

1) Skills scarcity is a problem both at technical and tertiary level. The decline of the technical and vocational education system is impacting negatively on output levels and quality for, among others, fitters, boilermakers, CNC operators, hydraulic technicians and so forth. At tertiary level, there is scarcity of mining and mechanical engineering skills. In-house training is significant, but hampered by poaching from other companies and from overseas (Kaplan, 2011).
2) In terms of R&D and innovation, the capital equipment industry is affected by declining resources for long-term, 'blue sky' R&D and pure innovation (Walker and Minnitt, 2006). Moreover, there is weak cooperation between the mining companies, capital equipment manufacturers and public research and education institutions (Kaplan, 2011).
3) The capital equipment manufacturing industry is negatively affected by weak competitiveness of Tier 2 suppliers. In particular, this is due to import parity pricing for steel, and declining competitiveness of the local foundry industry (Phele and Roberts, 2005; Phele, Roberts and Steuart, 2005).

4) South African capital equipment manufacturers struggle to compete with foreign OEMs on provision of finance packages. Companies like Sandvik and Atlas Copco offer attractive finance packages with competitive interest rates, and flexible finance terms and conditions. Local OEMs do not have access to financial resources required to offer these types of packages. Moreover, there is a lack of venture capital to enable SMEs to develop, manufacture and market new products. This restricts start-ups' entry in the value chain (Kaplan, 2011).

In Zambia, the inputs cluster is hampered by the following factors (Fessehaie, 2012; Kasanga, 2012):

1) Manufacturing firms often operate outdated plants and machines, old technologies and with weak quality assurance mechanisms. They lack R&D capabilities.
2) Lack of access to long-term capital to refinance production infrastructure rehabilitation and upgrade, and to maintain large stocks of inputs and spares in order to supply with short lead times;
3) High cost production structure. Communication, transport and utilities are problematic in terms of cost, reliability and access, raising the cost of doing business. Fluctuating foreign exchange rates make it difficult for local firms to plan expenditures and revenues. Import procedures are expensive and time-consuming.
4) Skills shortages in the areas of mechanical and electrical engineering, IT, and hydraulics, as well as at vocational and artisanal levels. There is a misalignment between skills demand driven by increasing FDI in various productive sectors of the economy, and the government skills development strategy. For example, there is no skills development strategy for the mining value chain.
5) Weak cooperation between local suppliers. Suppliers have not developed forms of indirect or direct cooperation to address their structural bottlenecks. They recently however joined forces under the Zambia Association of Manufacturers umbrella with the objective of developing a local content initiative.

4 Policy framework

4.1 Zambia

Until 2008, Zambia's mining sector was regulated by the 1995 Mines and Minerals Act, the piece of legislation which privatised the mining assets. The Act provided for fiscal incentives to be negotiated with each mining company and enshrined in bilateral Development Agreements (DAs). The DAs signed between 1997 and 2004 by Zambia and the mining companies included provisions on local procurement.[13] The mining companies were to grant local firms an adequate opportunity to bid for tenders and had to restrain from unfair discrimination. They also had to submit a local business development programme. This was to be monitored by a cabinet-appointed, inter-ministerial committee comprising the Ministry of Mines and Mineral Development and the Ministry of Commerce, Trade and Industry.

These provisions were largely disregarded by both the mining companies and government, for a range of reasons which include priority being given to taxation and labour issues, and poor institutional capacity of the Ministries involved. The government, through ZCCM Investment Holdings, is a shareholder in most mining companies, but this has not translated into more leverage to support local content. Moreover, policy-makers in Zambia have generally ignored the opportunities for private sector development inherent in upstream linkage development. The 2006 Fifth National Development Plan, which guided the policies of the

[13] Development Agreements between Government of the Republic of Zambia and NFC Africa (1998), Chibuluma Mines Plc (1997), Konkola Copper Mines Plc. (2004), Mopani Copper Mines Plc. (2000), Cyprus Amax Kansanshi Plc (1997).

Zambian Government at the time, promoted export-oriented growth. The 2005 Private Sector Development Reform Programme focused on cutting the cost of doing business, whilst the 2007 Zambia Development Agency Act set a framework to promote investment, through a range of regulatory simplifications and fiscal incentives, and established Multi-Facilities Economic Zones for selected priority sub-sectors. In 2008, Zambia adopted the Commercial, Trade and Industrial Policy.[14] Industries upstream to copper mining, especially service providers, were not included in any of these policy initiatives. In 2007, the IFC undertook a Suppliers' Development Programme. This was a donor and private sector-funded programme, with little ownership from government. The project was implemented solely by the mines' supply managers, with guidance from their CEOs, and IFC staff. [15]

The DAs' tax regime rapidly became an issue of major contention in Zambia's national political debate as the country tax receipts from the mining sector remained dismally low notwithstanding the copper price boom (Fraser and Lungu, 2007). In 2008, the Zambian government repealed the 1995 Act and replaced it with a new Act. The 2008 Mines and Minerals Development Act set new provisions on local supply firms. These best endeavour provisions foresee that, to the extent possible, the mining companies extend preferences to "materials and products made in Zambia" and to "service agencies located in Zambia and owned by Zambia citizens or citizens owned companies".[16] This approach tries to build mutual trust and collaboration between local suppliers and the mining industry rather than setting compulsory regulations on local sourcing (Kasanga, 2012). It should be noted that with regard to service providers, the Act focuses on firm ownership rather than value added content.

In July 2012, the Chamber of Mines of Zambia and the Zambia Association of Manufacturers, working closely with government, mining companies, and other key stakeholders, started the Zambian Mining Local Content Initiative (ZMLCI), which was officially launched in May 2013. The World Bank and IFC are providing facilitation support to the ZMLCI and the Focal Group. ZMLCI aims to identify actions to enhance local content. In 2012, Zambia has also developed an Engineering Products Industrial Strategy, which is part of a broader Strategy for Industrialisation and Job Creation. Concurrently, the country is in the process of initiating a Private Enterprise Programme – Zambia (PEP-Z), a UKAid-funded programme, which also targets suppliers to the mining sector.

4.2 South Africa

The 2011 National Development Plan (NDP) explicitly recognises upstream industries, such as capital equipment, chemicals, and engineering services, as an important target for industrial development (NDP, 2011, p. 125). This objective is being pursed under the Industrial Policy Action Plan 2013/2014 – 2015/2016 which sets as one of its objectives the development of a Mineral Value Chain Strategy which will result in an action plan to advance backward and forward linkages in key value-chains, namely ferrous, PGMs, titanium, polymers and mining inputs.

A number of policy measures in IPAP 2013 do not target directly backward linkage development but have an impact on some categories of supply firms. For example, IPAP 2013 foresees a policy intervention on Medium and Heavy Commercial Vehicles for infrastructure,

[14] The 2006 Citizens Economic Empowerment Act provided for measures to support Zambian-owned, "indigenous" enterprises. One of the most significant measures was preferential government procurement policies.

[15] The IFC Supplier Development Programme ran from 2007 to 2010, with funding from the mining companies, the IFC and Japanese International Cooperation Agency. The mining companies were Mopani Copper Mines, First Quantum Minerals Ltd, Lumwana Mines, and Chambishi Metals (the latter left after the 2008 crisis) (Newton Lungu & Associates, 2010).

[16] Section XIII of the Mines and Mineral Development Act (2008)

construction, mining and agriculture, especially 'yellow metals' manufacturers. Moreover, IPAP 2013 includes a sectoral intervention for the metal fabrication, capital and rail transport equipment cluster, recognising the opportunities of, among others, mining turnkey projects in South Africa, the rest of Africa and South America.

The DTI's Export Credit and Insurance Company (ECIC) provides 100% Political Risk Insurance Cover and 85% Commercial Risk Insurance Cover at preferential rates. ECIC required at least 50% of South African local content in the project: the lower the level of local content, the lower the insurance cover provided by the ECIC. Finally, the Mining Charter provides for local content measures. This was developed in 2002 by the Department of Mineral Resources (DMR) together with mining industry stakeholders, and amended in 2010. In 2009, the DMR undertook a review of the progress in implementation of the Mining Charter, and noted a remarkable lack of progress in the area of procurement. According to the assessment, 89% of companies had not given Historically Disadvantaged South Africans (HDSA) companies preferred supplier status, while 80% had not indicated commitment to the progression of procurement from HDSA companies over a 3-5 year time-frame. Reported level of procurement from HDSA companies averaged 37% of number of total vendors, although companies could not always ascertain the ownership and management control status of their HDSA suppliers, and less than 3% of value of total procurement expenditure. There was no evidence that stakeholders had identified levels of procurement from the HDSA companies and developed a plan to increase it. This led to the revision of the Mining Charter in 2010, with the amendment of the Broad-based Socio-Economic Empowerment Charter for the South African Mining and Minerals Industry. Mining companies committed to:

- Procure a minimum of 40% of capital goods from B-BBEE entities by 2014
- Ensure that multinational suppliers of capital goods annually contribute a minimum of 0.5% of annual income generated from local mining companies towards socio-economic development of local communities into a social development fund from 2010
- Procure 70% of services and 50% of consumer goods from B-BBEE entities by 2014

(These targets exclude non-discretionary spending).

Moreover, Government and social partners signed a Local Procurement Accord on 31 October 2011. This Accord has been signed by organised labour, business community constituents and Government. Business was represented by Business Unity SA and Business Leadership, to which several mining companies belong. In the Local Procurement Accord, business committed to progressively increase the levels of local procurement by the Top 84 companies (members of Business Leadership).

SECTION 2: FINDINGS

5 Data collection

The study is based on interview data collected between June and October 2014 in South Africa (Gauteng Province) and Zambia (Copperbelt Province). The interviews were conducted on the basis of semi-structured questionnaires and targeted OEMs in South Africa, supplier firms in Zambia and buyers. This sample design allowed for some level of triangulation of the data collected. Additionally, a number of institutional actors were also interviewed. The categories of respondents are presented in Table 8.

Table 8: Categories of respondents, June - October 2014

	South Africa	**Zambia**
Suppliers	14 OEMs, both South African and International, in Gauteng, KZN	33 mining supply firms. Combination of Zambian, international and South African OEMs in Kitwe, Ndola and Chingola (Copperbelt)
Buyers	EPCM firms, both South African and International, in Gauteng, KZN	
Institutions	South Africa Capital Equipment Export Council	• Kitwe Chamber of Commerce and Industry • Zambia Association of Manufacturers • Zambia Chamber of Commerce and Industry • Zambia Development Agency • Private Sector Development Reform Programme

There were several challenges in collecting data. In South Africa, 11 firms refused interviews, were not accessible, or had other priorities at the time, in particular the NUMSA strike. In Zambia, there was a considerable level of 'interview fatigue' and the mining companies did not grant their availability for interviews. Hence the closest information regarding buyers' strategies was collected through the EPCM firms' interview data. These data should be read with some caution, because for some product categories, EPCM firms' procurement strategies may differ from the mining companies' ones.

The case study focused on four clusters of products:

1. Mineral processing equipment;
2. Off-road specialised equipment;
3. Pumps and valves; and
4. Conveyor systems.

These product clusters were identified among the top Zambian imports from South Africa in chapter 3.2. In South Africa, the OEMs interviewed were involved in the 4 product clusters, with the addition of an OEM for mine support products. In Zambia, in addition to firms supplying products from the four selected clusters, interviews covered metal fabrication, electrical, civil, chemical and mechanical engineering.

This study makes a distinction between South Africa-based OEMs (which include all OEMs) and South African OEMs (domestic ownership). Similarly, the Zambia-based supply firms include international OEMs, Zambian firms (domestic ownership) and South African OEMs.

6 Entry and upgrading in the mining supply chain

6.1 Entry into the mining supply chain

Most South Africa-based OEMs were old firms. International OEMs had been established up to 130 years ago, in Europe or the US, and had, over decades, entered global markets, and built competencies across commodities and products. All the international OEMs examined in this study had been shaped by significant M&As. This was reflective of global trends in which OEMs have used M&As to acquire new intellectual property and innovation capabilities, expand their range of products, complement their pre-existing offering, access regional markets and reduce competition. Box 1 presents the company histories of FLSmidth and Weir Minerals as examples of this type of trajectory.

Most South African OEMs have been established during the apartheid era, under a very conducive environment for supplier firm upgrading. Buyer-supplier cooperation was intense and focused on technological innovations to meet the challenging ore extraction and processing requirements of the domestic mines. Mining houses were investing substantial resources in blue sky R&D through COMRO. Supply firms were generally protected from overseas competition and had access to skilled labour. The liberalisation process in the 1990s led to a decline of the manufacturing sector in general, and Tier 2 suppliers (foundries) in particular. The firms interviewed had been able to withstand considerable pressures from imports and a weaker local supply chain. They did that through different strategies: internationalising, merging, outsourcing and innovating. In comparative terms, it seemed that the South African OEMs have been internationalising later than the international OEMs, hence the latter had a more established regional footprint. Moreover, in this study, the South African OEMs have seen low levels of internationalisation in terms of mergers and acquisitions than their international counterparts. Only two companies out of eight had formed strategic partnerships with international OEMs in order to pursue product innovation and broaden their product portfolio.

Box 1: Growth trajectory of two international OEMs

Weir was established in 1886 in Scotland to supply capital equipment for the steamship industry. The firm later diversified into building machine tools and pumping stations for oil pipelines. WWI fuelled demand for warships and led the company into the production of artillery shells and aircraft. During WWII, the company expanded to marine equipment, field guns, and gun cartridges. In the 1950s Weir expanded its desalination operations. It also set up Weir Pumps to focus on pumps and auxiliary equipment and made a number of acquisitions of British pump, valve, and engineering services companies up until the 1980s.

It was not only the 1990s however that the company made significant international acquisitions. These acquisitions included Warman Water Pumps (Australia) – which led to Weir Warman being one of the world's largest pump OEMs-, Floway Pumps (US), Atwood and Morrill (US, valves) and Baton Rouge Machine Works (US, engineering services). In 1994 the Weir Group entered the slurry and specialty pump market by acquiring Envirotech Pump systems, a US-based industrial and sewage sludge pump maker with operations in Australia, Brazil, Canada, Chile, France, the Netherlands, Peru, Singapore, South Africa, and the UK. Weir Group further bolstered its international operations by adding Salweir (South Africa, pumps) in 1996, Entropie (France, desalination) in 1997, Schabaver (France, pumps) and SEBIM (France, valves) in 1998, and the heavy-duty pumps unit of Australia's North Ltd in 1999. In the 2000s, the company focused on shedding its non-core businesses,

reducing its exposure to the UK defence industry and allocating its resources to seeking niches with high barriers to entry where it is capable of market leadership or already leads.

Danish FL Smidth has been established 130 years ago. For 100 years, its main business was directed at the cement industry, but 30 years ago the firm expanded into other areas. FLSmidth made a number of acquisitions in the 1990s: Pfister, Ventomatic and MAAG Gear. With the acquisition of Fuller Company, FLSmidth gained a minerals processing division. Among subsequent acquisitions, in 2007, FLSmidth acquired GL&V Process, enabling it to gain a strong foothold in the global copper industry. Additional ones included Pneumapress and Centry, an engineering consultancy, Conveyor Engineering, EEL India (gaining a know-how in design and supply of major bulk material handling systems for cement, mining, heavy industrial facilities and bagging equipment worldwide).

In 2012, FLSmidth completed several critical acquisitions: Australian engineering and equipment supply company Ludowici Limited [2] a provider of coal centrifuges, vibrating screens and complementary wear resistant products and services for the minerals industries; Decanter Machine, a US manufacturer and supplier of centrifugal technology to the global minerals industries, TEUTRINE GmbH Industrie-Technik, a German company specialised in mobile solutions for repairs, refurbishments and installation services, and Australian service companies MIE Enterprises and Mayer Bulk which provide construction, commissioning, maintenance and repair services.

Weir Minerals is now the largest supplier of pumps for the mining sector in the southern Africa region, whilst FLSmidth is a major mineral processing system OEM in South Africa and in the region.

Source. http://www.hoovers.com ; http://www.flsmidth.com

The findings highlighted two important issues surrounding entry into the mining supply chain: firstly that new entrants may struggle to enter given the size and competitiveness of incumbents, and secondly that there was significant lateral migration of technologies, which opened up some opportunities for existing players.

Firstly, all but one of the OEMs interviewed had been established for decades, they had deep knowledge of the markets, well-established reputations, and large installed capacity to secure repeated orders and profitable aftermarket sales, which were particularly important when greenfield investment slowed down. This opened an important question regarding how new entrants could contest these markets. The example of a South African new entrant was illustrative. The OEM was the result of a JV between two existing players. It started as a joint project with Anglo American to find a system that could control roof movement in deep mining. This resulted in its flagship product, the unique ROCPROP roof-support system, which was exported to the rest of Africa, the US and Australia. The firm was expanding to drilling rigs and roof bolters. The trajectory of this firm suggested that the relationship with the parent companies was important in terms of access to resources for aggressive R&D and linkages to one of the world's largest mining companies to support demand for its innovation efforts. Also, the firm entered the Copperbelt market by 'piggy-banking' on the agent of the parent company. The evidence from other South African firms suggested that access to resources for upgrading and expanding into new markets was problematic. Hence, a South African start up, even if capable to develop an innovative product, may in fact struggle to enter the South African and regional market on its own.

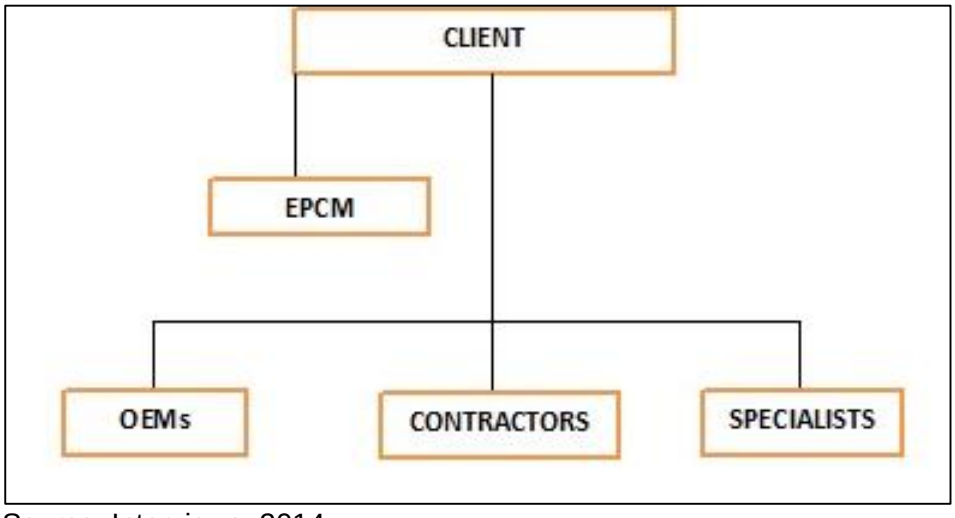
Secondly, both international and South African OEMs were characterised by significant lateral migration of technologies: they started off supplying sectors as diverse as electricity, food industry, recycling, infrastructure, construction, forestry, sugar, transport, and defence. Whilst

this process needs to be further unpacked to understand its determinants, there was prima facie evidence that there were opportunities for OEMs currently active in other resource and non-resource sectors to enter the mining value chain, and for mining OEMs to expand their markets beyond mining.

In Zambia, entry into the supply chain was more shaped by relationships and reputational assets. Unlike South Africa, entering and exiting the mining value chain seemed relatively easy, because the majority of firms were often pure traders, not specialised, hence facing lower capital and skills entry barriers. There were nevertheless few supply firms established by entrepreneurs with considerable expertise, who worked at the mines for many years, before setting up their own supply firm. They had good networks and knowledge of the technical and procurement side of the mining companies, which helped them entering the supply chain. These individual entrepreneurs were managing every aspect of their businesses, with no apparent succession plan. Their size and organisational structure made it very difficult to upgrade, because their capability to mobile resources and to manage change and expansion were limited.

One of the research questions investigated in the study concerned the role played by EPCM firms in promoting or constraining participation in the mining supply chain. Under an EPCM model, the EPCM firm is appointed by the client to act for and on behalf of it, e.g. procuring on behalf of the client. The client appoints the subcontractors, which are then managed by the EPCM firm. The engineering is done on a reimbursable basis. In this model the firm is essentially an extension of the client's team. Under a LSTK or Engineering, Procurement and Construction (EPC) model, the EPCM firm takes care of the procurement and appoints the subcontractors itself. The firm receives a lump sum for the engineering work, acts as a separate organisation and takes on the risk around price, delivery and schedule. The EPC model is preferred because it is more profitable. In both cases, the procurement process is essentially a joint decision making process. Even if the EPCM firm manages the tender, and prepares a final technical and commercial adjudication, this is then presented to the mining company for confirmation. The EPCM model is best illustrated in the diagram below provided by one EPCM firm:

Figure 11: EPCM model



Source: Interviews, 2014

EPCM firms active in the regional market originated from Canada, Australia, US and South Africa and had regional offices across the globe (Table 9). The region represented a growing share of the business for South Africa-based EPCM firms: 50% or more of their turnover. Businesses in the SADC region included copper (DRC, Zambia, Botswana), coal

(Mozambique), iron ore, uranium (Namibia), PGMs (Zimbabwe). Gold in West Africa was also important. Most of the EPCM work for Zambia was done out of South Africa.

When moving into the region, EPCM firms tapped into the South African inputs cluster, where they had long standing and well established relationships (Table 10). Proximity enabled them to monitor supplier performance. EPCM firms had good relationships with international OEMs and could source directly from their headquarters. If however there were South Africa-based subsidiaries, these would be given preference. The mining companies themselves had no preference in this regard, but if their project funding was underpinned by a credit agency, such as South Africa's ECIC, minimum local content requirements had to be met. The presence of South African engineers employed in Zambia's mines helped because they were familiar with South Africa-based suppliers. Zambian suppliers on the other hand did not work through EPCM, because of size and capabilities issues, and EPCM firms dealt with South Africa-based OEMs directly rather than through local agents and distributors. Zambian firms supplied the mining companies after their design and construction were completed, and operations had started.

It was also noted by a few OEMs that Australian/Canadian/Chinese mining companies tended to source from home countries' EPCM and OEMs. This issue however need to be corroborated by additional research, and previous research suggests that at least for the Chinese mining companies, this may not be entirely true (Fessehaie and Morris, 2013). One EPCM firm had a procurement arm based in Shanghai to tap into the Chinese supply network, if the client required it. However quality concerns over Chinese suppliers limited the penetration of Chinese OEMs into the regional mining supply chain.

Table 9: Main EPCM firms operating in the Southern Africa region

Company	Home country
DRA Global	South Africa
Tenova	International (originally Italian)
Senet	South Africa
Worley Parsons	Australia
MDM Engineering	South Africa
AMEC Engineering	Canada
Fluor SA	US
ADP Group	Canada
Hatch Engineering	Canada
Sedgman	Australia

Source: Interviews, 2014

Table 10: Key suppliers for EPCM firms

Category of capital equipment	Key suppliers
Mineral Processing	Sandvik Mining Metso Minerals Outotec FLSmitdth Vibramech Multotec IMS Citec
Offroad Special Vehicles	Barloworld

	Barloworld Equipment Liebherr Africa
Conveyor Systems	Osborn Engineering SEW Eurodrive Dunlop Belting BMG CPM Venk
Pumps and Valves	Weir Minerals Invincible Valves Warman Africa Curo Pumps DFC Mining
Electrical Equipment	Actom ABB South Africa Siemens Limited Denwa RWW

Source. Interviews, 2014

EPCM firms coordinated an important entry point for OEMs into the regional mining supply chain. This was particularly important for OEMs supplying mineral processing equipment, which reported that up to 70-80% of their sales were done through EPCM firms. Access to EPCM firms seemed critical for OEMs selling products that were installed at the mine construction stage. OEMs selling pumps, valves and offroad vehicles relied less on EPCM firms. Offroad special equipment OEMs in particular accessed the supply chain through contractors. Mining companies were in fact moving away from ore extraction, which was outsourced to external contractors. These would then procure their production and earth moving equipment from the OEMs. The role of contractors was forecasted to become increasingly important as mining houses in the region wanted to be less involved in material extraction.

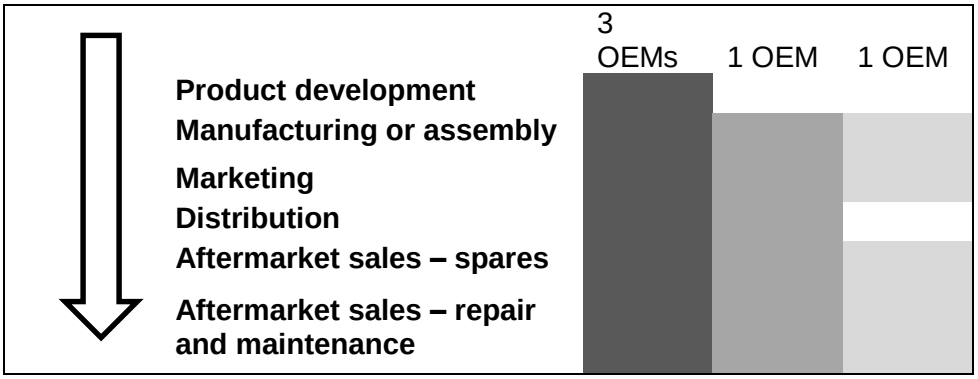
The OEMs confirmed that there was no particular entry barrier in supplying through EPCM firms. Indeed two OEMs reported that EPCM firms facilitated entry in the Copperbelt, which would have otherwise been difficult because of corruption in the mines' procurement processes, the incompetency of Copperbelt agents in supplying the correct products, and the importance of relationships to secure contracts. However this did not mean that there was no difference between selling to the mines or to EPCM firms. EPCM firms were heavily focused on offering the best possible technical solution at the lowest cost. Because of this, it was difficult for OEMs to sell innovative solutions that were more expensive in the short term, even if TCO was lower, and one OEM indeed reported having to sell at discounted prices.

6.2 Value addition and upgrading

South Africa-based OEMs were generally characterised by high degrees of local content. Most OEMs participated along the entire value chain, from product development to aftermarket sales (Figure 12 to 15). This finding however requires further qualifications.

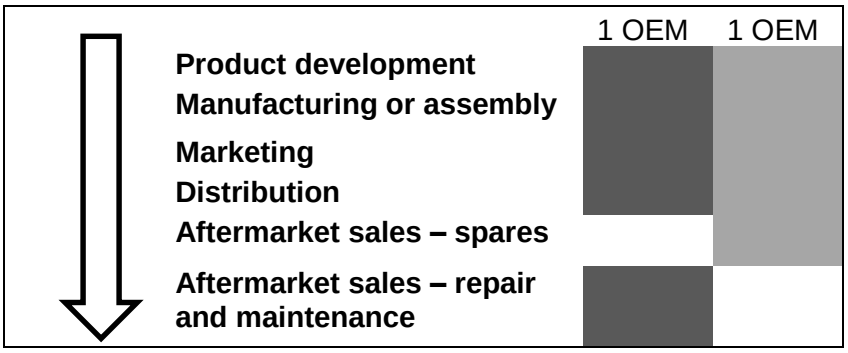
Product development was undertaken, to different degrees, across all four product clusters, with two exceptions: a mineral processing OEM which received designs from the parent company in Europe, and a South African heavy fabricator which operated as a contractor for OEMs. Firms were also involved in adapting their technologies across commodities and sectors.

Figure 12: Mineral processing OEMs - value added



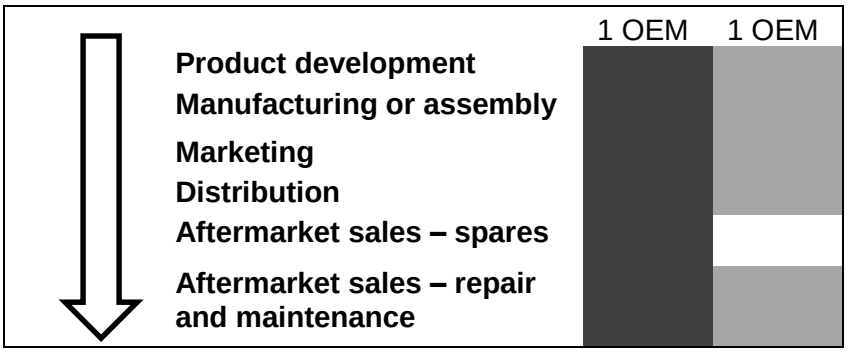
Notes. N=5. *Source.* Interviews, 2014

Figure 13: Conveyor system OEMs - value added



Notes. N=2. *Source.* Interviews, 2014

Figure 14: Pumps and valves - value addition



Notes. N=2. *Source.* Interviews, 2014

Figure 15: Offroad special vehicles – value addition

Aftermarket sales – repair and maintenance	

Notes. N=4. *Source.* Interviews, 2014

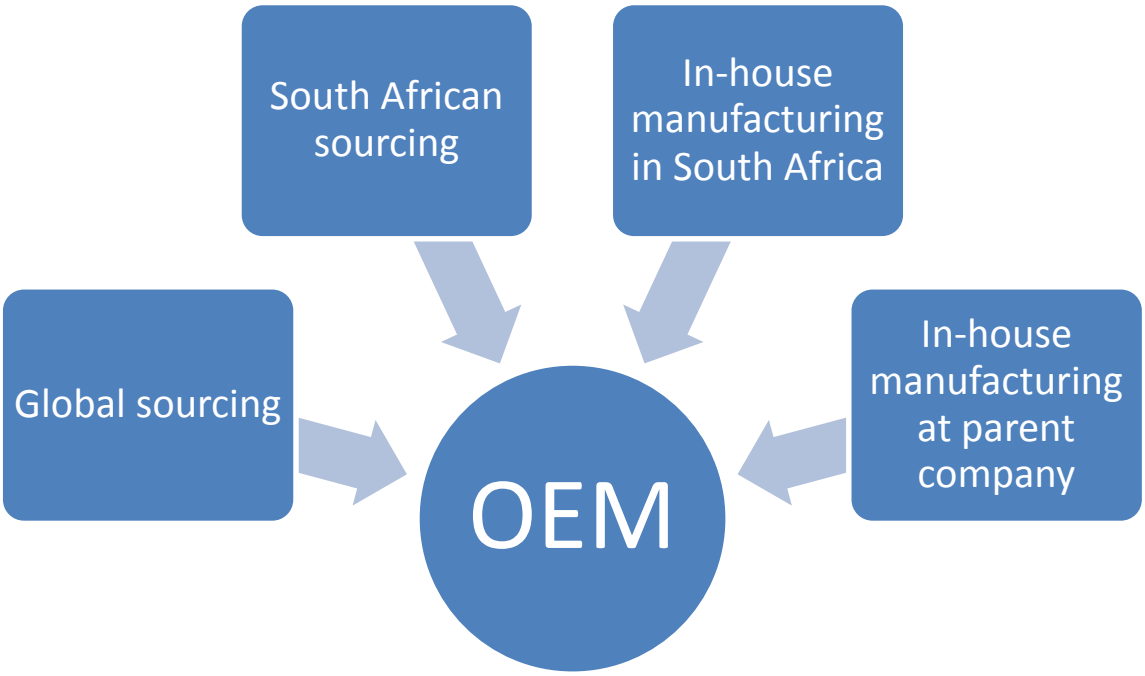
One international OEM was a technology centre for conveyer belts, material handling plant design, and mine hoists. It was involved mostly in product design, with some level of R&D undertaken locally. In general, however, for international OEMs, R&D was conducted in one or more centres in the US and Europe, and the IP was controlled by the parent companies. For example, one firm was part of an OEM with R&D centres in the US and Germany, dedicated to mineral processing and materials handling respectively, and the IP was controlled by the parent company in Denmark.

South African OEMs invested considerably on product development. For example, all the South African offroad vehicle manufacturers were involved in all stages of product design, including testing and commercialisation. The EPCM firms confirmed that South African OEMs were innovative and could match international OEMs in this respect. The case of Desmond Equipment was illustrative. The firm was established as a result of a significant effort at technological adaptation: equipment with sophisticated components was re-designed in order to make applications simpler. The electronic component was reduced, the equipment was suited to the harsh conditions and wet environment typically found in Africa, and the machinery was easier to operate and to maintain. Its product range included offroad trucks (particularly articulated dump trucks), front-end loaders, haulage tractors. These were sold to various sectors: municipalities, mining, harbours, airports, sugar industry, road-making, general construction and forestry.

All the OEMs in South Africa were involved in local manufacturing. However, the data suggest that the international OEMs had localised only part of their manufacturing operations. For example one mineral processing OEM manufactured locally pumps, crushers, and feeders, but these represented only 20% of the value of its mineral processing system.

International OEMs' manufacturing operations were structured around a multi-faceted strategy:

Figure 16: OEMs manufacturing strategy



Source. Author's analysis.

OEMs relied on global sourcing of non-IP components, especially heavy fabrication, from low cost, large scale, ISO certified producers in China, India, Indonesia, other Asian countries, Eastern Europe, etc. Competition among suppliers was stiff, and firm growth was linked to, among others, economies of scale, access to cheap steel, and very good infrastructure. Due to the exchange rate, South African heavy fabricators had become competitive. These contractors operated at the lower value added stages of the manufacturing supply chain. One firm interviewed was a South African firm contracted by OEMs to supply heavy fabrication work. The OEMs would provide the firm with product design and specifications and were responsible for distribution and marketing. The only value added contribution by the contractor was in the form of advising clients on the 'manufacturability' of their product design. In order to move up the value chain, the contractor concluded two JVs: one JV with a local firm to target underground mining equipment, the other JV with a Dutch firm to target fixtures to surface mining equipment.

OEMs did sub-contract South African manufacturers of specialised components, but manufacturing of components with high IP-content was vertically integrated. Two international OEMs for example reported that drive components and motorised pulleys were made by the parent company in Germany. It was not possible to assess the extent to which critical components were also manufactured by the OEMs in South Africa. One OEM reported that manufacturing of screen media and perforated plates was done in-house. Another OEM's manufacturing facilities included foundries, a machine shop, rubber facility, and a rubber and polyurethane facility. Lastly, one OEM manufactured in-house pumps, crushers, feeders and had a foundry.

South African OEMs tended to invest considerably in product and process upgrading: to improve the product design, to increase the product range, to improve the production process. They relied on some imported components when local suppliers were not cost or quality competitive. Previous research suggested that many firms switched to importing the final products altogether. Valves provided a good example of the degree of import penetration because it was a cost-driven value chain and most manufacturers turned importers. A South African OEM developed a three-fold strategy to face competition from Chinese manufacturers:

- In-house manufacturing of high quality valves, ISO and SABS certified. These products were mainly for the domestic market, which was protected by standards deviating from international standards.
- Sub-contracting of Chinese valves manufacturers, under own design. The OEM visited the Chinese factories to ensure they met the quality standards. These products were exported to the Middle East;
- Import of valves (not own design). The OEM monitored suppliers' ISO certification and designs, and tested the valves in-house

All OEMs were involved in marketing and distribution. As discussed in the next chapter, some buyers were increasingly interested in the supplier capability to provide full package solutions. Hence, some South African OEMs used their marketing and distribution activities strategically to offer a broader product portfolio. Bell Equipment for example completed its range by distributing equipment by John Deere, Finlay, Hitachi, Bomag and Liebherr. Dezzi on the other hand struggled to offer full range of products because they did not produce bulldozers.

Aftermarket sales were critical for almost all OEMs. The only exceptions were manufacturers of valves and specific components of conveyor systems, because these did not require repairing and/or spares but replacing.

Zambia mining inputs cluster was positioned at the bottom of the regional value chain. Zambian supply firms were not very specialised: they were involved in varying combinations of services (construction), manufacturing (fabrication, engineering) and distribution of imported products. They were scarcely involved in manufacturing activities, with the exception of fabrication and machining work, and some assembly work by the OEM subsidiaries. Local manufacturers relied on imports from South Africa for the highest value added components. None of the 33 firms interviewed had R&D budget, and only a few independent manufacturers were somehow involved in product development. Two thirds of the firms were involved in marketing and distribution, often as agents for South African OEMs, but also for Chinese and German ones. Some agents offered various levels of repair and maintenance services.

7 Competitiveness

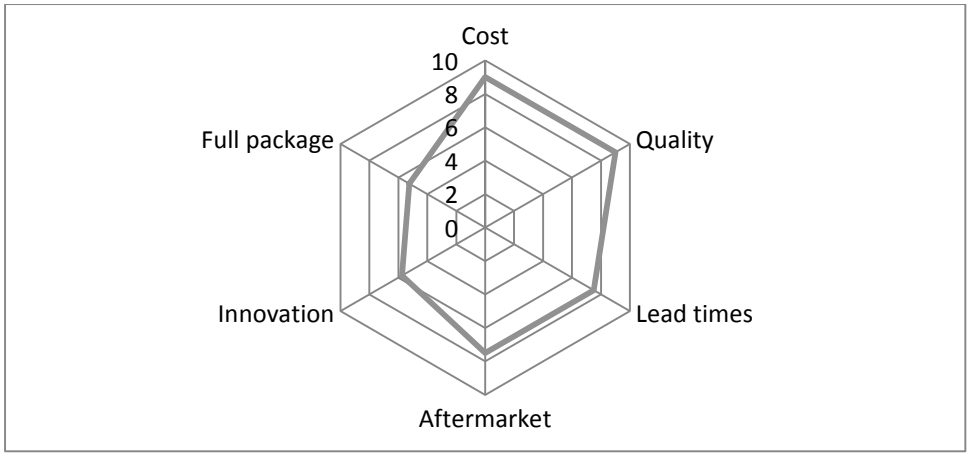
7.1 Critical Success Factors

Market requirements are referred to in GVC analysis as critical success factors (CSFs) (chapter 2.2). EPCM firms rated the weight attached to selected CSFs on a 1 to 10 Likert scale (1 being *unimportant*, 10 *very important*) (Figure 17).

Cost and quality

Cost and quality were ranked highest and in fact were order-winning CSFs. EPCM firms were focused on both the commercial and technical value of their offer. Cost mattered in terms of TCO, or cost effectiveness in the long period. Obviously there were variations across products, for example the value chain for standard valves was cost and lead times-driven. Buyers expected them to wear off due to contact with slurry, so quality was not the paramount criteria. On the other hand, the value chain for critical items such as conveyor systems and speciality valves was much less price sensitive. Cost as a market requirement was also a function of learning, as some mining companies had initially bought cheap low quality supplies but then moved to maximise TCO.

Figure 17: CSFs according to South Africa-based EPCM firms



Notes. N=4. *Source.* Interviews, 2014

Aftermarket services

Aftermarket services mattered. The EPCM firms provided guarantees to clients, hence the OEMs had to be top performers in terms of product quality and aftermarket services. In Australia, where they went into operations contracts with the mines and labour costs were high, EPCM firms focused on value added services and designed very sophisticated, high quality maintenance and operating systems which attracted a price premium but saved labour costs. In southern Africa, labour was relatively cheap and the mining companies tended to focus on least cost solutions.

Lead times

Lead times were less important than cost and quality because the mining houses and EPCM firms planned well in advance. They were however very important for suppliers of aftermarket services and civil engineering located in the Copperbelt. Zambian suppliers highlighted that when very short lead times were required, even cost considerations were overridden.

Innovation

Innovation and full package capabilities were not rated highly. It was argued that most equipment was standard, such as valves and pumps. Moreover, the mining companies tended to be rather conservative in their procurement decisions. For example, an EPCM firm explained that for a coal plant built in Mozambique it acquired high-tech/highly automated equipment but a lot of it was being used in the “manual” format.

Full package capabilities

Full package capabilities were seen as being the responsibility of the EPCM firm rather than its suppliers, but some mining companies were starting to require them. Full package suppliers reduced transaction costs for buyers as they had to deal with fewer suppliers, and could reduce stocks and logistics costs. There were variations though as some mining companies preferred to diversify their supply chain and have multiple suppliers. Local supplier capabilities influenced this decision: in South Africa, where firm capabilities were relatively high and there were artisans who knew how to maintain standard equipment, buyers would subcontract aftermarket services to various service centres, and would prefer to diversify their suppliers and risks. In Zambia, where supplier capabilities were low, buyers would rely on the OEMs for aftermarket services and valued full package options.

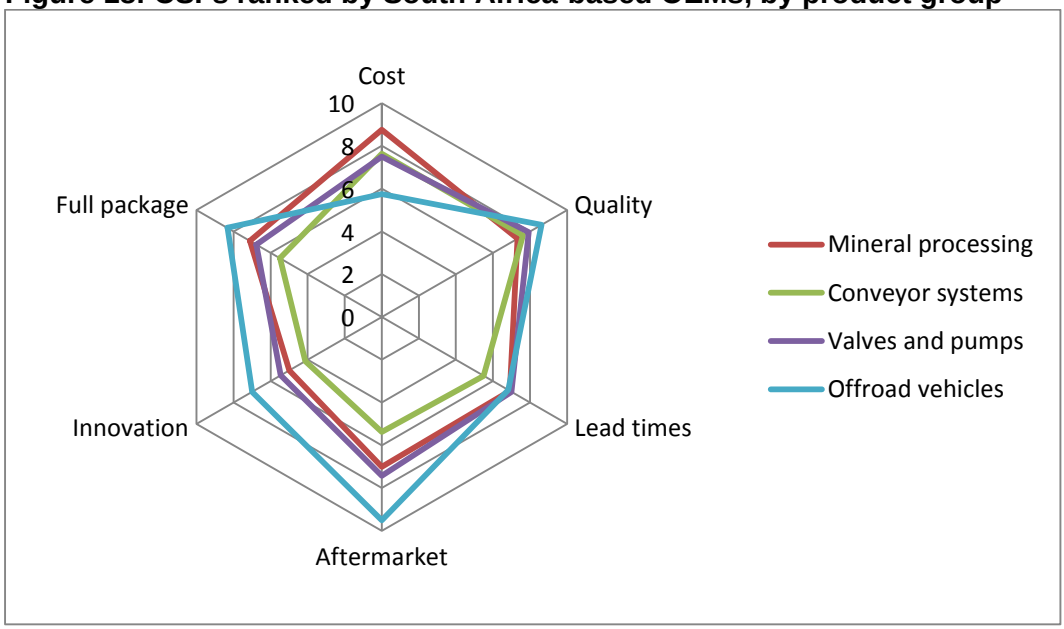
According to all categories of respondents, buyers' CSFs varied with firm ownership. Blue chip and mid cap companies focussed on TCO, whilst low cap companies were cost-driven. Western mining companies focused on long term profits hence they were willing to invest in quality products and make large scale capital investment. Indian companies were more geared towards smaller modular units, which required less investment and allowed faster installation times, and were less interested in innovation. Some OEMs said they had been cut out from supplying the Chinese companies when these were engaged in comprehensive packages that linked resource extraction and infrastructure development and brought their own suppliers. Both the Indian and the Chinese supply chains were strongly cost-driven. Some suppliers nevertheless mentioned that they were making headways with Chinese buyers and these were increasingly focusing on TCO and quality considerations.

7.2 Regional competitiveness

A key aspect of firm competitiveness is a sound understanding of what the market demands. If a firm competes on price within a quality-driven value chain, chances are it will not succeed not because its products are too expensive, but because it is pursuing the wrong strategy in the first place.

South Africa-based OEMs rated the weight attached by their buyers' to selected CSFs on a 1 to 10 Likert scale (1 being *unimportant*, 10 *very important*) (Figure 18). Cost and quality were ranked high by all OEMs, with the exception of offroad vehicles OEMs which rated their value chains more quality-driven. Lead times were rated very high by the OEM of valves and the heavy fabrication contractor. Aftermarket sales were not critical for some conveyor system components OEMs, but it was very critical for offroad vehicles OEMs. Innovation and full package capabilities ranked low across product groups, although they were somehow more important for offroad vehicle OEMs.

Figure 18: CSFs ranked by South Africa-based OEMs, by product group



Notes. N=12. *Source.* Interviews, 2014

Cost and quality

Except for the low ranking of costs for offroad vehicle OEMs, the CSFs are aligned to the ones identified by the EPCM firms. It should be taken into consideration however that offroad vehicle

OEMs supplied mainly directly to the mines or through contractors, which may be less price sensitive than EPCM firms.

Competition from Chinese suppliers had increased cost pressures on the South African inputs cluster, with few exceptions such as the secondary equipment market. Even innovation-driven OEMs were affected because of reverse engineering done in China with the help of Chinese buyers in the region. India was also becoming a competitor, for example Volvo had moved outsourcing of front-end loaders from China to India.

The valves OEM was focused on reducing costs because it operated in a cost-driven supply chain. Conversely, OEMs for mineral processing equipment, offroad special vehicles and pumps were competitive because they supplied high quality, ISO-certified products. Cost-wise, they focused on TCO, which meant ensuring long life span of the machine, low cost of repairs and maintenance, lower downtime, and energy saving. Clients were willing to pay a premium, which made these OEMs not the cheapest in the market. It was clear that they were not competing on price, because they would have not been able to withstand competition from China. Because of lower TCO and thanks to the exchange rate, South African OEMs had become more price competitive. An EPCM firm with a Shanghai-based procurement arm confirmed that, having done a lot of supply chain analysis, the South African OEMs were more cost effective.

OEMs have built a reputation as reliable suppliers. For some, being long established companies helped. One OEM had been in operation for 130 years, of which 50 in the Copperbelt. For companies with a history in the region, that also meant good stakeholder relationships, which allowed them to wither periods of political instability.

Lead times

In terms of lead times, OEMs for mineral processing equipment and pumps were on industry average or not very competitive. Some offroad vehicles OEMs were doing better. Lead times were a function of demand: if demand boomed, lead times would increase significantly, but they did so for all competitors. However, the mines and EPCM firms placed orders well in advance, and the OEMs were able to plan on the basis of the client's installed equipment and in some cases the OEMs helped with inventory planning and management. Hence, lead times were not an order-qualifier CSF.

Lead times however were a market-winning CSF for aftermarket services in the Copperbelt. Holding stocks for spares near the mines was important - one OEM maintained up to US$ 5 million worth of inventory in the Copperbelt. The mining companies did not want to hold expensive stocks but wanted to rely on short lead times from their suppliers. Some firms maintained 2 weeks lead times. OEM subsidiaries were more competitive than agents in this area. It was highlighted however that holding capital spares which were not replaced regularly carried tax implications. While the SADC FTA allows for duty-free import into Zambia, it must be shown that the spare has been sold. If the equipment has not been sold within 12 months, the OEM is liable for tax on the equipment. Therefore some OEMs would hold big ticket items in South Africa. Lead times were also influenced by demand in South Africa. For example, for high pressure valves, lead times increased from 10-12 weeks in 2000 to 18-22 in 2014.

Lead times were important for the valves OEM, which had to replace high volumes of valves within short timeframes. The low capability of Tier 2 suppliers however put them at a disadvantage. Imported small valves could be shipped and received within 15-20 days while ferrous castings from local foundries could take between 4-6 months to be manufactured and delivered.

Innovation

With the exceptions of products which were considered mature, both international and South African OEMs, across product groups, considered innovation a critical area for competitiveness especially to outperform Chinese OEMs.[17] One international OEM sponsored a Chair in condition monitoring at the University of Pretoria (Centre for Asset Integrity Management), plus a partnership with the University of Strathclyde, Scotland. In Zambia, the same OEM sponsored degrees at the local university and distance courses with UK universities. Collaborations with the mining companies were also common– for example Weir Minerals' Global Framework Agreement with Anglo American focused on improving energy consumption and lowering maintenance requirements across AA's operations in South Africa, South America, North America and Australia. In general, innovation seemed to take the form of incremental innovation and customisation of equipment. For example, in Zambia, the Australian mining company required wider, bigger and faster conveyor belts to move larger volumes. Innovation targeted also operational efficiency and energy saving.

Aftermarket services

All the OEMs with aftermarket services operations invested significant resources to be competitive in this area, although not all of them did so in the Copperbelt. Capital sales were very cyclical; hence aftermarket sales offered stability and sustainability to the business. One OEM was running 'service exchange programmes', where it took responsibility for the maintenance of the equipment and the client received a working piece of equipment. This type of offer required considerable capital investment: the firm needed in loco workshop facilities, replacement equipment, and technical staff. In South Africa, the OEM was able to provide comprehensive coverage, whilst in Zambia only for a limited number of products. Buyers in Angola, Zambia and DRC purchased spare parts from the onsets for critical items such as conveyor belts because access to aftermarket services was difficult.

International OEMs had some advantages over South African OEMs. They had branches across the globe, and used those in India and China to develop customer relationships there, and follow Indian and Chinese mining companies in Africa. At product design stage, South African subsidiaries received technical support from the parent companies' engineers and could send prototypes to the parent companies for testing. International OEMs would have engineers specialised in each machine, several R&D centres, and when there was a problem in the operations in South Africa or an urgent aftermarket service request, the parent company could pool resources and fly in engineers from other subsidiaries. Finally, when the South African subsidiary was producing for export, it received assistance from the subsidiary in the destination market to assist in meeting technical standards of that export market.

One EPCM firm rated South African OEMs competitiveness vs. international OEMs. The firm argued that the latter outperformed, but not by large margins, South African OEMs in terms of cost, lead times and innovation capabilities. In terms of quality, aftermarket services and full package capabilities, the South African OEMs were as competitive as the international ones.

7.3 Industry trajectory

[17] EPCM firms did not get involved in technology development with the OEMs and the mining company. They would only provide feedbacks to the OEMs regarding equipment performance.

The findings pointed to four main themes with regard to the trajectory of the industry: increasing importance of full package services and aftermarket services, localisation requirements and the export market.[18] The last one will be discussed in the next chapter.

Mining houses were increasingly relying on turnkey solutions from their suppliers. On the one hand this was due to their strategy to outsource any activity which fell outside their core business, on the other hand they struggled to access skilled labour, hence they had to tap into external expertise.

As a result, systems design and management responsibilities have been progressively shifted onto OEMs that had until recently only supplied equipment. These OEMs were upgrading to supply fully operational plants. This ate into the core business of EPCM firms, which would jealously protect process-related competences associated with putting together different equipment and systems. One OEM explained the details of its full package services offering: the firms supplied engineering and design of systems that maximised the purchase of their own technologies, requiring that at least 75% of equipment was sourced from its own portfolio. On the other hand, EPCM firms started offering their own branded equipment, which secured aftermarket business.

This two-fold development blurred the lines between OEM and EPCM, and most importantly had potential implications for tomorrow's most profitable activities in the capital equipment value chain. In terms of regional supplier capabilities, upgrading towards full package solution capabilities will require multiple strategies, including horizontal cooperation between OEMs to offer a full range of equipment or systems.

Aftermarket sales had become increasingly important for OEMs, especially in light of poor growth in South Africa's mining sector. Their capability to offer 'service exchange programmes', where the OEMs was responsible for every aspect of the equipment life span, would become increasingly important not only in South Africa, but also in areas like the Copperbelt where this trend was just starting. Access to skilled labour was of strategic importance to upgrade in this area.

Localisation requirements were likely to become more stringent not only in South Africa and Zambia, but in the entire African market. B-BBEE requirements and skills localisation requirements in Zambia already shaped the strategy of the OEMs. One OEM was planning a significant investment in Zambia, worth US$ 2 million. Planned investment included a bonded warehouse and a manufacturing facility for components, which implied that some activities would be relocated away from South Africa. The investment decision was driven by the need to upgrade the local presence, especially in light of the DRC market, and in order to meet more stringent local content requirements.

8 Extent and nature of regional linkages

South Africa's mining industry did not offer major growth perspectives for OEMs, except with respect to increased mechanisation, and hence opportunities of low and extra-low profile mining equipment, and large aftermarket services because of large installed fleet and equipment. For products more specifically linked to greenfield projects, such as conveyor systems, the only real growth opportunities rested in the export market.

[18] Other trends highlighted by the OEMs were the following: increasing mechanisation of mining in South Africa, mining becoming increasingly expensive and moving to remote areas in Africa and Latin America, increasing size of copper mining operations.

South Africa was a regional hub for the mining capital equipment supply chain. International OEMs targeted the entire SSA market, but SADC was the largest market.[19] South African OEMs targeted the global market. Other than the Copperbelt, their export markets included:

- SADC (Mozambique, Zimbabwe, Botswana, Angola, Namibia)
- Other Africa (Burkina Faso, Ghana, Sierra Leone, Guinea, Nigeria, Ethiopia),
- South America, Australia, Malaysia, Northern Europe (Sweden, Norway), India, Russia Mongolia

Export propensity between OEMs was high and varied across product groups:

- Mineral processing OEMs exported between 50 and 95% of their sales
- Conveyor systems OEMs between 30 and 60% of their sales
- Except for Bell Equipment, offroad vehicles OEMs around 30-35% of their sales
- Valves OEM only 10% of its sales

The regional market offered an important opportunity for South African OEMs focused on adapting technologies to Africa's environment (wet weather, weak skills base among workers and suppliers). Bell Equipment is one of South Africa's most successful OEMs, with a global footprint, and indeed exported 56% of its sales. Other South African OEMs however were struggling to enter the export market due to various intra-firm and exogenous constraints.

OEMs were looking at the Zambian Copperbelt as a regional supply centre for Central Africa. One OEM was investing in its Kitwe presence to set up a bonded warehouse to hold goods for cross-border sales to the DRC. The DRC in general was perceived such a risky environment that companies were not willing to set up a stable presence there. Apart from DRC, two OEMs were using Kitwe to supply also Tanzania, Botswana, Malawi, and Congo-Brazzaville.

The OEMs' internationalisation strategies in the Copperbelt showed two patterns. Firstly, there was a considerable amount of trial and error, with firms trying different strategies to enter the market, failing, and trying different ones. Failed strategies included working with local agents, cooperating with international OEMs on joint marketing and distribution, and trying JVs. In 2014 some South African OEMs were trying to set up a JV to build shared facilities. They had gone quite a long way in this process but the person who was driving the effort died. On the Zambian side, agents struggled to make connections with South African OEMs and the ones that were successful in setting up distributorship agreements had made significant efforts to gain the trust of the OEMs. It was also obvious that, without adequate support from South Africa-based OEMs, local Zambian firms were likely to fail to meet their expectations due to low firm capabilities.

Secondly, as expected, there was a progression from direct exports, to working with an agent or establishing a JV, to establishing a subsidiary. Direct exports reduced risks for the OEM, but there was a consensus that having local connections and knowledge increased market access. Plus being able to provide aftermarket sales was critical. Working with agents was difficult because they often lacked the technical knowledge to advice clients and they were not trusted to be loyal to one brand. For this reason, OEMs preferred sole distributorship agreements. In Zambia, conversely, many agents struggled to develop high trust relationships with their OEMs that would convince them to invest in training and higher stocks. The valves example is illustrative: according to trade data, 56% of Zambian valves were imported from South Africa. However, most of these were actually imported from China. Imports took place mostly through agents who lacked technical knowledge and were purely price-driven. As a result, the quality of valves supplied to mining houses was affected, with specifications of the

[19] Operations for the North African market were usually run from Europe.

valves ordered sometimes not matching the needs of mining operations and ending up in stocks of unusable valves piling up. In Zambia, in fact, a JV for high pressure valves did particularly well because the manager had a deep knowledge of the field, and had been in partnership with the South African OEM for long time. Unlike other agents, he was able to advise the mines, and provide repair services (although there was no investment from the South African partner in workshop facilities to upgrade this aspect of the business).

Establishing a subsidiary allowed firms to have complete control of their relationship with clients, and to ensure competitive aftermarket sales. Nevertheless this decision could be taken only if installed capacity at the mines justified the investment. Bell had the installed equipment to justify 5 branches: Kitwe, Mazabuka, Solwezi, Lusaka, Kitwe, and Mkushi. Smaller OEMs struggled to do so. It was estimated that it would cost R200 000 per month just for rent and employees (no equipment - with equipment it would be much more expensive) without a guarantee of securing orders. This was particularly risky for products that took time to sell. For example offroad vehicles are not products that "fly off the shelves" and often take up to one year to sell. For listed OEMs, having an installed capacity was essential for shareholders to agree to establish a subsidiary. The parent company policy could also be restrictive, for example, if it stipulated that there would be only one subsidiary per continent.

Localisation requirements had a two-fold effect on the OEMs' export strategies: local content policies in the Copperbelt forced many OEMs to take seriously the issue of employment, training and promotion of Zambian workers. For example an OEM employed 35 employees, of which only 3 were expatriates. Another OEM had 120 employees, of which only 5 were foreign expatriates and 80 were service technicians, split into one category of less skilled but proficient in reading electrical drawings, hydraulics etc, and another category of advanced skills. Given that these OEMs were heavily involved in aftermarket services, there was evidence that they built a local skills base. Local content policies in South Africa such as Eskom procurement policy may have had the perverse effect to reduce incentives for some firms to look outside the country, especially where the investment was difficult and uncertain.

The data suggested that linkages between South Africa-based OEMs and Copperbelt suppliers varied according whether these were subsidiaries or not (Table 11). Subsidiaries in the Copperbelt were supported by the South Africa-based OEMs in different ways: back up services, training of local staff, joint marketing, and access to credit lines. Training was done in-house and in South Africa (Table 12). In two cases, training occurred abroad, in Sweden and at a Mill Circuit University in South America. Zambia-based subsidiaries provided aftermarket services. Mostly, however they would not provide the entire range of repair and maintenance services, and fell back on the South Africa-based OEM for complex services. Moreover, only a few OEMs had plans to upgrade and build local capabilities.

Table 11: Zambia South Africa inter-firm linkages

	Linkages					**Local sub-contracting**		
	Back up support	Training	Credit	Joint product development	Joint promotion	Yes	Some	No
Subsidiaries	100%	100%	83%	0%	83%	0%	50%	50%
Others	33%	17%	0%	0%	17%	0%	17%	83%

Notes. N=12. *Source.* Interviews, 2014

Table 12: South Africa-based OEMs contribution to local knowledge intensification

	Training for Zambian firms	**Innovation in Zambia**

	In-house	In South Africa	Abroad	Support to local institutes	R&D budget	Product development	Subsidiary/agent involved in OEM/mine collaboration
Subsidiaries	100%	100%	50%	17%	0%	17%	17%
Others	17%	0%	0%	0%	0%	0%	0%

Notes. N=12. *Source.* Interviews, 2014

The OEMs which selected other entry modes, such as agents, JVs and direct exports, provided very little support to upgrade local capabilities. They did not have aftermarket services, did not invest in training and were not planning to do so. Credit lines were often tight or non-existent. These issues were raised by Zambian agents as a serious constraint to their competitiveness.

Taking into account higher value added activities, manufacturing and R&D, linkages were weaker even for the OEM subsidiaries. In terms of manufacturing, there was very little sub-contracting: small fabrication work, structural steel and lagging (Table 11). Beside OEM subsidiaries, Zambian supply firms in general struggled to source locally (only 10 – 30% of their inputs), for inputs such as machining jobs, casting, bearings, nuts and bolts. Construction companies had very high local content, except for steel imports from South Africa. OEMs would increase local sub-contracting if it reduced transport costs and helped meeting local content requirements, but the local manufacturing base was too uncompetitive, especially because the OEMs required ISO certified suppliers or at least firms with good quality assurance systems. It should also be noted that sometimes OEMs' global procurement strategy, set at HQs, relied on global low cost suppliers with little consideration for local content measures in the places like the Copperbelt. This made it difficult for the South Africa-based OEMs to work with local high cost vendors.

There was no joint product development and no R&D budget for the Zambian operations (Table 12). Even in cases where the South Africa-based OEMs cooperated with the mining companies in the Copperbelt to innovate or customise products, the involvement of local subsidiaries or agents was only in terms of logistics and providing customer feedback once the equipment was installed.

9 National and regional constraints

Two levels of constraints to firm upgrading emerged from the research: constraints at national level in Zambia and South Africa, and constraints of a regional nature.

Zambia was considered business friendly, more so than other neighbouring countries, in particular the DRC. There were nevertheless cost-raising factors which reduced the competitiveness of Zambia-based firms. These included unreliable electricity which meant firms had to invest in backup generators; poor quality and expensive industrial land; poor road and railway infrastructure – transport of a 20-foot container from China to Dar es Salaam or Durban costed US$2,000, but further transport to Lusaka costed an additional US$6,000 to 8,000; additionally the routes Kitwe-Chingola and Kitwe-Solwezi were unreliable due to poor road conditions. Some OEMs had to incur the expenses of chartering flights to deliver their equipment. Access to capital was reported by most Zambian firms, especially SMEs, as expensive and particularly problematic. The local business association also highlighted challenges in enforcing contracts between suppliers and mining companies.

There were also policy-related constraints. These included a withholding tax on expatriate labour; burdensome taxation regulations and procedures (Zambia Revenue Authority did not

allow firms to submit tax returns late even when most of them received payment three months after invoicing the mines); and high import duties on non-South African originating spares. The latter was particularly problematic because Zambia's tariff structure discouraged assembly operations (intermediate inputs attracted 5-15% duties) in favour of imports of final products. Some large suppliers benefitted from a new electronic payment system though a foreign bank, but this was not easy to access for smaller firms. Zambia's policy inconsistency was highlighted often during the interviews as a major impediment. For example, the hasty introduction and subsequent withdrawal of a regulation that required firms to trade in the domestic economy in Kwacha and not in US$. Another example often mentioned was the introduction of the export tax on copper concentrates, which prompted the mining companies to stockpile and put operations and capital expenditures on hold until the country built sufficient smelting capacity. This had the effect of reducing demand from supplier firms: two OEMs reported that their clients re-routed equipment originally ordered for Zambia to Latin America.

There was evidence that employment localisation requirements provided an incentive for OEMs to employ and train Zambian workers. There were however skills gaps, for example Zambian rock engineers were less trained and experienced than South African ones. The latter had to pass a demanding exam to become certified, which in 2013 only 5 out 80 passed, none of which was Zambian. Skilled Zambian workers were in high demand, and firms were struggling with workers' poaching. OEMs interviewed requested phase in flexibilities when establishing a presence in the Copperbelt. In parallel, it was difficult to get work permits for expatriate labour.

Access to procurement opportunities in the mining value chain was hampered by corruption and competition from briefcase businessmen. The latter would also import sub-standard products, which would require more active control measures from the Zambia Bureau of Standards (ZABS).

In South Africa, constraints faced by OEMs included skills scarcity, in terms of output and quality, with degree courses not conferring practical skills. Smaller South African OEMs struggled to find resources for marketing in Africa. Their turnover prevented them from accessing government incentives. Firms argued that their turnover was high due to the value of the equipment (one piece of equipment can cost R2.5 million), but did not reflect the volume of their sales nor their profitability. Hence, even a start-up or a SME could not access incentives which were earmarked for small companies. Moreover, smaller OEMs struggled to get funding to manufacture equipment to hold in stock, hence they were forced to make to order and lost sales opportunities from buyers interested in buying on the spot.

Moreover, smaller firms faced considerable red tape especially when exporting. For example, there were problems related to VAT payments. Copperbelt mining companies used to send trucks to South Africa on a daily basis to export copper. On the backhaul they would collect mining equipment. Previously, SARS did not charge VAT because it was recorded as an export. SARS had announced that it will not charge VAT only if the OEM transported the equipment to Zambia. This would imply that OEMs could not utilise "copper" transporters, which offered better rates.

The competitiveness of Tier 2 suppliers affected OEMs. For example, South African valves OEMs faced import competition where the cost of imports was 30% of cost of local manufacture. Steel castings in China costed R18/kg compared to R40/kg (early 2014 data). Moreover, imports would take 15-20 days lead times compared to 4-6 months for local production due to low capacity in the foundry sector.

South African firms needed more information from DTI on export market opportunities, incentives, and the implication of SADC for local OEMs. The DTI's Capital Projects Feasibility Programme (CPFP) covered 55% of the study costs. The objective was to have knock-on

effects on South African suppliers. However, interviews highlighted that some EPCM firms misused the funds thus the DTI clamped down on this project and limited its scope.

At regional level, there were two critical constraints. Firstly, there were conflicting local content policies in South Africa and Zambia. The DTI's ECIC local content requirements for a South African exporter into Zambia clashed with increasingly stringent localisation requirements set by the Zambian government. It was noted that indeed South Africa's industrial policy only targeted the domestic market not the regional one. Reciprocal and harmonised incentives schemes within SADC would provide a better framework to promote regional investment and mutually beneficial outcomes.

Secondly, the DRC offered important market opportunities for Zambia-based suppliers and South Africa-based OEMs. However, export documentation and handling requirements to DRC were cumbersome. Moreover, the DRC was characterised by a highly risky business environment which raised costs and reduced efficiency.

10 Summary conclusions and policy implications

The findings highlighted that in South Africa new entrants may struggle to enter the regional mining supply chain given the size and competitiveness of incumbents, but that there could be significant opportunities for lateral migration of technologies, hence for OEMs currently active in other resource and non-resource sectors to enter the mining value chain, and for mining OEMs to expand their markets beyond mining. In Zambia, barriers to entry were somehow lower because most suppliers were traders.

EPCM firms coordinated entry into the regional mining supply chain, especially for mineral processing equipment. They largely tapped into the South African mining inputs cluster for national and regional projects, with no preference given to South African OEMs. There was some evidence that OEMs supplying directly to the mining companies were finding it easier to offer more innovative products. Zambian suppliers were largely cut out of their procurement strategy.

In general, South Africa-based OEMs were characterised by significant degrees of local content, value addition and upgrading efforts. For international OEMs, considerable levels of R&D and manufacturing of low value added and high-IP content components were externalised to their parent companies or their globally-dispersed supply chain. South African OEMs had higher degree of value addition, but had to devise various strategies to cope with import competition, including distributing foreign products and importing some components. Zambian suppliers rested at the bottom of the regional value chain with low levels of specialisation, local content and value addition.

The regional value chain for mining capital equipment was driven by quality and TCO market parameters. Aftermarket services and full package capabilities were increasingly important and were found to be important elements in shaping the trajectory of the industry. Because they focused on TCO and quality, South Africa-based OEMs were able to withstand Chinese low-cost competition. For valves, however, which was a cost-driven value chain, cost reduction strategies were more important. Lead times for aftermarket services in the Copperbelt were critical.

Localisation requirements in Zambia were becoming increasingly stringent and there was evidence that employment requirements were already shaping the human resource strategies of OEMs in the Copperbelt. Localisation requirements in South Africa were discouraging some South African players to move into the regional markets.

South Africa was a regional hub for the mining supply chain. The OEMs' internationalisation strategies in the Copperbelt showed two patterns. Firstly, there was a considerable amount of trial and error in selecting modes of entry; secondly, OEMs progressed from direct exports, to working with an agent or setting up a JV, to establishing a subsidiary. The study found that South Africa-based OEMs supported their subsidiaries in multiple ways: back up services, training of local staff in the region and abroad, joint marketing, and access to credit lines. Zambia-based subsidiaries provided aftermarket services, but relied on the South Africa-based OEM for complex services. The OEMs which selected other entry modes, such as agents, JVs and direct exports, provided very little support to upgrade local capabilities.

Manufacturing and R&D linkages were weaker for any type of firm. There was very little sub-contracting and for very simple inputs, there was no joint product development and no R&D budget for the Zambian operations. Even in cases where the South Africa-based OEMs cooperated with the mining companies in the Copperbelt to innovate or customise products, there was no significant involvement of local subsidiaries or agents.

Suppliers in the region faced a range of constraints at national level, from poor infrastructure and policy inconsistency in Zambia, to skills constraints and scarce resource for regional marketing in South Africa. At regional level, two constraints stood out: inconsistency between local content policies in South Africa and Zambia, which made it difficult for firms to create a coherent strategy for investment and value addition, and difficult access to the DRC mining supply chain. The DRC was particularly important because Zambia was seen as a sub-regional hub for Central Africa.

The findings of this study suggest that there is significant scope for cooperation at regional level in the mining capital equipment value chain. A regional strategy to increase value addition in South Africa and Zambia should rest on two pillars:

3) Building a regional market across South Africa-Zambian Copperbelt-DRC Copperbelt.
4) Intensifying linkages between South African and Zambian mining inputs clusters.

Zambian and South African suppliers are already using the Copperbelt as a basis to participate in the DRC mining supply chain. OEMs find the DRC too risky to consider a solid market presence there. The DRC Copperbelt therefore offers an opportunity for Zambian suppliers to acquire larger economies of scale. This in turn implies that South Africa-based OEMs have more incentives to increase the value added content of their activities in the Zambian Copperbelt. This strategy however requires removal of barriers between South Africa, Zambia and the DRC. Such barriers include high transportation costs, and tariffs imposed by the DRC as a non-SADC FTA member. Lowering transportation costs requires regional cooperation in road and railways investment as well as on trade facilitation issues. Zambia and South Africa should facilitate the establishment of bonded warehouses. The latter would allow South Africa-based OEMs to move larger stock of equipment and spares to the Zambian Copperbelt to supply the regional market. It would lower transport costs thanks to bulk transport, and shorten lead times in supplying clients.

Linkages between South Africa-based OEMs and Zambian suppliers played an important role in supporting firm upgrading in the Copperbelt. A regional value chain strategy should leverage on this, and provide incentives to South Africa-based OEMs to build their market presence in the Copperbelt. Elements of this strategy should include cluster initiatives in South Africa and in Zambia to address constraints to firm upgrading, and establishing a regional approach to local content requirements which reduces conflicts in national local content incentives and support a win-win outcome. South African established OEMs and startup companies should be supported by DTI in establishing their Copperbelt subsidiaries and increasing their local value added content. This would be mutually advantageous: OEMs would become more competitive in terms of aftermarket services and lead times, and Zambia would benefit in terms

of, among others, employment, skills development, knowledge transfer, and sub-contracting opportunities. On the Zambian side, this strategy requires that local content policies are part and parcel of a broader industrialisation strategy. Multiple stakeholders, in particular the mining companies and the OEMs, need to be involved. Employment localisation requirements need to be complemented by an aggressive skills development strategy through technical and vocation schools and apprenticeship programmes. Particular support should be given to manufacturing companies to become Tier 2 suppliers to the OEMs, even if for simple, low value added components and spares initially. South Africa should have a forward looking policy and support Zambia's strategy in these areas. In the longer term, regional cooperation could target cooperation in technology innovation and R&D and higher value added activities in South Africa and the Copperbelt.

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