

South Africa's Industrial Expansion – The Role of Technology Transfer

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Abstract—The paper reviews South Africa's industrialization, the basis of its formation and to establish whether it can be expanded using technology transfer mechanisms principles. It also seek to draw comparisons from other industrialized countries and as a baseline, and take lessons on how these industrialized countries have achieved their secondary industrialization; hence they are known as the developed countries. It identifies the challenges faced by South Africa's current industrial base and recommend ways that could be meaningful in assisting it to be expandable. It also seeks to contribute to the existing body of knowledge on industrialization and technology transfer in advancing industry formation. It is also the intention of the paper to look at best principles outlined in operations management theories on how they could be of value in strengthening industrial formation and expansion. These principles include but not limited to the application of lean manufacturing principles, however they are not only applicable to the manufacturing sector but to any business optimization strategy. There will be emphasize on the role of the primary sector in South Africa's industrialization and the opportunities it ought to bring in strengthening and harnessing the success of the secondary sector formation.

Keywords—Industrialization, Expansion, operations and Technology transfer.

I. INTRODUCTION

SOUTH AFRICA is a mineral rich country and its industrialization was founded on the basis of its mineral resource endowment and this trend seemed to have remained throughout. This created a huge dependence on this depleting natural resource and seemingly the state did not put enough and decisive effort in dedicating resources to exploit opportunities presented by this sector and its potential to creating a long term secondary sector. This secondary sector focus would have a direct effect in assisting the country to deal with its triple challenges of unemployment (currently estimated to be at 24.9% as of the latest unemployment figures as released by [1], inequality and high poverty levels.

With the challenges of the 21st century's highly competitive global market, it is necessary to conduct a compelling study on how the current base can be transformed and allow an opportunity to further expand it.

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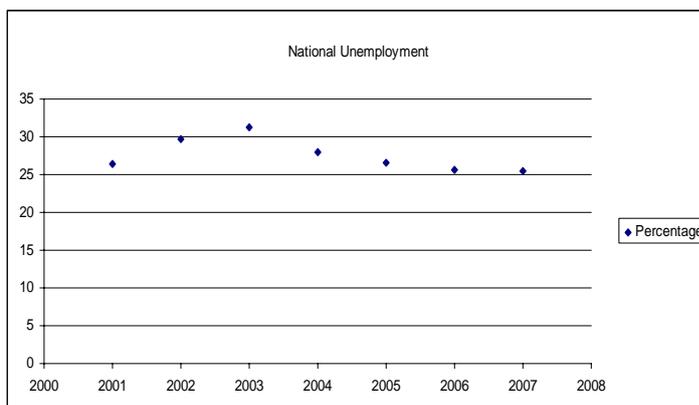


Fig. 1 Unemployment rate 2000 to 2008 (Source STATS SA, 2012)

It is the intention of the study to identify ways in which this industrial base can be expanded with the view of assisting in curbing these identified challenges using technology transfer and operations management principles as a tool and a guide to achieving that.

It is further expected that when the industrial base has been expanded, a ripe environment for the creation of new firms would be which would lead to new opportunities of employment being made available. Through technology transfer, it is expected that new sets of skills will be developed resulting to further sustainable jobs being created, as levels of innovation and creativity would rise. As the base expands, it is further expected that the growth domestic product (GDP) will increase as there will be more skilled people who will be easily consumed by the expanded industrial base and ultimately contribute towards government's target of economic growth of between three (3) and six (6) percent as the expandable income base would be larger.

The following conditions seems paramount in promoting industrialization; stable governments and well structured societies, strategic location of the country to its trading partners, heavy foreign investments, a low cost skilled and motivated workforce, a competitive exchange rate and low custom duties. Given these conditions, it is expected that some of these conditions would be beyond the direct control of the state; however being aware of the limitations allows the state to plan and put in place mitigating measures to manage and control the negative impact of those conditions to industry.

The study will not be able to identify solutions to all these conditions, but rather highlight constraints brought about by these conditions and create a platform for further studies to be conducted in finding ways that could assist in managing the

negative impact and possible contribute in efforts that would gravitate towards formation of possible solutions.

II. PROBLEM INVESTIGATED

South Africa's economy was built mainly on a mineral resource industry and allowed heavy reliance on the sector. The manner in which this sector was structured created an economy which is mainly consumption driven rather than an economy capable of producing foreign exchangeable goods and which came to be characterized by large scale capital intensive and resource based upstream activities. This was mainly due to the fact that there were no structured and focused efforts in maximizing full value chain creation of these minerals. Downstream beneficiation of these resources has never been realized.

Despite the remarkable progress that has been made in the trade reform, it is the matter of controversy whether the current approach to industrialization in South Africa will generate the required levels of growth, competitiveness and employment to break the country's level of unemployment cycle, inequality and poverty.

It is therefore necessary to investigate what would it take to ensure successful processing of downstream tradable products that would add the needed stimulus towards expanding the current industrial base.

III. INDUSTRIAL PERSPECTIVE

A. General View

There seems to be a widely accepted view that there is no single path to industrialization, each country is peculiar in its own way. Industrialization is referred to as an economic change brought about by technology. It is technology brought about by inanimate sources capable of continuous development as a result of applied scientific research. Effective usage of technology combined with human capacity may be called capital including the infrastructure that supports maintaining and increasing production. The creation of capital in industrialization results on accumulation of resources through limitations being placed upon consumptions. Industrialization could mean building up the entire supply chain locally [2]. The hard fact was that no country could become globally competitive without a broad and deep industrial base. Building such a supply chain takes decades, so considerations of scale; coordination and commitment pose massive development challenges.

A deep industrial base is a prerequisite for export success.

Reference [3] argues it is a widely accepted view that there is no single road to industrialization and each country is peculiar in this respect.

The right approach to industrialization is to stop looking for big ideas. He further argues that, there is one economics but many ways of applying it. Reference [3] suggests that the current nostrum of one size does not fit all is not itself a big idea but a way of expressing the absence of big ideas.

Reference [4] suggests the following:

- High development theorizing has overlooked the revolutionary transformation of industry and trade that occurred between 1985 to late 1990s
- The quest for Big Ideas may have failed because development economists are looking at 21st century industrialization using 20th century perceptions of trade and industry

Reference [5] suggests advances in science and technology leads to higher levels of industrialization. This in inverse creates goods and services that stimulate consumer goods demand. Increasing industrialization and corresponding profitability attracts investment capital, which leads to further industrialization.

B. South African Industrial Outlook

- 1) **Possible Constraints to the Current Industrial Formation:** The lack of access to technology and capital, control over education, a low level of commitment by industry to human resource development, research and development (R&D), promotion of best practice, poor supply chain relationships and excessively high inputs costs, created a poor skills base and low level of entrepreneurship within the South African context. This low level of entrepreneurship has gravely affected the creation of new industries.
- 2) **How to Improve the Situation:** There is a great need to bring into the mainstream economy new sectors. This requires a systematic approach and support for processing of products from raw or primary goods and converted to secondary or finished goods. This should be coupled by ensuring the logistics are good, the infrastructure is available and in good state, technology and other support processes for beneficiation are promoted and other means of converting for secondary utilization are encouraged.
- 3) **Industrial Policies:** The national industrial policy framework (NIPF) [6] sets out government's broad approach to industrialization with a number of key objectives. One of those is the promotion of a more labor absorbing industrial path with a particular emphasis on tradable labor absorbing goods and services. This is one of the principles underscoring the national growth path.

In addition to the above, the government has adopted an industrial policy action plan 2 (IPAP2) [7] following the first release of IPAP 1. This is aimed at creating systematic creation of industries. Cluster 1 of IPAP2 focuses on realizing the potential creation of metals fabrication, capital goods and transport equipment sectors.

Reference [8] argues that while it has been recognized that South Africa cannot ignore its basic comparative advantage in terms of the resource endowment, in light of current international and national trends, the limitations of a too exclusive reliance on simple export of unprocessed and semi beneficiated resources are also acknowledged. It has been pointed out that a sole reliance on base competitiveness, such as the abundance of natural resources and cheap unskilled labor force will create an increasingly low value economy.

4) **South Africa as a Developmental State:** It appears that external threats are some of the constraining factors which motivated industrial development in other countries highly industrialized countries. Alongside the external threats, other internal constraints also constitute an incentive to rapidly industrialize.

Similarly, South Africa should adopt this stance in looking at external constraints and converting them to opportunities for its industrial growth, for example lack of technology prowess can be turned as an opportunity to skill its labor force to be advanced in technology. Coupled with these external factors, it should look at its internal constraints such as low level of skilled work force as a demonstration that when these two factors are addressed, the country's industrial formation could take a step further towards its expansion. In the context of a developing country, technology is viewed as an important catalyst of corporate success and national economic growth [8].

Due to lack of resource capacities such as weak research and development (R&D), limited investment in R&D, production and manufacturing capability, weak infrastructure and technological disadvantage [8], many developing countries depend mainly on foreign direct investments (FDIs) from the multinational corporations (MNCs) as their primary source of technology to enhance the technological capabilities and competitiveness of local industries [9]. This is mainly because MNCs own; produce and control the bulk of world technology in which they undertake nearly 80% of all private R&D expenditures worldwide.

Given South Africa's basis of its industrial formation, there have been a number of new industrial strategies that are meant to deal with the following key issues:

- Investment and support of all stages of potential productive enterprises with particular emphasis being placed on industries engaged in the beneficiation of the country's diverse range of natural resources. This is meant to bring into the economy sectors of production that has not been there before. This requires a systematic support for the processing of products, ensuring that the logistics are good, infrastructure is good and that there is technological and other support necessary for the processes of beneficiation.
- Integration of manufacturing sector with the business services associated with the new economy (high-tech industries particularly those associated with the information and technology sectors).
- Simulation of regional production systems within Southern African region, beginning with raw material products and later evolving into assembly and manufacturing activities and greater export orientation.

It is apparent from review that industrial planning since 1994 of South Africa as it became a more liberalized economy, a considerable emphasis has been given to those sectors and industries which the country has a comparative advantage on, particularly those engaged in processing of mineral resources and energy. The limitations for a too

exclusive and semi-beneficiated resources are acknowledged as a constraint in the expansion of the industrial base.

It is argued that although resource based industrialization would perpetuate the pattern of dualism and inequality present in a typically resource rich country, it might not result in substantially worse interpersonal distribution than any other industrialization strategy ever being implemented.

Between 1945 and 1954 Southern Rhodesia (Zimbabwe) and South Africa experienced a decade of rapid industrial growth. It was the moment when Southern Rhodesia's economy 'took off' and categorized as follows, (1) and the period of South Africa's 'industrial revolution', (2) when 'manufacturing output grew especially rapidly', (3) Yet despite its importance as a watershed in the restructuring of regional political economy, neither this period nor the process of secondary industrialization have received much scholarly attention

C. Origins of South African Industrialization

Mineral discoveries in the 1860's, 1870's, and the 1880's had an enormous impact on Southern Africa. Diamonds were initially identified in 1867 in an area adjoining the confluence of the Vaal and the Orange rivers, although it was not until 1869 to 1870 that findings were sufficient to attract a "rush" of several thousands of fortune hunters. Four mines were developed, and the town of Kimberley was established. The town grew quickly and became the largest urban society in the interior of Southern Africa in the 1870's and 1880's. The economics of diamond production and marketing soon led to consolidation. Within two decades of the first diamond find, the industry was essentially controlled by one monopolistic company, Cecil Rhodes's De Beers Consolidated Mines. The diamond industry became the key to the economic fortunes of the Cape Colony by providing the single largest source of export earnings, as well as by fuelling development throughout the colony. Whereas the Cape's exports in 1870 had been worth little more than £2,000,000, with wool providing the bulk of earnings, by the end of the century the value of exports had risen to more than £15,000,000, with diamonds alone accounting for £4,000,000. Industrialization and Imperialism, 1870-1910.

Gold soon eclipsed diamonds in importance. Africans had mined gold for centuries at Mapungubwe (on the border with Zimbabwe) and later at the successor state of Great Zimbabwe, and they had traded with Arabs and Portuguese on the east coast of Africa. In the 1860's and the 1870's, Europeans made a number of small finds of their own, but the major development took place in 1886 when potentially enormous deposits of gold were found on the Witwatersrand (literally, "Ridge of White Waters" in Afrikaans, commonly shortened to Rand) near present-day Johannesburg. English speaking businessmen who had made their fortunes in the diamond industry quickly bought up all the auriferous claims and established a series of large gold-mining companies that were to dominate the industry well into the twentieth century. Industrialization and Imperialism, 1870-1910.

Although beset by a number of technological problems in its early days, gold mining on the Rand grew rapidly, with output increasing from £80,000 in 1887 to nearly £8,000,000, or one-fifth of the world's gold production, in 1895. By the end of the century, more than £60,000,000 of capital had been invested in the gold industry, most of it by European investors, who thereby continued the pattern developed at Kimberley that Southern Africa received more foreign investment than the rest of Africa combined. The gold mines employed 100,000 African laborers, five times as many as did the diamond mines, and drew these men from throughout Southern Africa, although most came from Portuguese-ruled areas of Mozambique. Johannesburg, the newly established hub of this industry, had a population of 75,000 Europeans by the end of the century, which made it the largest city in Southern Africa.

D. Industrialization in South Africa Post 1994

- *The Pre-1994 Industrial Economy: Stagnation and Crisis*

In the early 1990s South Africa faced an economic crisis. Gross domestic product (GDP) and investment rates were falling. The external capital account had been in deficit for almost a decade. Export growth of goods and services was volatile and sometimes negative. Furthermore, exports were highly concentrated around mining and mineral products. The exchange rate was overvalued. The tariff regime and industrial incentive schemes were indiscriminately protective of domestic industry. The legacy of apartheid in and outside the industrial economy has resulted in a widespread poverty, extreme inequalities and mass exclusion from economic activities. This led to high unemployment on the one hand and low levels of productivity and competitiveness on the other.

Recognizing these challenges, there was broad agreement that South Africa needed to shift away from its inwardly focused and uncritically protected domestic economy, and integrate into the global economy in a more export-oriented and diversified manner. Thus, the immediate focus of post-apartheid industrial and trade policy was a 'defensive' set of interventions aimed at arresting and reversing industrial decline.

- *Industrial Development Interventions since 1994: Restructuring*

The South African economy has undergone substantial high-level restructuring since 1994, notably the stabilization of the macro-economy and opening up to world trade. Macroeconomic variables such as inflation and the fiscal deficit have been stabilized, with the movement to a market-determined exchange rate regime. Trade liberalization was undertaken through South Africa's offer to the World Trade Organization (WTO) in 1993, coupled with the negotiation of two major free trade agreements thereafter: with the European Union (EU) and Southern African Development Community (SADC).

Industrial policy over the last ten years has largely been informed by the notion of 'supply-side measures' to

restructure the production side of the economy in order to deal with the increased global competition introduced by trade liberalization. This was in contrast to expensive and ineffective export support measures such as the 'demand led' General Export Incentive Scheme (GEIS), which tended to subsidize exports that would have occurred anyway.

Substantial sectorial support measures were put in place for two main sectors: 1) the Motor Industry Development Programme (MIDP) for automotive and 2) the Duty Credit Certificate Scheme (DCCS) for clothing and textiles. The National Industrial Participation Programme (NIPP) was put into place to ensure that large foreign purchases by state entities secure offsetting investment obligations in the domestic economy. New incentives were introduced to raise overall levels of manufacturing investment such as the Tax Holiday Scheme (THS), and the Small and Medium Manufacturing Development Programme (SMMDP) later extended beyond manufacturing as the Small and Medium Enterprise Development Programme (SMEDP). An incentive program for large, strategic projects was introduced.

- *Strategic Industrial Projects (SIP)*

The Spatial Development Initiatives (SDIs) were aimed at facilitating investment in regions of inherent economic potential, but that had been underdeveloped because of apartheid neglect. This was centered on a set of infrastructure corridors. The Critical Infrastructure Fund (CIF) was initiated to supplement the cost of project specific infrastructure. Legislation for Industrial Development Zones (IDZs) was passed to provide for purpose-built industrial estates linked to international ports or airports, which contains controlled Customs Secured Areas (CSAs). To date Coega and East London IDZs have been highly successful.

A range of support measures were put into place to support a shift to a more competitive environment.

These were generally based on the logic of getting small- and medium- sized firms to act collectively, to undertake functions that they would not do individually. Programs included the Sector Partnership Fund (SPF), Competitiveness Fund (CF), and support for the establishment of Export Councils, and the Export Marketing and Investment Assistance (EMIA) program. Increased matching grant support for research and development was introduced. The Support Programme for Industrial Innovation (SPII) provides funding for the development of manufacturing products and processes. The Technology and Human Resources for Industry Programme (THRIP) supports partnerships between the private sector, universities and science councils in research projects undertaken for industrial purposes.

Over the period, both the policy and the agencies for the support of Small Medium and Micro Enterprises (SMMEs) were developed and refined. This has culminated in the publication of the Integrated Small Business Development Strategy and the consolidation of small business support agencies into a single small and medium firm agency: the Small Enterprise Development Agency (SEDA) and the

Micro-finance Apex Fund (SAMAF) to support micro-enterprises. Legislative amendments to accommodate cooperative enterprises into the enterprise development system were also made.

In recognition of the apartheid legacy of high levels of corporate and industry concentration in the economy, a far more robust Competition Act was introduced in 1998. The rationale of the new legislation was that competition policy must form a fundamental part of industrial policy, by dealing with anticompetitive behavior flowing from concentration and facilitating entry and growth of small and black owned firms and foreign direct investment.

Various policies and programs were developed to facilitate Black Economic Empowerment (BEE), including the establishment of the National Empowerment Fund, and promulgation of the BEE Act, followed by the phased release of the Broad-based Black Economic Empowerment (BBBEE) Codes of Good Practice. The Black Business Development Supplier Programme was introduced to finance services to help black owned firms improve their core competencies.

- *Industrial Development Path since 1994*

While the potential for de-industrialization that loomed in 1994 was averted South Africa's economic performance since 1994 has been mixed. Gross Domestic Product (GDP) growth averaged three percent to 2003 and 4.5 percent since 2004, with GDP per capita growth rising from one percent to three percent. Per capita growth performance has slightly outstripped that of sub-Saharan Africa (1.1 percent) and Latin America (0.8 percent), but below that of high growth regions such as South (3.7 percent) and East Asia (6.2 percent).

This growth performance has occurred in the context of important structural changes in the South African economy. The tradable sectors such as agriculture, mining and manufacturing have undergone a relative decline in the economy: from 32 percent in 1994 to 28 percent of GDP in 2006. Private non-tradable sectors such as financial services; Construction; Trade; Catering and accommodation; Transport; Communications and other private services dominated growth, increasing from 47 percent to 56 percent. Public non-tradable sectors, Government and state owned enterprises also declined from 22 percent to 16 percent of GDP.

This structure of growth accounts for the changes in the patterns of formal employment since 1994.

Absolute employment numbers within the tradable sectors of the economy declined from 3,013,205 to 2,582,414, particularly in the two primary sectors: Agriculture and Mining. Public non-tradable employment remained more or less stable at around 1.6 million. Private non-tradable employment grew from 4,244,969 to 5,589,791. While total employment (i.e. both formal and informal) grew from 11,035,345 in 1994 to 12,179,346 in 2006 this was outstripped by the growth in the labor force, leading to unemployment of 26.1 percent in 2006.

Growth and employment have been fundamentally affected by developments with respect to the post-apartheid pattern of

capital and skill intensity. The highest growth sectors since 1994 have largely been in a skill-intensive non-tradable services and capital-intensive upstream resource-based manufacturing. Skill intensity across all sectors of the economy has increased, including the tradable sectors. However the overwhelming majority, over 70 percent of employment in the tradable sectors still comprises low and unskilled workers with around 60 percent in Manufacturing. By contrast, the private and public non-tradable sectors are far more skill intensive with low and unskilled workers accounting for only around one third of employment.

Fixed investment as a percentage of GDP during the transition period has been low but has grown to around 20 percent of GDP by 2006. Low levels of state owned company's investment have been a major contributor to overall low investment levels. Low state owned company's investment has negatively affected the tradable sectors in two important ways. First, underinvestment in transport facilities has led to inefficiencies with respect to exports of tradables. Second, low investment levels have resulted in the decline of important manufacturing sub-sectors that provide inputs into the state owned companies. Notwithstanding overall low investment levels, capital intensity in manufacturing has increased with growth in manufacturing being driven predominantly by capital intensive resource-processing industries with the notable exception being the automotive industry. However, substantial investments have also been made in sectors such as tourism.

Export performance has also been mixed over this period. There has been important diversification of the export basket away from reliance on minerals. Resource-based sectors continue to dominate manufacturing exports, although their share declined from over 74 percent in 1994 to 61 percent in 2006. The automotive industry has been the most important source of manufacturing export growth and diversification. South Africa has also not sufficiently integrated into rapidly growing areas of global trade, such as electro-technical products. Muted export performance in non-tradable goods and services is of concern in a context of high unemployment since skill intensity in these sectors is lowest and hence offers the best opportunities for creating employment for relatively unskilled workers.

In geographic terms, economic activity remains concentrated around the three traditional metropolises: Gauteng, Durban/Pietermaritzburg and Cape Town. Tertiary and secondary sectors dominate the economic structures of these more affluent provinces, with primary sectors accounting for a relatively small proportion of gross geographic product (GGP). Conversely, the poorer provinces tend to be more reliant on the primary sector, with a relatively small manufacturing base, except for Mpumalanga and the Eastern Cape. Similarly BEE in the manufacturing sector, in particular, has shown slow progress, with BEE transactions being most dominant in the mining and financial services sectors.

Reference [10] suggests that lack of access to technology and capital, control over education, a low level of commitment by industry to human resource development, research and development (R&D), the promotion of best practice, poor supply chain relationships and excessively high inputs costs, created a poor skills base and low level of entrepreneurship within the South African context. This low level of entrepreneurship and gravely affected the creation of new industries. There is a need to bring into the economy new sectors. This requires a systematic support for the processing of products from primary/raw materials to secondary/finished goods. This should be coupled by ensuring that the logistics are good, the infrastructure is available and in good state and that technological and other support for processes of beneficiation are promoted and other means of converting goods for secondary utilization.

Reference [6] sets the vision for South Africa's industrial framework trajectory is:

- To facilitate diversification beyond the countries current reliance on traditional commodities and non-tradable services. This would require the promotion of increased value addition per capita characterized particularly by movement into non-traditional tradable goods and services that compete in export markets as well as imports.
- The long term intensification of South Africa's industrialization process and movement towards knowledge economy
- The promotion of a more labor absorbing industrialization path with a particular emphasis on tradable labor absorbing goods and services and economic linkages that becomes a catalyst to employment creation.
- The promotion of broader based industrialization path characterized by greater levels of participation of historically disadvantaged people and marginalized regions to the mainstream industrial economy.
- Contributing to the industrial development in the African continent with a strong emphasis on building its productive capacity.

E. Causal Link between Strong Industrial Base and Economic Growth

Sustainable development cannot be achieved on a weak industrial base. There is a strong link between the level of industrialization, economic growth and development. Manufacturing is critical and probable the most important engine of long term growth and development.

Industrialization helps countries to achieve high growth rate, diversify their economies and reduce exposure to external global shocks (issues paper by African union commission on conference of African ministries of Economy and Finance).

F. Alternative Approach to Industrialization

Reference [10] argues that natural resources especially minerals, are a wasting asset; suffering long term price

decline, having volatile prices and being environmentally unfriendly and thus cannot contribute to industrial long term development. Arguments however fail to recognize that a number of developed countries (such as United States, Canada, the Nordic countries and lately Austria) have enjoyed economic success despite a reliance on such an unfashionable sector such as minerals. Key to the success of these countries' industrial development was the utilization of the resource base as a platform for achieving economic diversification. The further processing of natural resources together with the development and support of capital goods and services sector directly linked to the resource base played a pivotal role in ensuring that the benefits of the natural resource endowment continued long after their depletion.

The thinking towards integrative learning across lines and improving processes horizontally. Reference [11] argues that an operations management fundamental addresses bottlenecks, which are a generic everyday operational challenge. Reference [12] purports that operations management and supply chain management can facilitate the creation of competitive advantage that can lead to new business and firm growth development.

The understanding and application of some of these principles by relevant businesses are fundamental in improving and expanded the current industrial base of the country. Need to discuss more and link to industrialization and technology transfer in a convincing manner. It is clear that South Africa, unlike the other countries that are rich in natural resources was unable to convert these natural resources to finished tradable goods. An emphasis to further processing of natural resources to downstream processed products would have necessitated increase of technology usage and improve better trading advantage with the rest of the developed countries and improve means technology transfer. Key constraints to the development of manufacturing and other value added tradable sectors in South Africa are identified as follows:

- An exchange rate that remains volatile and generally over valued
- The high cost and limited allocation of capital to productive sectors, particularly the relatively more labor intensive and value adding sectors in the economy
- Failure to adequately exploit domestic supply opportunities of the public capital expenditure program, other large public fleet expenditure as well as private procurement expenditure
- The monopolistic provision and pricing of key inputs into manufacturing and other productive processes and the concentrated purchasing power of outputs of these sectors
- A weak skills system which does not adequately respond to the needs of the productive sector
- Aged, unreliable and expensive rail and ports system

Higher electricity prices and the transition to a lower carbon economy in the context of increasing climate change and environmental concerns is the challenge. Globally the impact of the recession continues to be felt, particularly with respect

to the slow recovery of South Africa's traditional trading partners. South Africa's value added exports have predominantly gone to traditionally advanced markets such as European Union (EU) and the United States of America, while primary and semi-processed commodity exports have been demanded by large developing economies such as China and India. South African manufacturing exports will thus be faced with a long and painful adjustment period. These challenges include:

- Bottlenecks and backlogs in logistics, energy infrastructure and skills, which constrains economic growth and raises costs
- Low domestic savings and inadequate levels of investment in the productive sectors of the economy
- Economic concentration and price collusion in key parts of the economy which raises costs and limits innovation and new enterprise development
- An uncompetitive currency that limits employment growth in manufacturing, mining, agriculture and tourism and
- A persistent balance-of-trade deficit funded with short term capital inflows attracted largely by high interest rates by international standards.

These are:

- Infrastructure, through the massive expansion of transport, energy, water, communications capacity and housing, underpinned by a strong focus on domestic industry to supply the components for the build programs
- The agricultural value chain, with a focus on expanding farm-output and employment and increasing the agro-processing sector
- The mining value chain, with a particular emphasis on mineral beneficiation as well as on increasing the rate of minerals extraction
- The green economy, with programs in green energy, component manufacture and services
- Manufacturing sectors in Industrial Policy Action Plan 2
- Tourism and certain high level services.

In each of these areas clear targets of the jobs potential has been developed and state agencies have now been directed to work on implementation plans. This looks like reproduction of government documents. Only the cream of the information must be summarized and referenced! The new growth path commits South Africa to work in partnership with other countries on the continent to build a single African integrated economy embracing one billion consumers, and to focus immediately on expanding economic links with the rest of the continent.

G. Transformed Industrialization

The second unbundling also transformed industrialization. Before the Information and Communication Technology revolution and the second unbundling, it was impossible to develop a globally competitive industry without a broad and deep industrial base. Typically the nations had to have their

productions bays inside their respective countries. After the second unbundling, advanced-nation firms offshored labor-intensive segments of their supply chain to developing nations. This completely changed the industrialization process in the developing nations that received these offshored stages. Of these changes it would seem that those involving technology were most radical. As rich nation manufacturers sought to produce certain parts, or complete certain manufacturing stages more cheaply, they moved production facilities abroad. The output had to mesh seamlessly with continually evolving production processes in other nations, so the multinational typically deployed its firm's specific technology in the foreign factory. This technology lending which is very different than "technology transfer" could revolutionize a developing nation's industry almost overnight. At first this was limited to export processing zones and "triangle trade" (i.e. Japan ships computer parts for assembly to China which ships the final good to Europe). As cost pressure led to growing specialization and scale, multiple developing nations were folded into the supply chain. This is clearest in East Asia where it can be seen in year 1985 versus year 2000.

H. Developmental State Agenda in Supporting Industrialization

The concept of a developmental state was first conceived of and used by in the Ministry of International Trade and industry and the Japanese miracle in his description of Japan's developmental scenario and industrialization process. Reference [13] portrayed the Japanese state as a plan-rational one that guided economic development by, among others, promoting technology transfer, planning industrial structure and providing incentives for achieving set targets [13].

The notion of a developmental state finds prominence in support of the countries growth in industrial base. In South Africa, policy makers have already proclaimed a developmental state before taking any steps towards realizing it, [14]. Recognition that the country has social, economic and institutional challenges makes developmental state imperative. Two main factors could assist in forging a South African democratic developmental state. First of all, the vast mineral wealth of the country is a potential enabling factor in that it could provide revenue to promote human centered development focused on improving education, health and other social services along similar lines as Norway [14]. However, cognisance must be taken of the fact that mineral or any other form of wealth is neither a necessary nor sufficient condition for the emergency of a developmental state [15]. Globalization has also been cited as another challenge, there are issues in balancing competing interests of ordinary people with those of investors. The most formidable challenge might be the existence of a dispossessed and disenfranchised black population.

I. Global Industrial Comparison

There are a number of economies that have performed successfully in recent decades despite a reliance on an unfashionable sector such as minerals. Most notable, in Sweden, Finland and the United States, the natural resource sector evolved from a position of low technology based, on low cost of labor to one that is characterized by a highly skilled, knowledge intensive and export orientated activities. Such a growth strategy was based not so much on the continued exploration of a rich natural resource base but on increasing the domestic value added associated with such natural resources and by promoting the development of those activities which naturally tend to cluster around resource based processing and extraction activities. These included industries supplying critical side stream inputs (capital equipment, consulting services, consumables etc) and activities engaged in the further processing or utilization of the outputs (downstream industries).

There is a view that for nations to achieve economic prosperity the following phases would apply:

- The economic growth is initiated by and limited to the development of industries associated factor endowments (Capital, labor, and natural resources). Despite the fact that virtually all countries begin their industrialization process at this state
- Repeated investment and upgrading in these initial competitive industries stimulates the emergence of cluster of similar and associated industries. Each cluster assists in broadening the individual base of the economy.
- Continual innovation and human resource development within firms and commitment by government ensures that growth is sustained and the competitiveness of the original resource base is maintained and embedded in other sectors throughout the economy. A central factor in this stage of development is a gradual reduction in the dependence of the economy on the initial factor endowments for competitive advantage.

IV. TECHNOLOGY TRANSFER

A. Role of Technology and Innovation

The process of industrialization is one of a shift from learning to use existing technologies to increasing innovation and development of domestic technologies.

Technology is channeled into an economy through three main conduits. First, it can be imported from abroad and adapted and adopted to local conditions. This is the most important form of technological absorption in the initial stages of industrialization. Second, it can be embodied in the form of foreign direct investment (FDI).

Reference [16] argues that a number of industries are extremely difficult to enter in the global market without attracting the proprietary technologies involved via foreign direct investment.

Finally, domestic research and development generates indigenous technologies. This is the most difficult but also potentially the most rewarding form of innovation and technology that a country can engage in due to its risky nature and the long-term time horizons involved in investment in new technologies or innovations.

B. Impact of Technology Transfer on Industrialization

As the main source of technology and knowledge, the multinational corporations provide their technologies to the host countries through various channels. The choice of technology channels depends on the nature of the technology, such as age, complexity, characteristics of the host country, the education levels of the workforce, availability of skills and the type of those skills, technology transfer requirements and the local competition. Reference [17] argues that exporting goods and services creates potential for transferring technological information to the technology recipient because they can easily absorb, adapt and improve the required technology in the capital goods and equipment's if they have the capabilities to undertake efficient learning. Exporting capital goods to the host country indirectly promotes technology transfer through trainings provided by the technology supplier's experts to the local firms especially on how to operate, maintain and repair the imported machinery. Reference [18], suggests that foreign research and development embodied in the imported capital goods has a significant positive impact on total factor productivity of the imported countries.

Reference [19] suggests technology is considered as a strategic factor for any country's development and an important means of success for the organizations. He further suggests that, technology development can be regarded as the most important step in the industrial development of the developing countries. This therefore suggests the transfer of these technologies from the developed countries to the developing countries seems to be necessary. He further argues that technology transfer is a link of directed actions through which a series of technology components are utilized in training, absorption and development. Technology transfer should be done with taking all of its components, such as equipment, employee, science and organization. Despite the dominant and significant role of mineral related activities in South Africa, particularly since the 1970's, it has been argued that there has been a historical wasting of resources. The economy was built on a minerals industry that consumed rather than produced, which was characterized by large scale, capital intensive and resource based upstream activities.

Reference [19] argues that an emphasis on minerals and energy related activities effectively led to policies which supported its core sectors and precluded the adoption of other industrial policies of diversification away from economic dependence on South Africa's resource base. Countries depending on traditional endowments for continued growth and development are facing increased competition. The information and communication technology revolution has

assisted in reducing many of the geographical barriers and transport costs associated with the export of raw materials. Raw materials are increasingly being traded internationally which has meant that the manufacturers throughout the world are faced with similar prices. Secondly, the diffusion of information and production knowledge has increased. Wider access to information and easier means of communication has enhanced the efficiency of markets and enabled capital and skills to flow to where they can be employed most productively.

Reference [10] attest that while it has been recognized that South Africa cannot ignore its basic comparative advantage in terms of its mineral resources, in light of current international and national trends the limitations of a too exclusive reliance on the simple export of unprocessed and semi benefited resources are acknowledged.

Due to lack of resource capacities such as weak research and development (R&D), limited investment in R&D, production and manufacturing capability, weak infrastructure and technological disadvantage [8], many developing countries fail to transfer and operate technology successfully. This is also because they depend mainly on foreign direct investments (FDIs) from the multinational corporations (MNCs) as their primary source of technology to enhance the technological capabilities and competitiveness of local industries [9]. This is mainly because MNCs own; produce and control the bulk of world technology in which they undertake nearly 80% of all private R&D expenditures worldwide. The technologies which are transferred by MNCs benefit the host country in terms of achieving long term economic growth, providing a higher potential of innovation performance/capabilities [20], increasing technological capabilities [21], enhancing the organizations competitive advantage [22], enhancing organizational learning effectiveness [23], providing a positive effect on productivity and increasing the technological development of local industry [24]. Innovation studies done on firm level in both the European and developing countries suggest that the sources of innovation, in the sense that new technology is brought in the firm is not from its own research and development or even local domestic research and development conducted by institutes of higher learning or special institutions [25]. The main sources are technology embodied in machinery and equipment, technical information and specialized inputs from technology suppliers of inputs and components, licensed technology.

Reference [26] suggests China is proof that its faster economic growth is attributable to its aggression in acquiring foreign technology, developing technological capability and diffusing technology. The main source of acquiring knowledge are trade, foreign direct investment, technology licensing, foreign education and training, use of diaspora, copying and reverse engineering and accessing foreign information in print and internet.

C. Basis for Technology Transfer

The importance of international technology transfer (ITT) for economic development can hardly be overstated. Both the acquisition of technology and its diffusion foster productivity and growth. As invention and creation processes remain overwhelmingly within the developed countries, most developing countries must rely largely on imported technologies as sources of new productive knowledge [27].

However, considerable amounts of follow-on innovation and adaptation occur in such countries. Indeed, these processes effectively drive technological change in developing nations.

Developing countries have long sought to use both national policies and international agreements to stimulate ITT.

In 2001, world trade organization (WTO) members established a Working Group on Trade and Technology Transfer to examine the relationship between trade and the transfer of technology and explore what might be done under WTO auspices to increase ITT to developing countries.

D. Technology Transfer Mechanisms

Many developing countries depend mainly on foreign direct investments (FDIs) from multinational corporations (MNCs) as their primary source of technology to enhance the technological capabilities and competitiveness of local industries [9]. This is mainly because multinational corporations own; produce and control the bulk of the world technology, in which they undertake nearly 80% of all private research and development (R&D). Technologies which are transferred by multinational corporations benefit the host country in terms of achieving its long term goals as it provides an opportunity for the host country with higher potential for innovation and increasing the technological development of the local industry [28].

Among the main and effective technology transfer channels are exporting, foreign direct investment, licensing and joint ventures. Reference [29] technology spill-over could occur through demonstration effects; when the local firms have the opportunity to learn by observing the multinational corporations operate their superior technology [30]. Exposure to the multinational corporation's superior technology may force local firms to improve their own production methods.

E. Technology Receiver

Technology development can be regarded as the most important step in the industrial and economic development of the developing countries, [19] suggests. Technology transfer is a linked chain of directed actions through which a series of technology components are utilized in training, absorption, development and economical uses in a place other than the original place. Technology transfer should be done taking all its components, such as equipment, people, science and the organization. It is expected that social and economic development from the field of technology transferred only if the transferred technology is in consistent with the different

social structures and when all structures contribute to the technology transfer in a concordant manner.

In any technology transfer project after knowing the technology, determining the policies and the appropriate provider of technology transfer is of great importance for the receiver of the technology. When the receiver of the technology decided to transfer a specific technology, he can then discuss the determination of policies and appropriate provider of technology transfer.

Reference [19] suggests that Technology Transfer process at any stage of its progression, including choosing the Technology Transfer project, choosing the providers and/or receivers and choosing the Technology Transfer method, requires decision-making. In any Technology Transfer, after knowing the technology, it is very important for the receiver of the technology to decide for policies and the appropriate provider of the technology is considered as a strategic factor an important means of success for the organizations, which are willing to be active in the scene of global competitions.

Technology transfer should be done with taking all of its components, such as equipment, employee, science & organization.

Reference [19] further suggests that on the technology transfer (TT) front there should be stages that must be taken into account. The process is of different and continuous stages and can be divided into three main parts:

1. Choosing and acquiring the technology
2. Concordance, utilization and absorption of the technology
3. Developing and spreading technology

Each one of the stages such as choosing the technology transfer project, choosing the provider(s) and receiver(s) of technology and choosing the technology transfer method requires decision making. Analytical Hierarchy Process has been used for analyzing the choice of technology for developing countries.

F. Criteria in Choosing Technology

The identified criteria for choosing a technology are:

- a) Ability to use technical knowledge for producing other products
- b) Ability to enhance and support creation of industry in the country
- c) Appropriate schedule in getting access to the technology
- d) Ability to train local human resource

G. Model for Technology Transfer

Reference [11] suggests there seems to be a great need for the state to encourage and support a concerted effort that will ensure there are workable partnerships between universities and industry.

Traditional definitions of technology transfer often assume a smooth shift of intellectual property. The term itself implies movement from one entity to another.

Exports are not the only form to exploit firm's technological advantage in international markets; another way is to transfer their know-how to foreign firms. However it would be expected that the host country has the capital

equipment and capabilities to exploit new ideas and devices into production. Another way of exploring innovation generated at home by international market, to install foreign direct investment productive facilities in host countries and produce in loco new products and processes.

It is rather unfortunate that developing countries seem to be receiving the crumbs of the transnational's innovative activities. It is rather clear the transnational companies do not find it convenient to locate technological activities in developing countries despite the significant wage differences.

Technology agreement seems to have become an important and growing channel to transfer know-how across countries.

A need for a new paradigm of technology transfer will be a greater collaboration between university and industry collocating in a single space to work on industry's problems as a way to further the research and commercialization of new technologies. Although this call for partnership is not new, these partnerships tend to be very difficult to enact. Industry resists working with universities because there is too much risk for the potential return on investment.

Among the conceptual models are Rous & Low which deal with determining the needs of the applicant of technology and the technological contribution respectively.

H. Impact of Globalization on Technology Transfer

The weight of science based commodities is constantly increasing in world trade; foreign direct investment (FDI) by transnational corporations (TNCs) is an important vehicle for the transmission of innovation across the world. Trans-border scientific and technological cooperation is absorbing more energies and resources of governments and firms. It is argued that globalization of technologies offers new opportunities for development, but that they are no means available without deliberate effort to absorb innovation through endogenous learning. Technology transfer has to be assessed jointly with the country's capability to make use of technology, absorb it and adapt it to local conditions. Access to acquisition of foreign advanced technology by itself is not sufficient to ensuring local technological and industrial development. Technology is not simply a set of blueprints, or of instructions that if followed to the tee will always produce the same outcome. Technology is not instantaneously and costless accessible to any firm. A firm does not simply select the preferred option from the freely available international technology shelf.

I. Technology Transfer Constraints

Reference [8] argues that in the context of a developing country, technology is viewed as an important catalyst of corporate success and national economic growth. Due to lack of resource capacities such as weak research and development (R&D) base, limited investment in R&D, production and manufacturing capability, weak infrastructure and technological disadvantage, many developing countries depend mainly on foreign direct investments (FDIs) from the multinational corporations (MNCs) as their primary source of

technology to enhance the technological capabilities and competitiveness of local industries. This is mainly because MNCs own produce and control the bulk of world technology in which they undertake nearly 80% of all private R&D expenditures worldwide.

Other research studies have proposed technology transfer as one mechanism by which developing countries can break the vicious cycle of economic underdevelopment. From the technology transfer initiatives, the host-country will also benefit in terms of improving quality of life, achieving technology progression through research and development, and increasing tax revenue.

The ultimate test of technology success is transfer of research to commercially viable and clinically useful products. This goal continues to be problematic in the technology for mobility area, [29].

J. Channels of Technology Transfer

Numerous channels exist through which technology transfer can happen. Trade in goods and services are one of them. All exports bear some potential for transmitting some technological information. Imported capital goods and technological inputs can directly improve productivity by being used in production processes. A second channel is foreign direct investment. Multinational enterprises generally transfer technological information to their subsidiaries, some of which may leak to the host country. A third major channel of technology transfer is direct trade in knowledge via technology licensing. This may occur within firms, amongst joint ventures or even between unrelated firms.

Technology transfer involves exchange of information between those that have it and those that do not have. The former cannot fully reveal their knowledge without destroying the basis of trade, creating a well known problem of asymmetric information. Buyers cannot fully determine the value of the information before buying it. This can lead to large transaction costs that stifle market based technology transfer.

K. Selecting Methods for Technology Transfer

Technology transfer has often been regarded as an important mechanism for increasing productivity, which is an important measure in production, commercialization and distribution of goods and services. In today's business environment, technology transfer plays an important role in the business strategy. Companies are increasingly dependent on technology transfer in dealing with the enhanced product complexity, greater customer and quality requirements for better service and increased competitive pressures.

Technology transfer methods depending on the type of technology and its supplies and recipient partners in some cases are very diverse. The degree of efficiency of each technology transfer method depend on some factors such as nature of technology, recipients technical abilities, recipients knowledge abilities, recipients human capabilities, suitable

infrastructure between partners and management of technology transfer.

L. Developed versus Developing Countries on Technology Prowess

The advantage of developed countries does not lie in the greater endowments of nonhuman inputs per worker or in superior overall efficiency as much as in a superior ability to exploit new technology. As a result, developed countries export new developed products and the rent on their monopoly in products accounts for their higher wages. Developed countries may have an added advantage in producing new products, and these advantages includes and not limited to a more skilled labor, external economies and a simple difference in social outlook.

The stocks of new and old products are determined over time by two processes of technological change. This is innovation and technology transfer. Innovation is the processes by which new products are created and technology transfer is the process by new products are transformed into old products.

V. OPERATIONS ON INDUSTRY

Developments in South African industry generally reflect the socio-political context of the time; this is according to [30]. They further argue that prior to the political emancipation of the country; the previous government followed a policy of inward industrialization with the purpose of becoming self-sufficient in most of its industrial needs.

Local companies were late in the adoption of contemporary operations management approaches such as world class manufacturing (WCM) and lean production.

Reference [11], production and operations management involves the management of the transformation processes in a business to providing for the manufacture of goods and/or for rendering of services [31].

He further purports that production and operations management is the closest that business comes to the act of creation and to creating value. As production and operations management entails creativity, productivity and adding value, it should be given pride of place in the affairs of any business. Production and operations management has passed through several stages of development, from basic agricultural activities to fast-growing cities with factories. POM grew out of the industrial revolution when Adam Smith, for instance, was known for his emphasis on the specialization of labor.

From an operations management perspective, cross-disciplinary research and practice is a fruitful approach that leads not only to new insights but also results in tangible benefits for firms.

Reference [32] suggests operations management and entrepreneurship can lead to new value creation across and within industry and firm-level boundaries. Operations management involves processes but rely heavily upon the ability to innovate and operationalize in a dynamic environment. Operations management and supply chain can

facilitate the creation of sustainable competitive advantage that can lead to new businesses and firm growth development.

VI. CONCLUSION

As a way of concluding, a growth strategy based not so much on the continued exploration of a rich natural resource but on increasing the domestic value added associated with natural resources is required. This should be supported by promoting the development of those activities which naturally tend to cluster around resource based processing and extraction activities.

Despite many positive and promising pointers, the country has not fully maximized on its good fortunes which, if it were to take full advantage of it, that could propel South Africa to a highly industrialized economy.

It is clear though that technology prowess and highly skilled personnel capable of operating and developing new technology plays a vital role in industrialization. This is evident in the highly industrialized nations that have a depth of highly advanced human capital and advanced technology.

It is apparent that for South Africa to ensure it reaps maximum benefits out of its natural resources there is a dire need for the country to dedicate resources in ensuring a highly skilled workforce is developed. This workforce should be in a position to take advantage of the opportunities created by technology transfer mechanisms; both in the form of being consumed by industries created through technology transfer and also provide an opportunity for them to create their own firms.

It is expected that through these technology transfer initiatives, a new set of skills would be developed which would result in new the development of new industries.

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