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The Challenge of Domestic Iron and Steel Production in Nigeria

By

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Research Article

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ABSTRACT

A vibrant iron and steel sector is necessary for the infrastructural and technological development of any nation. Nigeria is blessed with all the raw materials required for steel development including iron ore, coal, natural gas and limestone. At the third national development plan (1975 – 1980) specifically between 1976 and 1978, Nigeria commenced the construction of two integrated iron and steel plants located at Ajaokuta (ASC) and Aladja (DSC) and three rolling mills at Oshogbo, Jos and Kastina. The 1.3 mtpa ASC is based on blast furnace/basic oxygen furnace (BF/BOF) technology with rolling product capacity of 5.2 mtpa. DSC has a 1.0 mtpa steel melting plant for the production of 0.96 mtpa of billets and 0.32 mtpa of rolled products, while supplying 210,000 tonnes of billets each to Oshogbo, Jos and Kastina rolling mills. These projects were expected to kick start a vibrant iron and steel sector in Nigeria. However, due to several factors including political, technical, logistical and managerial challenges, all these publicly-owned iron and steel companies folded up in Nigeria. The privately-owned iron and steel companies, which are mostly rolling mills that dependent on the integrated mills for billets are now threatened due to lack of raw materials. The publicly-owned iron and steel companies (ASC, DSC and the three inland rolling mills) were privatized in 2000- 2005, but most of them are still moribund, except DSC that functions below her capacity. Except all these challenges are tackled, iron and steel development in Nigeria will be a mirage.

Keywords: Backward integration policy; employment effects, furnace, iron and steel policy; iron ore; policy instability.

1. INTRODUCTION

Nigeria is a fast developing country but lacks some basic infrastructure especially in the rural sector. The country has fared well in certain sectors of the economy such as oil and gas, telecommunication and recently in the cement manufacturing subsector. Nigeria currently produces over 2.6 million barrels of crude oil per day and has therefore installed extensive oil and gas facilities including nearly 200 flow stations, 3 refineries, 5 coastal terminals and extensive networks of pipelines, flow lines and bulk lines (Ohimain et al. 2004). In the last 10 years, the Nigerian telecommunication coverage has improved with the sector installing thousands of masts and associated cables. In April 2011, Nigeria had over 117 million connected lines with a teledensity of 64.70 (Okpanachi and Obute, 2011). Recently, the Nigerian cement manufacturing subsector has become self-sufficient producing over 28 million tonnes of cement, while the country's demand is nearly 20 million tonnes per annum. However, in the rural sectors certain basic facilities are still lacking such as good roads, portable water, railways etc. Agriculture, which the rural area is known for, is not optimal as they lack farm mechanization and facilities to preserve agricultural produce. Electricity in the country is poor and unstable with less than 45% of the people connected to the national grid (Adenikinju, 2003; Ibitoye and Adenikinju, 2007). Apart from the cement subsector, manufacturing activities is low due to shortage of electricity. The country's population is increasing at the rate of 3% and the population has now reached 167 million. Yet there is no adequate housing in the country. Iron and steel is required in all the aforementioned sectors. It has been recognized that the growth of Nigeria is slow due to lack of domestic production of iron and steel.

Iron and steel is very important for the growth of any modern society. Iron and steel plays a major role in the industrialization and infrastructural development. Though, Nigeria has the potentials of becoming a regional economy in the West African sub-region, but the economy of the country cannot be strong and vibrant without growth in its iron and steel sector or without the use of iron and steel in the manufacturing sector (Agbu, 2007). For instance, Nigeria is attempting to gather associated gas, which is currently being flared. Lots of gas utilization projects are emerging in the country including several thermal power plants, 2 additional LNG (Brass and Olokola), extension of West African

gas pipeline beyond Ghana to other West African countries and installation of the trans-Sahara gas pipeline to Europe. All these infrastructural development requires iron and steel. Nigeria is attempting to boost the agricultural sector and have released policies for the partial substitution of wheat in flour and inclusion of biofuel in Nigeria's automotive fuel mix (Ohimain, 2010, 2012). Nigeria is also implementing key millennium goal development (MGD) projects, which involves infrastructural developments such as irrigation, farm mechanization, food processing infrastructures, road and bridge construction, housing development etc. All these developmental activities requires iron and steel products.

Nigeria is blessed with all the major raw materials needed for the production of iron and steel including 3 billion tonnes of iron ore (Adebimpe and Akande, 2011; Bamalli et al., 2011; Nigerian Embassy, Hungary, 2012; Alafara et al., 2005), 3 billion tonnes of coal (Agbu, 2007), and limestone in excess of 700 million tonnes (RMRDC, 2001) and 187 billion SCF of natural gas. Meanwhile, the annual estimated per capita consumption of iron and steel in Nigeria has increased from 5 kg in 1968 (Adedeji and Sale, 1984) to 130 kg in 2012 (Uzondu, 2012). Planning for the Nigerian steel sector started in 1958 (Mohammed, 2002), but over 50 years after the country is yet to establish a stable iron and steel sector despite after huge investment of over $ 7 billion. Despite the huge investments in the sector, the Ajaokuta Steel Company (ASC) failed to take off while Delta Steel Company (DSC) and the three government-owned inland/satellite rolling mills in Oshogbo, Jos and Kastina are moribund, working under low capacity utilization. The reasons for the poor performance of the Nigerian steel sector include inadequate funding, poor planning and implementation and political influences (Agbu, 2007). Until recently, the nation's steel requirement was met since independence (1960) by imports from western nations particularly US, Great Britain, Germany, Japan and recently, by relatively cheap and sub-standard steel from some Asian nations (Agbu, 2007). The country is now spending a large portion of her foreign exchange for the importation of steel products, while still investing heavily in the domestic production of steel. This is double jeopardy. The privatization that was carried out in 2004 – 2005 did not revive the sector, but rather transformed the companies to private monopolies (Mohammed, 2008). Because the two integrated iron and steel companies in Nigeria (ASC and DSC) are unable to produce billets for the 20 steel rolling mills in the country, the sector is dependent on imported billets. But due to the high cost of billet importation, many steel companies are unable to function. The few steel companies that are operational though at low capacities, is now dependent on recycling of scrap iron and steel obtained mostly from municipal solid wastes (Ohimain, 2013; Ohimain and Jenakumo, 2013). The aim of this study therefore, is to appraise the Nigeria iron and steel sector with the view of suggesting the way forward. The study also provided an opportunity to update the information concerning iron and steel development in Nigeria. The methodology of this study is based on literature survey.

2. POLICY AND LEGAL FRAMEWORK AND THEIR EFFECTS ON STEEL DEVELOPMENT IN NIGERIA

Policies and legal framework are very important to guide development activities of any nation. Nigeria has released several fiscal and economic development policies. Vision 20: 2020 economic blueprint as approved by the federal executive council clearly recommended that the nation shall produce 12.2 million tonnes of steel per annum by the year 2020 out of which Ajaokuta steel plant is to produce 5.2 million tonnes/ annum, DSC to produce two million tonnes per annum and the remaining by private entrepreneurs if Nigeria is to join the league of 20 industrialized nation by 2020. Collier et al. (2008) presented economic policy option for a prosperous Nigeria. But this section of the paper is focused on policies pertaining to steel development in Nigeria (Table 1). It should however be noted that work has already started on adhoc basis in the iron and steel sector before policies guiding the sector was released. Planning for the Nigerian steel industry started in 1958, whereas exploration started at the Itakpe iron ore deposits in 1963 (Akinrinsola and Adekeye, 1993). Between 1961 and 1965, several foreign/western companies who came to assess the Nigerian steel sector reported that the sector is not feasible due to several reasons including lack of domestic market, high cost of the technology and infrastructural development, lack of manpower, poor grade of iron ore in Nigeria and other international political considerations (Agbu, 2007). However, in 1967, Russian experts came to Nigeria to conduct feasibility studies toward the establishment of iron and steel plant in Nigeria. During the period 1960 – 1970, the federal government directly coordinated the iron and steel sector in Nigeria.

There are instances of policy inconsistency. The vision 2020 document targeted the production of 2 million metric tonnes of steel products from DSC, whereas the plant is designed to produce 1 million tonnes of liquid still at full capacity. It is therefore uncertain if the government plans to expand the plant by doubling its capacity before 2020.

During the second National Development plan (1970 – 1974), the government established the National Steel Development Authority (NSDA) that was saddled with the responsibilities of iron and steel development in Nigeria. NSDA using Russian experts conducted various geological surreys that led to the discovery of commercial quantities of iron ore in Nigeria. During the third National Development plan (1975 – 1980), the government signed various agreements (1976 – 1978) for the construction of two integrated steel plants (DSC and ASC) and three rolling mills at

Oshogbo, Jos and Kastina (Mohammed, 2002). Through Decree No. 60 of 18th September 1979, the government dissolved NSDA, which metamorphosed into several organizations:-Ajaokuta Steel Company, Delta Steel Company, Jos Steel Rolling Company, Kastina Steel Rolling Company, Oshogbo Steel Rolling Company, National Iron Ore Mining Company, National Steel Raw Materials Exploration Agency, National Metallurgical Development Center, and Metallurgical Training Institute (Mohammed, 2002). While the three rolling mills and DSC were completed on schedule. ASC was not completed after over 40 years of intermittent construction work.

Table 1: Policy and legal framework pertaining to steel development in Nigeria

	Policy	Era	Implications	Effects
1	Decree No 19 of April 14, 1971	2nd National Development Plan 1970 – 1974 (FGN, 1970)	Setting up of the Nigerian Steel Development Authority (NSDA), functions • planning construction and operation of steel plant • Carry out geological surveys, market surveys, metallurgical research and training	Signaled the beginning of iron and steel development in Nigeria
2	Decree No. 60 of 18th September 1979	3rd National Development Plan 1975 – 1980 (FGN, 1975)	Dissolving the NSDA and establishing successor companies and research institutes	NSDA was dissolved and the following companies established; [i] Ajaokuta Steel Project, Ajaokuta [ii] The Delta Steel Company, Ovwian-Aladja [iii] Jos Steel Rolling Company, Jos [iv] Kastina Steel Rolling Company, Kastina [v] Oshogbo Steel Rolling Company, Oshogbo [vi] National Iron Ore Mining Company, Itakpe [vii] National Steel Raw Materials Exploration Agency, Kaduna [viii] National Metallurgical Development Center, Jos [ix] Metallurgical Training Institute, Onitsha
3	Import substitution policy	2002 - date	Reduction of product importation, while boosting domestic production	The policy encouraged domestic production
4	Backward integration policy, 2002	2002 – 2012	Companies importing steel products are to commence installation of steel production plants	ASC rolling mills were completed before the iron and steel making mills
5	Privatization policy 1999	2004 – 2005	Established the National Council on Privatization	Government owned steel companies were privatized during the 2004-2005 era
6	Vision 20: 2020	2002 – 2020	Set targets for steel production in Nigeria.	The nation shall produce 12.2 million tonnes of steel per annum by the year 2020 out of which ASC is to produce 5.2 million tonnes, DSC to produce 2.0 million tonnes and the remaining by private entrepreneurs

7	Fiscal year 2001 steel price tariff	2001 – date	Tariff in all rolled products increased from 30% to 65% and billets decreased from 10% to 5%	The change in tariff boosted domestic steel production

During the period 2002 -2012, the government implemented the backward integration policy, whereby import licenses for steel products were only granted to companies which have plans for domestic steel productions. Hence, the Russian contractors built the rolling mills in ASC first (and started using imported billets from Ukraine) before embarking on the steel plant, which was never completed till date. However, some authors reported that ASC was 98% complete as of December 1994 (Izon, 1995; Mohammed and Yusuf, 2004). In 1999 the government established the National Council on Privatization (NCP) and Bureau of Public Enterprises (BPE) which midwife the sale of ASC, DSC, National Iron Ore Mining Company (NIOMCO) and the rail track from Itakpe to Aladja to Indian companies, while the three inland rolling mills were sold to Nigerian investors. The privatization that was done was not transparent (Mohammed, 2008) and was unable to revive the steel sector. The inconsistent policy framework, corruption and poor contracting strategy led to the failure of the iron and steel sector in Nigeria.

3. IRON ORE EXPLORATION SUCCESSES AND CHALLENGES

Availability of raw materials is strategic to any manufacturing outfit. The major materials for steel production is iron ore and other input such as coking coal, limestone, dolomite, refractory clays and metal additives such as chromium, nickel, molybdenum, manganese etc. the nature of the mineral (physical and chemical), purity, concentration and availability in commercial quantities can affect the technologies required for mineral mining, processing, utilization, quality of the products and the general viability of the enterprise.

Exploration for iron ore started in Nigeria in 1963 (Akinrinsola and Adekeye, 1993) and by 1972/1973 commercial quantity of iron ore was discovered at Itakpe, Kogi state. By 1977, iron ore discoveries at Itakpe had reached 200 million tonnes (Ola et al., 2009). More exploration efforts yielded other discoveries in Agbaja, Ajabanoko, Chokochoko, Agbade-Okudu and Nsude Hills. Inventory of proven iron ore reserves in Nigeria is presented in Table 2, while iron ore reserves under investigation is presented in Table 3. Agbaja has the largest iron ore deposit of 2 billion tonnes.

Table 2: Nigeria iron ore reserves (%) and extent of development

	Percentage occurrence (%)									Reserved (tonnes)	Extent of development as at 2012
Location	Fe	Fe_2O_3	SiO_2	Al_2O_3	CaO	MgO	P_2O_5	MnO	TiO2		
Agbaja	45 – 54	62.64	8.55	9.60	0.72	0.38	4.16	0.14	0.37	2 billion	Exploration & development ongoing
Itakpe	38 – 45	53.10	44.80	1.00	0.30	0.20	0.05	0.05	0.10	200 – 300 Million	Operational but moribund
Ajabanoko	35.61	47.74	0.41				0.11	0.05	0.06	30 million	Exploration & development ongoing
Chokochoko	37.43	47.65	4.30				0.05	0.52		70 million	Yet to be developed
Agbade Okudu	37.43	29.41	0.62							70 million	
Nsude Hills	37.43									60 million	

Source: Modified from Federal Ministry of Petroleum and Mineral Resources (1993), Bamalli et al (2011)

Table 3: Nigeria iron ore deposits under investigation

Locations	State	Iron content, %
Muro Hills	Nasarawa	25 – 35
Dakingari	Kebbi	22 – 52
Tajimi	Kaduna	22 – 52
Ayaba	Kaduna	27.5
Rishi	Bauchi	14 – 19
Gamawa	Bauchi	40 – 45
Karfa	Borno	34 – 45
Eginija (Egenerga)	Benue	34 – 45
Oko	Anambra	34.4
Gbege		42.7
Ajase		39.0

Sources: Modified from Federal Ministry of Petroleum and Mineral Resources (1993), Raw Materials Research and Development Council (2010), Bamalli et al (2011) and other sources

Despite the abundance of iron ore in Nigeria, there are some technological challenges in using them for steel making. Apart from Agbaja that has an iron (Fe) concentration of 45 – 54%, the concentration of Fe in the other proven fields is medium, in the range of 35.61 at Ajabanoko to 38% at Itakpe. The other iron ore fields under investigation basically have low Fe content in the range of 14 – 52%. Low grade ores requires extra technology and investment in beneficiation plant to process the ores to meet the required standard for steel production. Secondly, Agbaja fields, which has the largest iron reserves (2 billion tonnes) and highest Fe concentration (45 – 54%) is challenged by the presence of high phosphate in the range of 1.25% (Obot and Anyakwo, 2012; Anyakwo and Obot, 2011) to 4.16% (Federal Ministry of Petroleum and Mineral Resources, 1993) as P_2O_5. Phosphorus has been reported to cause deleterious problems in steel responsible for brittleness causing the steel to fracture even under low stress (Obot and Anyakwo, 2012). Other problems associated with high phosphorous in steel include challenges of strong primary segregation during solidification of castings and formation of high brittle streaks between metal grains thereby impeding plastic deformation (Anyakwo and Obot, 2011), hence the phosphorous level in steel should be less than 0.02%. Adedeji and Sale (1984) reported that Agbaja ore is very irreducible at 1100ºC because of sintering of the ore. Other authors have reported technical challenges during the beneficiation of Agbaja ore (Uwadiale and Hall, 1985; Uwadiale and Nwoke, 1983), which resulted in the abandonment of the field (Anyakwo and Obot, 2011) until recently when an Australian firm started a fresh exploration and development of the field (Energio, 2011). Recent studies show that Banded Iron Formation (BIF) occurs in central Nigeria specifically in the Lokoja-Okene-Kabba triangle. The most notable iron ore occurrence in this region are found in Itakpe, Ajabanoko, Ochokochoko, Tajimi, Agbado-Okudu, Ebiya, Ero, Echaraku, Ozenyi and Udiarehu. Based on the % Fe content, the ores in this region could be classified as rich ores (> 50 % Fe), medium grade ores (30 – 50 % Fe) and lean ores (25 – 30 % Fe) which respectively constituted 4.5%, 85.4% and 13.1% of the total iron ore reserves (Synterra, http://synterra.co/index.php?option=com_content&view=article&id=72:iron-ore-deposits nigeria&catid=49:iron&Itemid=77&lang=en 07 December, 2012).

Apart from challenges associated with the iron ore deposits in Nigeria, there are also challenges with the coal deposits as well. Though Nigeria has large deposits of coal, but most of them are non-coking, hence, unsuitable for steel production. For instance, the country has largest coal deposits in Enugu, which is reasonably free of impurities, but it is non-coking. On the other hand, the Lafia-Obi coal has coking properties but is high in ash and sulphur, and the deposits has structural problems (Agbu, 2007). Other materials need for steel production is available in abundance in Nigeria. The country has abundant deposit of limestone in excess of 700 million tonnes (RMRDC, 2001), 1.87 trillion cubic feet of natural gas (Ohimain, 2010), scrap iron (Ohimain, 2013; Ohimain and Jenakumo, 2013), 837 million tonnes of limestone (RMRDC, 2001) and yet to be quantified ferro-alloy minerals such as manganese, vanadium, nickel, zircon, molybdenum, columbite, tantalite (Bamalli et al., 2011), however, bauxite is imported.

4. IRON AND STEEL DEVELOPMENT SUCCESSES AND CHALLENGES

Following exploration successes, the next stage is the development of the mine fields, installation of mineral processing equipment and iron and steel production facilities. Out of the six proven iron ore deposits in Nigeria (Table 2), only the NIOMCO at Itakpe was fully developed and started operations in 1977. The Itakpe iron ore has an iron content of 35%, hence a 2.5 metric tonnes beneficiation plant was installed in 1991/1992, which was designed to produce and supply 2.15 million metric tonnes/yr of 63/64% Fe suitable for blast furnace at ASC and 0.55 million metric tonnes of super concentrated 66/68% iron ore suitable for direct reduced iron technology at DSC (Ola et al., 2009; Mohammed, 2002; Adebimpe and Akande, 2011; Agbu, 2007; Ohimain, 2013), which represented 100% and 40% of iron ore requirement of ASC and DSC respectively. A standard rail link of 327 km was installed linking NIOMCO to DSC for the transportation of iron ore. The rail link has a capacity of transporting 20 million tonnes of iron ore per year. NIOMCO which employed 1892 staff (Agbu, 2007) was designed to beneficiate about 3.3 million tonnes per annum (Mtpa) of concentrated iron ore.

Recently, (2011 – 2012) an Australian company Energio Ltd, acquired licenses to explore and develop the Agbaja and Ajabanoko iron ore fields. The company plans to drill 700 exploration holes which will total 20,000m, representing about 10% of Agbaja field. The exploration target of the company is 2.0 – 3.3 billion tonnes of iron grade in the range of 40 – 53% Fe, 1.2 – 2.7 billion tonnes of Iron in the range of 40 -53% and 1.2 million tonnes of banded iron formation in the grade range of 30% Fe, with rock chippings having a grade of 55%, therefore showing potential of direct shipping ore. The company planned to develop Agbaja field by producing at 10 mtpa (Energio, 2011). Agbaja field development has other benefits because it is well serviced by roads, it is within 50 km to ASC and the 414 MW Energy Power Plant, it is about 68 km to NIOMCO and the Itakpe-Warri rail line, it is located 300 km southwest of the Nigerian capital, Abuja.

At the third national development plan (1975 – 1980), specifically between 1976 and 1978 contracts were awarded for the construction of two integrated iron and steel plants (ASC and DSC) and three rolling mills at Oshogbo, Jos and Kastina. The 1.3 mtpa ASC is based on blast furnace/basic oxygen furnace (BF/BOF) technology with rolling product capacity of 5.2 mtpa. DSC has a 1.0 mtpa steel melting plant for the production of 0.96 mtpa of billets and 0.32 mtpa of rolled products, while supplying 210,000 tonnes of billets each to Oshogbo, Jos and Kastina rolling mills.

The contract for the construction of DSC was awarded in 1975 to a German-Austrian consortium to install a turn-key Electric Arc Furnace (EAF) with direct reduced iron (DRI) technology in Ovwian-Aladja, Delta State. The project was completed in schedule in 1981 and the plant became operational 29 January 1982. DSC is equipped with 1.5 mtpa pellet plant, two Midrex DRI plant of 510,000 tpa capacity each, 1.8 mtpa electric arc furnace with three, 6 strand continuous casting plants and 320,000 tpa 18-stand rolling mills and a power plant of 110 MW. DSC was strategically located close to oil fields in the Niger Delta for the supply of gas direct reduces iron. DSC location is well serviced by roads, linking to Itakpe mining site by rail and close to Osubi Airport and Warri sea port.

The three inland rolling mills (Oshogbo, Jos and Kastina) were similarly installed on schedule. German firms installed Oshogbo and Jos, while Japanese firm supervised the installation of Kastina rolling mills.

While successes were achieved for the construction of DSC and the three inland rolling mills, construction of ASC was never concluded. Over the years, several EPC contracting firms (Table 4) were engaged. The contract which was originally awarded in 1979 was scheduled for completion in 1986 (Mohammed, 2002), was never completed after spending over $ 4.5 billion up to 2002 (Mobbs, 2002) without producing any iron from crude iron ore. The government has continued to spend money without being able to complete the project. After over 40 years of intermittent construction work, facilities installed at the ASC site are listed in Table 5.

The reasons for the failure to completely install and operate the ASC are many. The project appeared too massive for a nation without any previous experience in steel making. Mid way towards the installation, the capacity was doubled. This would definitely lead to variation in the cost of installation. The general contracting procedure was faulty resulting in different EPC contractors working at different times. There were several years of dormancy (no activity) during the construction period. For instance, from mid 1990 to 2005, a period of 15 years, there was no meaningful construction activities at the site. Also, the rolling mills that were completely installed where not operated for 14 years (Agbu, 2007). After each period of dormancy, it costs the government huge amount of money to continue the construction work. In fact, it would have been better to install a turn-key plant at Ajaokuta rather than attempting to design a steel plant. This strategy worked well for DSC. The rivalry between the western and Eastern blocs also negatively affected the project. It appears that western nations are unwilling to support the project. The eastern bloc that supported the project, were unhappy that Nigeria is politically pro-west.

Table 4: Companies that have attempted to install or operate Ajaokuta Steel Complex

Era	EPC contractor (Lead)	Achievements (work done)
18 September 1979 - 1999	Tiaj prom export (TPE), Russia	Facilities installed include; iron plant, steel plant, power plant, rolling mills
13 October 2003 – 2004	Solgas Energy, USA	No visible progress
2001 – 2003	TPE	Project was incomplete
August 2004 – 2013	Global Infrastructure Holding Ltd (GIHL) member of Ispat industries Ltd, India	November 2004 rolling plant began operation and by 2006 BF started working. Steel products were produced and even exported to Ghana and Sierra Leone

Table 5: Installed facilities at Ajaokuta steel complex

S/N	Type	**Plant unit**	**Capacity (p.a)**
1	Rolling mills	Light section mill (320mm)	400,000 tonnes
		Wire rod mill (150mm)	130,000 tonnes
		Billet mill (900mm//630mm semi continuous)	795,000 tonnes
		Medium section and structural mill (700mm)	560,000 tonnes
2	Iron and steel mills	Blast furnace	
		Sintering plant	
		Raw materials preparation and handling system	2,640,000 tonnes
		Alumino-silicate refractory plant	43,400 tonnes
		Tar-bonded dolomite refractory plant	8,800 tonnes
		Lime plant	91,000 tonnes
		Coke-oven battery (1 of 2 completed)	440,000 tonnes
		Oxygen plant	36,000 m^3/hr
3	Engineering works complex	Foundry and pattern making shop	7, 000 tonnes
		Forge and fabrication shop	8,800 tonnes
		Machine and tools shops	19,000 tonnes
		Power equipment repair shop	Repair of electric motors/ generators etc.
		Rubberizing shop	Repair of conveyor belt; manufacturing of seals etc
		Erection base	Fabrication/assembly of various structures/ components
4	Power plant	Thermal	110 MW

Source: modified from Mohammed (2002), Agbu (2007)

Government direct interference on the project especially following the dissolution of NSDA in 1979 was too much. The policy climate was unstable (Table 1). The location of the project at Ajaokuta appears to be politically motivated. Agbu (2007) reported that 3 sites (Onitsha, Warri and Ajaokuta) were initially selected for the project, and Onitsha was the preferred site. But due to political consideration above national development, the project was sited at Ajaokuta. The same political considerations influenced the location of the three inland rolling mills at Oshogbo, Jos and Kastina, which are ment to receive billets from far away DSC.

At a time, the government implemented the backward integration policy in the manufacturing sector. Application of this policy in ASC resulted in the installation of the rolling mills before the iron and steel productions facilities like the furnaces. Hence, it became possible to operate ASC using imported billets from Ukraine, yet the company is unable to produce iron from basic ore. A company that was originally designed to produce billets from iron ore operated epileptically on imported billets. At a time, the company was privatized to an India company, who was also unable to fully revive or complete the installation of the plant. ASC also faced some technological uncertainties. An American company recommended the installation of strategic Udy process, a direct reduction process that was being tested as at then . But this process failed to meet commercial scale requirements

(Mohammed, 2002). Russian experts recommended BF/BOF that was finally installed at ASC. At a time when there were challenges in the plant, Kolbe steel (Japan) recommended the removal of the BF/BOF and replacing it with fast melt direct reduced iron, this strategy was not accepted by Nigeria. Few publications reported that ASC was 98% completed as at December 1994 (Izon, 1994; Mohammed and Yusuf, 2004). However, an attempt to revive ASC through securing $104m from World Bank failed, because the bank considered the more than 25 years old Russian BF/BOF as obsolete as at 2002 (Mobbs, 2002). Recently (January, 2013), the UK Department for International Development (DFID) described the ASC as marginal (Chukwu, 2013). Following the government policy on privatization, ASC was conceded to Indian firms, which was terminated in 2013.

5. OPERATIONAL CHALLENGES

The Nigerian steel sector faced a lot of operational challenges primarily due to poor planning, contracting strategy, design, funding and political instability. For instance, the political location of most of the steel projects made their operations costly. Iron was being mined at NIOMCO, Itakpe in North central Nigeria. It was being sent to DSC down south for the production of billets, a distance of 327km by rail. Billets produced from DSC was sent to the three inland rolling mills, one in south western Nigeria (Oshogbo), another in North central (Jos) and the third in North West (Kastina), all these locations being far from Aladja from where the billets were produced. Of course, this practice attracted a huge logistical cost.

Another challenge is that of funding/operational cost. After the successful construction of DSC, NIOMCO folded up, DSC followed and because of lack of billets the other three government owned rolling plants also folded up. Following the privatization of the public steel companies in Nigeria (2004 – 2005), the DSC started operations in December 2005 after about 10 years of inactivity (Agbu, 2007), though, the three inland rolling mills are still moribund. Lack of transparency in the privatization process also contributed to the collapse of the Nigerian steel sector.

At inception, the country lacked trained manpower for steel production. But during the third national development plan (1975 – 1980), thousands of Nigerians were trained in Nigeria and abroad (India, Russia, Germany, UK, Japan etc). Unfortunately, when the public steel sectors collapsed, the staff were left in limbo for a long time, which resulted in the accumulation of huge pension liabilities. These huge pension liabilities made the steel companies to attract fewer premiums during the privatization exercise. Agbu (1992) reported that factors constraining the iron and steel industry in Nigeria are many including inadequate funding, poor planning and implementation and political considerations rather than economic and technical considerations that influenced the location of the government-owned iron and steel companies. Thus resulting in a situation where some of the projects were uncompleted (ASC) and those that were completed operated below capacity (DSC and the inland rolling mills).

Nigeria lost a golden opportunity to employ a lot of her citizens by not completing the Ajaokuta steel project. If the phase 1 of the project was completely installed and operational, the multiplier effect would have been enormous including direct employment of 10,000 workers at the plant, 20,000 in the raw materials industries and 30,000 workers in downstream industries utilizing iron and steel products (Mohammed, 2002). On 13 October 2003, the government entered a contract with Solgas Energy, USA, to rehabilitate, complete, commission and operate ASC. As part of the agreement, 9000 jobs were to be generated for the steel plant, 10,000 jobs for the power plants (Agbu, 2007). All these opportunities eluded Nigeria due to the non-completion of the Ajaokuta steel projects.

6. CONCLUSION

Nigeria is blessed with abundant iron ore, coal, natural gas, limestone and other raw materials needed for the production of iron and steel and the development of a vibrant iron and steel sector. Planning for iron and steel in Nigeria started in 1958, while exploration of iron ore started in 1963, and by 1972, commercial quantities of iron ore was discovered at Itakpe. Other discoveries soon followed. Nigeria now has over 3 billion tonnes of proven iron ore reserves. At the end of the third national steel development era (1975 – 1980), contracts were awarded for the construction of two integrated iron and steel plants (ASC and DSC) and three inland rolling mills located at Katsina, Oshogbo and Jos. Apart from ASC that was partially completed, all the others were fully completed and commissioned. These projects were expected to kick start a vibrant iron and steel sector in Nigeria. However, due to several factors including political, technical, logistical and managerial challenges, all the publicly-owned iron and steel companies folded up in Nigeria. The privately-owned iron and steel companies, which are mostly rolling mills that are dependent on the integrated mills for billets are now threatened due to lack of raw materials. The publicly-owned iron and steel companies (ASC, DSC and the three inland rolling mills) were privatized in 2000- 2005, but most of them are still moribund, except DSC that functions below her capacity.

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REFERENCES

Adebimpe, R.A. and Akande, J.M. (2011). Engineering economy analysis on the production of iron ore in Nigeria. Geomaterials 1: 14 – 20.

Adedeji, F.A. and Sale, F.R. (1984). Characterization and reductbility of Itakpe and Agbaja (Nigerian) iron ores. Clay Minerals 19: 843 – 856.

Adenikinju, A. F. (2003). Electricity infrastructure failure in Nigeria: a survey-based analysis of the costs and adjustment responses. Energy Policy. 31, 1519-1530

Agbu, O. (2007). The iron and steel industry and Nigerias industrialization: Exploring cooperation with Japan. Institute of developing economics, Japan external trade organization.

Agbu, O. Technological acquisition, development and infrastructural politics; a case study of Nigeria's Ajaokuta Steel Project 1967 – 1992. PhD thesis Department of Political Science, University of Nigeria, Nsukka

Akinrinsola, E.O. and Adekeye, J.I.D. (1993). A geostatisical ore reserve estimation of the Itakpe iron ore deposits Okene, Kogi state. Journal of Mining and Geology 29 (1): 19 – 25.

Alafara, A.B., Adekola, F.A. and Folashade, A.O. (2005). Quantitative leaching of a nigerian iron ore in hydrochloric acid. J. Appl. Sci. Mgt. 9(3): 15 – 20.

Anyakwo, C.N. and Obot, O.W. (2011). Laboratory studies on phosphorous removal from NigeriasAgbaja iron ore by *Bacillus subtillis.* Journal of Minerals and Materials Characterization and Engineering 10(9): 817 – 825.

Bamalli, U.S., Moumouni, A. and Chaanda, M.S. (2011). A review of Nigerian metallic minerals for technological development. Natural Resources 2: 87 – 91.

Chukwu, L. (2013). Fresh controversy over PIB, Ajaokuta steel company. The Guardian Sunday 13 January, 2013.

Collier, P., Soludo, C.C. and Pattillo, C. (2008). Economic policy options for a prosperous Nigeria. Palgrave Macmillian.

Nigerian Embassy, Hungary (2012).Solid minerals.http://nigerianembassy.hu.Accessed 7 December 2012

Energio. (2011). Energy on the cusp of major iron ore opportunity in Nigeria. Proactive investors. Run by investors for investors. Federal Ministry of Petroleum and Mineral Resources, (1993). Inventory of Nigerian Minerals, Mines and Miners. Pp. 1 - 29. Federal Republic of Nigeria (1970). Second national development plan 1970 – 1974, Lagos, Central planning office, federal ministry of economic development. Federal Republic of Nigeria (1975). Third national development plan 1975 – 1980, Lagos, Central planning office, federal ministry of economic development.

Ibitoye F.I., and Adekinikinji, A. (2007). Future demand for electricity in Nigeria. Applied Energy 84: 492 – 504

Izon, D. (1994). The mineral industry of Nigeria. United States Geological Survey Minerals Book 1994. USGS.

Mobbs, P.M. (2002). The mineral industry of Nigeria. United States Geological Survey Minerals Book 2002. USGS.

Mohammed, S.A. and Yusuf, H. A. (2004). Ajaokuta Steel Company Ltd. African Iron and Steel Development Association, Abuja, Nigeria, 6th April 2004

Mohammed, S.A. (2002). Nigerian steel industry-historical development. African Iron and Steel Development Association, Abuja, Nigeria

Mohammed, S.A. (2008). Privatization of the iron and steel industry in Africa. Paper presented at the 8th International Arab Iron and Steel Conference, held at Doha, Qatar 17th – 19th march, 2008.

Obot, O.W. and Anyakwo, C.N. (2012). Removal of phosphorous from Nigeria's Agbaja iron ore through the degradation ability of *Micrococcus* species. International Journal of Water Resources and Environment Engineering 4(4): 114 – 119.

Ohimain, E. I., Andriesse, W and van Mensvoort, M.E.F. (2004). Environmental Impacts of Abandoned Dredged Soils and Sediments: Available Options for their Handling, Restoration and Rehabilitation. Journal of Soils and Sediments, 4 (1): 59-65.

Ohimain, E. I. (2010). Emerging bio-ethanol projects in Nigeria: Their opportunities and challenges. Energy Policy**.** 38: 7161-7168

Ohimain, E. I. (2012). The benefits and potential impacts of household cooking fuel substitution with bio-ethanol produced from cassava feedstock in Nigeria**.** Energy for Sustainable Development. 16: 352 – 362

Ohimain, E. I. (2013). Scrap Iron and Steel Recycling in Nigeria. Greener Journal of Environmental Management and Public Safety. 2 (1): 1 - 9

Ohimain, E. I. and Jenakumo, C. B. (2013). Scrap metal recycling and valorization in Bayelsa State, Nigeria. The Journal of Materials Science. 119: 137 - 147

Okpanachi, E. and Obutte, P. C. (2011). Can Institutional Reforms Liberate Africa from the Globalization Ghetto? Lessons from Economic Reforms in Nigeria's Fourth Republic. Paper presented *at* The 4th European Conference on African Studies (ECAS 4) on the theme: „African Engagements: On whose terms?" at Ekonomikum - Centre for research and education in economics and social sciences, Uppsala University, 15-18 June, 2011.

Ola, S.A., Usman, G.A., Odunaike, A.A., Kollere, S.M., Ajiboye, P.O. and Adeleke, A.O. (2009). Pilot scale froth flotation studies to upgrade Nigerian Itakpe Sinter Grade iron ore to mixres-grade super-concentrate. Journal of Minerals and Materials Characterization and Engineering 8(5): 405 – 416.

Raw Materials Research and Development Council (RMRDC, 2001). Technical brief on minerals in Nigeria. Limestone/marble. ISBN: 978-2043-73.9.

Raw Materials Research and Development Council (RMRDC, 2010). Steel raw materials in Nigeria. ISBN: 978-2043-79-6.

Uwadiale, G.G.O.O. and Nwoko, M.A.U. (1983). Beneficiation of Agbaja iron ore by reduction roasting-magnetic separation: semi pilot plant scale-up and establishment of residence point of phosphorous, National Steel Council, Metallurgical Research and Test Division, Jos, Nigeria.

Uwadiale, G.G.O.O. and Hall, A.J. (1985). Mineralogy of ironstone from Agbaja deposit Nigeria in relation to beneficiation. Trans. Inst. Minerals and Metallurgy 94: 161 – 165.

Uzondu, J. (2012).The thriving scraps metal business. Nigerian World 01/17/2012.