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THE FOUNDRY INDUSTRY: A SUSTAINABLE INDUSTRIALIZATION AND DEVELOPMENT STRATEGY FOR NIGERIA

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ABSTRACT: *A nation's technological growth and economic development is often predicated on her level of industrial practice and manufacturing. Nigeria's economy however is dependent largely upon importation of spare parts and machine component for such vital sectors of the economy as ship building, railways, agriculture, cement industry, food processing, power generation, etc. This is largely because Nigeria has given little or no attention to manufacturing and industrialization. In this paper, the foundry industry is emphasized as the bedrock for sustainable industrial and economic development of Nigeria as every other subsector are linked with foundry products. Demand for foundry products in Nigeria is presented and Government efforts toward sustained foundry practice as well as problems confronting Nigerian foundries are also highlighted. It is concluded that foundry industries are profitable ventures and can serve as a source of employment to graduates, and is thus of strategic importance in a nation's strive for industrialization. Therefore, development of foundry industries should be of strategic concern to planners of rapid industrialization of any nation. Finally, recommendations constituting the way forward in ensuring a better foundry practice and sustainable development in Nigeria are made.*

KEYWORDS: Foundry, Metal Casting, Industrialization, Sustainable Development, Nigeria

INTRODUCTION

Metal casting which is one of the earliest manufacturing processes known to humans, generally involves pouring molten metal into a refractory mould with a cavity of the shape to be made, and allowing it to solidify. When solidified, the desired metal object is taken out from the refractory mould either by breaking the mould or taking the mould apart (Rao, 2001). The origins of this process date back about 5,600 years to ancient Mesopotamia – and except for a few modern innovations in the molds themselves – the process has remained relatively unchanged since then. Metal casting also known as founding or foundry is extensively used in manufacturing and could be regarded as substantial bedrock for a nation's industrial growth. The importance of metal casting products in the society and in the world of today is indicated by how societies depend extensively upon metals and metal products. Practically all metal products start by first being cast in ingot (Daudal, 2002). For instance, metal ingot from which other areas of metal shaping starts must first be cast. Therefore, without the casting process of metal casting (foundry), there would be no metals, and if there were no metals, there would be virtually nothing. Many products would be nonexistent if it were not for metal casting, as metal cannot be obtained in a useable form from the earth. Major components of machine tools, power plants, industrial machinery and equipment, automobile, agricultural and textile industry and several others are products of the foundry industry. The development of foundry technology therefore, should be of strategic concern to

planners of rapid industrialization of any nation (Patrick and Akintunde, 2017). One can therefore rightly say that the acquisition of foundry technology is basic to economic development and self reliance.

In Nigeria however, little attention has been given to the development of the casting industry for too long. This is one of the reasons for our over dependence on imported spare parts and machine components for such vital sectors of the economy as ship-building, automobile, railways, agriculture, cement industry, food processing, power generations, etc (Jimoh et al, 2013).

Demand for Foundry Products

The consumption of foundry products in Nigeria is rising as economic growth takes off. Raj Gupta calculates the size of the Nigerian market for steel products at about 2.5 million tonnes annually. Of this, 1.77 million are long steel products like rebars. Domestic output in these product groups is estimated at 1.2 million tonnes. The rest, supplied from abroad, consists mainly of higher quality steel products (FINNFUND, 2010). An average of steel products such as standard plates, hot-rolled coil, cold-rolled coil and rebar is $464.7 using Chinese prices, which means Nigeria imports roughly 7.1 million metric tonnes of steel annually.

Steel makers, made up of players in the basic metal, iron and steel and fabricated metal, invested ₦202.97 billion in the second half of 2016 as against ₦37.05 billion in the first half (MMSD, 2017).

According to Okundaye (1995), the National Demand for cast metal products in Nigeria increased steadily from 72, 000 tonnes to 292, 000 tonnes (1985) to 425,000 in (1990s) and 794, 000 tonnes by the turn of the century, for which the National Committee on Foundry Development estimated 40% of these requirements as automotive components (Alpha, 2013; Okundaye, 1995). In Nigeria, 120,000 tons of foundry products are required to meet industrial demand and at present only four foundries have managed to survive out of the sixty registered active ones as of 1995 to cater for this huge demand (Barberopoulos, 2012). This gap (over 70%) in casting products supply has only been met through importation over the years. Infact, the Nigerian Minister of State for Mines and Steel Development, Abubakar Bawa Bwari, at a Mines and Money event in London, with the theme: "The Business Case for Nigeria, as a Mining Destination", has recently disclosed that Nigeria still imports an estimated $3.3 billion worth of steel and associated derivatives annually (Abah, 2018). And in 2017, ores and metals import for Nigeria was 3.3 %. Though Nigeria ores and metals imports fluctuated substantially in recent years, it tended to decrease through 1991 - 2017 period ending at 3.3 % in 2017. According to World Steel Association (2018), Nigeria imports of ingots and semis was at level of 51 thousand tonnes in 2017, down from 65 thousand tonnes previous year, this is a change of 21.54 % as shown in Figure 1. Ocheri et al (2017) identify the following areas which depend on foundry products:

Agricultural Sector: Machine components of agric-machines: (tractors, harvesters, tillers etc.) among which are, shafts, pulleys, flywheels, couplings, rollers, pump and compressor, impellers pump casings, parts of mowers, ploughs and cultivating equipment, corn mills parts and plates, oil expellers parts, water pumps and hand pump.

Petroleum Industry: Machine components and mechanical parts, including: Valves, pipes fittings, bearings and bearing housings, cast-iron couplings, heat exchanger sheets, conveyor components etc.

Power Industry: Machine components and mechanical parts, including: Pump and compressor, impellers, pump casings, ducting, power distribution structural parts, and furnace and boiler parts etc.

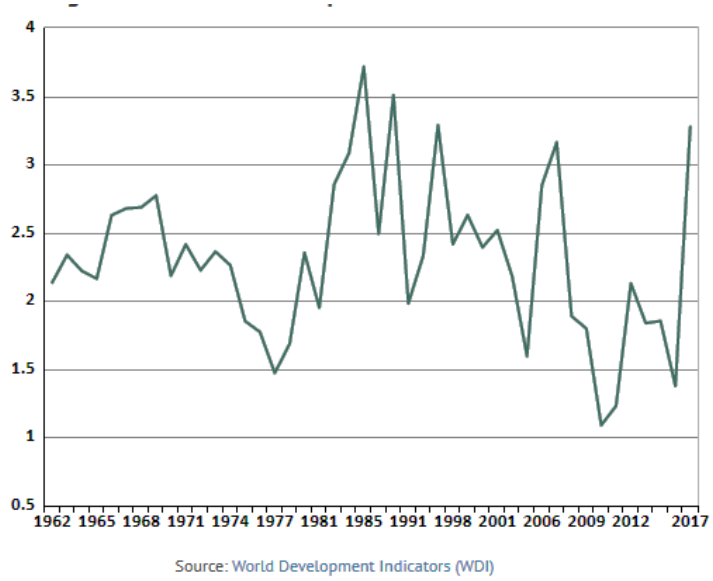
Automobile Industry: Machine components and mechanical parts including: Engine blocks, cylinder heads, brake discs, brake drums, manifolds, axles, gear boxes, crank shafts, pinions, rollers, steering knuckles, callipers, rock arm carburettor bodies, connecting rods, piston, fuel pumps, intake manifold, master cylinder body, transmission housing, Valve rocker arm, crank cases, Engine block, cylinder heads, etc. Currently installed vehicle assembly capacities in Nigeria stands at more than 70,000 vehicles per year, in total 7 companies have started to assemble vehicles. According to Global Auto Industry Market Report (2015), automotive industries where Vehicles are assembled such as Stallion Motors assemble vehicles for Hyundai, Nissan, Tata and Ashok Leyland at the former Volkswagen of Nigeria (VON) plant in Lagos, which the company took over in 2012 and Nissan have increased their sales from around 1,000 new vehicles in 2012 to around 6,000 in 2014 assembled in the country (GAI, 2015). Innoson Vehicle Manufacturing (IVM) has an installed capacity of 10,000 vehicles. Peugeot Automobile Nigeria (PAN), currently targeting to assemble around 3,000 vehicles, but having much space for growth at its plant in Kaduna which was originally built in the 1980s. Also assembling passenger cars, Dana Motors, which is part of Nigerian Dana Group revealed current capacities plans to assemble the whole Kia range of passenger cars in 2015. The company assembles Kia Rio, Cerato and Optima at its plant in Lagos. Also, Anammco, Leventis and Sinotrucks Nigeria are assembling trucks in the country (GAI, 2015). The total vehicles capacity in Nigeria as of 2014 was 78,000 with Truck assembly capacity of 3,000 and car and bus assembly capacity of 75,000 (GAI, 2015). This just accounted for 8.7% of the vehicles produced on the continent and 0.078 % of global production in 2015 (Delliot, 2014; KPMG, 2017; PwC, 2015). This production is negligible for a country of 170,000,000 people with the largest economy in Africa; the country GDP of $520bn in 2013 as compared to $350bn of South Africa as the continent's number two (Onigbinde and Sosami, 2017).

Defence Industries: Machine components and mechanical parts including: Munitions shells for grenades and land mines rocket war-heads components for tanks and artillery bodies, etc.

Electrical Equipment: Motor frames heads, Refrigerator compressor part for power lines, cast resistor, Electric base change over switch bodies, gear switch bodies, Gland (dating) etc.

Ceramic and Refractory Industry: Extrusion press dies, impellers, Ceramic press arm, stone polishing spirals, dies for tiles and bricks, etc.

From the foregoing, it becomes clear that every other manufacturing industry depends on foundry for their machine component parts and spare parts.



DATE	VALUE	CHANGE, %
2017	3.3	138.05 %
2016	1.4	-25.74 %
2014	1.9	0.87 %
2013	1.8	-13.69 %
2012	2.1	72.96 %
2011	1.2	13.02 %
2010	1.1	-39.41 %
2009	1.8	-4.82 %
2008	1.9	-40.29 %
2007	3.2	11.09 %
2006	2.8	78.49 %
2003	1.6	

Figure 1: Nigeria Imports of Ingots

(Source: World Development Indicators (WDI))

Government Efforts Toward Foundry Industries in Nigeria

Successive governments in Nigeria since the 70's had tried to put in the country's developmental plans guidelines to diversify the economic base of the country from the dependence on oil which accounted for over 90% of Nigeria's foreign exchange earnings in the last three decades (National Committee on Foundry Development, 1993). The objective was to evolve a new industrial policy which would lead to the much-desired technological development and sustainable economy in Nigeria and self-reliant with the metal manufacturing sector being a vehicular medium for bringing this lofty policy into reality. The foundry industry was therefore envisaged to play a pivotal role as a major metal manufacturing activity in line with the independent study reliably conducted by the following bodies: The Federal Office of Statistics, National Committee on Industrial Development (NCID) and the National Committee on foundry Development under the auspices of United Nations Industrial Development (UNIDO) from 1965 to 1985. From these studies, it shows how the National Demand of cast metal products in Nigeria steadily increased from 72, 000 tonnes to 292, 000 tonnes (1985) to 425,000 in (1990s) and 794, 000 tonnes by the turn of the century, for which the National Committee on Foundry Development estimated 40% of these requirements as automotive components (Okundaye, 1995).

In view of this, the Nigerian government has formulated some policies aimed at enhancing increased foundry practice in Nigeria. The national policies on Foundry development are very laudable. They include:

a) The promotion of growth and spread of foundries and allied metal forming industries in the country.

b) The promotion of metal forging and spare parts manufacturing industries.

c) The development and promotion of machine tools industries.

d) The development of indigenous engineering capabilities for the design and manufacture of plants and machinery

Realizing, the important role of the engineering subsector, the Federal Government established the National Agency for Science and Engineering Infrastructure (NASENI) in 1992, to remedy the nation's previous mistakes and map out strategies to develop the level of Nigeria's capability in the production of delivery systems and components. NASENI organized the existing Foundries companies to form the Foundry Association of Nigeria (FAN), a forum for favorable government foundry policy. NASENI has assisted FAN enormously to channel the views and aspirations of the foundry men to government. Through their joint efforts and that of the Nigeria Society of Engineers, NSE, it was possible to win the mandate of government to ban the exportation of metal scraps, one of the major raw materials for foundries.

Problems Facing Nigerian Foundries

The Nigerian foundry industries like other industries in the country are not without its own problems, which tend to restrain the growth and development of foundries. Several attempts have been made to discuss the present status of the metal casting technology in Nigeria and the future prospects for the growth and development of technology vis avis the nation. These problems are given as follows:

1) **Grant of Inadequate Finance:** Adequate finance is required by the foundries, because these industries required installation, of heavy and costly machines and large investment of capital in land and building at the initial stage are to be started a large scale to make the investment paving.

2) **Problem of Working Capital:** Current assets or working capital is required for the purchase of raw materials with a view to processing the materials into castings and founder for meeting the day today expenses of the industries, such as payment of salaries stationary, rent, rates, working capital generally involves the use of short term funds in business in quickly convertible into cash through a regular cycle. The materials are changed into castings, castings are sold out to realize cash and cash is utilized in purchasing of materials or for other purposes Adequacy of working capital helps a lot in maintaining industry.

3) **Release of Subsidy and other Incentives:** There is a need to release huge amount of subsidy and other incentives to foundry industries as they require huge amount of adequate amount of working capital to carry its operations smoothly. Incentive like packages should be provided for the development of these foundry industries.

4) **Raw Material Problems:** The price of raw material goes on increasing, Due to this fact it is not possible for the foundry men to produce casting as per the specification of the

customer at a competitive price. The arrangement should be made to produce and distribute the raw materials at a reasonable price to the foundry industries to produce a good quality casting which is helpful to the foundry people.

5) **Electricity problems:** The consumption of power is very high for foundry units. As electric power is relatively cheaper to generate and what is easier to transmit over a long distance. Therefore, it is necessary to avoid load shedding and supply electric power on a continuous basis. This also provides a good measure of size and growth of foundry units.

6) **Labour Problems:** Availability of skilled, semiskilled, and unskilled labours are the major problems to the foundry industries. Sometimes production of casting is hampered due to the non availability of skilled workers. Due to this it is not possible to the specification of the unskilled working which is an extra burden the part of foundry man.

7) **Design problems:** Indeed, the challenge for today's foundry is to develop new and more efficient processes and material designs that will meet the technology of tomorrow. Until now, the process of perfecting a part for mass production has required the development of a mold, casting a prototype, testing, and then a series of refinements until the end product meets the exact specifications. It can take anywhere from a week to a month to cast a specific metal part, depending on the complexity of the design. That process, if duplicated several times, can cost thousands of dollars as well as many weeks or months of lost time. Preventing defects and avoiding what can be extraordinarily costly rework is the key to efficiency at an operation where single manufactured pieces can weigh up to a tonne. New technologies such as 3D scanning and 3D measurement instruments along with 3D printing are dramatically changing the way products are designed, constructed, and perfected. By using point-cloud software with a 3D scanning attachment, exact measurements are uploaded to a computer, modifications are made, and a 3D printed model is produced within hours or a day. This technology enables supremely fast, accurate, and reliable prototypes to be made.

   The 3D design and printing process increases the total design time but dramatically reduces the overall cost of the end product. By reducing the number of prototypes that are needed to perfect the design you're left with an increased supply of viable prototypes as well as less wasted product.

CONCLUSION AND RECOMMENDATIONS

Major components of machine tools, power plants, industrial machinery and equipment, automobile, agricultural and textile industry and several others are products of the foundry industry. These are essential tools, equipments and parts urgently and constantly needed in every developing and developed country. Hence foundry industries are profitable ventures and can serve as a source of employment to graduates, and is thus of strategic importance in a nation's strive for industrialization. The development of foundry industry therefore, should be of strategic concern to planners of rapid industrialization of any nation. In Nigeria however, little attention has been paid to the development of the foundry for too long. This explains the country's over dependence on imported spare parts and machine components for such vital sector of the economy. Therefore, any study and government effort that focuses on this important subsector is invaluable. To this end, the following are recommended.

- Government should encourage indigenous foundry practice in Nigeria by embarking on foundry programs, giving incentives to trainees and providing enabling and conducive environment for such practice

- The foundries need to urgently do more than pay lip service to technological changes if they must compete favorably with foreign manufacturers and induce sales, thus the state-of-the-art machines and equipment for production must be acquired.

- The urgent need to put in place growth driven policy that will lead to sustainable development of the foundries cannot be overemphasized. Government can support patronage by encouraging its agencies and other private sector end-users to look inward and source their castings locally. This can only be achieved by the enactment of the local content policy for foundry products.

- For Nigeria foundries to compete favorably, government should also initiate special credit schemes for foundries in Nigeria. This will boost their ability to respond to technological changes, thereby improving the quality of their products.

- Government should encourage indigenous production of spare parts, machines and make a legal pronouncement that 30-40% of our spare parts production must have local content, this will further encourage our foundry men to step up their productions to meet our demands

- Industrial Banks should provide loans to genuine foundry men and foundry industries to assist them take off with production

- Government should try as much as possible to remove tariff on imported foundry machineries and equipments.

- Research and Development (R & D) in foundry materials to aid total input substitution should be encouraged.

- Nigeria should toe the developmental steps taken by India, Malaysia, Brazil, Mexico and other newly industrialized nations (NIN)

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APPENDIX

List of Private and Public Foundries in Nigeria

S/N	Names	Location	Category
1	Nigerian Foundries Ltd.	Lagos	MPF
2	Michael Kunle Foundry Nig. Ltd.	Lagos	SPF
3	Jimex Industries Nig. Ltd.	Nnewi	MPF
4	Associated Tech. & Eng. Ltd. (ATEL)	Lagos	SPF
5	Central Workshop, Fed. Min. of Works	Lagos	SGF
6	Continental Foundry Ltd.	Lagos	SPF
7	Muhayak Eng. Coy	Owo	SPF
8	Addis Eng. Ltd.	Lagos	SPF
9	Olympic Tech. Ltd.	Abagana	MPF
10	P. O. Idokoji (Abco) Foundry	Warri	SPF
11	Systemax Foundries Ltd.	Sango-Ota	SPF
12	Aranla Industries Nig. Ltd.	Warri	SPF
13	Grand foundry & Eng. Ltd.	Lagos	MPF
14	Leos Eng. Ltd.	Lagos	SPF
15	Basic Tech. Industries Ltd.	Kano	SPF
16	Bisbol Eng. Ltd.	Sango-Ota	SPF
17	Indus Mechanique Nig. Ltd.	Lagos	SPF
18	Dormanlong Eng. Ltd.	Lagos	MPF
19	Foundry and Metallur. Serv. Nig. Ltd	Lagos	LPF
20	S. SOA (Nig.) Foundry Ltd.	Warri	SPF
21	Dozik Foundry Ltd	Kano	SPF
22	Alagura Foundries and Ventures Ltd.	Ota	SPF
23	Auto Components	Sango-Ota	SPF
24	Premier Foundries Ltd	Warri	MPF
25	F. A. Foundries Ltd	Lagos	SPF
26	MARTH Foundry Ltd	Lagos	SPF
27	Isaho Industries Ltd	Nnewi	SPF
28	Ebunso Nig. Ltd	Nnewi	MPF
29	Castek Ltd	Lagos	MPF
30	ACKO International Ltd	Lagos	SPF
31	Ajaokuta Steel Foundry	Ajaokuta	MGF
32	Scientific Equip. Dev. Inst. (SEDI)	Minna	SGF
33	Federal SC. Equip. Centre	Enugu	SGF
34	Nigerian Machine Tools	Osogbo	MGF
35	CADD	Zaria	SGF
36	FIIRO	Lagos	SGF
37	Delta Steel Foundry	Warri	MGF
38	Hydraulic Equipment Dev. Centre	Kano	SGF
39	National Metallurgical Dev. Centre	Jos	SGF
40	Cast Product Ltd	Lagos	SPF
41	Abayomi Foundries Ltd	Ibadan	SPF
42	S. T. Foundries Ltd	Sango-Ota	SPF

43	Makstech Industries & Eng. Ltd	Ilesa	SPF
44	Gabmunis Foundries	Otta	SPF
45	Genesis Foundry	Otta	SPF
46	Sunday Foundry Moil	Lagos	SPF
47	Bemidele Foundry	Otta	SPF
48	God First Foundry	Lagos	SPF
49	Adekunle Foundry	Lagos	SPF
50	Shegun Makinde Foundry	Otta	SPF
51	Alagura Foundry	Lagos	SPF
52	Unique Foundry	Enugu	SGF
53	Kolmak Foundry and Engineering Works	Otta	APF
54	EEMAC Foundry Tech.	Lagos	SPF
55	Foundry and Metallurgical Services Ltd	Lagos	MPF
56	Kunle Foundry	Otta	SPF
57	God Foundry	Otta	SPF
58	Ayos Engineering Foundries	Lagos	SGF
59	PRODA	Enugu	SGF
60	Abbey Foundry Ltd	Lagos	MPF
61	Foundries and Engineering Works Ltd	Ondo	SPF
62	Bindele Foundry Ltd	Otta	SPF
63	Foundry Works Ltd	Lagos	MPF
64	Segun Makinwe Foundry	Lagos	SGF
65	Adegold Foundry Ltd	Otta	SPF
66	Foundry Tech. Ltd	Otta	MPF
67	Foundries Limited	Ondo	SPF
68	Foundry Services Ltd	Lagos	SPF
69	Ayos Foundry and Engineering Work Ltd	Lagos	SGF
70	Alagura Foundries and Ventures Ltd	Otta	SPF

Source: Foundry Association of Nigeria, Lagos, Foundry Chronicle Vol. 1 No 7 & 8

KEY:

SPF: Small Private Foundry
LPF: Large Private Foundry
MGF: Medium Government Foundry
MPF: Medium Private Foundry
SGF: Small Government Foundry