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FOUNDRY IN PERSPECTIVE: PROBLEMS AND PROSPECTS OF NIGERIAN FOUNDRY INDUSTRY

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ABSTRACT

Foundry is concerned with the production of castings that form part of or are entirely components of a machine. Foundry Industry has a lot of export potential, and plays a significant role in industrial development of any nation. Consequently, this study is an overview of World Foundry Industry (WFI) in relation to technological development and economic growth. To this end, foundry activities in some selected countries were x-rayed viz-a-viz Nigeria. Results obtained indicated that less than 30% of spare parts and machine component requirements of the Nigeria vital industrial sectors (agriculture, cement, food processing and power) were met. The huge gap of over 70% is still being filled through importation. As a consequence, critical look was paid to the array of problems confronting the Nigeria Foundry Industry (NFI) and its prospects. And for improved performance in terms of quantity and quality of castings both for domestic and export needs, and employment generation, recommendations were made.

KEYWORDS: Castings; Foundry; Foundry industry; Machine component; Spare parts

INTRODUCTION

Foundry technology plays a vital role in virtually all technological takeoff and industrialization for three basic reasons. First, almost every piece of machinery and equipment has its component manufactured in a foundry. Second, most of the non-cast part of any equipment are initially made of the proper alloy composition in a foundry and cast into blanks before they are finally machined, pressed forged, drawn, rolled or extruded into the required shapes for use. Third, scraped components and machines are taken back to the foundries and recycled into new components (Pribulova et al., 2006; Asuquo & Bobo-jama, 2008; Belay, 1972; Majekodunmi, 1997). Therefore, the foundry industry occupies a high priority as far as technological development of any nation is concerned.

Major components for agricultural machines, machine tools, automobile, textile industries, power plants, industrial machinery, oil and gas equipment, cement manufacturing equipment, mining and quarry have been easily and economically produced more relatively through foundry technology routes than the other routes (Abubakar, 1992; Fakoloju, 2003: Adebayo & Lawal, 2004; Rao, 2001; Mikhailor, 1989). There is hardly any major machine or equipment which has no components that have been cast in a foundry (Oyetunji & Alamene, 2002; Rao, 2001). Recent, invention of low-melting non-ferrous metal casting technology has further enhanced the contribution of foundry industry to technological development of many nations (Jimoh et al., 2013; Lazar et al., 2020). Also, transformation of economic systems in different countries has been hinged on variations of foundry production (Lazar

et al., 2020). In fact, casting production is considered as one of the main factors influencing the development of World economy (Foundry in Nigeria, 2014; Lazar et al., 2020; Nwigbo, 2019). Despite increased development of other technologies as means of production, foundry technology has continued to occupy its place of pride as a significant input to economic and civilization development of nations. Importance placed on foundry industry in the technology world may have been informed by the fact that direct shaping of metal products of practically every degree of complication can be realized easily relative to the other technologies. Also, it allows for limited number of technological procedures, and hence, the elimination of several additional operations, which are necessary when other production techniques are employed vantage of this method, even when castings are in the range of high-tech (Fakolujo, 2003; Nwigbo, 2019).

The World Foundry Industry in Perspective

Among the world leading casting producers are India, Brazil, Canada, China, Taiwan, Czechoslovakia, Egypt, France, Germany, Italy, Japan, Korea, Mexico, Poland, Romania, Spain, Sweden, Turkey, United Kingdom and United States (WFO, 2018). From statistics on worldwide production grey cast casting in 1991-92 shown in Table 1, China's foundry production is ranked first in the world for many years now, and accounts for about 44% of the world production (WFO, 2018). In 2017, output of grey iron increased 3.9% compared to 2016 from 20.35 to 21.15 million tons. Ductile iron (includes vermicular graphite cast iron) showed a year-on-year increase of 4.2% from 13.2 to 13.75 million tons, while cast steel showed a relative higher increase of 8.8%, driven by the rapid growth of rail transportation, mining and metallurgical heavy machinery and construction machinery industries, accounting for 11.3% of the total output (10.8% in 2016 and 10.2% in 2015).

However, China cannot be said to be a powerful casting country, because developed countries make their casting industries powerful and strong by attaching importance to the use of information technology as well as by using advanced casting technologies (WFO, 2018). Hence, the soft power of China's casting enterprises is far behind that of the developed countries, including the USA and Japan, and even behind the newly industrializing countries and the developing countries, including Brazil and India (WFO, 2018). Survey by the World Foundry Organisation (WFO) in 2017-18 on the activities of World Foundry Industry (WFI) have shown that the excellent market conditions, particularly in the major consumer industries, such as automobile and machinery manufacture have brought about increasing growth in the demand for foundry products throughout the world. For instance, India has more than 5,000 foundry units with an installed capacity of approximately 7.5 million tonnes per annum. Today, India foundry industry after 73 years of independence is adjudged the second largest producer of castings. The majority (nearly 95%) of the foundry units in India falls under the category of small-scale industry, while domestic market for foundry industry is also poised for a vertical growth (WFO, 2018, Indian Foundry Association, 2017; Dugar, 1994). Foundry industry report from Austria production shows that sales and employment increased in 2017. The total production in 2017 amounted to about 318,190 tons, i.e. an increase of 1.1 % over 2016. Total sales of the branch increased by 6.9 % over 2016 to a volume of about 1.49 billion € (WFO, 2018). The total castings production of the Egyptian foundry industry in 2010 was 35000 tonnes per year. However, as a result of the political and economic instability in the country over the past few years, production of castings

dropped to around 200,000 t/year in the year 2017. In addition, export activities are rather limited and are experienced by only 4-5 foundries (WFO, 2018). The categories of castings production are depicted in Table 2. Castings production of Finland has improved over the years. The total production of castings has shown remarkable increase. Iron and steel castings production in the year 2017 was put at 66.417 tons, which is 15 % more compared to year 2016. Also, iron and nodular iron casting production increased with about 14 %, and steel casting production about 26 %. Metal castings production was 5.896 tons, which is about 24 % more than the previous year. The value of the casting production of Finnish foundries was 228 million €, which was 7 % more relative to what was obtained in 2016. In 2017, the Italian Foundry industry experienced a more extensive recovery condition among the various production sectors and much more encouraging than 2016. In 2017, the weight of castings produced by Italy's ferrous and non-ferrous foundries was 2.236.843 tons, which corresponds to a growth in production volumes of +7.1% over 2016. The turnover in the same period was increased by +8.6% (7.011 million of euros). The highest growth (+7.8%) was seen in the production of iron castings, while among the non-ferrous metals the output of aluminum castings increased by 7.4% (WFO, 2018), South Korea produces more than 2.3 million tonnes of castings annually with average production per plant is 2,600 tonnes per annum. South Korea occupies the tenth place in the world, and the fifth largest after Germany, the United States and France. There are about 550 iron and steel foundries and 100 non-ferrous metal foundries. About 90% of the castings are ferrous metals, including cast iron and cast steel. With the market penetration of electric cars, Korea is also gearing up to replace gasoline and diesel fuel. Consequently, it is anticipated that the demand for aluminum and magnesium components will increase sharply rather than cast iron castings. After the global crisis of 2008, Mexico has become one of the strongest industries in the world in the foundry market. The foundry industry is one of the base industries of the entire productive chain and it is positioned among the top 10 countries in the international production ranking of the sector (WFO, 2018). The Mexican foundry sector closed 2017 with an approximate turnover of 7.8 billion dollars, an approximate production close to 3 million metric tons generating more than 50,000 direct employees and another 100,000 indirect jobs that manufactures ferrous and non-ferrous products for various customer sectors in the country, including automotive, railway, aerospace, pumps and hydraulic systems, construction, machine tool, metal-mechanical, agriculture and mining (WFO, 2018).

A general view of the Romanian metal casting industry reveals two main directions, which are: (1) automotive industry, with aluminium and magnesium castings (2) hand moulding parts, designated to machine building, energy, transportation or shipping sectors, with castings produced in grey or ductile iron, as well as in steel, or also in aluminium. Over the last years the metal casting production stabilized, but structural changes are visible: non-ferrous increasing while iron alloys decreases (American Foundry Society, 2020; WFO, 2018).

There are 1,952 facilities in the U.S metal casting industry with an industry capacity of 15.2 million tons, and a forecast capacity utilization of 72% was made in 2018. According to Metal Casting Industry Forecast and Trends report, which was published by the American Foundry Society (AFS), U.S. metal casting industry sales was revealed to increase by 4.7% to reach $33 billion in 2018, after hitting an estimated $30.6 billion in 2016. Growth in 2019 is expected to be 1.8%. In

the short term, from 2017-2020, annual growth rate of 2.3% was forecasted. A 2.9% long-term annual growth rate for the industry was estimated through 2026. The top casting industries in the U.S. are motor vehicle manufacturing, aerospace product and parts manufacturing, transportation equipment manufacturing (NAICS 336), iron pipe, fittings, ingot molds, engine, turbine and power transmission, pump and compressor manufacturing, and railroad rolling stock manufacturing These industries account for nearly 40% of all casting sales (American Foundry Society, 2020; WFO, 2018).

In United Kingdom, most foundry sectors have continued to enjoy increased turnover and orders over the years. The non-ferrous sector benefited from the continued growth of the automotive industry which resulted in strong demand levels and increased orders. There have been increases in enquiries and orders with delivery times stretching out in ferrous sector saw. Also, the aerospace has improved with increases in orders and the defense sector also remained strong. However, offshore oil and gas projects have seen only a small recovery and continued to suffer, due to the global economic situation and lack of investment. The automotive sector has continued its strong performance, with UK car production hitting 1.67M in 2017. Car exports remained at historically high level, with 1.33m shipped worldwide – 79.9% of total production. Exports provided a counterweight to domestic market challenges, up 4.8% in the month (The European Foundry Association, 2020; WFO, 2018).

Foundry Industry in Nigeria

Nigeria is endowed with about 3 billion tons of proven iron ores reserves, making the nation a haven of vast investment opportunities, particularly in the foundry industry (Alpha, 2013). A country with population of close to 200 million people (Table 4) and endowed with abundant human and material resources definitely holds a lot of prospect (Olusogo et al., 2018). In 70's and 80's, there were scores of steel foundries and other end use industries in Nigeria (Inuwa, 1995), and they contributed significantly to the nation's technological growth (Foundry chronicle, 1996; Inuwa, 1995). Today, jobbing and captive types of foundry are well established in Nigeria, while the production type, which supports a high level of industrial development is not (Holtzer et al., 2012; Foundry chronicle, 1996). Also, most foundries in Nigeria still practice the old method of sand-casting and very few other methods at a very low level of production (Abioye et al., 2012; Adebayo and Lawal, 2004; Foundry Chronicle, 1996).

National Demand of cast metal products in Nigeria has continued to enjoy steady increase of which, 40% are automotive components (Apeh et al., 2000; Okundaye, 1995). Survey by the National Agency for Science and Engineering Infrastructure (NASENI) in 1995 showed that Nigeria has about 160 foundries, but only 60 of them are registered. Regrettably, a few numbers of these registered ones have been able to meet less than 30% of the nation's industrial demand of foundry products, which is put at 120,000 tons (Barberopoulos, 2012). The remaining gap, which is over 70% is still being filled through importation (Inuwa, 1995). Also, export activities of foundry in Nigeria are rather nonexistent. No doubt, innovation, and enhancement of production effectiveness become a challenge for foundry industry in Nigeria, and hence, its inability to compete internationally and provide the needed stimuli to national technological growth and development.

Problems of Nigerian of Foundry Industry

Lack of raw materials

Due to indiscriminate exportation of iron ore and ferrous metals against government regulations have resulted into their high demand and high

cost. Pig iron, ferrous-alloys and some fluxes are still being imported translating to high cost of production. Refractory lining materials, particularly for electric arc furnaces are also being imported. Though there exist local sources of suitable refractory materials, but they are yet to be developed (Adebayo & Lawal, 2004; Oyetunji & Alamene, 2002).

Poor and inadequate infrastructure

The foundry industry like its peers depends largely on electricity supply for its major operations like such as mixing of moulding sand in the mixer, moulding using machines,

melting using electrically controlled furnaces operating the conveyor and cranes during pouring of molten metal, shaking out and fettling, and finally machining of the casting and other finishing operations (Okundaye, 1995). However, because of erratic power supply from Electricity distribution companies, most of the foundries procure high powered generators with their cost in terms of initial purchase and also operation. This they do using a huge portion of their capital which they would have used for further expansion of operations. Water is used in the foundry shops during moulding as it forms between 6% and 8% of the moulding sand mixture in green sand moulding. It is also required during heat treatment and other uses. Similarly, water services in many parts of Nigeria is unreliable so foundry shops require their own water supply system which is built and run at additional burden on the expenditure of the industry.

Foundries obtain their raw materials and equipment from places at far distances from their locations. They depend largely on land transportation to convey these goods to their respective factories.

However, land transport is comparatively costlier than rail transport which is highly undeveloped in Nigeria. Apart from this the roads are not maintained regularly thus posing risk to the goods being transported as the probability of the haulage truck involvement in accident is very high. If this happens, the operation of the foundry is jeopardised. The nation's transport system is ineffective and costly, which affects the foundry industry in terms of movement of raw materials, equipment and manpower, which also adds to cost of production (Okundaye, 1995).

Low level of operation/technology

Most Nigerian foundries have remained small-scaled in terms of capacities and technology. They have not been able to transform to production foundries due to their inability to introduce modern foundry techniques. Most still largely practice the old sand casting technique (Foundry chronicle, 1996), while few using sparingly at low scale modern techniques like centrifugal, die and investment casting methods. Most modern methods such as: shell moulding, flaskless moulding, squeeze casting, permanent mould casting, full mould process are not practiced by Nigerian foundry shops (Foundry chronicle, 1996). Entrepreneurs often lack adequate information about appropriate machinery and technologies available locally. Importation of high technology (equipment, spare parts and technical personnel) is out of question owing to its high financial implication.

Lack of modern equipment / methods

Nigerian foundries mostly rely on aging and old equipment and methods primarily because the new ones are expensive to purchase and operate. They basically still employ the manual method of moulding, pattern removal, mould assembling, metal pouring, shaking out, fettling and cleaning methods (Foundry in Nigeria, 2014).

Low level of production

Nigerian foundries by design are of the jobbing and captive types (Foundry chronicle, 1996; Inuwa, 1995). They are meant to serve the demands of a small size clientele. However, they still operate far below their installed capacity,

mainly because they do not get the right size of orders from the patrons.

Low patronage

Foundries in Nigeria operate far below installed capacities (Foundry in Nigeria, 2014). This is due to Nigerians penchant for imported products at the expense of homemade ones. Consequently, products, including industrial spare parts and spare parts for domestic or house hold equipment or machines, which could be produced locally are imported.

Low level of investment

Foundry industry is a highly capital intensive one, involving a great deal of investment capital at both local and foreign levels. Investment level in foundry industry in Nigeria is low (Patrick et al., 2017; Foundry in Nigeria, 2014), and hence the low development. For instance, the telecommunication industry received a great boost due to the high investment in that sector.

Government policies

There has not been any obvious government policy targeted at foundry industry development in Nigeria (Okundaye, 1995). For examples, there is no financial policy to encourage lending of funds; there is no policy to encourage foundry industrial based research into equipment and machine components manufacture and production of spares for existing machines, as most equipment spares are still being imported at the expense of locally produced ones. It is well known that government policy charts the path to development and drives development in a particular sector, as exemplified in the cassava content of bread and the local content in the oil sector etc.

Training and manpower development

The training of foundry manpower has not been accorded the priority it deserves (Oyetunji & Alamene, 2002), as not enough emphasis is placed on education in the ND, HND and B.Sc. curriculum of institutions in Nigeria. Also the equipment and machines for training are hardly adequate if not non-existent or non-functional (Abioye et al., 2012; Oyetunji & Alamene, 2002). Industrial based training is limited by the facilities available to a particular foundry shop which may not have universal scope in the industry and therefore limiting skill acquisition and development.

Financial limitations

In Nigeria, foundries cannot invest in expansion and new technology, because they do not have the capacity to source for fund from the money and capital market. Also, they cannot also assess fund from the stock market due to the stringent conditions of interest rate, terms of repayment and collateral (Jimoh et al., 2013). Most public sector foundries are underfunded and, in consequence, are unable to maintain

equipment let alone acquiring new and modern ones. The private foundries do not have access to loans, and where they do; cost of borrowing is high with prohibitive conditionality.

Market/Marketability

A large percentage of most equipment spare parts and industrial spare parts are castings (Oyetunji & Alamene, 2002; Rao, 2001). Hence, market for foundry products is wide. However, most of these equipment/machines are imported into the country (Rao, 2001). This is at the expense of locally produced ones. Home market may not be favoured, because Nigerians tend to believe that quality of imported products is better the counterparts.

Management ineptitudeness

In setting up of foundry workshop, most of the managers lack effective and formal planning and necessary information, including labour market opportunities, cost, customer preferences, behaviour of competitors, new production systems. In addition, most managers are incompetent and inexperienced both in management and in line.

Scarcity of development institutions

There is a shortage of development institutions to provide a range of assistance package in areas such as pre-investment studies, preparation of feasibilities studies, training and development of prospective entrepreneurs and managers, and business advisory generally (Oyetunji & Alamene, 2002).

High cost of production

High and increasing cost of production of casting can be hinged on poor infrastructural facilities, high interest and exchange rates, low effective demand for goods, liquidity squeeze and fallen capacity utilisation rates.

Prospects of Foundry Industry in Nigeria

Impact of foundry industry on nations' technological growth and economic development is huge, and Nigeria cannot be an exception. Despite the array of problems confronting Nigerian Foundry Industry, its prospects are high in terms of technological growth, self-reliance and economic development.

Technological growth

Machines / equipment and their spare parts will be produced locally, and the multiplier effects will include improved level of skill and job creation.

Self-reliance

The nation will be self-reliance in term of technology. As the foundry industry will be able to increase its production capacity to meet domestic consumption of the nation's industries, including automobile, petroleum, textile, cement, agricultural both qualitatively and quantitatively, and also produce for export needs.

Economic development

Foundry industry will reduce dependence on foreign machines and equipment, thus saving foreign exchange (Okundaye, 1995). For instance, military ammunitions and equipment will be produced locally for domestic consumption. In addition, it will provide entrepreneurial opportunities for a large number of people, and as a result, foster competitions, promote the use of local raw materials, mobilise domestic savings for investment; and possibly contribute to foreign exchange earnings through export of foundry products to other countries in Africa and other parts of the world.

CONCLUSIONS

From the foregoing, it is concluded that lack of raw materials; poor and inadequate infrastructures; low level of operation/technology; lack of modern equipment and methods; low level of production; low patronage; low level of investment; government policies; lack of training and manpower development, insufficient finance; management ineptitude, scarcity of development institutions; and high cost of production are the problems militating against the growth of the industry.

RECOMMENDATIONS

Based on the findings, the following recommendations are made:

i. Foundry industry should have more serious plans for human resources development and proper links with the research and development organizations.
ii. Government should encourage private sectors to invest in exploration and exploitation of local sources of raw materials. Government should be pragmatic in leading in this venture and within a specified time to privatise these companies. This should not be seen as negating the policy of government on privatisation but as a necessary intervention to develop the sector of the economy. As soon as this raw materials exploitation yields the desired result, Government should immediately ban importation of such from outside the country. Government should as a matter of urgency conclude its programme on the full commissioning of Ajaokuta Steel Company, Delta Steel Company and Aluminium Smelting Company of Nigeria

(ALSCON). Government should place total ban on the exportation of local scraps and ores that are needed to feed this exploitation companies.

iii. Government should establish a research institute for foundry research and equipment development, to initiate research into adapting new technologies and updating old ones and passing on their results to the existing foundries for commercialisation. Government should encourage industry based research by our local foundries; foundry companies should pool resources together to form a research and development consortium, to fund research projects.

iv. There is the need to actively encourage the local manufacture of machines, and equipment e.g. electric motors, petrol and diesel engines, compressors, water pump and the like, that would require components and spare parts produced locally in our foundries. Government should provide enabling environment for the indigenous production of most foundry equipment needed for the casting operations such as furnaces crucibles, pragmatic presses etc.; the highly mechanised production type of foundry should be encouraged in Nigeria.

v. Adequate funding of organisations involved in development of appropriate technologies for the foundry industry should be done. Government should make enough funds available to tertiary institutions that have foundry related course for updating their training equipment and for retraining of staff. Government through the Bank of Industry should make substantial credit available to the foundry industry; Government, Banks and engineer-entrepreneurs should encourage investments in the foundry industry.

vi. Engineer-entrepreneur should improve his technical competence by attending short courses, vocational training courses etc. Engineer-entrepreneur should take advantage of small business counselling on technical and management matters rights from appraisal stage. This should be in such areas as financial management, production planning and control, financial analysis and appraisal. Higher institutions, small business associations SBO), non-governmental organisations (NGO's) should adopted some approaches, which include seminars and workshops. These training and discussion sections are usually free or at a minimal cost; foundry industry should regularly send their staff for short courses and this would help to reduce dependency on expatriate staff and provide ready source of manpower for research and development.

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Table 1: World Wide Production of Grey Iron Casting (1991-1992). Source: (WFO Global Foundry Report, 2018)

S/No	Country	Production
1.	United States	3,943,500
2.	Brazil	697,140
3.	India	2,000,000
4.	Canada	334,922
5.	China	7,276,000)
6.	Romania	576,987
7.	United Kingdom	633,000
8.	Spain	390,000
9.	Turkey	405,000
10.	Sweden	193,000
11.	Poland	608,650
12.	Mexico	525,000
13.	Korea	867,900
14.	Japan	3,925,176
15.	Italy	1,160,000
16.	Germany	2,310,000
17.	France	991, 230
18.	Egypt	243,300
19.	Czechoslovakia	909,520
20.	Taiwan	907,900

Table 2: Category of Egyptian Foundry Castings. (Source: WFO Global Foundry Report, 2018)

S/No.	Product Type	Quantity (t/y)
1.	Grinding media of high Cr- white irons	15,000
2.	Manhole covers	50,000
3.	Miscellaneous spare parts	10,000
4.	Steel castings	10,000
5.	Aluminum alloy's castings	7,000
6.	Copper and copper alloys	8,000

Table 3: United States of America Castings Production (2017-2020) (Source: American Foundry Society, 2020)

S/No.	Product	Quantity
1.	Gray Iron	3,210,350
2.	Ductile Iron	2,490,970
3.	Malleable Iron	40,515
4.	Steel	1,245,790
5.	Copper Base	205,440
6.	Aluminum	1,686,230
7.	Magnesium	142,740
8.	Zinc	322,230
9.	Other non –ferrous	51,040
	TOTAL	9,395,305

Table 4: Nigeria Population Growth Rate (Source: Nigeria Population Growth Rate, 2019)

S/No	Population	Year	% Increase
1.	**211,400,708**	2021	**2.55**
2.	206,139,589,	2020	2.58
3.	200,963,599	2019	2.6
4.	195,874,683,	2018	2.62