Implementation of Computer Integrated Manufacturing in the Nigeria Machine Spare Parts Manufacturing Process in the Light of Globalization

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Abstract— **Sophistication in the information and technology sector has resulted to economic liberalization in respect of trade and investment. Quality goods and facilities produced by high technological processes from the major industrialized countries flood the Nigeria market. The net effects have been poor industrial capacity utilization, high industrial mortality and indifference towards the actualization of the technological potentials to achieve competitive and sustainable development in the manufacturing sector. This is particularly true in the machine and machine parts industry. This paper assesses the Nigeria machine and machine parts industry in the light of globalization and liberalization of trade. A review of research and development effort in this sector by the Federal Government of Nigeria was carried out. Manufacturing systems in Computer- Aided Process Planning (CAPP), Computer-Aided Design (CAD), Computer - Aided Manufacturing (CAM) were outlined. The production chain processes of some active steel firms were assessed in respect of their level of CAD and CAM integration and CIM compliance. A model in local capacity acquisition that embraces computer automation manufacturing using the instruments of Computer Integration Engineering (CIM) to put the industry on the track of sustainable development and global economic competitiveness was developed.**

Index Terms— **Parts, Machine, globalization, Liberalization, Automation**

I. INTRODUCTION

Industrial development is the baseline of the modern global economy. The globalization and liberalization of the world's economy has resulted to an aggregation of consumers taste and global expansion of industrial technology and products resulting to a highly competitive global manufacturing sector. Production firms now have to contend with competitors all over the world. Low international freight costs and easy accessibility of information over the internet have transformed the world into a monolithic accessible market with its attendant effects [1].

Globalization of trade has placed some hurdles in the development and sustenance of manufacturing industries in developing economies because of the entrenched global competition. It is imperative that these economies must formulate precise, strategic and functional templates to nurture and consolidates it industrialization process to be formidable in the face of global competitiveness [2]. High industrial mortality in developing countries is traceable to their lack of capacity to withstand the competitiveness in manufacturing market impose by global liberalization of trade [3]. In the global trade setting, it is only a vibrant manufacturing sector that can enhance economic growth, raise and sustained the standard of living of any nation. In this regard, developing economies need to embrace tactical and favorable policies to harness their natural resources to develop the manufacturing sector through appropriate technology acquisition to serve as a tool to enhance their gross domestic product [4].

In this global economic dispensation, liberalization of trade with the attendant flooding of the Nigeria markets with all sorts of goods has almost reduced the Nigeria economy to an ordinary import to sell status especially in the machines and machine components sector with near 100% percent importation [5]. This has suppressed the Nigeria manufacturing sector which is characterizes by narrow operational profile on a production platform that is based on obsolete traditional manufacturing technology that is manually oriented [6], labor intensive with high energy and process material consumption. These factors have eroded the competitiveness of these industries with the collapse of a large number of them [7]. Since the openness of the Nigeria economy is continual due to multilateral and bilateral trade agreements, the Nigeria Machine and machine components industry must upgrade its operational base to accommodate modern manufacturing technique on Computer Integrated Manufacturing (CIM) that has the potency to enhance the quality of local products, minimize unit production cost and entrench high level efficiency into the industrial management systems. The CIM implementation will elevate and stabilize the competitive profile of locally manufactured machines and machine components parts, eliminate the proliferation of fake machine parts and generate massive wealth for the elimination of unemployment and poverty [8].

Highly developed manufacturing firms will lead to more research and development efforts, produce high quality products, contribute meaningfully to the country's GDP, enhance their global competitiveness and become major players in international trade and world economy.

This paper assesses the Nigeria machines and machine parts industry with a view to develop a model that embraces computer automation manufacturing in the context of Computer Integration manufacturing (CIM) to project the industry on a high trajectory of sustainability and global competitiveness in the light of international liberalization of trade. The Nigeria machine and machine parts industry is an integral part of the iron and steel industry.

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II. ANALYSIS OF GOVERNMENT STRATEGIES TO DEVELOP GLOBAL COMPETITIVE AND SUSTAINABLE PATH FOR THE NIGERIA MANUFACTURING SECTOR.

Government made a number of development plans to stimulate growth of the manufacturing sector. A summary of the critical appraisal of these plans and interventions is given below,

The First National Development Plan involved import-substituting industrialization (ISI) with the objective of harnessing national economic resources using cost and benefit factor to allocate them to essential industrial projects as a systematic attempt at industrial development [9]. The main objective of the ISI program was to stimulate the start-up and growth of industries to enhance indigenous participation by changing the ownership structure and management of industries. The ISI program was highly driven by foreign expertise. Nigerian investors did not possess adequate resources and the techno-managerial capacity to establish and manage such business outfits. There was lack of human resources including techno-managerial capabilities and skills necessary for initiating, implementing, and managing industrial establishments. The low Nigeria technological capacity hindered the program objective and substantial industrial growth in the economy.

It was clear at this time that Nigerian entrepreneurs did not have the money or the techno-managerial capacity to establish and manage such enterprises and so the government had to lead the way. On a balance, a critical appraisal of the nature of the industrial development challenge of the 1970s reveals that the limitation was not so much that of finance but dearth of human capital. This was all the more evident by the fact that project preparation, feasibility studies, engineering drawings and designs including construction, erection, and commissioning, relied greatly on foreign technical skills and services.

The 1972 Act on Indigenization of Enterprises Operating in Nigeria culminated in an indigenization policy which was replaced by the Nigerian Enterprises Promotion Act of 1977 [10]. This was followed by the Third National Development Plan, 1975-1980, with emphasis on public sector investment especially in the heavy industry. At this stage Nigeria entrepreneurs preferred investments in the light, low technology consumer industries with heavy dependence on imported machinery and raw materials. The prosperity of oil boom in this period encouraged the importation of good which negated real industrial growth as envisaged under the Third National Development Plan.

In 1986 a national science and technology (ST) policy was formulated with the objective of creating awareness of ST in national industrialization. The Raw Materials Research and Development Council, was established by Decree No. 39 in 1987, to facilitate the achievement of the technological self-reliance in the industrial sector [11]. The Standards Organization of Nigeria (SON) was also established for the purpose of ensuring standardization and adequate quality control in industrial production.

The ST was largely not successful due to the narrow base of ST research, disconnect between the manufacturing sector from Research and Development activities, and insufficient funding. Innovation was also absent in this period of industrial development.

A. Nigeria Industrial Revolution Plan (NIRP)

The Federal Government of Nigeria launched the NIRP in 2015 to serve as policy framework to promote industrial development in Nigeria. The fundamentals objective of the NIRP is given below;

The NIRP's objective is to build Nigeria's competitive advantage, to expand the scope of industry, and to facilitate the expansion of the manufacturing sector. The direct and indirect approach were adopted to promote industrialization.

The direct approach identifies sectors where Nigeria can excel based on an assessment of the country's comparative advantage. The Nigeria Industrial Revolution Plan formulated specific initiatives and interventions to enhance productivity in some target sectors to increase production output. NIRP establishes cross cutting interventions that address competitiveness of the entire manufacturing sector in Nigeria to create a broad Nigerian platform for manufacturing to thrive, while private capital determines which sectors will grow.

III. THE CURRENT SITUATION OF MANUFACTURING INDUSTRIES IN NIGERIA

According to the new Nigeria Industrial revolution Policy, the Nigerian manufacturing sector has failed to undergo the critical structural transformation necessary for it to play a leading role in economic growth and development. The sector is structurally weak and basic industries such as iron and steel are not fully in place. The technological base for manufacturing is lacking in many sectors. The skilled manpower necessary to guarantee competitiveness in today's dynamic and globalized world is insufficient.

Systemic issues of infrastructure, mostly related to power and transport, have led to escalating costs and non-competitive operations. Consequently, the sector is unable to attract the necessary investment for economic growth and remains a small player in the economy. In recent years, the sector's average share of GDP is about 5 percent [12], contributions to foreign exchange earnings have been minimal, and the share of employment and government revenue generated have been low.

The Nigerian iron and steel industry has essentially focused on downstream processing activities by importing intermediate processed raw materials, which are then finished in Nigeria from cold steel rolling operations. There exist 21 steel mills in Nigeria majority of which are not in production. There also exist a numbers of steel factories dedicated to the processing of scrap metals by melting them in steel furnaces to form simple steel products. Although, this type of steel processes has significant environmental impart in the cleanup of the environment, the supply of process material is not stable and the product from the process is not top grade as in effect it is recycled steel which is limited in application. The implication is low capacity in the design and production of steel base machineries which are the bedrock of the industrialization process [13].

IV. MANUFACTURING SYSTEMS

Manufacturing systems can be broadly divided into conventional or traditional manufacturing system and Programmable Automation Manufacturing systems.

A. Conventional (Traditional) Manufacturing System

In the conventional manufacturing cycle practiced for so many years in industries, engineering drawings, are prepared by design draftsmen and then used by manufacturing engineers to develop the process plan. The activities involved in designing the product were separated from the activities associated with process planning. Essentially, a two-step procedure was employed. This was both time consuming and involved duplication of effort by design and manufacturing personnel.

B. Programmable Automation Manufacturing Systems

Programmable Automation systems includes the use of Computer Aided Design (CAD), Computer Aided Manufacturing tools—e.g., robotics, numerically controlled (NC) machine tools, and Computer Aided Techniques for Management—e.g., Management Information Systems (MIS) and computer-aided Process Planning (CAPP). When systems for design, manufacturing, and management are used together in a coordinated system, the result is Computer-Integrated Manufacturing (CIM).

The essential difference between a conventional factory and programmable automation process is the latter's use of information technology to provide machine control and communication. The use of computers and communications systems allows these machines to perform a greater variety of tasks than fixed automation can perform, and to automate some tasks which previously necessitated direct human control.

Though labor savings seem to be the most obvious benefit of automation, savings through more efficient use of materials may be more significant in many manufacturing environments. In particular, automation manufacturing systems can reduce waste, reduce levels of finished product inventory, and reduce the manufacturer's substantial investment in the products that are in various stages of completion.

- *Computer-Aided Process Planning (CAPP*)

CAPP is the use of computer technology to aid in the process planning of a part or product in manufacturing. CAPP is the link between CAD and CAM in that it provides for the planning of the process to be used in producing a designed part. Process planning is concerned with determining the sequence of manufacturing operations needed to produce a given part or product. The resulting operation sequence is documented on a form typically referred to as a route sheet containing a listing of the production operations and associated machine tools for a work part or assembly.

- . *Computer Aided Design (CAD)*

CAD is an electronic drawing board for design engineers and draftsmen. CAD is also the core of Computer Aided Engineering (CAE) in which engineers can analyze a design and maximize a product's performance using the computerized representation of the product using the optimization process.

Optimization is the process of choosing the best among a set of finite or infinite alternative by finding the conditions that give the maximum or minimum value of a function which leads to establishing the best or optimal solutions [14]. Improved production and design tools coupled with advanced computational resources have made optimization an important process. Applied optimization involves the discovery and design of solutions through appropriate techniques associated with the formulation of the problem in a specific manner. This optimization process enables manufacturers to reduce development lead times for production, improve the quality and reliability of products, and the minimization of energy for forming products to reduce manufacturing cost [15].

The design of a product, especially a product of some complexity, involves an intricate set of tradeoffs between marketing considerations, materials and manufacturing costs, and the capabilities and strengths of the company. The number of choices involved in design is immense. Determining which of many alternative designs is best involves making choices among perhaps 100,000 different materials, each with different characteristics of strength, cost, and appearance; it also involves choices between different shapes and arrangements of parts which will differ in ease of fabrication and assembly.

- *Computer Aided Manufacturing (CAM)*

CAM is the use of computer software to control machine tools and related machinery in the manufacturing of products. CAM may also refer to the use of a computer to assist in all operations of a manufacturing plant, including planning, management, transportation and storage. Its primary purpose is to create a faster production process and components and tooling with more precise dimensions and material consistency, which in some cases, uses only the required amount of raw material (thus minimizing waste), while simultaneously reducing energy consumption. CAM is a subsequent computer-aided process after computer-aided design.

(CAD) and sometimes computer-aided engineering (CAE), as the model generated in CAD and verified in CAE can be input into CAM software, which then controls the machine tools.

V. FACTORS MILITATING AGAINST COMPETITIVE MACHINE COMPONENTS PRODUCTION

Manufacturing firms in Nigeria are facing many challenges and problems. These constitute major hurdle to effective local and global competitiveness. As a result, Nigeria remains a monoproduct economy and underdeveloped.

A number of research initiatives have been undertaken in respect of the weak manufacturing base of the Nigeria manufacturing sector. Some of their findings are summarized below;

According to [16], these includes, high production costs, poor infrastructures, finance, competition from imported goods, limited scope of operation, etc. These factors lead to rising operational costs without increasing sales volume.

The findings conform to MAN's and [16] observations in their various documentation of factors militating against the manufacturing sector of the Nigerian economy. They are summarized thus:

i. Poor and deteriorating infrastructural, compounded by collapsed electricity supply which impacted negatively on capacity utilization
ii. Unbridled influx of cheap imports of sub-standard, fake and used products, including dumping of all

manner of finished goods in the name of trade liberalization.

iii. Smuggling and unbridled importation and dumping of cheap and substandard goods which usually suffocate local manufactured products.

iv. Non completion of the development of core industries particularly the Petro-chemical as well as Iron and Steel Industries.

v. Dearth of qualified skilled middle level manpower worsened by the decaying educational system.

Other factors include, slow rate of technology acquisition stemming from low investments in Research and Development efforts, absence of the needed collaboration between the manufacturing sector and the research institutions on the other hand. Reference [17] also summarized the problems of the manufacturing sector as follows;

Counterfeit and smuggled goods have practically displaced local brands in the domestic market. Counterfeiting obviously damages the business of companies, while employees lose jobs due to decline in sales. Their mode of manufacturing techniques is both manual and machine operated. Complete automation of operations is still a far cry. Their major machines, machine parts and raw materials are import oriented with the attendant foreign exchange implications.

MAN has officially declared that of its 2000 members, 30 percent mostly small and medium scale industries (SMIs) in Nigeria have closed down, 60 percent of them ailing while just 10 percent of them, notably the multinationals currently operate at sustainable level.

VI. ASSESSMENT OF PRODUCTION FACILITIES OF SOME ACTIVE STEEL FIRM FOR CIM COMPLIANCE

An assessment of the CIM compliance of some active steel companies in Lagos was carried out. Consideration was given to automation in the design process, level of CAD and CAM integration and overhaul CIM compliance. The results of the inspection is presented in Table 1 and 11.

Table 1: CIM Profile of Some Major Nigeria Steel Mills

Industry	Business	Material handling	Inventory and material control	Design approach
African Steel Mills PLC, Lagos	Manufacturers of steel billets, wires, angle bars, rods, etc.	Manually oriented with material handling equipments	Computer stock taking without CIM links	Full application of CAD
Sparkwest Steel Industries, Lagos	Designing, Manufacturing & Supply of Telecom and Power Towers	Manually oriented with material handling equipments	Computer soft wares application	Full application of CAD
Total steel Ltd, Lagos	Rebars of 8mm - 25mm, Wire coils, Structural Steel Angles, etc.	Manually oriented with material handling equipments	Computer stock taking without CIM links	Minimum CAD application
Saba steel Industries Nigeria Limited	Production of steel doors, hot rolled coils, seemless pipes, reinforced bars, steel tubes, etc.	Semi-automated material handling process	Stock taking without CIM	Minimum application of CAD
Top Steel Nigeria Limited	Melting of scrap metals to form second grade steel	Manually oriented with material handling	Stock taking without CIM	No direct link with CAD application

Table 11: Results of CIM Assessment

Industry	CAM features	Level of CAD/CAM integration	Product handling & assembly	Overhaul CIM compliance
African Steel Mills PLC, Lagos	Isolated automated machines without CIM links	No direct integration between CAD and CAM	Manual with lifting appliances	No direct CIM links
Sparkwest Steel Industries, Lagos	Automated machines with minimum CAM features	No direct integration between CAD and CAM	Manual with lifting appliances	Minimum CIM compliance in inventory control
Total steel Ltd, Lagos	No actual related CAM feature	No direct integration between CAD and CAM	Computer stock taking without CIM links	Minimum CAD application
Saba steel Industries Nigeria Limited	Automated machines with minimum CAM features	No direct integration between CAD and CAM	No direct integration between CAD and CAM	Minimum CAD application
Top Steel Nigeria Limited	Isolated machines with minimum CAM features	No direct integration between CAD and CAM	No direct integration between CAD and CAM	No direct CIM links

VII. BLUEPRINT FOR STRATEGIC UPGRADING OF THE NIGERIA MACHINE AND MACHINE PARTS SECTOR INTO GLOBAL COMPETITIVENESS

Giving the limiting success achieved by the various Government strategies to successful revitalize the Nigeria Iron and Steel manufacturing sector to place it on the path of sustenance and global competitiveness, some innovative approach which must take into cognizance core technical issues that are vital to the sector revitalization, its efficient operation and global competitive capacity acquisition were identified and high lightened. This issue involves the following pertinent technical issues;

i. Indigenous staffs training in the planning, design, manufacture and operation of computerize automation manufacturing in compliance with CIM.
ii. Development of a manufacturing base dedicated to the production of machine and machine spare party for the Nigeria industry.
iii. Revitalization of the Nigeria iron and steel sector to develop material for the design and manufacture of machines and machine parts.
iv. Developments of strategic computerize automation manufacturing and maintenance policies, procedure and packages to service the Nigeria iron and steel industry in machine and machine parts production.
v. Development of product and safety standard to conform to Nigeria Industrial Standard (NIS) and ISO Standards.
vi. Formulation of realistic development programs for the development and upgrade of the Nigeria iron and steel sector to standard manufacturing entities using FDI under a regulatory frame work.

A. Indigenous staffs training in the planning, design, manufacture and operation of computerize automation manufacturing in compliance with CIM.

A comprehensive program should be developed and implemented to achieve local content capacity building in the use of CIM in the manufacture of machines and machine parts. CIM integrate the design and manufacture of products with a view towards optimizing all elements involved in the life cycle of the product [20]. This extends to the use of simplified method of products analysis through Computer Aided Design (CAD), Computer Aided Engineering (CAE) and Computer Aided Manufacture (CAM) of machines and machine components. This capacity will empower the indigenous engineers to integrate the design process of machines and machines components with materials, manufacturing methods, process planning, assembly, testing and quality assurance of machines and machine components. This will make the indigenous engineering team to acquire a fundamental understanding of the characteristics, capabilities, and limitations of materials, manufacturing processes and performance of machineries and equipments involves in the iron and steel sector. This thorough understanding of the process planning, manufacturing, operation and performance of machine systems and machines parts is required to produce and operate equipments that are adaptable to local service conditions in the use of machines and machine components in Nigeria

A framework should be initiated to ensure all lower skilled and mid-skilled roles in the Nigeria iron and steel industry are occupied by competent Nigerians and with formidable plans to staff high skilled positions with Nigerians over a period of 10 years of program implementation [19].

B. Development of a Manufacturing Base Dedicated to the Production of Spare Parts for the Nigeria Machines and Machine Components Market

Easy access to high performance, cost effective and durable spare parts is vital to the successful operation of the Nigeria iron and steel industries, machines and machine components market in a competitive economy driven by profit maximization. This require the efficient operation and management of the following manufacturing sector,

i. Forming and shaping process of machine components and equipments
ii. Casting of necessary machine components
iii. Machining process and machine tools operation for the production of machine components and equipments
iv. Joining processes and equipments for the assembly and maintenance of machine components and equipments

- *Forming and Shaping Process and Equipments.*

In the forming process a work piece in the shape of a plate, sheet, bar, rod or wire is formed into various parts configuration by plastic deformation using various forming processes and machines. In this process various component and parts used in the rail and train system, automotive industry, construction, aircraft components and parts are produced. The forming and shaping process consist of the following processes;

i. Flat and shape rolling of metals
ii. Forging operations
iii. Extrusion processes
iv. Drawing and sheet metal forming processes
v. Powder metallurgy
vi. Processing forming of plastic and composite materials
vii. Others include bending, shearing, spinning, squeezing, etc.

- *Metal Casting Process and Equipments*

The casting process basically involves the pouring of a molten metal into a mould patterned after the part to be manufactured allowing it to solidify and the removing of the part from the mould. A large variety of parts and components are made by casting, such as engine blocks, locomotives and rolling stock components, crankshafts, automotive components and power trains, agricultural and railroad equipments, etc. Advanced machinery and automated process control have replaced traditional method of casting due to increase demands for high quality castings with close dimensional tolerance. Rapid advances in computers and modeling techniques have led to important innovations in modeling various aspects of casting which include fluid flow, heat transfer, and microstructures developed during solidification under various casting process conditions [20]. This level of expertise is required for the production of rugged and versatile parts and component for the Nigeria iron and steel industry, and machine components market to withstand the operational stress and exertion they will encounter in operation for optimum service delivery. A versatile foundry base equipped with CIM facilities is a pivot for sustained

machine spare parts production which is a requisite for industrialization.

7.2.3 Machining Process and Machine Tools Operations

A well stocked, standard and functional machine tools workshop is fundamental to the optimum operation of machineries in any service delivery and machinery process like the rail industry, automobile industry, and machine components market. Components and parts produced by casting, forming and shaping process require further machining operations into parts with close tolerance and dimensional accuracy before the product is put into use. Machining is economical in the production of small quantity of machine parts or components which material and parts shapes allowed to be machined at high rates and quantities and with high dimensional accuracy. Computer controlled machine tools and modern techniques are now available which are capable of making functional machine parts of any dimension

- *Joining Processes and Equipment*

Many machines and components consist of parts that are systematically joined together so that the machine can function reliably and be produced economically. Joining is an all-inclusive term, covering processes such as welding, brazing, soldering, adhesive bonding, and mechanical fastening. Joining of parts is required for various technical reasons which include;

i. Many products are impossible to be manufactured in a single piece.
ii. Products such as automobile engines and parts, locomotives, rolling stocks and rails are designed to be taken apart for maintenance or replacement of their parts.
iii. Ease of Packaging, transporting and assembly at the site of usage of machines.

- *Revitalization of the Nigeria Iron and Steel Industry.*

The iron and steel industry produce steel bars, rods, plates, wires and sheet metals for the forming and fabrication of components, parts and machines. A functional and highly productive iron and steel industry is fundamental to the economical and successful operation and maintenance of any machinery base service delivery process and manufacturing operation such as the automobile industry and railway sector [21]. In this respect, the revitalization of Nigeria steel industries is vital to the successful operation of the Nigeria Iron and Steel industry. The Ajaokula and Delta steel complex and the National Iron Ore Mining Company, Itakpe, must be repositioned for the local supply of the required materials for the spare parts base development sector of the Nigeria machines and machine components industry and market..

- *Development of product and safety standard to conform to Nigeria Industrial Standard (NIS) and ISO Standards.*

Products safety and standards are essential elements for the reliable and effective operations of machine systems and machine parts with high performance and structural integrity. Local content manufacturers of machine systems and components should be encouraged to build safety and quality into products to conform to the ISO and NIS standards. Machine components in automobiles, rail systems and components standards should be developed in partnership with the Standard Organization of Nigeria (SON) and building of test centers for validation of the integrity of the components.

- *Formulation of Realistic Development Program for the Iron and Steel Industry.*

The Nigeria Machine Spare Parts Industries needs a program of development that will elevate it to acquire an international competitive status capable of spare parts production. Programs of development with adequate resources should be worked out and strictly implemented [22]. These developments plan should include the following;

i. Repositioning of the Ajaokula and Delta steel complex and the National Iron Ore Mining Company, Itakpe for responsive and enhance materials and service delivery.
ii. Provide for training programs for indigenous engineers and technicians in partnership with reputable operators and manufactures of machine and machine components parts.
iii. Establish a conducive climate for the generations of funds and private sector participation through public – private sector programs in perspective of an economic viable and competitive iron and steel sector for the production of machine components parts within a regulatory frame-work.
iv. Develop policies to support the initial assembly of machine system equipments for the Nigeria Market.
v. Develop an agenda for the provision of essential funds and equipments to the Nigeria steel industry to develop the materials for the consumption of the machine components, equipment and spare parts manufacturing base.
vi. Develop and provide the necessary policy back up and funds for the establishment of the iron and steel manufacturing base. This sector should have capability in the manufacture of automobile engines, locomotives, rolling stocks and tracks with CIM, and advance maintenance requirements and technology of engine systems [22].

VIII. ANALYSIS OF FINDINGS

Some of the critical challenges facing the Nigeria Iron and steel industries, machine components manufacture and their transformation to a sustainable and internationally competitive and responsive industrial sector have been documented. The various solutions on the Nigeria iron and steel manufacturing sector by previous government strategic planning and policy implementation revolved around funding, upgrade and management of the sector with investment injection from the private sector. This paper gives focus to core technical issue besetting the operation of the iron and steel manufacturing sector in the form of obsolete production resources planning and management approach, use of outdated technology in the manufacturing process, reliance on foreign expertise in the operation, maintenance and supply of machine spare parts.

The results of the assessment of three active steel firms in Lagos indicated that while the companies employ isolated automated machines and processes, there is no direct CAD and CAM integration and the overhaul level of CIM

compliance is very low. The level of human monitoring and intervention is very high in the production chain processes. Thus, the versatility, flexibility and benefits of CIM are lacking. Consequently, the firms will not be able to compete with their foreign counterparts that employ high level of CAD, CAM and CIM compliance.

In as much as adequate funding, private sector investment injection and control, are vital instrument for the repositioning of the Nigeria iron and steel sector, the core technical issues highlighted above form the pedestal to launch the sector into a high trajectory of resource management efficiency, competitive goods production, minimization of cost and material wastage that will entrench global competitiveness that can withstand the rigors of liberalization of international trade.

The iron and steel manufacturing sector should have easy access to indigenous resource persons with expertise in computer manufacturing automation systems for planning, design and manufacture of machines and machine components. A well stocked and qualitative spare parts supply chain with a local base coupled with a robust routine and prevented maintenance schedules with dedicated staffs having access to modern advanced computer systems and programs for enhanced maintenance operation is equally vital.

Most factories involve in iron and steel work with machine components production are dominated by foreigners, most spare parts are imported with the depletion of the value of the Naira. This foreign expertise will only configure the sector in a way that their relevance will continue to be appreciated and will conceal most of the technical knowledge from indigenous engineers and technicians. The results will continue to be an inefficient, unreliable and uncompetitive iron and steel sector

Resource persons with local human capacity in the planning, design and manufacturing of machine components parts in CIM, supported with virile spare parts manufacturing base with expertise in the planning, design, and manufacturing considerations and requirements of primary forming and shaping process, reinforced with a versatile joining process and equipment technology form the basis for the successful revitalization and sustenance of the Nigeria iron and steel sector..

This Nigeria iron and steel manufacturing base will create massive job opportunities in the Nigeria economy and other ancillary industries, act as a wealth creation tool and save hard earned foreign exchange. It can also serve as a components and parts source for the manufacturing of automobiles and their spare parts. The Nigeria Automotive Council estimated that ₦500B was spent on spare parts importation for the automobile industry alone in 2012 [23].

There is need for the nation's engineering infrastructure to be established in order to facilitate the local production of machinery and equipment which will strengthen the industrial growth and development of the economy. Again, concrete efforts must be made towards encouraging domestic innovations and inventions in harnessing and incorporating modern method of manufacturing as this will facilitate the reduction of franchise agreements which preclude Nigeria Manufacturers from exporting and massive gains in foreign exchange.

The adoption of local content requirement and an enabling environment to protect foreign investment will stimulate the development of the Nigeria iron and steel manufacturing sector by utilizing the expertise of reputable manufacturers in machine systems, components and equipments under an appropriate Memorandum of Understanding (MOU). This will give the needed boost for youth employment, engagement and reduction of youth restiveness in social vices, armed robbery and kidnappings.

IX. CONCLUSION

This paper carried out an analyses of the challenges and constraints of the Nigeria iron and steel manufacturing sector with a focus on core technical issue that are fundamental towards the successful revitalization, operation and sustenance of the sector as a virile entity for the production of quality machines and machine components with global competitive content to withstand the liberalization of international trade due to the globalization. In the true spirit of national development the government should establish the necessary policy framework and funds in a public - private partnership program to enhance local content capacity development and resources acquisition in core technical issues that have been highlighted to reposition and sustain the activities of the Nigeria machines and machines components industry as an economically viable entity to deliver qualitative and efficient services to the Nigeria economy.

The implementation of the local content capacity drive in the operation of the Nigeria machines and machine components industry will contribute to the attainment of a vibrant steel sector that will enhance the Gross Domestic Product and exploitation of Nigeria's abundant natural resources.

The sector will also generate economic activities in downstream industries, creates job opportunities and acquisition of technical skills, and helps in the transfer of technology and provision of machine parts and tools.

X. RECOMMENDATION

The upgrade of the facilities and local human capacity acquisition of the technology of automation manufacturing compliant with CIM should be done in phases.

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