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ESTABLISHMENT OF THE RELEVANT CRITERIA FOR MACHINE TOOLS CAPACITY DEVELOPMENT IN NIGERIA

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Editorial Comment: *This article is published on the grounds of its contribution to technological development and policy administration*

Abstract

This study established relevant criteria for developing the capacity building in machine tools industry. A preliminary study was conducted in some relevant establishments in Nigeria through questionnaires, using the traditional paper pencil method (PAPI). The information obtained was useful for the development of elemental criteria for machine tools capacity in Nigeria .The criteria identified were highlighted. The results were interpreted, analysed for the development of actual manpower, actual equipment, actual energy and actual raw materials in both design and fabrication using probability theory. These relevant criteria are critical parameters for developing the sector for optimum performance.

Keywords: capacity development, manpower, equipment, energy, raw materials.

1.0 Introduction

A viable and effective machine tool industry will contribute greatly to the nation's economy. How efficient and quality the industry becomes depends on some underlying factors that will strategically enhance its capacity. The machine tool industry is mostly a capital good sector which is mainly for the development of machinery building engineering in Nigeria. This sector formed the heart and foundation for industrialization and technological transformation in the country. This is because of its immediate intervention in engineering and engineering capacity development. The industry as related is designed to provide for itself the equipment to use and for other sub sectors, hence the need for effective, qualitative, strategic and deterministic plan to be develop within an acceptable frame of work.

Nigeria deserves rapid industrialization, but has little capacity for designing and building of machine tools. Capacity inadequacy has made Nigeria to rely on imported technology for machine tools development. This step involves passing on technical information, equipment and actual transplantation of whole networks of institutions, values, work method and infrastructure of imported technology. Ariyo, (2004), made it clear that this step actually posed serious adaptation problem and the situation was further worsened when the technology structure was introduced before the social and infrastructure prerequisites are ready.

1.1 Development of Technological Capacity for Building Machine Tools Industry

In today's emerging of developing technology for building machines tools, Nigeria has to maintain a strong technological position by developing strong strategy to acquire needed technology. Nations have several methods of acquiring technology that are normally portrayed as relative distinct. The ability to contribute a controlling element of technology system is frequently the key to having a technology acquiring capacity (Aderoba, 2000). With the delay of promotion of indigenous

technology in Nigeria, available technology become obsolete when compared to modern technology. The capacity to search and select the most appropriate technology for machine building from many alternative technologies is, of course, fundamental; but technologies, which are known to exist, are not readily available. The available local technologies are not considered appropriate enough therefore; there is a need to make provision for alternatives.

1.2 Government Approach towards Developing Machine Tools Industry

In trying to develop Nigeria machine tools building capacity, approaches towards its development were reviewed by many researchers. Jimoh,*et al*(2013), attributed the non-performance of machine tools Oshogbo and other related ancillaries to inadequacy of requisite resources for its capacity development. With the view to establish the relevant criteria for onward capacity development, the government have been pursuing increasing dependence and effective utilisation of local resources seeking to achieve the various objectives of the society since independence. It was in this plan that federal government began to take concrete steps to start the development of some key component of a capital goods sector, like Nigerian machine tools Oshogbo (Iweriebor, 2003). The aim of this paper is to establish relevant criteria for the machine tools industry in Nigeria for effective capacity development.

2.0 Capacity Requirement for Machine Tools Industry

The rate of development of machine building technology depends on manpower, equipment, raw materials, and energy development. Moreover, the development of all these capacities for machine tools building cannot succeed in the absence of careful consideration of all influencing factors, which include financial, environment, socio-political, information resources and infrastructural facilities. Jimoh,*et al*(2013). Majority of work carried out on machine tools development was centred on the policy making, suggestions and prescriptions on how individual resources that constitute the machine tools building capacity can be developed, without quantitative analysis of the individual resources and influencing elements.

Therefore, for an effective machine tools capacity development, it is important that a meaningful, concrete and result –oriented strategies has to be devised. This is to generate and sustain the technological take-off of machine tool building of the nation. Hence, there is a need for quantitative analysis of individual machine building elements in terms of level of development and how the respective elements can be improved. This paper therefore addresses the following:

- establish those elements necessary for machine tools development through identification of its resources on ground with set up standard.

- establish criteria equations for each contributing elements to the development of machine tools building capacity.

2.1 **Manpower Development**

A lot of work has been done by many researchers to put a lasting solution to manpower problem as related to capital goods sector development. Most people that have worked on manpower research focused more on manpower planning than manpower development. In recent years, a lot of attention has been given to manpower planning model and their applications in the industries.

This paper actually tries to go further in evaluating the manpower capability using system approach method, which involves manpower planning and manpower development. Since skill formation go beyond quantifying the number of university, polytechnics, or trade schools required to train qualify hands. Skill formation in this paper is related to strategy of manpower development rather than

narrow concept of education and planning. This system approach to manpower development will be appropriate this time because of increased number of jobs in machine building industry that requires knowledgeable, skilled and experienced workers rather than unskilled workers. Manpower capacity development for machine tools building is quiet difficult in the past because of no analytical evaluation of the requirement for machine tools building. Therefore, this paper has tried to establish criteria equations for each contributing elements for manpower development.

2.2 Raw Material Development

The raw material in this context, includes such metallic minerals as iron ore, tin bauxite, copper, zinc, lead nickel; non-metallic mineral like limestone, kaolin, gypsum, phosphate, talc, dolomite, salt, silica, sand, mica, barite, bentonite, feldspar; fuel mineral, like petroleum, gas and coal. Iweriebor (2003) made it clear that the inability of government agencies like; National Steel Raw Material Exploration Agency (NSREMA), National Metallurgical Development Centre, (NMDC), Nigerian mining cooperation (NMC),Raw Material Research and Development Council (RMRDC) , to discharge their duties is a serious challenge to the development of machine tools industry in Nigeria.

2.3 Equipment Development

Iweriebor (2003) stressed the importance of developing indigenous machine and equipment to produce machine tools since most of the technology transfer is through the sophisticated imported machine equipment and many lacks the technical knowhow to operate and to maintain the equipment. This entire step is a deliberate action to put the country in perpetual technological slavery and industrialization bondage for life.

The first major capital equipment project in the general machine sector was the Engineering Materials Development Institutes [EMDI]. It is to undertake research and development of the manufacturing process and system for the conversion of semi – processed materials into engineering materials for use in design and production of machinery and equipment in that sector. The second major project is the Hydraulic Equipment Development Institute (HEDI), Kano. National Engineering Design and Development Centre (NEDDC), is the third important project of NASENI. All these agencies are put in place by the government to be able to design and build equipment that can be operated and maintained domestically without the attention of the expatriate but unfortunately, the agencies are unable to live up to expectation.

2.4 Energy Development

Accurate assessment of prevailing technical realities in power generation industry is the only management tool for improving power generation. So far, power generation development is the basis of development of machinery in Nigeria. It is quite necessary to develop the technical capacity for power generation for a reasonable development of machine tool in Nigeria. Aderoba, (2000) made it clear that, electricity constitutes an essential input in the industrial development process and also is the biggest operational problem facing industries in Nigeria today.

Requisite energy, in terms of quality and quantity is a function of power generation, power transmission and distribution. A lot of models have been developed to forecast and predict the demand of energy by different authors; as Oke (2002) and Madueme (2002), using basic empirical model mode and composite model respectively. Oke et al, (2007), examined three levels of models for predicting electricity demand in Nigeria. Another model was formulated to predict electricity energy consumption rate, by Ibe and Akerleper (2005). In all the literatures, none of them talked on how the machine tool's electricity supply can be improved.

3.0 Research Methodology

A preliminary study was conducted in some relevant establishments in Nigeria to obtain information on the criteria useful for the development of effective machine tools capacity in Nigeria, through questionnaires using the traditional paper pencil method (PAPI).The relevant establishments, where information was gathered include; Basic Raw Materials Industries and Promotion Agencies , Basic Equipment and Promotion Agencies, Energy Production Industries and Promotion Agencies and Human Resource Development establishments and Agencies. Based on the information gathered, the relevant criteria (manpower, equipment, raw materials, finance, environment and socio-political factors) for machine tools building were established. The aforementioned elements were analysed critically to establish the following major resources for development of machine tools. These are: actual manpower, actual raw material, actual equipment and actual energy. All these capacities are developed along the line of machine design and fabrication.

Fig.1 showed hierarchy of machine tools building capacity in Nigeria. At at the top of the hierarchy is the overall goal, i.e. Machine tools Building Technological Capacity (MBTC). The overall goal is broken down into two sub goal, Machine Fabrication (MFC) and Machine Design Capacities (MDC) which are further decomposed into contributory factors which overlapped and these factors are Manpower, (MP), Equipment (EQ), Energy (EN), and Raw Materials(RM) resources. These contributory factors are broken down into sub –contributory factors, which are Quantity (Q) and Quality (q). At the bottom of the hierarchy are the items to be compared, which are Nigeria actual level of development as regards to machine tools building technological capacity(N) and the standard technological capacity(S), set up for an operative machine tools industry. For simplicity, and to be able to address all the elements and sub –elements that contribute to machine tools building technological capacity, it is preferable to determine the level of quality and quantity of the contributory factors, to be followed by capacity determination for the equipment, energy and raw material as regards to machine building in Nigeria and compared with set up standard. Based on the above, the machine fabrication and design capabilities of Nigeria are determined.

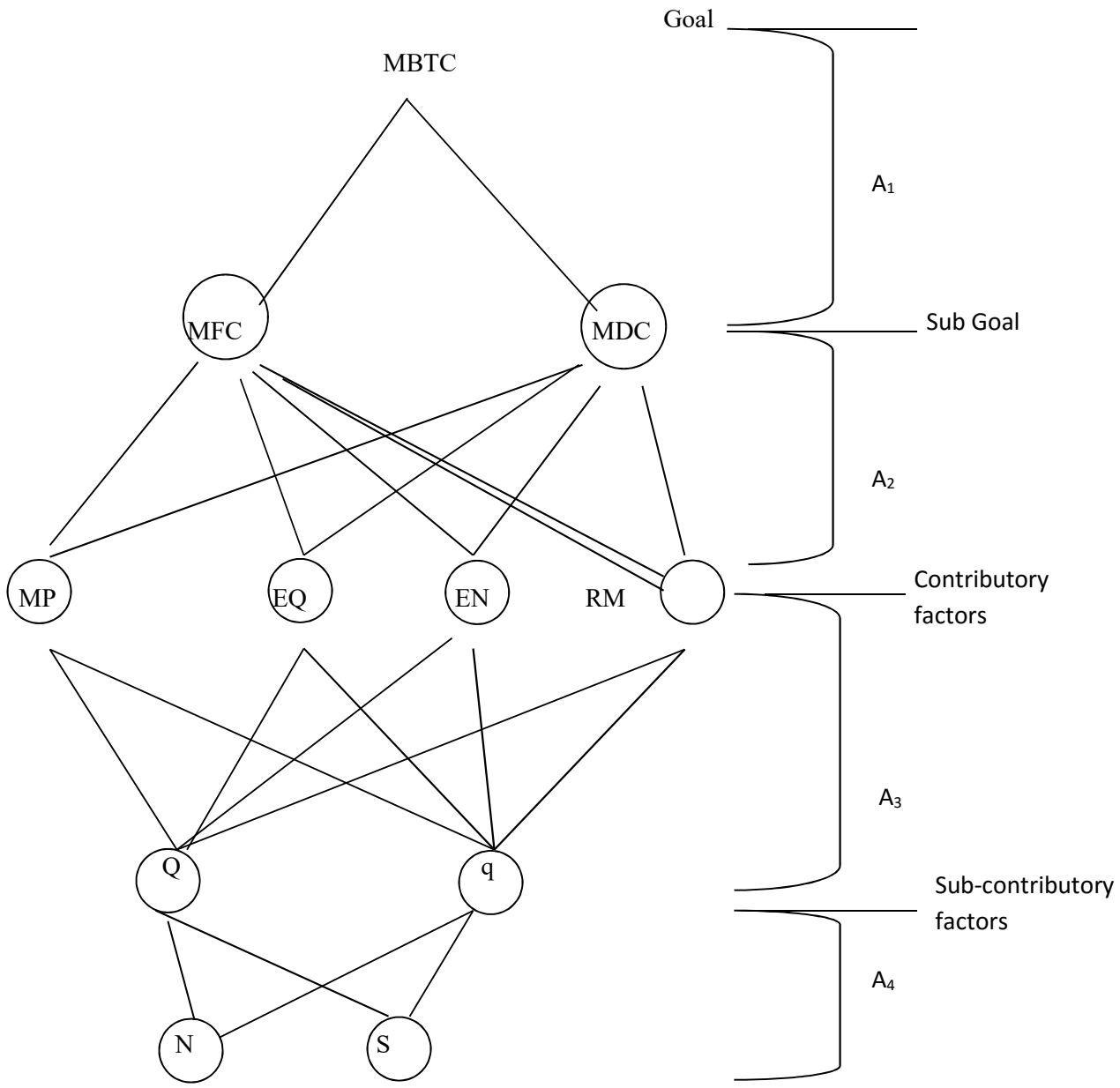

Fig 1: Hierarchy of Machine Building Capacity Development in Nigeria

4.0 Results and Discussion

An effective manpower in machine tools development is a function of requisite education, requisite experience and involvement in research and development. Therefore, the level of manpower capacity in both design and fabrication can be determined using probability theory and since these three elements are non- mutually exclusive and can be represented by a Venn diagram shown in Fig.2

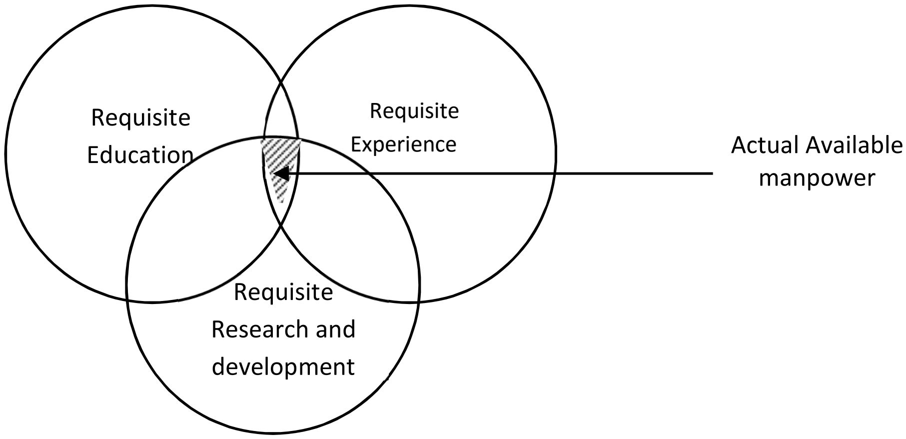

Fig. 2 Venn Diagram for Machine Tool Manpower Development Capacity

4.1 Actual available manpower for machine tool fabrication (X_{F1}).

$X_{F1} = Py_xF_{11} \cap y_xF_{12} \cap y_xF_{13} =$
$[Py_xF_{11} \cup y_xF_{12} \cup y_xF_{13} \quad Py_xF_{11} \quad Py_xF_{12} \quad Py_xF_{13} + Py_xF_{11} \cap y_xF_{12} + Py_xF_{13} \cap y_xF_{12} + Py_xF_{11} \cap y_xF_{13}]$ …….. 1

4.2 Actual available manpower for machine tool design (X_{D1}) is therefore:

$X_{D1} = Py_xD_{11} \cap y_xD_{12} \cap y_xD_{13} = [Py_xD_{11} \cup y_xD_{12} \cup y_xD_{13} \quad Py_xD_{11} \quad Py_xD_{12} \quad Py_xD_{13} + Py_xD_{11} \cap y_xD_{12} + Py_xD_{13} \cap y_xD_{12} + Py_xD_{11} \cap y_xD_{13}]$ … (2)

Where,

$P(y_{XD11} \cap y_{XD12} \cap y_{XD13})$ and $P(y_{XF11} \cap y_{XF12} \cap y_{XF13})$ = Probability of having number of people that have requisite education, requisite experience and requisite research and development in Machine Tool design and fabrication respectively.

$P(y_{XD11} \cup y_{XD12} \cup y_{XD13})$ and $P(y_{XF11} \cup y_{XF12} \cup y_{XF13})$ = Probability of having people with either requisite education or requisite experience or requisite research and development, which is equal to the total number of employee in the establishment in involving in design and fabrication respectively.

$P(y_{XD11})$, $P(y_{XD12})$ and $P(y_{XD13})$ = Probability of having people with only design education, experience and research and development respectively.

$P(y_{XF11})$, $P(y_{XF12})$, $P(y_{XF13})$ = Fabrication education, experience and research and development respectively.

4.3 Actual available equipment

Equipment for developing machine tools is a function of availability and functionality of design and fabrication equipment and facilities. In this section some machine are available, but are not functioning. These two factors are responsible for determination of equipment capacity level and are mutually exclusive, as shown in Venn diagram in Fig. 3. The probability of having required equipment for machine tool development is given by;

$X_{D2} = Py_xD_{21} = Py_xD_{21} \cup y_xD_{22} \quad Py_xD_{22}$…………………………………3

$X_{F2} = Py_xF_2 = Py_xF_{21} \cup y_xF_{22} \quad Py_xF_{22}$ ……………………….............4

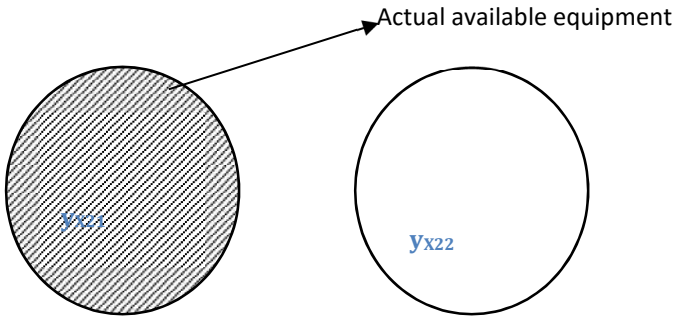

Fig. 3: Venn diagram for machine tool Equipment Development Capacity

where

$P(y_{XD21})$ and $P(y_{XF21})$ = Probability of having a functional design and fabrication equipment, respectively.

$P(y_{XD21} \cup y_{XD22})$ and $P(y_{XF21} \cup y_{XF22})$ = Probability of having a functional or non-functional design and fabrication equipment respectively.

$P(y_{XD22})$ and $P(y_{XF22})$ = Probability of have non-functional design and fabrication equipment respectively.

4.4 **Actual available raw material**

Raw material for machine tool development is function of good quantity and quality raw material. The raw materials are either good or bad and these factors are responsible for appropriate raw material and they are mutually exclusive.

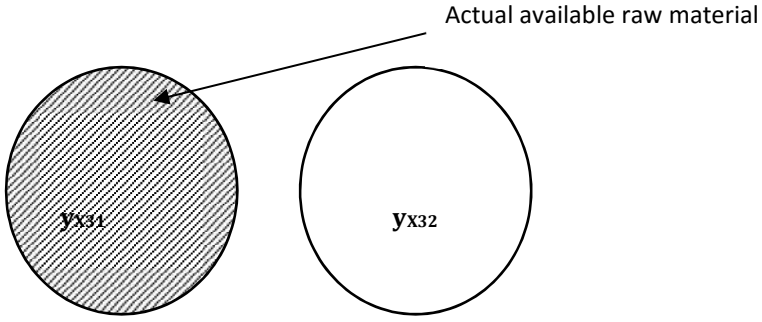

Fig. 4 Venn diagram for Raw Material Development Capacity

$$X_{F3} = Py_xF_{31} \cup y_xF_{32} \quad Py_xF_{32} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

$$X_{D3} = Py_xD_{31} \cup y_xD_{32} \quad Py_xD_{32} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

Where

$P(y_{XF31})$ and $P(y_{XD31})$ = Probability of having good quality raw material for design and fabrication respectively.

$P(y_{XF31} \cup y_{XF32})$ and $P(y_{XD31} \cup y_{XD32})$ = Probability of having good or bad quality raw material for design and fabrication respectively.

$P(y_{XF32})$ and $P(y_{XD32})$ = Probability of having bad quality raw material for design and fabrication respectively.

4.5 **Actual available energy**

Energy required for machine tool development is a function of the quality and quantity of energy available, this energy can be either good or bad. The elements that are responsible for appropriate energy are mutually exclusive. This is shown in fig 5

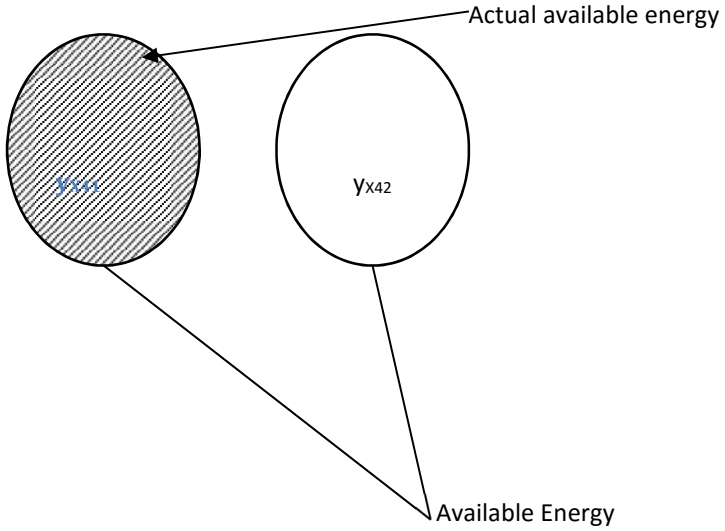

Fig. 5 Venn diagram for Energy Development Capacity

$Py_xF_{41} = Py_xF_{41} \cup y_xF_{42}$ Py_xF_{42} ……7

$Py_xD_{41} = Py_xD_{41} \cup y_xD_{42}$ Py_xD_{42} ……..8

Where

$P(y_{XF41})$ and $P(y_{XD41})$ = probability of having good quality energy for fabrication and design respectively.

$P(y_{XF41} \cup y_{XF42})$ and $P(y_{XD41} \cup y_{XD42})$ = Probability of having good or bad quality energy for Machine Tools fabrication and design respectively.

$P(y_{XF42})$ and $P(y_{XD42})$ = Probability of having bad quality energy for Machine Tool fabrication and design respectively.

5.0 Conclusions

The paper has pointed out the relevant criteria found useful in the development of capital goods sectors, including machine tools industry. These relevant criteria are critical parameters for the development of the sector. It is important that a meaningful, concrete and result –oriented strategic plans developed in this paper is to be employed by the Government to generate and sustain the technological take-off of effective machine tool building for the nation.

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