DEVELOPMENT OF A MODEL FOR CAPACITY BUILDING FOR MACHINE TOOLS INDUSTRY IN NIGERIA

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APPROVAL PAGE

CERTIFICATION

This work has not been presented elsewhere for the award of a degree or any other purpose

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DEDICATION

The thesis is dedicated to God and my parents – Late Dr. D. E. Okẹ and Mrs L. Oke

ACKNOWLEDGEMENT

I thank God Almighty for making this work a reality despite all odds. I would like to acknowledge and appreciate the academic contribution and moral support rendered by my Major Supervisor, Prof A. A. Aderoba. I also express my gratitude to my Co – Supervisor, Prof. S. B. Adejuyigbe for his support and useful suggestions.

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I also acknowledge the assistance rendered by the management and staff of Nigerian Machine Tools Osogbo for making available necessary data / information used in this study. May God continue to sustain the industry. I also thank Engr Adebolu, the Director of Engineering Services, Nigerian Machine Tools Osogbo for the assistance rendered; may God bless you abundantly.

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ABSTRACT

With a view to achieve industrial growth, Nigeria has tried to establish a sound infrastructure involving among many other things, the establishment of an indigenous machine tools industry. Unfortunately, machine tools industry's development in Nigeria is adversely affected by uncertainties in capacity building in some areas which include technology, manpower, raw materials, equipment and energy.

This thesis developed a robust model to achieve a desirable, dynamic and balanced capability of building and upgrading machine tools capacity in Nigeria. The model was developed for determining the machine tools technology capacity level in terms of machine design and machine fabrication capacity. The parameters determined from the model include, manpower, equipment, raw materials and energy capabilities for machine tools design and fabrication. The capacity outcomes were compared with established standards. The shortages and / or surpluses in each elemental capacity were determined using statistical difference method. This established appropriate funds to be allocated to each resource at specific time to yield required and appropriate resources capacity level within the time schedule.

A dynamic programming technique with concept of adaptive control theory was used in machine tools resources capacity development. A feedback control system with adjustable coefficients was developed to minimize the effects of the uncertainty of the process parameters identified as manpower, raw materials, equipment and energy. The adjustable coefficient was made dynamic from available fund that was allocated in appropriate proportion depending on the level of development required of each system parameter. A software named CAMTCAD-2008 in Visual Basic was developed for effective implementation of the model. The model was validated with the data collected from Nigerian Machine Tools, Oshogbo.

The result of the model has shown an inadequate level of development in resources for capacity building in the machine tools industry at a particular time. The model has revealed an immediate cost benefit in spreading the development of the system over the years. It was further observed from the result that the financial cumulative effect does not favour long-term period of system development. This may be due to variation in time value of money. This model

further helped in identifying all the resources that have shortfall or surplus in their capacity levels and provided a clue of what the industry has to put in place in order to meet acceptable standards.

The model gave an insight on future development and direction of advancement in machine tools building in Nigeria thereby making a way for optimal development of machine tools that is technically sound, environmentally friendly and economically justifiable. The resulting software is amenable to practical application of technologically based qualitative forecasting strategies for planning, managing and development of machine tools industry in developing economies like Nigeria. This model has enhanced a sustainable structure for future development and direction of advancement in machine tools industry.

NOMENCLATURE

e_o, machine tool capacity output error

e_{il}, identifier error in machine tools development

i, number of stage of development

j, element of machine tools industry development

N, the number of year of project implementation

Q, Controller parameter (fund)

Q_U, money for unit development of machine tool

Q_{di} distributed money at specific year (i)

Q_{dij} distributed money to each resources j at specific year (i)

Q_r, required fund for further development

Q_{H}, total amount of money allocated at a specific time

t, time of development

β, machine tools building capacity development

σ_f, machine tools fabrication capacity development

σ_d, machine tools design capacity development

υ_{mf}, manpower for machine tools fabrication capacity development

υ_{qf}, equipment for machine tools fabrication capacity development

υ_{rf}, raw material for machine tools fabrication capacity development

υ_{ef}, energy capacity for machine tools fabrication capacity development

υ_{md}, manpower for machine tools design capacity development

υ_{qd}, equipment for machine tools design capacity development

υ_{rd}, raw material for machine tools design capacity development

υ_{ed}, energy for machine tools design capacity development

ϕ_{mfj}, available manpower for machine tool fabrication

ϕ_{mfe}, available manpower with requisite education for machine tool fabrication at a specific tim

ϕ_{mfx}, available manpower with requisite experience for machine tool fabrication at specific tim

ϕm_{ft}, available manpower with requisite training for machine tool fabrication at specific time

$\phi m_{fex,}$ available manpower with requisite education and experience for machine tool fabrication at specific time

$\phi m_{fet,}$ available manpower with requisite education and training for machine tool fabrication in specific time

$\phi m_{ftx,}$ available manpower with requisite training and experience for machine tool fabrication at specific time

$\phi_{mftex,}$ available manpower with requisite education, training and experience for machine tool fabrication at specific time

ϕ_{mdp} available manpower for machine tool design at specific time

ϕ_{mde} available manpower with requisite education for machine tool design at specific time

$\phi_{mdx,}$ available manpower with requisite experience for machine tool design at specific time

$\phi_{mdt,}$ available manpower with requisite training for machine tool design at specific time

$\phi_{mdex,}$ available manpower with requisite education and experience for machine tool design at specific time

$\phi_{mdet,}$ available manpower with requisite education and training for machine tool design at specific time

$\phi_{mdtx,}$ available manpower with requisite training and experience for machine tool design at specific time

$\phi_{mdtex,}$ available manpower with requisite education, training and experience for machine tool design at specific time

$\phi_{Tmfij,}$ total manpower available for machine tool fabrication at a specific stage

$\phi_{Tmdij,}$ total manpower available for machine tool design at a specific stage

$\phi_{rmf,}$ required manpower for machine tool fabrication

$\phi_{rmd,}$ required manpower for machine tool design.

$\psi_{mfi,}$ total available manpower level for machine tool fabrication at a specific stage

$\psi_{mdi,}$ total available manpower level for machine tool design at a specific stage

α_{mfi} useful available manpower level for machine tool fabrication at a specific time

α_{mdi} useful available manpower level for machine tool design at a specific time

ν_{mft}, actual useful available manpower level for machine tools fabrication at a specific stage,

ν_{mdt}, actual useful available manpower level for machine tools design at a specific stage

ϕ_{qft}, available equipment for machine tools fabrication at a specific time

ϕ_{qdt}, available equipment for machine tools design at a specific time

ϕ_{qfN}, functional equipment and facilities for machine tools fabrication at a specific time

ϕ_{qfn}, non functional equipment for machine tools fabrication at a specific time

ϕ_{qdN}, functional equipment and facilities for machine tools design at a specific time

ϕ_{qdn}, non functional equipment for machine tools design at a specific time

ϕ_{Tqfij}, total equipment available for machine tool fabrication at a specific stage

ϕ_{Tqdij}, total equipment available for machine tool design at a specific stage

ϕ_{rqf}, required equipment for machine tool fabrication at a specific time

ϕ_{rqd}, required equipment for machine tool design at a specific time

φ_{qft}, total available equipment level machine tools fabrication at a specific time/stage

φ_{qdt}, total available equipment level machine tools design at specific time/stage

α_{qft}, useful available equipment level for machine tool fabrication at a specific time

α_{qdt}, useful available equipment level for machine tool design at a specific time

ν_{qft}, actual useful available equipment level for machine tools fabrication at specific stage,

ν_{qdt}, actual useful available equipment level for machine tools design at specific stage

ϕ_{rft}, available raw material for machine tools fabrication at a specific time

ϕ_{rdt}, available raw material for machine tools design at a specific time

ϕ_{Trfij}, total raw material available for machine tool fabrication at a specific stage

ϕ_{Trdij}, total raw material available for machine tool design at a specific stage

ϕ_{rrf}, required raw material for machine tool fabrication at a specific time

ϕ_{rrd}, required raw material for machine tool design at a specific time

ϕ_{rfQ}, quality raw material for machine tools fabrication at a specific time

ϕ_{rfq}, non quality raw material for machine tools fabrication at a specific time

ϕ_{rdQ}, quality raw material for machine tools design at a specific time

ϕ_{rdq}, non quality raw material for machine tools design at a specific time

λ_{mfe}, level of available manpower with requisite education for machine tool fabrication at a specific time

λ_{mfx}, level of available manpower with requisite experience for machine tool fabrication at a specific time

λ_{mft}, level of available manpower with requisite training for machine tool fabrication at a specific time

λ_{mfex}, level of available manpower with requisite education and experience for machine tool fabrication at a specific time

λ_{mfet}, level of available manpower with requisite education and training for machine tool fabrication at a specific time

λ_{mfte}, level of available manpower with requisite training and experience for machine tool fabrication at a specific time

λ_{mde}, level of available manpower with requisite education for machine tool design at a specific time

λ_{mdx}, level of available manpower with requisite experience for machine tool design at a specific time

λ_{mdt}, level of available manpower with requisite training for machine tool design at a specific time

λ_{mdex}, level of available manpower with requisite education and experience for machine tool design at a specific time

λ_{mdet}, level of available manpower with requisite education and training for machine tool design at a specific time

λ_{mdte}, level of available manpower with requisite training and experience for machine tool design at a specific time

λ_{qfN}, level of available functional equipment and facilities for machine tools fabrication at a specific time

λ_{qfn}, level of available non functional equipment for machine tools fabrication at a specific time

λ_{qdN}, level of available functional equipment and facilities for machine tools design at a specific time

λ_{sqdn}, level of available non functional equipment for machine tools design at a specific time

λ_{rfQ}, level of available quality raw material for machine tools fabrication at a specific time

λ_{rfq}, level of available non quality raw material for machine tools fabrication at a specific time

λ_{rdQ}, level of available quality raw material for machine tools design at a specific time

λ_{rdq}, level of available non quality raw material for machine tools design at a specific time

λ_{efQ}, level of available quality energy for machine tools fabrication at a specific time

λ_{efq}, level of available non quality energy for machine tools fabrication at a specific time

λ_{edQ}, level of available energy for machine tools design at a specific time

λ_{edq}, level of available energy for machine tools design at a specific time

ϕ_{mdtexl}, level of available manpower with requisite education, training and experience for machine tool design at a specific time

ϕ_{mftexl}, level of available manpower with requisite education, training and experience for machine tool fabrication at a specific time

φ_{rf}, total available raw material level machine tools fabrication at specific time/stage

φ_{rd}, total available raw material level machine tools design at specific time/stage

α_{rf}, useful available raw material level for machine tool fabrication at a specific stage

α_{rd}, useful available raw material level for machine tool design at a specific stage

ν_{rf}, actual useful available raw material level for machine tools fabrication at specific stage,

ν_{rd}, actual useful available raw material level for machine tools design at specific stage

ϕ_{ef}, available energy for machine tools fabrication at a specific stage

ϕ_{ed}, availâble energy for machine tools design at a specific stage

ϕ_{Tefi}, total energy available for machine tool fabrication at a specific stage

ϕ_{Tedi}, total energy available for machine tool design at a specific stage

ϕ_{ref}, required energy for machine tool fabrication at a specific stage

ϕ_{red}, required energy for machine tool design at a specific stage

ϕ_{efQ}, quality raw energy for machine tools fabrication at a specific stage

ϕ_{efq}, non quality energy for machine tools fabrication at a specific stage

ϕ_{edQ}, quality energy for machine tools design at a specific stage

ϕ_{cdq} non quality energy for machine tools design at a specific stage

φ_{cij}, total available energy level machine tools fabrication at specific time/stage

φ_{cdi}, total available energy level machine tools design at specific time/stage

$\alpha_{(f)}$, actual available energy level for machine tool fabrication at a specific stage

α_{cdi}, actual available energy level for machine tool design at a specific stage

v_{cff}, actual available energy level for machine tools fabrication at a specific stage

v_{cfi}, actual available raw material level for machine tools design at a specific stage

σ_{ff}, actual level of available machine tool fabrication capacity at a specific stage

σ_{df}, actual level of available machine tool design capacity at a specific stage

ki , fractional developmental level of other machine tools resources

r_{ij} , error in each machine tools resources

ℓ_{Tij} ,.total error in the machine tools system

βi, actual level of available machine tool building capacity

γ_{ij}, weighted error of each machine tools resources

Q_{ij} fund for unit marginal value improvement of each machine tools resource

Q_{f0} fund for unit marginal improvement of the machine tools system

α_i weighted fund for each machine tools resources improvement

Q_a, actual money for machine tools development

Q_S ,amount of money already spent for machine tools development

δ_i, value of the resources with highest development level

β, real machine tool capacity output

βm, ideal machine tool capacity output

CHAPTER ONE

INTRODUCTION

Despite Nigeria's early recognition of importance of machine tools in the nation's industrialization, the country has not escaped the dependence on imported machinery inherited as part of the colonial legacy (Oladipo, 1988). With a view to achieve the industrial growth and to reduce the nation's dependence on importations, especially in the engineering sector, Nigeria has tried to establish a sound infrastructure involving among many other things, the establishment of machine tools industry (Agiobenebo and Agiobene 1989; AMT, 1998). Unfortunately, up till now the goal of establishing the machine tools industry in the area of machine building is yet to be achieved, despite huge investments made by the Federal Government of Nigeria on the Machine Tools sector of the economy (Olaoye, 1985).

Nigeria deserves rapid industrialization, but has little capacity for designing and building 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. Laditan, 2000 stated that the technology acquisition through technology transfer has been very costly and ineffective because most of the industries like the Nigerian Machine Tools Oshogbo, Ajaokuta Steel Plant, Delta Steel Company, e.t.c. established through these processes became inefficient, underutilized, debunked from local economy and eventually incapable of generating exports, skills or employment.

Keeping in view the present level of technology existing in Nigeria, it is obvious that relying on external acquisition of technology to build machine tools will no longer fit the configuration threats, opportunities and capacities faced by Nigeria in today's environment. Aderoba (1989) attributed the machine building problems to low Nigeria content in terms of raw materials, manpower, energy and equipment, which formed the bases for machine tools technology development. He further stated that the problem of machine tools was worsened by the mismanagement of funds allocated to various resources that are responsible for the development of machine tools industry. These abnormalities have led to a dearth in job, skills development, and capacity building/utilization of machine tools sector and consequently shaping the destinies of other sectors of the economy in a negative direction in a way, which seem inevitable and irreversible. The importance of developing indigenous capacity for building machine tools taking into consideration the needs, resources, environmental factor and lifestyles of the people was stressed by Aderoba (1988).

In Nigeria as at now, there are scantily formulated and coordinated strategies that are aimed at the systematic transformation of machine tools building production system and capacities. Moreover, there had been no significant achievement in modification and adaptation of imported technology, and the development of indigenous technology as well. Therefore, for an effective machine tools building technological capacity, it is important that a meaningful, concrete and result –oriented strategy be devised to sustain the technological take-off of machine tool building of the nation.

Therefore this thesis focuses on the development of concrete and result – oriented strategies aimed at developing technological capacity for machine tools building. This involves the upgrading of indigenous technologies through gradual development of all relevant resources for machine building to meet up with functional machine tools technological capacity through proper disbursement and management of funds to all necessary resources responsible for indigenous machine tools development.

1.1 Background of the study

According to Obi (1989), any economy that is unable to produce machinery and equipment lacks the capacity to directly transform its own savings into investment since capital accumulated in such an economy cannot be sustained without complementary import machinery and equipment for production of other goods and services. Unfortunately, in spite of the nation's potential, various public authorities in Nigeria have all along neglected building of capacity necessary for the development of machine tools sector which is the base for producing machineries and equipment

(Dickenson, 2007). In an effort to develop machinery, the country heavily relies on the importation of technologies rather than adopting, molding and transforming the local technology to a form sustainable for machinery production.

This approach has not helped the situation since no country would willingly transfer technology that would undermine the potentials of sale of its finished products to other countries (Girvan, 1979). Obi (1989) stated further that imported technology has not been profitable to Nigeria and it has failed to close the increasing gap between Nigeria and developed countries, because of continual stagnation of technological competence. Adejuyigbe and Aderoba (2000) stated that external acquisition of technology no longer fits the configuration threats, opportunities and capacities faced by Nigeria in today's environment. Interest has been focused on what happens to these technologies after acquisition since most of the industries like Nigerian Machine Tools Oshogbo, Ajaokuta Steel Plant, Delta Steel Company, e.t.c. established through these processes became inefficient, underutilized, debunked from local economy and eventually become incapable of generating exports, skills or employment.

In the recent Nigerian Oil and Gas 2007 exhibition, Nigerian indigenous companies cried out that power infrastructure and equipment has made it difficult to meet the advanced challenges posed by their operations. The emphases were laid on how to increase the capacity of indigenous machine tools and fabrication industries to meet up the challenges. Therefore, the idea of developing appropriate technology capacity for machine tools building taking into consideration the needs, resources, environmental factor and lifestyles of the people therefore becomes very important, which is the focus of this research.

1.2 Scope of the study

The sector that produces machinery and equipment in the manufacturing industry is usually referred to as a capital goods sector. The products of this sector include, mechanical machineries and equipment, electrical machinery, apparatus, and appliance, transport equipment, professional and scientific (measuring and controlling) equipment (Kolade, 1990). Out of all these products, only mechanical machineries and equipment played a major role (being the bedrock for other categories of capital goods) in economic development of any nation and it needs special attention.

Therefore, this study developed a technology strategic model which focuses on machinery production capacity of machine tools industry. Machine tools are basic mechanical machinery used to produce or repair other machine parts.

1.3 Modeling Concept

The mathematical modeling in this study was used to determine the present machine tools building capacity level, using probability and goes further to upgrade each machine building elemental capacities using dynamic programming with adaptive control parameters to actualize real machine tools capacity as stated in the initial project implementation manual of machine tools industries in Nigeria (NMT, 1994).

The resulting software named Computer Aided Machine Tools Capacity Development (CAMTCAD -2008) was proposed to control all the elements and the resources of machine tools capacity building.

1.4 Specific Objectives of the Research

The specific objectives are to:

a. assess the capacity utilization for building machine tools industry using relevant criteria;

b. develop a model for resource appropriation of capacity building in machine tools industry;

c. develop a computer software for effective implementation of the model developed in 'b'; and

d. validate the model developed using data obtained from Nigerian Machine Tools, Oshogbo.

1.5 Research Methodology

A preliminary study was conducted in some relevant establishments in Nigeria to obtain information on the criteria useful for the development of appropriate model for machine tools capacity building in Nigeria. Some of the relevant establishments where information was collected 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 for machine tools building were established which include technology, manpower, equipment, raw materials, finance, environment and socio-political factors. The aforementioned criteria were analyzed mathematically and this formed the basis of the developed model for machine capacity building. In developing the model, the benchmark of machine tools resource requirement was done using probability theory and machine building capacity resources planning was done using dynamic programming and control theory.

The model was developed for determining the machine tools technology capacity level in terms of machine design and machine fabrication capacity. The parameters determined from the model include, manpower, equipment, raw materials and energy capabilities for machine tools design and fabrication. The capacity outcomes were compared with established standards. The shortage and/or surplus in each elemental capacity were determined using statistical difference method. From this, appropriate funds to be allocated to each resource at specific times were established.

A dynamic programming technique with concept of adaptive control theory was used in machine tools resources capacity development. A feedback control system with adjustable coefficients was developed to minimize the effects of the uncertainty of the process parameters identified as manpower, raw materials, equipment and energy. The adjustable coefficient was made dynamic from available funds that were allocated in appropriate proportion depending on the level of development of each system parameter and fund per unit marginal value improvement of each resource with respect to total final fund per marginal improvement of the machine tools.

A software named Computer Aided Machine Tools Capacity Devlopment (CAMTCAD-2008) using Visual Basic was developed for effective implementation of the model. The model was validated through data collected from Nigerian Machine Tools Oshogbo

1.6 Expected Contributions of the Research to the Knowledge

The research is expected to:

(a) establish technologically based qualitative forecasting strategies for planning, managing and development of machine tools industry.

(b) enhance a sustainable structure for future development and direction of advancement in machine tools industry; and

(c) provide a software amenable to practical application of the machine tools sector of the Nigerian economy.

CHAPTER TWO

LITERATURE REVIEW

Industrialization was embraced in the early 1960's as a vehicle for rapid economic and social development knowing that no industrialization without development of indigenous technology capacity to build machine most especially machine tools, in which other goods and services emanated (Atteh, 1992). In trying to develop Nigeria machine tools building technological capability, it is necessary to reviews the past approaches adopted in developing technology capacity in machine tools industries in Nigeria.

2.1 Development of Technological Capacity for Building Machine Tools Industry

In today's environment of developing technology of building machine tools, Nigeria has to maintain a strong technological position by developing a strong strategy to acquire needed technology. The ability to contribute a controlling element of technology system, and the core technology, is frequently the key to having a technology acquiring capacity (Aderoba, 2000). Recognition of the adverse effects of external dependence was responsible for specific objective of the Fourth National Development plan, 1981, titled 'Greater Self Reliance', that is, increased dependence on our own resource in seeking to achieve the various objective of the society. An important dimension of self-reliance is technological self-reliance most especially in the area of building machine tools for production and repair of other machinery used for production of goods and services. (Oyeniyi, 1984).

With the in the promotion of indigenous technology in Nigeria, available technology becomes obsolete when compared to modern technology. This creates a bigger problem of technology stagination, thereby makes technology to be looked upon as the preserve of the developed countries and was thought unattainable by Nigeria.

The capacity to search and select the most appropriate technology for machine building from many alternatives is of course fundamental; but technologies, which are known to exist, are not readily available. The capacity to acquire them includes the capacity to identify technology source, the capacity to tailor the technology to suit local conditions and the capability to transfer technology as when necessary from abroad or within countries (Bhalla and Fluitman, 1985)

The locally available technologies are not considered appropriate enough and there is a need to make provision for alternatives. To do this, technological Options in Fig. 2.1 is modified to fit the need and the situation of Nigeria Machine Tools. The modified technological Options for building machine tools is shown in Fig. 2.2

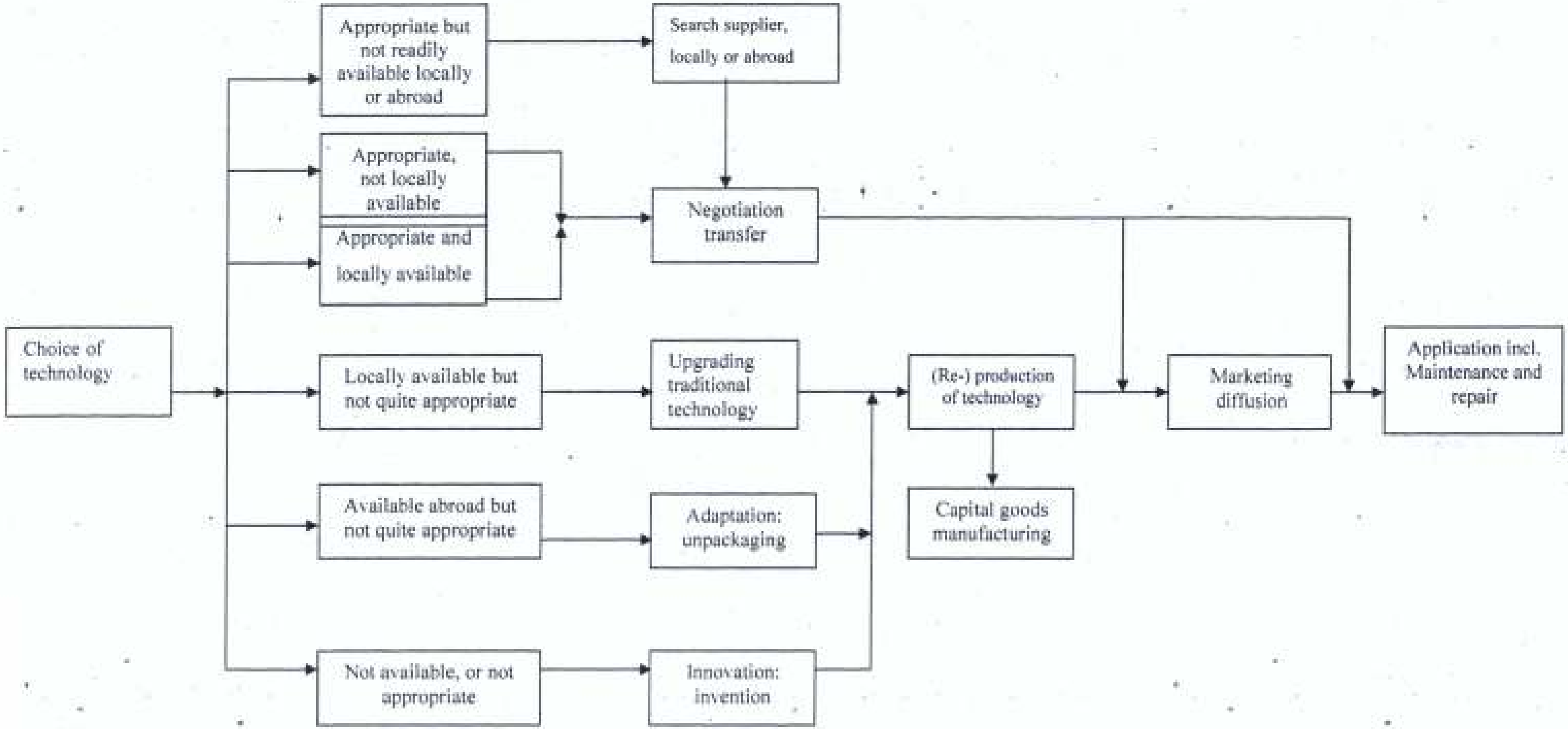


Fig.2.1: Relationship of Technological Options.

Source :(Bhalla and Fluitman, 1985)

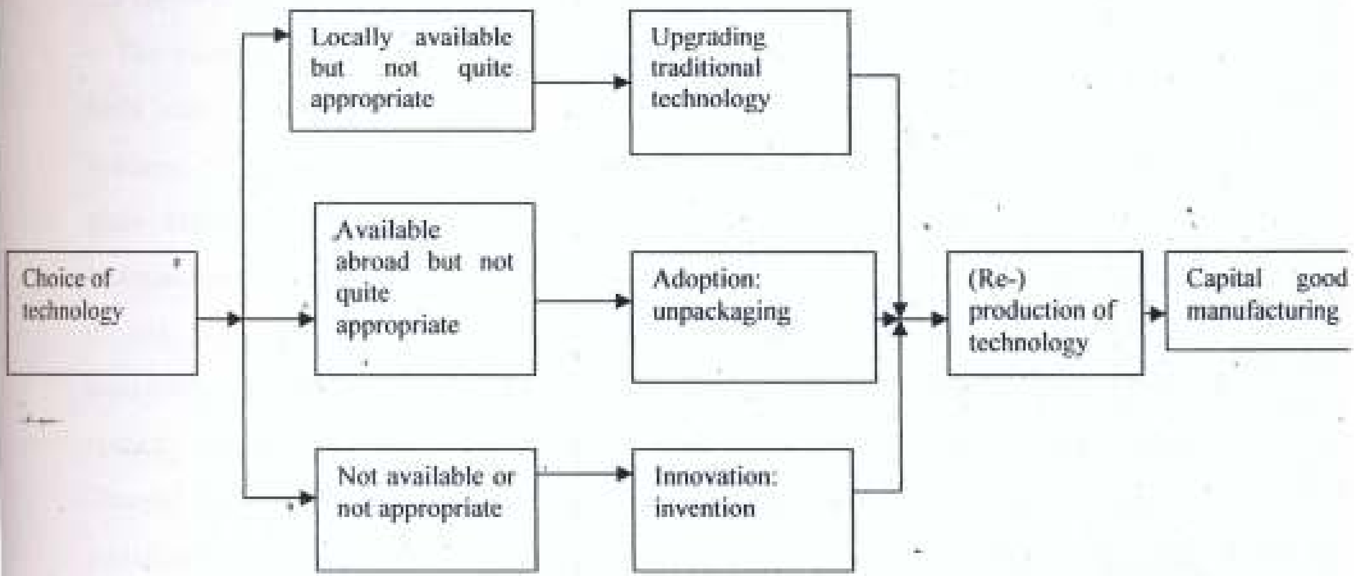


Fig.2.2: Relationship of Technological Options for Machine Tools Industry

2.2 Importance of Machine Tools Industry

The most strategically important component of capital goods sector is the machine tools industry (Olaniyan, 2006). Machine tool are sometimes referred to as 'mother machine' which are power – driven machines used to work on metals, wood, plastic and glass. Machine tools are centrally important to the existence of a domestic engineering and machinery building. This sub-sector of the capital goods is the heart and foundation of the capacity for self-actuated national industrialization and technological transformation because it provides the equipment for itself, the other capital goods sub-sectors, the intermediate good industries sector and for consumer goods industries (Nagpal, 1986). Machine tools development will help to develop a national capacity for sustaining existing machineries that are operable by ensuring the prompt replacement or substitution of parts and to generally assist in expanding the manufacturing base and capacity of nations (Finegolg, 1994). Machine tools, which is the mother of capital goods industry, is relatively labour-intensive. It has also been proven that machine tools industry is quite a dynamic industry in the sense that it is a carrier of the process of many technological innovations which in turn are transmitted to other sector of the economy (Difilipo, 1986).

Machine tools can be classified into two main categories: metal cutting machines and metal forming machines. The machines that fall under metal cutting machines are lathes, milling, shaping, drilling, gear hobbing, and broaching machines. Metal forming machines comprise presses, forge hammer shearing, welding and explosion forming machine. In order to determine the basic requirements to build these machines, the major component parts, material composition and the manufacturing techniques of producing them must be known. This will give an insight to the appropriateness and adequacy of manpower, equipment, raw materiasl and energy required for the production of each component part. An economical and reliable fabrication technique must be adopted to manufacture the various components of a machine. In fact, the selection of material and appropriate choice of method of fabrication forms an important aspect influencing the design considerations (Aronson, 1996). The fabrication techniques to be used depend on the material, size, shape and surface finish of the component parts. This consequently determines the human resource, raw materials, equipment and the energy requirement for the production of the machine parts.

2.3 Development of Machine Tools Industry in Nigeria

Development of machine tools industry is supposed to have a technological feedback resulting in gradual reduction on importation of machinery. Nigeria with its abundant natural resources and manpower conceived the fulfillment of this objective through her National development. Based on this plan, Nigeria Machine Tools, Oshogbo, and Ajaokuta Manufacturing and Repair Shop Complex, Metallurgical and Machine Tool was esterblished. At the initial stage of machine tools, the industry was expected to assemble machine tools. The manufactured machine tools were actually proposed to cater for around 38% of the total demand of machine tools in Nigeria up to 1985 (NMT, 1994). Unfortunately, up till now (2009) this objective is yet to be achieved.

The selection of plants and machinery for machine tools division, tool room and foundry has been made with the consideration that machine tools production in Nigeria will be based on production' and not mass production. The reason for planning the three other two divisions along with the machine tools division is to provide required industrial manpower, quality castings and facilities for manufacturing of jigs, fixtures, special tools, gauges ,e.t.c. (AMT, 2000). Training center was also planned to organize intensive training to develop required skills not only for assembly but also to cover manufacturing activities in the subsequent phases.

In drawing up the production programme, the main consideration has been the demand, minimizing the lead time for indigenous availability machines development of skills, use of appropriate technology, future needs, quality requirements and optimization of facilities to achieve the best economy commensurable with capital investments (Oladipo, 1988). Despite all these good plans, Nigerian machine tool factories are still in their infancy, their product range is narrow and cannot adequately provide the needs of the transformation envisaged in this plan (Louis and Adeola, 1992). This is because local professionals, technicians and craftmen need to gain experience in the design and manufacture of machine tools. This makes it necessary for invitation of expatriates who more than often exploit the nation. Moreover, mismanagement of funds for the development of machine tools industry is another major hindrance.

2.4 Government Approach towards Developing Machine Tools Industry

In trying to develop the capacity of Nigeria machine tools, it is necessary to review approaches that has been pursued and used by the government since independence in Nigeria. The strategy adopted in first national development plan, (1962-1968), was to import substitution industrialization through transfer technology. This makes no provision for development of goods and services in particular. Implementing industrialization policies was hampered by various problems including among others a weak raw material base, lack of technological know how, shortage of management manpower, reliance on imports for capital goods and raw materials (Okojie, 1985).

The second nation development plan, 1970-1974, noted the problem created by the import substitution industrialization strategy. Government decided to upgrade local production of intermediate and capital good for sale to other countries. At this time, the policy was made without concrete implementation. It was only in the third national development plan, 1975-1980, that the Federal government of Nigeria gave indication that it had begun to understand the urgent need of the engineering sector and its centrality to sustainable industrial transformation. With reference to the first and second plans, the third development plan did not articulate a comprehensive policy and strategy for the development of primary engineering and machine industries, which are necessities for the development of machine tools (Oni, 1999). The plans only focus on development of intermediate goods or base material industries such as iron and steel. It was as a result of recognition of the adverse effect of external dependence on foreign country for goods and services that actually initiated the idea of self- sustenance in fourth developmental plan (1981-1985). This aims at, increasing dependence on local resources in seeking to achieve the various objectives of the society. It was in this plan that Federal government began to take concrete steps to start the development of some key components of a capital goods sector, like Nigerian machine tools Oshogbo.

2.5 History of Nigerian Machine Tools, Oshogbo

The Nigerian Machine Tools Limited is the leading industrial equipme manufacturing in sub-Saharan Africa (NMT, 1994). It was 85 to 15 percent equ ventures between the Federal government of Nigeria and the India government – Own Hindustan Machine Tools (international) limited. The agreement was signed in the y 1979 and it was incorporated with share capital to the sum of N20 million. The Nige machine Tool Oshogbo was conceived in the Nation's 4th National Development Pl (1976-1980) which supported the establishment of industries for production of capi and engineering goods of intermediate technology content.

The Federal Government objective in setting up the project was to:

- establish a self-reliant machine tool complex in Nigeria for the local manufacture a marketing of machine Tools, spares and accessories;
- support and influence the country's drive toward industrialization and self-reliance the manufacture of engineering goods;
- train Nigerian Engineers and technicians in art of machine tools production;
- conserve valuable foreign exchange for the country by meeting substantial part of demand for machine tools through local manufacture
- aid, establish and develop ancillary units and assist down-stream user industries
- assist entrepreneurs and user industries by offering total project – engineering turnl consultancy services for Nigerian and ECOWAS sub-regional market and prov effective after-sales service for the products.

The types of machine tools selected for manufacture for Nigeria machine to Oshogbo are as follows;

(i) Power hacksaw

(ii) Lathe machine

(iii) Milling machines – medium size vertical and universal

(iv) Shaping machine

(v) Drilling machine – Bench and pillar type

(vi) Pedestal grinder and

(vii) Guillotine shears.

The project on the long-term, as to add manufacturing of metal-forming machine, sharing machine, pressure die casting machine, forging machines, numerically controlled machine for products requiring precision technology. Despite all the efforts made by the government to revolutionize the building of machinery in Nigeria since second nation development plan, up till today, all is of no avail because of the government inability to address the foundation of the problem of building capital goods sector which is the technological capability of developing machinery (Radnor, 1991). The Federal Government of Nigeria (FGN) has privatized 100% of the enterprise to a domestic core investor named Bowell Nigeria limited that would be able to turn around the enterprise since the objective of set up the project cannot be achieved since all these years. As a springboard for industrial development, the role of the Nigeria Machine Tools limited Oshogbo in the Nation's economy cannot be over emphasized. Therefore it needs more attention than privatization programme of the government. The need to be able to develop the resources necessary for the development of machine tools to achieve the set up goal is very necessary.

Nigeria machine Tools can be broadly divided into three sections namely production section, engineering section and administrative section. In this study production and manufacturing sections of the machine tools industry was considered.

2.5.1 Production Section

Production section of Nigeria machine Tools limited has two sub units, they are manufacturing unit and foundry unit of the industry. These units are responsible for the major production of machinery, equipment and spare parts. Production section is shown Fig. 2.3.

2.5.2 Engineering Section

Engineering section of Nigeria Machine Tools limited (NMT) has five sub units. They are production planning, store, quality control, researches and design. These are the units where the proper planning seeks to deploy the facilities of the company in such a manner that the required quantity of the product is manufactured to the right quality at the required time by the best and cheapest method. The chart in Fig. 2.4 shows various divisions in engineering section.

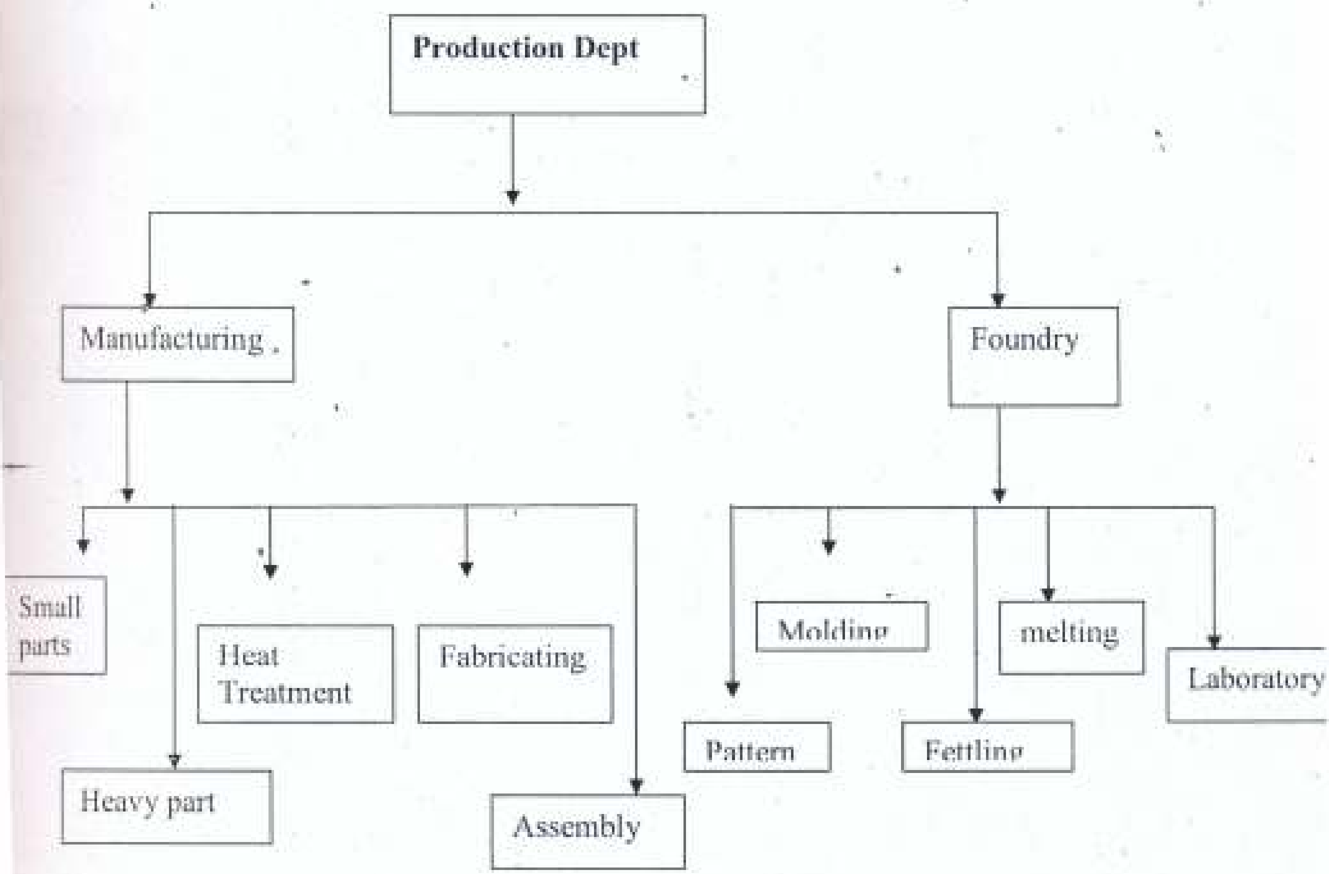


Fig. 2:3: Oganisation of Production Department in NMT Oshogbo.
Source: (NMT, 1994).

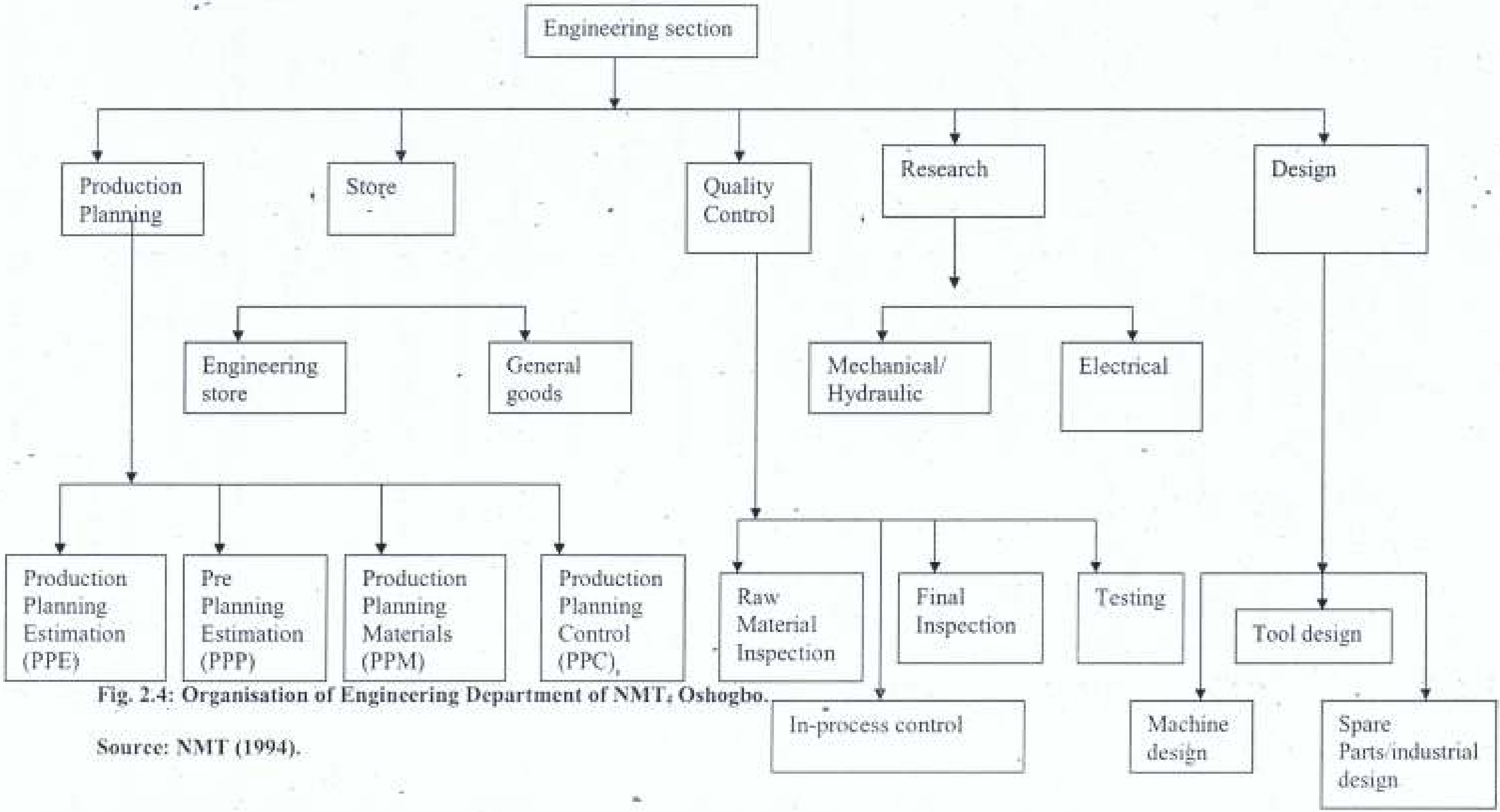


Fig. 2.4: Organisation of Engineering Department of NMT, Oshogbo.

Source: NMT (1994).

Tables 2.1 and 2.2 show the Production and Engineering departments with sections, units, and their functions.

Table 2.1: Organisation of Production Department

MODULE	UNIT	FUNCTIONS
Manufacturing Shop	Small Parts	Machining of small round parts, flats, gears, sprockets, hub, bushes and other small parts.
	Heavy Parts	Machining of rounds, flat above 7kg.
	Heat Treatment	Annealing,carburizing,hardening,electroplating, nickel plating and blackening of parts.
	Assembly	Sub-assembly final assembly and Testing of machines.
	Fabrication	All sheet metal work requiring folding, rolling, cutting, welding, forming, blanking, punching and profile cutting.
Foundry Shop	Molding	Sandmoulding of cast parts.
	Pattern Shop	Production of wooden, plastic and metal pattern.
	Fettling	Fettling of cast products.
	Melting	Melting and control of composition of cast material.
	Laboratory	Sand testing, metallographic analysis and measurements.

Table 2.2: Organisation of Engineering Department

MODULE	UNIT	FUNCTION
Research	Mechanical / Hydraulic	Design of mechanical and hydraulic systems.
	Electrical	Design of electrical systems.
Design	Machine	Design of machine and machine parts, sub - assembles and assemblies.
	Design	Drawing of part, sub – assemblies and assemblies.
	Tool Design	Design and selection of cutting tools, special tools, jigs and fixtures.
	Spare Parts and Industrial design	Design of spare parts and industrial machine parts.
Production Planning	Production Planning Estimation (PPE)	Time and cost estimation. Establishment of performance standards and breakeven analysis.
	Pre-Production Planning (PPP)	Linking of design with production department.Method of work study.
	Production Planning Material (PPM)	Materials Inventory control.

	Production Planning Tools (PPT) Production planning Control (PPC)	Procurement,Resharpening, reconditioning and maintenance of tools. Release of production papers and raw materials to production department. Liaising with inspection department for periodic and routine checks of materials.
Quality Control	Raw Material Inspection	Inspection of all raw materials.
	In – Process Control	Inspection and control of all in – process production activities.
	Final Inspection	Inspection of final assembly.
	Testing	Testing of final assembly.
Store	Engineering Store	Management of stores comprising engineering parts, subasssemble and assembles.
	General goods	Management of non – engineering goods in storage.

2.6 Resources for Capacity Building of Machine Tools in Nigeria.

This technological capacity building is a carefully articulated strategy which is conceived and devised for the integrated development of resources which include; basic raw material, scientific research facilities and engineering and technical personnel of all types. It includes also the supportive political administration-financial policies and infrastructure.

Appropriate machine design facilities for development of machine tools is a function of requisite quality and enough design material, equipment/ tools and energy which can be obtained from related intermediate capital good sector, raw material based industries and nation grid of power generation plant .

Moreover, appropriate fabrication facilities for developing machine tools are function of requisite quality and enough fabrication raw material, equipment/tools and energy. These are obtainable from corresponding fabrication intermediate capital goods industries, raw material based industries and National grid of power generating plant, respectively. Appropriate trained skill and technical staff for development of machine tools in Nigeria depends on requisite education and requisite experience. These are acquired from formal learning institution, Research Development Institute, Technological training center, industry and industry village depending on the categories of technical staff.

2.6.1 Manpower Capacity

Machine tools manufacture demand more than average ability and experience in certain trade which are peculiar to its production. This can be acquired, sometimes in a short time, if the trainees are properly selected and systematically trained. One of the important machines tools building capacity is human resources; highly skilled personnel is required in relevant engineering field such as mechanical, electrical, mining, metallurgy and material. The development of human resources is based on clear understanding of basic technology requirement for the manufacture of machine tools (Ayensu, 1997). Machine tools manufacture involve high labour content of technically skilled and semi-skilled categories talented and trained design and engineering personnel are also required, which involve highly trained personnel such as Engineers, technologist, technician, craftsmen and artisans, apart from specialized personnel training in project engineering/application engineering and servicing of machine tools.

In developing manpower, four ranges of skill and capacities are put into consideration.

(i) Machine operation/fabrication skill;

(ii) Manufacturing technology skill;

(iii) Product design skill; and

(iv) Research and development skill.

(i) Machine Fabrication Skill Capacity

Machine fabrication skills, this includes aspects of the manufacturing processes such as casting, forging, machining, heat treatment, assembly and welding. This skill can be taught in polytechnic and technical colleges as well as acquired on the job or in training center. These sets of people are called technicians and craftsmen. The factors that is responsible for this capacity development is requisite education and requisite experience development.

(ii) Manufacturing Technology Capacity

Manufacturing technology is technology for organizing, managing and executing factory operations, which produce machine tools. This is essentially the ability to organize and deploy the necessary skills, raw materials, equipment and management to convert a product design to a technically and economically desired product. The skill can also be taught in the Polytechnic, University and as well acquired on the job.

(iii) Product Design Capacity

This capacity has three phases; feasibility study, basic design and detailed design. It is highly trained and extensive experienced Engiñeers and technologists that are usually involved in product design. This capacity help firm or industry to conceptualize, define and actually design a product that is acceptable on both economic and technical grounds.

(iv) Research and Development Capacity

This capacity seeks appropriate combination of already existing technical knowledge so that it can be used to refine and modify established machine tools. All categories of technical personnel are necessary to be participants in this development to be able to improve in area of operation.

It is therefore necessary to know the human resources technological level of the country to produce machine tool before one can be thinking of further development. The evaluation of requisite manpower for building machine tools is based on requisite education, requisite experience and requisite research. The level of requisite education can be determined by knowing the number of Engineers, Technologists, Technician, Craftsmen and the artisan compared to set up standards. Also the level of requisite experience is determine by knowing number of all categories of technical staff with five years experience compared to set up standard. The level of requisite research for quality skill is a factor of technical personnel involving in research compared to set up standard.

2.6.2 Equipment Capacity

Apart from highly trained personnel, highly sophisticated equipment for production of machine tool is necessary. The development of facilities/ equipment for production of machine tools is based on the clear understanding of manufacturing technology requirement. Machine tool fabrication equipment capacity is function of:

(i) Requisite standing intermediate capital goods sector

(ii) Requisite machine building and design promotion service

(iii) Requisite standard design center

(iv) Requisite related research and development institute

The evaluation of fabrication and design equipment capacity is based on quantity and quality of equipment production capacity of intermediate capital goods sector with the support of machine building and design promotion service, standard design center, and related research and development institute.

2.6.3 Raw Materials Capacity

Machine tools materials being planned and controlled can be categorized into two: direct materials and indirect materials. About 60 – 70% of machine tool weight is that of casting which is to be supplied by the foundry within the complex (NMT, 1994). The other major raw materials included mild steels, medium carbon steel, case hardening alloy steels, tool steel, aluminum, bronze, malleable iron, alloy steels, high speed, tool steel, ferrous casting, forging and malleable casting.

Nigerian machine tools Oshogbo foundry is designed to produce 1800 tons per annual and 160 metric tons of intricate and quality grade iron casting per month. The raw material available for the production of castings in the foundry division was not adequate to meet the capacity as initially planned to be made available from indigenous source, through establishment of steel plant.

The steel plant has not been able to cater for requirement of this complex mainly because there are no facilities to cater for wide varieties of sizes and small quantity required. The same is applicable to other raw materials (RMRDC, 1991). Basic material industries requires a network of highly sophisticated and advanced national research and development facilities, institute and laboratories for provision of knowledge of quality and quantity of raw material.

Requisite quality and quantity of raw material for raw material development capacity depend on basic material industries and raw material promotion agencies (RMRDC, 1991). The level of quality and quantity are determined from the production capacity of the basic material industries with the support of material promotion agencies

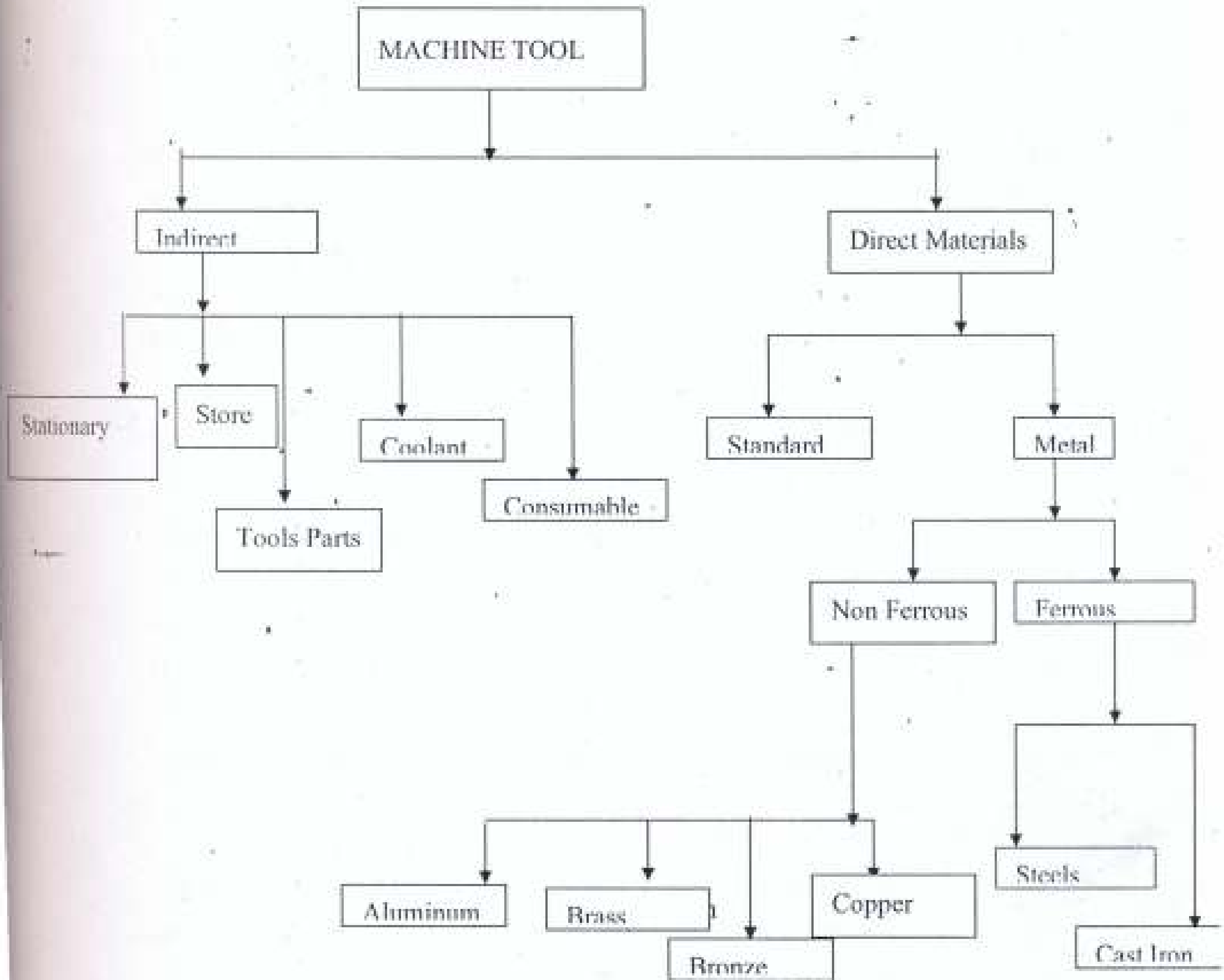


Fig. 2.5: Materials for Machine Tool Production
Source: NMT (1994)

2.6.4. Energy Capacity

Energy and its utilization constitute the transforming agent that allows raw material conversion to finished product, using industrial processes through appropriate proportion of interaction between material and appropriate equipment under some suitable condition (Awayemi, 1987). Energy resources can either from national grid or fossil fuel and this is very important for operation of equipment for development of machine (Megbowon and Adewunmi, 2002). Machine tools industry makes use mostly of electrical source of energy either from gas, hydrothermal plant through NEPA as national grid. The importance of electricity in the process of national development of machine cannot be overemphasized, but the unfortunate thing is that electrical power supply has been unreliable. Electricity is an essential tools in manufacturing of machine tools and its production cannot be sustained without effective, reliable, and large scale supplies of electricity (Madueme, 2002).

2.7. Previous Studies on Capacity Requirements for Machine Tools Industry

The rate of development of machine building technology depends on manpower, equipment, raw materials, and energy. 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 and information resources.

Past work on machine tools building technology development in the area of skill formation and manpower development, raw material development, tools and equipment planning and development energy requirement for machine building are enumerated in the follow sections.

2.7.1 Manpower Development.

Human resource consists of skilled worker, unskilled labour, professional personnel and management. Human resource in sufficient number, where and when required; their quality in terms of formal knowledge and practical experience as well as skill and attitude is highly required for reasonable development (Mogassibi, 1984). The purpose of manpower planning in any industrial organization is to have an efficient control of staff structure so as to bring about optimal productivity at minimum cost (Offiong and Nsien, 2003). The aim of manpower planning is to match the future manpower needs (demand) and resources (supply) in the light of multiple objectives, e.g. economic conditions, production/sales trends, people's skill, inventory government regulations as well as organization history with the policies regarding hiring, promotion and retirement.

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. The use of markov chain models for description of structures in hierarchical manpower system has been extensive advocated by Offiong and Nsien (2003). Some of models deal only with the different structures of the organizations in general while others concentrated on certain aspects of organizations such as age, length of service wastage and promotion (Nsien, 1997; Lesson and Al-Nuaimi 1973).

Okojie (1985), saw manpower development problem as a problem which is solvable using systems approaches for skill formation for technological self-reliance. Despite the fact that the suggestion is good but it has not provided analytical means of achieving this goal. Oladeji (1989), also tried to address manpower development as a factor that necessitates serious consideration of perspective planning. It is so because of long time gestation period associated with education investment. He ends up without any formulation that is useful in forecasting forecast additional manpower requirements taking into consideration range of time projection. Laditan (2000), made it known that lack of skill and knowledge along with counter productive attitude are constraints to machine building development. Fafunwa (1991) made it known that the, pre-requisite for machine tools industry development is manpower and in manpower development, education, is central. It was further stated that technological process in machine tools building is impossibility without the existence of an adequate supply of competent and qualified engineers, technologist, technician, craftsman and artisan.

Most of those people that have worked on manpower research actually focused more on manpower planning than manpower development. Manpower planning activities actually involve inventory of skills require for technological development and preparing manpower forecast (Babalola,1990). While manpower development activities include making provision for selecting employees and training new existing employees, deployment of trained personnel, performance improvement (on-the-job training) and career development (Offiong and Nsien, 2003).

This research work 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 hand. Skill formation in this work is related to strategy of manpower development rather than narrow concept of education planning. Through this approach, the number of engineer, technologist, technicians, craftsmen, and artesian per thousand for a reasonable development of machine tools in appropriate ratio of categories to meet up with the set up manpower capacity for machine tools development will be established.,

This system approach to manpower development will be appropriate this time because of increased number of jobs in building machine that requires knowledgeable and experienced workers rather than manual workers. Manpower capacity development for machine tools building is quite difficult in the past because of no analytical evaluation of the requirement for machine tools building. Therefore, this project has tried to do the comparative analytical evaluation of manpower capacity on ground with set up standard. The project goes further to develop a model to upgrade the short fall of the required manpower technological capacity.

2.7.2 Raw Material Development

Folayan (2004) stated that the abundant raw materials for building of machine tools in Nigeria are available and it was underutilized. The raw material include such metallic minerals as iron ore, tin, bauxite, copper, zinc, lead nickel; non metallic mineral like limestone, kaolin, gyosum, phosphate, talc, dolomite, salt, silica, sand, mica, baryte, bentonite, feldspar; fuel mineral, like petroleum, gas and coal.

Moreover, inability of government established agencies like National Steel Raw Material Exploration Agency (NSREMA), National Metallurgical Development Center, (NMDC), Nigerian mining cooperation (NMC) like Raw Material Research and Development Council (RMRDC) National Metallurgical Development Center, (NMDC), to discharge their duties is seriously disturbing the development of machine tools. Akintunlaji *et al.* (2006) developed software for material requirement planning but the model does not make provision for surplus and shortage in material requirements.

2.7.3 Equipment Development

Badaway (1991) stressed the important of developing indigenous machine and equipment to produce machine tools since most of technology transfer through the sophisticated imported machine equipment are beyond technical know how of our people to operate and to maintain. This entire step is a deliberate action to put the country in perpetual technological slavery and industrialization bondage for life.

Godkin (1988) stated that, until a drastically action is taken to replace the expatriate with indigenous services in supplying equipment, the machine tools industrial can not function. Government has tried by promulgation of National policy on Science and Technology in 1986, which resulted to the formation of National Agency for Science and Engineering Infrastructure (NASENI) in 1992. NASENI has established three related machine building project for design and building machine in Nigeria.

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 Center (NEDDC), Nnewi is the third important project of NASENI. All these agencies are put in place by the government to design and build equipment that can be operated and maintained domestically without the attention of the expatriate, unfortunately the agencies are unable to live up to expectation.

2.7.4 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 term of quality and quantity is a function of power generation, power transmission and distribution. The quantity of energy is a function of energy generated and quality of energy is a function of energy transmitted and distributed. Osoba (1983), stated that development of machine tools, a sub sector of capital goods is a pre-requisite for industrialization, which is also pre-requisite to rapid economic development and growth. Azee (2004), also stressed the needs for increase energy input for accelerating the development of machine tools and made it clear that the cost of machinery and auxillaries equipment to produce this energy has risen to such an incredible level that it is very difficult to acquire. Esan and Awosope (1981) made it known in their finding that energy is needed for practically all the activities for building machine tools. Madueme (2002) also stressed the importance of effective, reliable, and large scale supplies of electricity in sustaining Machine tools plant sub sector of capital goods sector.

Tunde (1996) made clear that poor performance of machine tool sector can not be dissociated from PHCN's poor performance which is not only managerial weakness or operation incompetence but it rest squarely on the fact that the agency operates in a technological void environment. A lot of models have been developed to forecast and predict the demand of energy by difference authors such as Oke (2002) and Madueme (2002) using basic empirical model ph1 (θ) mode and composite model respectively. Moreover, Oke *et al.* (2007) examined three levels of models for predicting electricity demand in Nigeria. In all, none of the literature spoke on how the machine tool's electricity supply can be improved.

2.8 Distinguishing Features of Current Study

Majority of past work centered on the policies 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.

In Nigeria as at now, despite all the past approaches in resolving the problem of machine tools development, there are scanty clearly formulated and coordinated strategies that aimed at the systematic transformation of machine tools building production system and capacities (Carlsson and Wohlgemuth, 1996). Therefore, for an effective machine tools building technological capacity, it is important that a meaningful, concrete and result –oriented strategies has to be devised 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 element in term of level of development and how the respective elements can be improved. Moreover, there is a need for interaction of all these elements that constitute machine building at their effective developmental stages. The contribution of each element in development of machine building capacity is being viewed as an important factor that deserves evaluation.

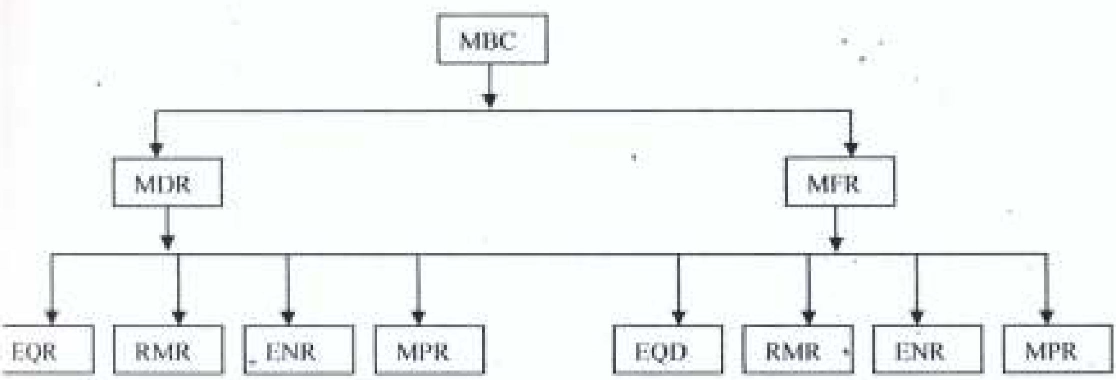
This work therefore addresses the following:

- quantitative analysis of individual machine building through comparative analytical evaluation of resources capacity on ground with set up standard.
- develop a model to upgrade the short fall in the required resources technological capacity by allocating the appropriate fund to each of the resources.
- access the contribution of each elements to the development of machine tools building capacity.

CHAPTER THREE

METHODOLOGY

A preliminary study was conducted in some relevant establishments in Nigeria to obtain information on the criteria useful for the development of an appropriate model for machine tools capacity building in Nigeria. Some of the relevant establishments where information were gathered include; Basic Raw Materials Industries and Promotion Agencies (BRMIPA), Basic Equipment and Promotion Agencies (BEPA), Energy Production Industries and Promotion Agencies(EPIPA) and Human Resource Development establishments and Agencies (HRDEA). Based on the information gathered, the relevant criteria for machine tools building were established which include technology, manpower, equipment, raw materials, finance and environment and socio-political factors. The aforementioned criteria were analyzed mathematically and this formed the basis of the developed model for machine capacity building. The major parameters for development of machine tools are: Manpower, Raw material, Equipment and Energy. All these capacities are developed along the line of machine fabrication and design capabilities as shown in Fig. 3.1.



MBC – Machine Building Capacity,**MDR** – Machine Design Resources, **MFR** – Machine Fabrication Resources, **EQR** – Equipment Resources, **RMR** – Raw Materials Resources, **ENR** - Energy Resources, **MPR** - Manpower Resources.

Fig. 3.1: Interrelationship of Resources for Capacity Building.

The software developed shows the database of standard resources that are required for machine tools industries and existing available resources as in the case study of Nigerian Machine Tools Limited in Oshogbo. The resulting software is intended to control all the mechanism for influencing elements and the resources of machine tools. The software package also determined the technological capacity level of machine tools as at now based on the existing resources and further determined the present technological capacity development of Nigeria machine tools.

This model will consider among others the following:

(i) system frame work for model development;

(ii) benchmark estimation determination;

(iii) development and integration of machine tools technological capacity resources; and

(iv) development of database for machine tools technological capacity.

Software development involves flow chart, algorithm, and the use of Visual Basic programming software in capacity Computer Aided Machine Tools Capacity Development (CAMTCAD-2008) to implement the model. The steps to be followed in developing the model are shown in Fig. 3.2.

3.1 Systems Frame work for Model Development

The need for comprehensive assessment of technology is extremely important to most Machine Tools Industries in Nigeria. Technology forecasting method will be a veritable tool for assessing, planning and decision making as regards future potential of technology and direction of change in machine tools industries. The intending model for developing indigenous technology capacity for machine tool building can be conceived as an integrated assessment tools to comprise essential technological, economical, social and environmental factors as model input for machine tools building technological capacity development. This model development involves organization of resources such as manpower, finance, facilities, time and energy with technology, information and force of nature so that as far as possible the future machine tool building capacity of Nigeria will be achieved with the objective set for it.

The model to be developed is of two stages which include planning and upgrading stage. The first major step in the mathematical model involves determination of machine tools building technological level using probability theory based on studies on a comprehensive set up of Nigerian machine tools.

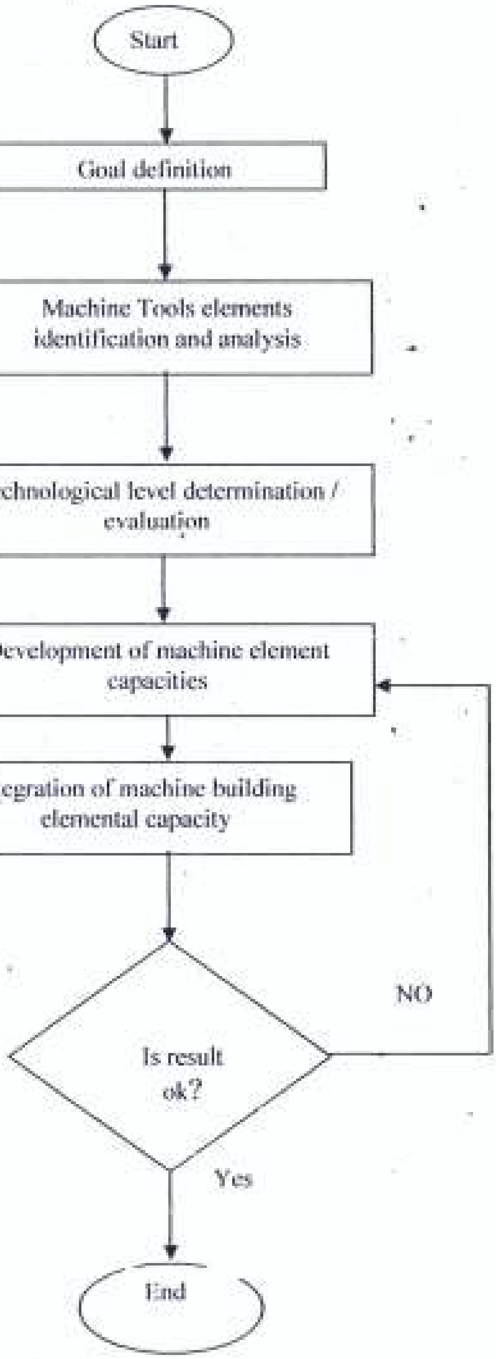


Fig. 3.2: Model Flowchart

It goes further to develop each machine building elements and resources capacities, then mix or integrate all the resources in appropriate proportion. The developed model result to user orientated intelligent decision making tools model for Nigerian machine tools building capacity that enable one to make strategic choice of machine tools capacity element/or elements and resource/resources to be developed base on Nigeria machine tool technological level.

This model will identify resource/resources that is/are not adequate or surplus. The resources of machine tools building technological capacity actually include appropriate and adequate manpower, raw material, equipment and energy. This thesis addresses the problem by proposing strategy of making a significant progress in formulating predictive model. The first phase of the model determines the Nigeria technological capacity level of building machine tools compared with set up standard. The second phase sequentially addressed all the abnormalities discovered in the phase one by upgrading and integrating all the elemental capacities to the standard level set up for sustainable machine tools industry. In developing this model each resource of machine tools building capacity is addressed with all its *input or influencing* control elements

3.1.1 Systems Analysis of the Problem

In Nigeria as at now, despite all the past approaches in resolving the problem of machine tools development, there are scanty of clearly formulated and coordinated strategies that aimed at systematic transformation of machine tools building production system and capacities. Moreover, there had been no significant achievement in modification and adaptation of imported technology and the development of indigenous technology (Aderoba, 1989). Therefore, for an effective machine tools building technological capacity, it is important that meaningful, concrete and result –oriented strategies have to be devised out to generate and sustain the technological take-off of machine tool building of the nation.

The rate of development of machine tools building technology depends on careful consideration of seven contributory constituent elements, which represent the input elements for development of resources for machine tools technology capacity. The contributory elements of machine tools building include;

(i) research and development;

(ii) specialist workshop and facilities;

(iii) engineering and consultancy;

(iv) Information;

(v) management planning and financing;

(vi) education system; and

(vii) socio-political situation.

The output result of the interaction of the constituent elements as shown in Fig. 3.4 are the machine tools building recourses which include, manpower raw material, energy and equipment. Each element of machine tools building must be supportive of every other, through a network of demand and supply relationships and through pattern of pressure and response as shown Fig. 3.3. From this figure, it can be seen that, for meaningful machine tools development, technical training centers are required to train technicians for effective use of specialist workshop. Engineering and consultancy institution also needed to utilize the outcomes of research institude.The outcome of this research are expected to be in conformity with the needs of Engineering and consultancy institution. The combined efforts of all the constituent elements are necessary for effective production of machine tools. Besides, financial and environmental situation of the country must be conducive before a tangible machine tool technology capacity could be developed.

3.2. Determination of Benchmarks for Machine Tools Resources

The model was developed for determining the machine tools technology capacity level in terms of machine design and machine fabrication capacity. The parameters determined from the model include, manpower, equipment, raw materials and energy capabilities for machine tools design and fabrication.

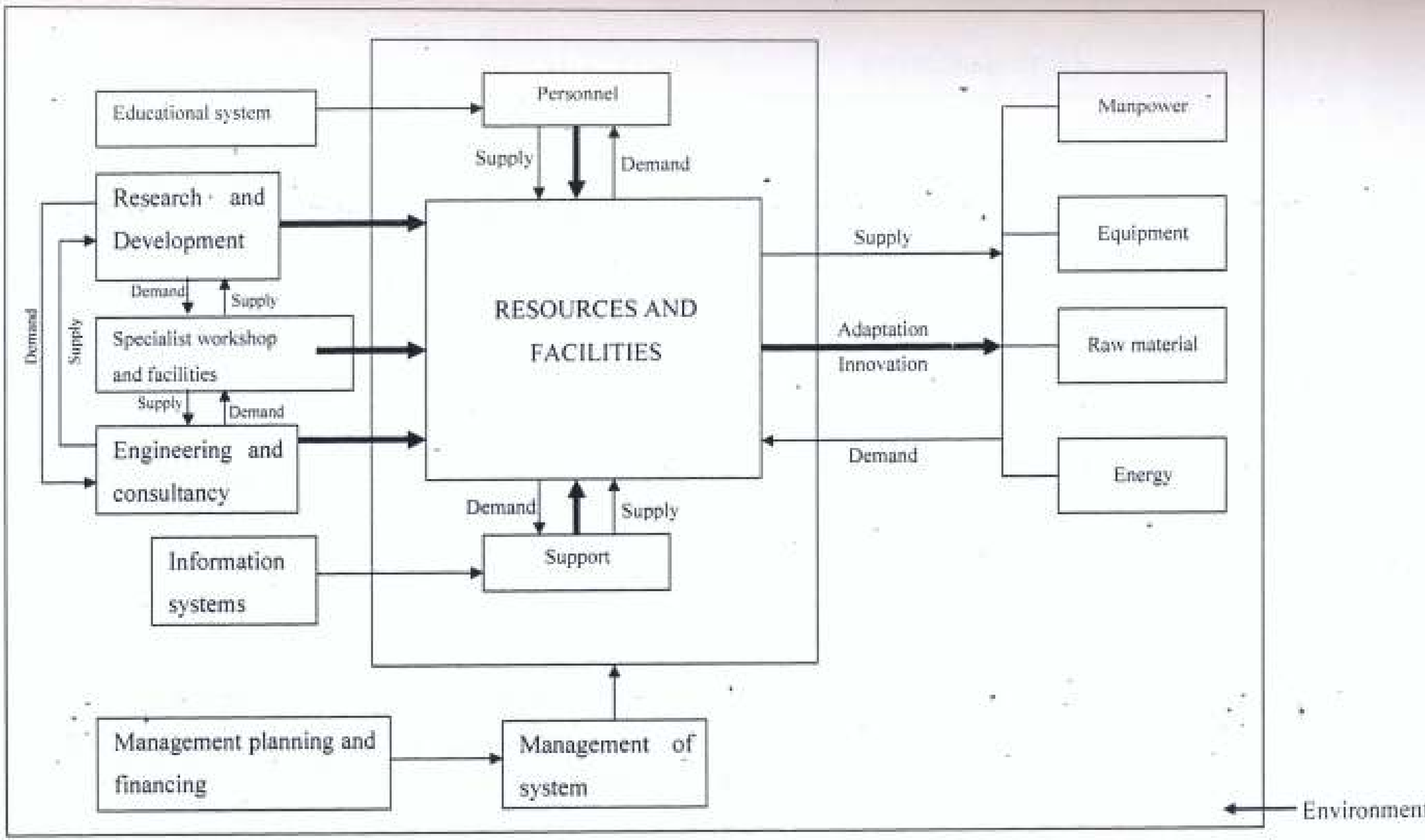


Fig. 3.3:Facility System

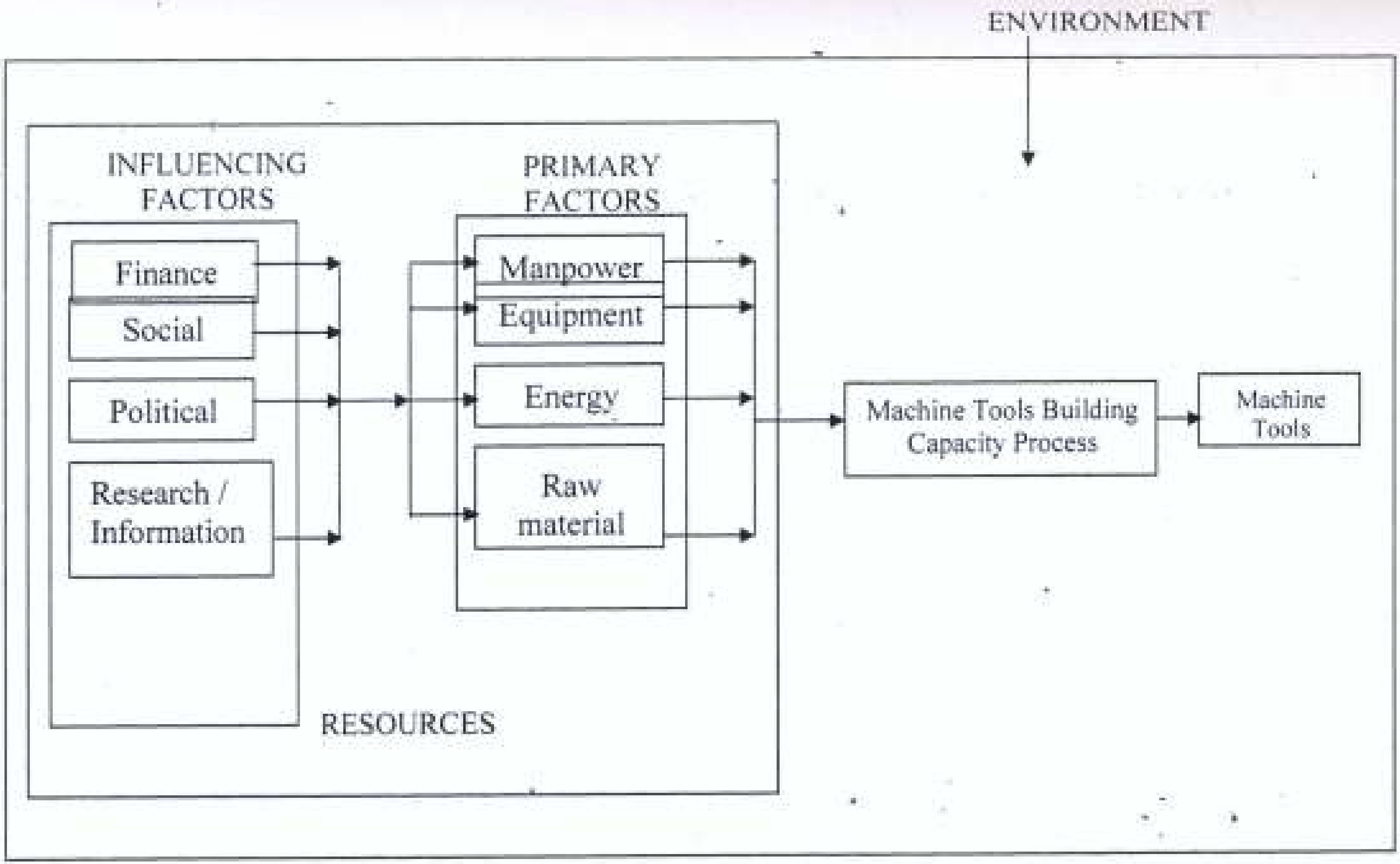


Fig. 3.4: Capacity System

The capacity outcomes were compared with established standards for functional and productive machine tools industry. This gave the direction in determining the shortfall or surplus in each elemental capacity thereby establishing appropriate funds to be allocated to each resource at specific time to yield required and appropriate resources capacity level within a time frame.

This first phase of the model tried to expose the quantity and quality of design and fabrication facilities required for the country to be able to design and fabricate machine tools. Nigeria's ability to design and fabricate machine tools appropriately lies on factors such as requisite education in various fields of engineering like, Mechanical, Metallurgical, Mining and Electrical Engineering. This education can be acquired in learning institution and research institutes.

Moreover, the Engineers are required to have relevant experience in machine designed, material and fabrication of these machines. The first part of the model is about knowing the present status of level Nigerian machine tools technological capacity compared to the set standard, using probability concept.

3.3 Upgraging of Capacity Resources for Machine Building

This is the second stage of the model formulation where the technological capacity level determined in the first stage is upgraded. A dynamic programming technique with concept of adaptive control theory was employed in machine tools resources capacity development. A feedback control law with adjustable coefficients was developed to minimize the effects of the uncertainty of some process parameters such as manpower, raw materials, equipment and energy (Camacho and Bordons, 2001).

The adaptive law developed using discrete time system with direct Parameter Adaptive Algorithm (PAA), in Fig 3.5 is based on minimization of the error signal between the responses of the actual system and ideal. The adjustable coefficient is developmental fund that is allotted in appropriate proportion depending on the level of development of each system parameter as determined in the first part of the model thereby minimized the system error with time until system error tends to zero. To achieve optimal technological capability for machine tools building at this stage, sufficient understanding of the impact of individual output variables on the various levels of development from design stages to the fabrication stages is required.

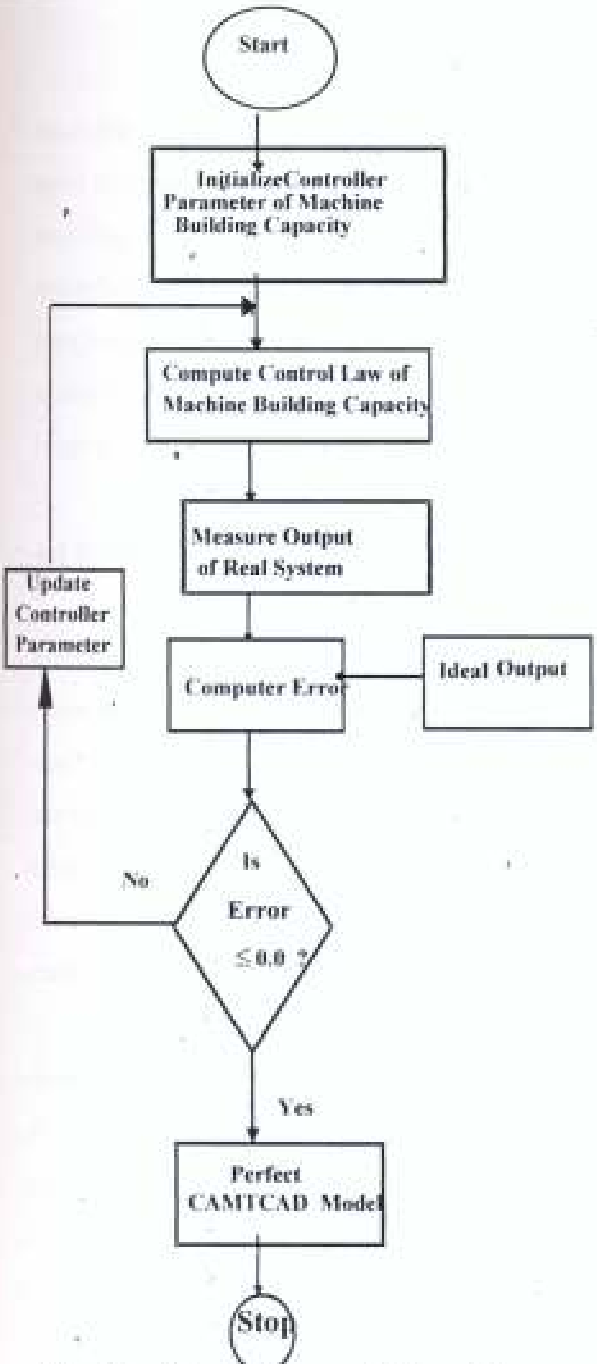


Fig. 3.5: Flow Diagram of Algorithm

CHAPTER FOUR

MODEL FORMULATION

The first major step in the mathematical model involves determination of machine tools building technological level using probability theory. This model was used to determine each machine tool resources level and consequently machine tools building capacity technological level for a specific period. The second stage of the modeling is the upgrading of each of machine tools building resources using dynamic programming with adaptive control techniques to actualize machine tools capacity as slated in the initial project implementation manual of machine tools industries in Nigeria.

4.1 Estimation of Benchmarks for Machine Tools Building

The first phase of the model formulation is the planning stage, which involves knowing the Machine tools technological capacity state in term of machine design capacity and machine fabrication. This can be determined by knowing machine tools, manpower, equipment, raw materials and energy capability and compared them with set standard for functional machine tools industry.The resulting shortfall or surplus in each elemental resource capacity has led to the use of appropiate forecasting technique based on linear regression for the determination of quality and quantity of each capacity within frame of achieving the target.

The ranking of present state of machine tool technological capacity with set standard is accomplished by decomposing Machine tool capacity to Machine tools fabrication capacity and machine tools design capacity. The influencial elements of the resulting separation include manpower, energy raw material and equipment capacity.

Fig. 4.1 shows hierarchy of machine tools building capacity in Nigeria. 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-goals namely, Machine Fabrication (MFC) and Machine Design Capacities (MDC). The sub-goals are resources called contributory factors which are Manpower, (MP), Equipment (EQ), Energy (EN), and Raw Materials(RM) resources. There are sub-contributory factors which are measured in term of quantity (Q) and quality (q). At the bottom of the hierarchy are the items that are to be compared with Nigeria actual level of development as regard machine tools building technological capacity(N) and standard technological capacity(S) set up for an operative machine tools.

For simplicity and to be able to address all the elements and the sub –elements that contribute to machine tools building technological capacity, it is preferable to first determine the level of quality and quantity of contributory factor, follow by determination of the equipment, energy and raw material capacities of machine building in Nigeria. Based on this, the status of machine fabrication and design facilities capabilities of Nigeria are determined. The hierarchical structure of the process is shown in Fig 4.1. The system is dynamically motivated, the result of one stage is an input to the next stage until the overall objective of achieving the benchmark of machine tools technological capacity is attained.

This can be expressed mathematically as follows;

That machine tools building capacity development (β) is a function of machine tools fabrication capacity development (σ_f) and machine tools design capacity development (σ_D).

$$\beta = f(\sigma_{f}, \sigma_{f}) \quad (4.1)$$

Moreover, machine tools fabrication capacity development (σ_F) is a function of Manpower (υ_{mf}), Equipment (υ_{qf}), Raw Material (υ_{rf}), and Energy (υ_{ef}) Capacity. Machine tools design capacity (σ_d) also depends on Manpower (υ_{md}), Equipment (υ_{qd}), Raw material (υ_{rd}), and Energy (υ_{ed}).

This is expressed in Equations (4.2) and (4.3), respectively.

$$\sigma_{F} = f(\upsilon_{mf}, \upsilon_{qf}, \upsilon_{rf}, \upsilon_{ef}) \quad (4.2)$$

$$\sigma_{D} = f(\upsilon_{md}, \upsilon_{qd}, \upsilon_{rd}, \upsilon_{ed}) \quad (4.3)$$

Manpower requirement for the development of machine tool fabrication (υm_F) capacity is related to requisite education (ϕ_{mfe}), experience (ϕ_{mfx}) and research and development (ϕ_{mft}).

Manpower capacity for machine tool design (υ_{md}), also depends on requisite education (ϕ_{mde}), experience (ϕ_{mdx}) and research and development (ϕ_{mdt}).

These are expressed in Equations (4.4) and (4.5), respectively.

$$\upsilon m_F = f(\phi_{mfe}, \phi_{mfx}, \phi_{mft}) \quad (4.4)$$

$$\upsilon m_D = f(\phi_{mde}, \phi_{mdx}, \phi_{mdt}) \quad (4.5)$$

Equipment for developing machine tools Fabrication (υ_{qf}) is a function of well functional equipment and facilities (ϕ_{qfN}) and non functional equipment (ϕ_{qfn}). The same thing is applicable to equipment development for machine tools design (υq_d), which also depends on well functional equipment and facilities (ϕ_{qN}) and non-functional equipment and facilities (ϕ_{qfn}).

These are expressed in Equations (4.6) and (4.7) respectively.

$$\upsilon q_F = f(\phi_{qfN}, \phi_{qfn}) \quad (4.6)$$

$\upsilon q_D = f(\phi_{qdN}, \phi_{qdn})$ (4.7)

Raw material for machine tool development is a function of quantity and quality. The raw material for machine tools fabrication (υr_f) can either be in conformity (ϕ_{rfQ},) or not (ϕ_{rfq}). Similarly, the raw material for machine tools design (υr_d), is in conformity (ϕ_{rdQ},) or not (ϕ_{rdq}). These factors are responsible for raw material appropriation for machine tools building. These are expressed mathematically in Equations (4.8) and (4.9), respectively.

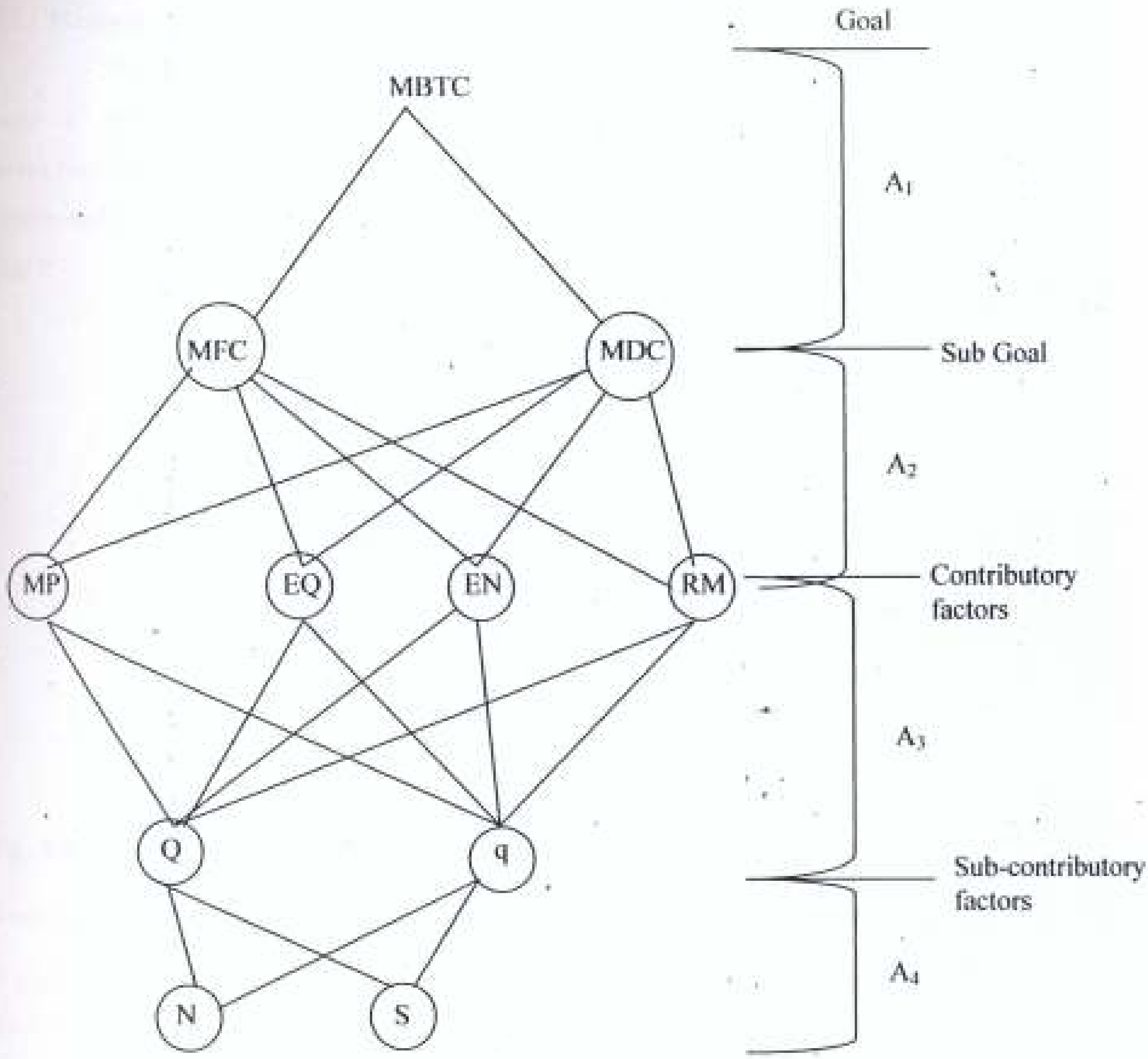
$\upsilon r_F = f(\phi_{rfQ}, \phi_{rfq})$ (4.8)

$\upsilon r_{FD} = f(\phi_{rdQ}, \phi_{rdq})$ (4.9)

Energy required for machine tool development is considered to be a function of energy availability in terms of quality and quantity. The energy required for machine tools fabrication (υ_{ef}) can either be regular (ϕ_{efQ}) or epilectic (ϕ_{efq}) and this is similar for machine tools design (υ_{ed}) regular (ϕ_{edq}) or epilectic (ϕ_{edq}), respectively. These are also expressed in Equations (4.10) and (4.11)).

$\upsilon e_F = f(\phi_{efQ}, \phi_{efq})$ (4.10)

$\upsilon e_D = f(\phi_{edQ}, \phi_{edq})$ (4.11)



MBTC - Machine Building Technology Capacity, **MFC** - Machine Fabrication Capacity, **MDC** - Machine Design Capacity, **MP**- Manpower Capacity, **EQ** - Equipment Capacity, **EN** - Energy Capacity,**RM** - Raw Material Capacity, **Q** - Quality, **q** - quantity, **S** - Standard Capacity,**N** -Actual Capacity.

A_1, A_2, A_3 and A_4 - Stages of Machine Building Capacity Determination

Fig 4.1: Hierachical Levels of Machine Development

4.1.1 Manpower Benchmark Estimation

Manpower for developing machine tools is considered to be a function of requisite education, requisite experience and involvement in research and development in machine design and fabrication. The level of manpower capacity is determined using probability theory and is represented by a Venn diagram shown in Fig. 4.2

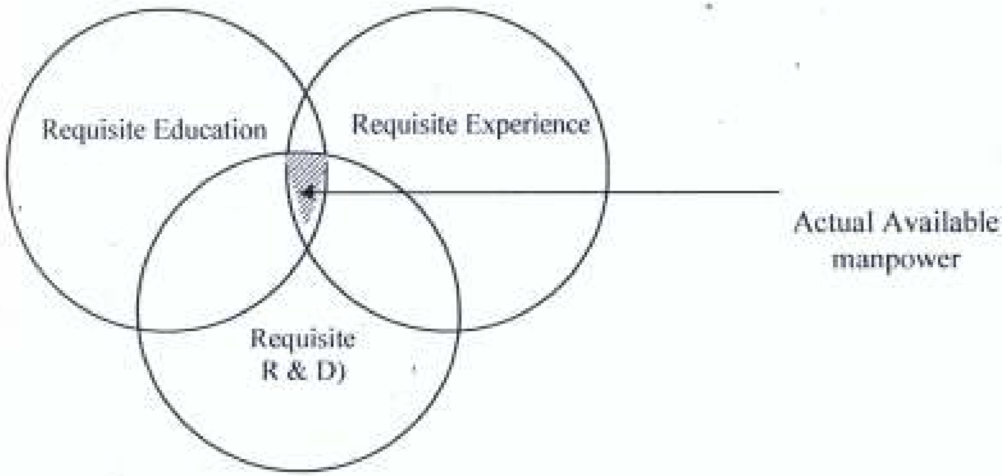


Fig. 4.2: Venn Diagram for Manpower Development

Available manpower (ϕ_{mft}), for machine tool fabrication as shown in the venn digram is expressed in Equation (4.12) as a function of groups of manpower available for fabrication of the machine tool in the industry. These are group of people with requisite education (ϕ_{mfe}), experience (ϕ_{mfx}), research and development (ϕ_{mft}), education and experience($\phi\ m_{fex}$), education and training($\phi\ m_{fet}$), training and experience (ϕ_{mftx}), and education, training and experience(ϕ_{mfte}).

$$\phi_{mft} = f\left(\phi_{mfe},\quad \phi_{mfx},\quad \phi_{mft},\quad \phi_{mfet},\quad \phi_{mfex},\quad \phi_{mfex},\quad \phi_{mftex}\right) \tag{4.12}$$

In the same vein, total manpower available for machine tool design (ϕ_{mdy}), are expressed in Equation (4.13) a as a function of groups of manpower available for machine tools design in the industry. The group also include people with Requisite: education (ϕ_{mde}), experience (ϕ_{mdx}), research and development (ϕ_{mdt}), education and experience (ϕ_{mdex}), education and training(ϕ_{mdet}), training and experience(ϕ_{mdtx}), and education, training and experience(ϕ_{mdtex})

$$\phi_{mdij} = f(\phi_{mde},\ \phi_{mdv},\ \phi_{mdt},\ \phi_{mdet},\ \phi_{mdes},\ \phi_{mdcs},\ \phi_{mdtes}) \tag{4.13}$$

Total manpower available for machine tool fabrication at a specific time is expressed in Equation (4.14) based on Equation (4.12).

$$\phi_{Tmfij} = \sum_{j=1}^{n} \phi_{mfij} \tag{4.14}$$

j = 1, 2, …, n and i = 1……….N

j = the number of different groups of manpower available in the industry at a specific time and in this case n = 7

i = the number of stages of development

The corresponding available manpower level for machine tools fabrication, (φ_{mfi}) is expressed in equation (4.15) using the outcome of equation (4.14). Where (ϕ_{mf}) is the expected number of manpower for effective operation in the machine tool industry.

$$\phi_{Tmfij} / \phi_{mf} = \varphi_{mfi} \tag{4.15}$$

Total manpower available for machine tool design at a specific time is expressed in Equation (4.16) based on the information in Equation (4.13)

$$\phi_{Tmdij} = \sum_{j=1}^{n} \phi_{mdij} \tag{4.16}$$

The corresponding available manpower level for machine tools design (φ_{mdi}), is expressed in Equation (4.17) using the outcome of Equation (4.16). Where (ϕ_{mdi}) is the expected number of manpower for effective operation in the machine tool industry at specific time

$$\phi_{Tmdij} / \phi_{mdi} = \varphi_{mdi} \tag{4.17}$$

In estimation of manpower benchmark for machine tools fabrication (α_{mf}) and design (α_{md}), it is important to note that actual manpower capacity development is a function of requisite education, training and experience. The aforementioned elements are mutually exclusive as illustrated by Venn diagram in Fig. 4.2. Based on this, the useful available manpower level for machine tool fabrication (α_{mf}) and design (α_{md}) is expressed using probability relation in Equations (4.18) and (4.19) respectively. This is the probability of having a group of people that have all fabrication education, experience and training $p(\phi_{mfetr})$ and design education, experience and training $p(\phi_{mdetr})$, respectively.

$$p(\phi_{mfetr}) = p(\phi_{mfe} \cup \phi_{mft} \cup \phi_{mfr} \cup \phi_{mfet} \cup \phi_{mfer} \cup_{\phi_{mftr}} \cup \phi_{mfetr}) -$$

$$p(\phi_{mfe}) - p(\phi_{mft}) - p(\phi_{mfr}) + p(\phi_{mfet}) + p(\phi_{mftr}) + p(\phi_{mfer}) \qquad (4.18)$$

$$p(\phi_{mdetr}) = p(\phi_{mde} \cup \phi_{mdt} \cup \phi_{mdr} \cup \phi_{mdet} \cup \phi_{mder \cup \phi_{mdtr}} \cup \phi_{mdetr}) -$$

$$p(\phi_{mde}) - p(\phi_{mdt}) - p(\phi_{mdr}) + p(\phi_{mder}) + p(\phi_{mdet}) + p(\phi_{mdtr}) \qquad (4.19)$$

where,

$p(\phi_{mdetr})$ and $p(\phi_{mfetr})$ = Probability of having number of people that have requisite education, requisite experience and requisite research and development together in machine tool design and fabrication respectively.

$p(\phi_{mde} \cup \phi_{mdt} \cup \phi_{mdr} \cup \phi_{mdet} \cup \phi_{mder \cup \phi_{mdtr}} \phi_{mdetr})$ and

$p(\phi_{mfe} \cup \phi_{mft} \cup \phi_{mfr} \cup \phi_{mfet} \cup \phi_{mfer \cup \phi_{mftr}} \phi_{mfetr})$ = Probability of having people with either requisite education (ϕ_{mde}) and (ϕ_{mfe}) or requisite experience (ϕ_{mdt}) and (ϕ_{mft}) or requisite research and development (ϕ_{mdr}) and (ϕ_{mfr}) or requisite education with experience (ϕ_{mdet}) and (ϕ_{mfet}) or education with training (ϕ_{mder}) and (ϕ_{mfer}) or training with experience (ϕ_{mdtr}) and (ϕ_{mftr}) or education with training and experience (ϕ_{mdetr}) and (ϕ_{mfetr}). This is equal to the total number of employee in the establishment in involving in design (ϕ_{Tmd}) and fabrication (ϕ_{Tmf}), respectively.

$p(\phi_{mde})$, $p(\phi_{mdt})$, $p(\phi_{mdr})$ = Probability of having people with only design education, experience and research and development, respectively.

$p(\phi_{mfe})$, $p(\phi_{mft})$, $p(\phi_{mfr})$ = Fabrication education, experience and research and development, respectively.

Probability of having different categories of manpower for machine tools fabrication in the system, expressed in terms of number of manpower for machine tools fabrication in different group and total available manpower for machine tools fabrication in machine tools industry as expressed in Equation (4.20). Also Equation (4.21) also expressed probability of having different categories of manpower for machine tools design in the system, in term of number of manpower for machine tools design in different groups and total available manpower for machine tools design.

$$\frac{\phi_{mfetx}}{\phi_{Tmf}} = \frac{\phi_{Tmf}}{\phi_{Tmf}} - \frac{\phi_{mfe}}{\phi_{Tmf}} - \frac{\phi_{mft}}{\phi_{Tm}} - \frac{\phi_{mfx}}{\phi_{Tmf}} + \frac{\phi_{mfex}}{\phi_{Tmf}} + \frac{\phi_{mfex}}{\phi_{Tmf}} + \frac{\phi_{mfex}}{\phi_{Tmf}} \tag{4.20}$$

$$\frac{\phi_{mdetx}}{\phi_{Tmd}} = \frac{\phi_{Tmd}}{\phi_{Tmd}} - \frac{\phi_{mde}}{\phi_{Tmd}} - \frac{\phi_{mdt}}{\phi_{Tmd}} - \frac{\phi_{mdx}}{\phi_{Tmd}} + \frac{\phi_{mdex}}{\phi_{Tmd}} + \frac{\phi_{mdex}}{\phi_{Tmd}} + \frac{\phi_{mdex}}{\phi_{Tmd}} \tag{4.21}$$

Equation (4.20) and (4.21) is factorized to give

$$\alpha_{mf} = 1 - \frac{1}{\phi_{Tmf}}\left(\phi_{mfe} + \phi_{mft} + \phi_{mfx}\right) + \frac{1}{\phi_{Tmf}}\left(\phi_{mfex} + \phi_{mfex} + \phi_{mfxt}\right) \tag{4.22}$$

$$\alpha_{md} = 1 - \frac{1}{\phi_{Tmd}}\left(\phi_{mde} + \phi_{mdt} + \phi_{mdx}\right) \frac{1}{\phi_{Tmd}}\left(\phi_{mdex} + \phi_{mdtx} + \phi_{mdet}\right) \tag{4.23}$$

Useful available manpower level for machine tool fabrication (α_{mf}) and design (α_{md}) is expressed in Equation (4.24) and (4.25) in terms of level of development of development of different categories of manpower for machine tools fabrication and design. These include developmental level of people with fabrication and design education (λ_{mfe}) and (λ_{mde}) ,experience (λ_{mfx}) and (λ_{mdx}), training (λ_{mft}) and (λ_{mdt}), education and experience (λ_{mfex}) and (λ_{mdex}), education and training (λ_{mfet}) and (λ_{mdet}), training and experience (λ_{mftx}) and (λ_{mdtx}), respectively

$$\alpha_{mf} = \lambda_{mftex} = 1 - \left(\lambda_{mft} + \lambda_{mfx} + \lambda_{mfe}\right) + \left(\lambda_{mfet} + \lambda_{mfex} + \lambda_{mftx}\right) \tag{4.24}$$

$$\alpha_{md} = \lambda_{mdtex} = 1 - \left(\lambda_{mdt} + \lambda_{mdx} + \lambda_{mde}\right) + \left(\lambda_{mdex} + \lambda_{mdet} + \lambda_{mdtx}\right) \tag{4.25}$$

Then, using the outcomes, (α_{mf}) and (α_{md}) of Equations (4.24) and (4.25), the level of actual useful available manpower for machine tools fabrication(v_{mft}) and design (v_{mdt}) at specific stage of development is computed based on available manpower for machine fabrication (ϕ_{Tmf}) and design (ϕ_{Tmd}) and the required manpower for fabrication (ϕ_{mf}) and design (ϕ_{md}). These relations are given in Equations 4.26 and (4.27), respectively.

$$v_{mfi} = \alpha_{mfi} x \frac{\phi_{Tmfi}}{\phi_{mf}} \tag{4.26}$$

$$v_{mdi} = \alpha_{mdi} x \frac{\phi_{Tmdi}}{\phi_{md}} \tag{4.27}$$

From equations (4.15) and (4.17), actual available manpower for machine tool fabrication can be written as Equations (4.28) and (4.29), respectively.

$$v_{mfi} = \alpha_{mfi} x \varphi_{mfi} \tag{4.28}$$

$$v_{mdi} = \alpha_{mdi} x \varphi_{Mdi} \tag{4.29}$$

4.1.2 Equipment Benchmark Estimation

Equipment for developing machine tools is a function of well functional design and fabrication equipment and facilities. These two factors are responsible for determination of equipment capacity level and are mutually exclusive as shown in Venn diagram in Fig. 4.3. Available equipment (ϕ_{qfi}), for machine tool fabrication as shown in the venn digram is expressed in Equation (4.30) as a function of functional (ϕ_{qfN}) and non functional (ϕ_{qfn}) equipment available for fabrication of the machine tool in the industry.

$$\phi_{qfi} = f(\phi_{qfN}, \phi_{qfn}) \tag{4.30}$$

Similarly, total equipment available for machine tool design, (ϕ_{mdi}) are expressed in Equation (4.31) as a function of functional (ϕ_{qdN}) and non functional (ϕ_{qdn}) equipment available for machine tools design in the industry

$$\phi_{qdi} = f(\phi_{qdN}, \phi_{qdn}) \tag{4.31}$$

Total equipment available for machine tool fabrication at a specific time is expressed in equation (4.32) based on Equation (4.30).

$$\phi_{Tqfi} = \sum_{j=1}^{n} \phi_{qfij} \tag{4.32}$$

$j = 1, 2, \ldots, n$ and $i = 1 \ldots\ldots\ldots u$

j = the number of different groups of equipment available in the industry at a specific time and in this case $n = 2$

i = the number of stages of development

The corresponding available equipment level machine tools fabrication, (φ_{qfi}) is expressed in Equation (4.33) using the outcome of Equation (4.32). Where (ϕ_{eqf}) is the expected number of equipment for effective operation in the machine tool industry.

$$\phi_{Tqfi} / \phi_{eqf} = \varphi_{qfi} \qquad (4.33)$$

Total equipment available for machine tool design at a specific time is expressed in Equation (4.34) based on the information in Equation (4.31)

$$\phi_{Tqdy} = \sum_{j=1}^{n} \phi_{qdy} \qquad (4.34)$$

The corresponding available equipment level, (φ_{qdi}) is expressed in Equation (4.35) using the outcome of Equation (4.34). Where (ϕ_{eqd}) is the expected number of equipment for effective operation in the machine tool industry at a specific time

$$\phi_{Tqdy} / \phi_{qdi} = \varphi_{qdi} \qquad 4.35)$$

In estimation of equipment benchmark for machine tools fabrication and design, it is also important to note that actual equipment capacity development depends on functional equipment. The aforementioned elements are non-mutually exclusive as illustrated by Venn diagram in Fig 4.3 Based on this, the useful available equipment level for machine tool fabrication (α_{qf}) and design (α_{qd}) are expressed using probability relations in Equations (4.36) and (4.37), respectively. This is the probability of having functional equipment fabrication $p(\phi_{qfN})$ and design $p(\phi_{qdN})$ in place.

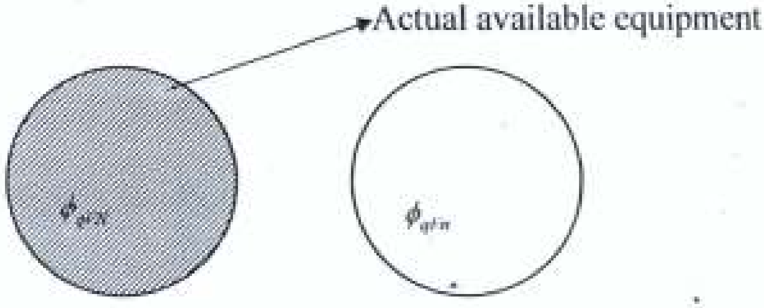


Fig. 4.3: Venn Diagram for Equipment Development

$$p(\phi_{qfN}) = p(\phi_{qfN} \cup \phi_{qfn}) - p(\phi_{qfn}) \tag{4.36}$$

$$p(\phi_{qdN}) = p(\phi_{qdN} \cup \phi_{qdn}) - p(\phi_{qdn}) \tag{4.37}$$

Where

$P(\phi_{qdN})$ and $P(\phi_{qfN})$= Probability of having a functional design and fabrication equipment, respectively.

$P(\phi_{qdN} \cup \phi_{qdn})$, and $P(\phi_{qfN} \cup \phi_{qfn})$ = Probability of having a functional or functional design and fabrication equipment, respectively.

$P(\phi_{qdn})$ and $P(\phi_{qfn})$ Probability of having non functional design and fabrication equipment ,respectively.

Probability of having good and functional equipment(λ_{qfN}) available for machine tools fabrication in the system, is expressed in terms of number of equipment for machine tools fabrication in different groups (ϕ_{qfN}, ϕ_{qfn}) and total available equipment for machine tools fabrication (ϕ_{Tqf}) in machine tools industry. (Equation (4.38)). Also Equation(4.39) also expressed probability of having functional equipment λ_{qdN} available for machine tools design in the system, in termS of number of equipment for machine tools design in different group $(\phi_{qdN}, \phi_{qdn})$and total available equipment for machine tools design (ϕ_{Tqd}) .

$$\frac{\phi_{qfN}}{\phi_{Tqf}} = \frac{\phi_{Tqf}}{\phi_{Tqf}} - \frac{\phi_{qfn}}{\phi_{Tqf}} \tag{4.38}$$

$$\frac{\phi_{qdN}}{\phi_{Tqd}} = \frac{\phi_{Tqd}}{\phi_{Tqd}} - \frac{\phi_{qdn}}{\phi_{Tqd}} \tag{4.39}$$

Useful available equipment level for machine tool fabrication (α_{qf}) and design (α_{qd}) are expressed in Equations (4.40) and (4.41) in term of level of development of development of different categories of equipment for machine tools fabrication and design. These include developmental level of functional fabrication and design (λ_{qfN}) and (λ_{qdN}), and non- functional fabrication and design (λ_{qfn}) and (λ_{qdn}), respectively.

$$\alpha_{\varphi f} = \lambda_{\varphi fN} = 1 - \lambda_{\varphi fn} \qquad (4.40)$$

$$\alpha_{\varphi d} = \lambda_{\varphi dN} = 1 - \lambda_{\varphi dn} \qquad (4.41)$$

The outcome, ($\alpha_{\varphi f}$) and ($\alpha_{\varphi d}$) of Equations (4.40) and (4.41) are used to determine the levels of actual useful available equipment for machine tools fabrication(v_{qfi}) and design($v_{\varphi di}$) at specific stage of development as computed based on available equipment for machine fabrication ($\phi_{r\varphi f}$)and design($\phi_{r\varphi d}$) and the required equipment for fabrication ($\phi_{s\varphi f}$) and design ($\phi_{s\varphi d}$). These relations are given in Equations (4.41) and (4.42), respectively.

$$v_{\varphi fi} = \alpha_{\varphi fi} \times \frac{\phi_{r\varphi fi}}{\phi_{s\varphi f}} \qquad (4.41)$$

$$v_{\varphi di} = \alpha_{\varphi d} \times \frac{\phi_{r\varphi d}}{\phi_{s\varphi d}} \qquad (4.42)$$

From Equations (4.33) and (4.35), actual available equipment for machine tool fabrication and design are written as Equations (4.41) and (4.42), respectively.

$$v_{\varphi fi} = \alpha_{\varphi fi} \times \varphi_{\varphi fi} \qquad (4.43)$$

$$v_{\varphi di} = \alpha_{\varphi di} \times \varphi_{\varphi di} \qquad (4.44)$$

4.1.3 Raw Material Benchmark Estimation

Raw material for machine tool development depends on quantity and quality. The raw material is either of good quality or not. These factors are responsible for appropriation of raw material in mutually exclusive way

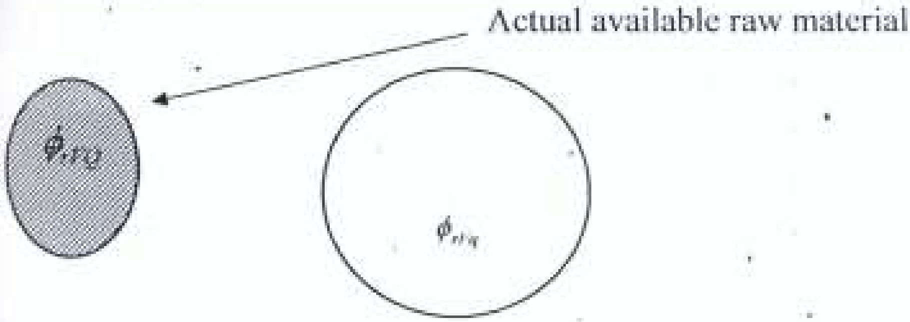


Fig. 4.4 Venn Diagram for Raw Material Development

Available raw materials, for machine tool fabrication (ϕ_{rfj}) and design (ϕ_{ndj}) as shown in the Venn diagram (Fig.4.4) is expressed in Equations (4.45) and (4.46) as a function of conformed (ϕ_{rfQ}) and (ϕ_{ndQ}) and non-conform (ϕ_{rfU}) and (ϕ_{ndU}) raw materials, respectively.

$$\phi_{rfj} = f(\phi_{rfQ}, \phi_{rfq}) \tag{4.45}$$

$$\phi_{ndj} = f(\phi_{ndQ}, \phi_{ndq}) \tag{4.46}$$

Total raw material available for machine tool fabrication and design at a specific time is expressed in Equation (4.47) and (4.48) based on Equation (4.45) and (4.46) respectively.

$$\phi_{Trfj} = \sum_{j=1}^{n} \phi_{qfij} \tag{4.47}$$

$$\phi_{Tnd} = \sum_{i=1}^{n+2} \phi_{nds} \tag{4.48}$$

Total available raw material level for machine tools design (φ_{rd}) and fabrication (φ_{rf}) are given in Equations (4.49) and (4.50), respectively. Where (ϕ_{rnd}) and ϕ_{rrf} represent is the expected quantity of quality raw materials for machine tools design and fabrication, respectively for effective operation in the machine tool industry at specific time.

$$\varphi_{rd} = \frac{\phi_{trd}}{\phi_{vrd}} \tag{4.49}$$

$$\varphi_{rf} = \frac{\phi_{trf}}{\phi_{vrf}} \tag{4.50}$$

In determine the raw material available, which can either be conformed or non-conformed. It implies that two determinant elements for determining raw material availability are non mutually exclusive. Therefore, the useful available raw material level for machine tools fabrication (α_{rf}) and machine tools design (α_{rdt}) is obtained using probability theory and is expressed in Equations (4.51) and (4.52), respectively. This is the probability of having conformed raw material for fabrication and design $p(\phi_{rdN})$ in place $p\left(\phi_{rN}\right)$

$$\alpha_{rf} = p(\phi_{rfQ}) = p(\phi_{rfQ} \cup \phi_{rfq}) - p(\phi_{rfq}) \tag{4.51}$$

$$\alpha_{rdt} = p(\phi_{rdQ}) = p(\phi_{rdQ} \cup \phi_{rdq}) - p(\phi_{rdq}) \tag{4.52}$$

where,

$P\left(\phi_{rdQ}\right)$ and $P\left(\phi_{rfQ}\right)$ =Probability of having conformed raw material for design and fabrication respectively.

$P\left(\phi_{rdQ} \cup \phi_{rdq}\right)$, and $P\left(\phi_{rfQ} \cup \phi_{rfq}\right)$ = Probability of having conformed or defective raw material for design and fabrication respectively.

$P\left(\phi_{rdq}\right)$ and $P\left(\phi_{rfq}\right)$ =Probability of having defective raw material for design and fabrication respectively.

Probability of having conformed (non-defective) raw material for machine tools fabrication (λ_{rfQ}) is expressed in term of quantity of raw materials for machine tools fabrication and design in different groups $\left(\phi_{rfQ}, \ \phi_{rfq}\right)$ and total available raw materials for machine tools fabrication (ϕ_{Trf}) in machine tools industry is expressed in Equation (4.53). Also Equation (4.54) expressed probability of having non- defective raw materials(λ_{rdQ}) for machine tools design in the system, in terms of quantity of raw materials for machine tools design in different groups (ϕ_{rfQ}, ϕ_{rfq}) and total available raw materials for machine tools design (ϕ_{Trd}).

$$\frac{\phi_{rfQ}}{\phi_{Trf}} = 1-\frac{\phi_{rfq}}{\phi_{Trf}} \tag{4.53}$$

$$\frac{\phi_{rdQ}}{\phi_{Trd}} = 1-\frac{\phi_{rdq}}{\phi_{Trd}} \tag{4.54}$$

Useful raw material level for machine tool fabrication (α_{rfs}) and design (α_{rds}) are expressed in Equations (4.56) and (4.58) in terms of levels of development of different categories of quality of raw materials for machine tools fabrication and design in the system. These include developmental level of non- defective raw materials for machine tools fabrication and design (λ_{rfQ}) and (λ_{rdQ}) and defective raw materials for fabrication and design (λ_{rfq}) and (λ_{rdq}), respectively.

$$\alpha_{rf} = \lambda_{rfQ} = 1-\lambda_{rfq} \tag{4.55}$$

$$\alpha_{rfs} = 1-\lambda_{rfq} \tag{4.56}$$

$$\alpha_{rd} = \lambda_{rdQ} = 1-\lambda_{rdq} \tag{4.57}$$

$$\alpha_{rds} = 1-\lambda_{rdq} \tag{4.58}$$

Available raw material for machine tool fabrication (v_{rf}) and design (v_{rd}), when useful raw materials for machine fabrication (ϕ_{rfQ}) and design (ϕ_{rdQ}) are compared with required raw material capacity for fabrication (ϕ_{rrf}) and design (ϕ_{rrd}), respectively are given by Equations (4.59) and (4.60)

$$v_{sfi} = \alpha_{sfi} \times \varphi_{sfi} \quad (4.59)$$

$$v_{sdi} = \alpha_{sdi} \times \varphi_{sdi} \quad (4.60)$$

4.1.4 Energy Benchmark Estimation

Energy required for machine tool fabrication is a function of quality and quantity, and it may be defective or non-defective. The elements that are responsible for appropriate energy are mutually exclusive.'

Available energy for machine tools fabrication

$$\phi_{efj} = f(\phi_{efQ}, \phi_{efq_i}) \quad (4.61)$$

Also, available energy for machine tools design

$$\phi_{edj} = f(\phi_{edQ_i}, \phi_{edq_i}) \quad (4.62)$$

Total available energy for machine tools design

$$\phi_{Tedi} = \sum_{j=1}^{n} \phi_{edij} \quad (4.63)$$

Total available energy level for machine tools design and fabrication are given in Equations (4.64) and (4.65), respectively.

$$\varphi_{edi} = \frac{\phi_{Tedi}}{\phi_{red}} \quad (4.64)$$

$$\varphi_{efi} = \frac{\phi_{Tefi}}{\phi_{ref}} \quad (4.65)$$

The energy available for the system can either be defective or non-defective. It implies that two determinant elements for determining energy availability level are non- mutually exclusive as shown by Venn diagram in Fig. (4.5).Therefore, the useful energy level for machine tools fabrication (α_{efi}) and machine tools design (α_{edi}) are shown in Equations (4.69) and (4.72) respectively.

$$\alpha_{ef} = p(\phi_{efQ}) = p(\phi_{efQ} \cup \phi_{efq}) - p(\phi_{efq}) \quad (4.66)$$

$$\frac{\phi_{efQ}}{\phi_{Tef}} = 1 - \frac{\phi_{efq}}{\phi_{Tef}} \quad (4.67)$$

$$\alpha_{ef} = \lambda_{efQ} = 1 - \lambda_{efq} \quad (4.68)$$

$$\alpha_{ef} = 1 - \lambda_{eN} \quad (4.69a)$$

The level of available energy for machine tool fabrication (v_{ef}) when useful energy for machine design (ϕ_{efQ}) is compared with required energy capacity (ϕ_{ef}) is given by Equation (4.69b)

$$v_{ef} = \alpha_{ef} \times \varphi_{ef} \quad (4.69b)$$

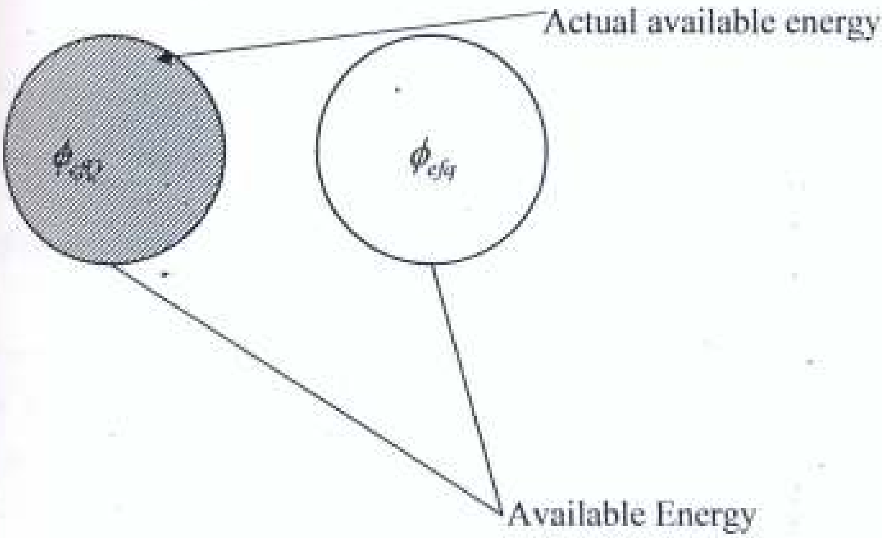


Fig. 4.5: Venn Diagram for Energy Development

For machine tools design

$$\alpha_{edt} = p(\phi_{edQ}) = p(\phi_{edQ} \cup \phi_{edq}) - p(\phi_{edq}) \quad (4.70)$$

$$\frac{\phi_{edQ}}{\phi_{Ted}} = 1 - \frac{\phi_{edq}}{\phi_{Ted}} \quad (4.71)$$

$$\alpha_{ef} = \lambda_{efQ} = 1 - \lambda_{efq} \quad (4.72)$$

$$\alpha_{ek} = 1 - \lambda_{ekq} \quad (4.73a)$$

Then the level of available actual energy availability for machine tool design (ν_{ek}) when useful available energy for machine design (ϕ_{ekh}) is compared with required equipment capacity (ϕ_{ed}) is given by Equation (4.73b)

$$\nu_{ek} = \alpha_{ek} \times \varphi_{ek} \quad (4.73b)$$

Where

$P(\phi_{efQ})$ and $P(\phi^{*}_{ekQ})$ = probability of having regular energy for fabrication and design respectively.

$P(\phi_{efQ} \cup \phi_{efq})$, and $P(\phi_{ekQ} \cup \phi_{ekq})$ = Probability of having regular or defective energy for Machine Tools fabrication and design respectively.

$P(\phi_{efq})$ and $P(\phi_{ekq})$ = Probability of having epileptic energy for Machine Tool fabrication and design respectively.

4.1.5 Machine Tool Capacity Bench mark Estimation

Machine tool capacity as earlier stated depends on requisite manpower, energy, raw material and equipment facilities capacity for design and fabrication. All of them must be utilized in appropriate value before machine tool can be fabricated or designed.

Therefore, actual level of available capacity for machine tool fabrication is the average of what is obtainable in Equations (4.28), (4.43), and (4.57) and (4.68). This is summarised by Equation (4.74)

$$\sigma_{ft} = \left(\sum_{j=1}^{n} \nu_{fti} \right) / n \quad (4.74)$$

$$\sigma_f = (\upsilon_{mf} + \upsilon_{qf} + \upsilon_{rf} + \upsilon_{ef}) / 4 \quad (4.75)$$

Also actual level of capacity available for machine tool design capacity is determined as the average of what is obtainable in equations (4.29), (4.44), (4.58) and (4.73).This is expressed in equation (4.76) as

$$\sigma_{di} = \left(\sum_{j=1}^{n=4} \nu_{dij} \right) / n \quad (4.76)$$

$$\sigma_{d} = (\upsilon_{md} + \upsilon_{qd} + \upsilon_{rd} + \upsilon_{ed}) / 4 \quad (4.77)$$

Also, actual level of capacity available for machine tool building is obtained from Equations (4.74) and (4.76) as

$$\beta i = \left(\sum_{j=1}^{n=2} \sigma_{ij} \right) / n \quad (4.78)$$

$$\beta i = (\sigma_{s} + \sigma_{d}) / 2 \quad (4.79)$$

Where, i = 1…………………N

i = number of stages of development which is equal to project implementation plan period

4.2 Upgrading and Integration of Machine Building Capacity Elements

A simple adaptive control technique is used in the design of machine tools plant capacity upgrading control system. The main control design problem stems for certainty in the knowledge of operating parameters. A feedback control law having adjustable coefficients, which are adapted online by self-turning algorithm, can minimize the effect of the uncertainty of these parameters ((Landau, 1982).

Machine tool sector in Nigeria is a complex system that needs a control design technique augmented with an identification technique aimed at obtaining a progressively better understanding of plant (Swindebanh and Higg, 1989).

The two steps will be taken separately by self turning regulator technique of adaptive control that will be used in developing this model. The first step is on-line identification of the system error and the second steps which is the control part is minimisation of identified model output error from ideal system output, through simultaneous adjustment of the controller parameters.

The self-turning regulator first identifies the plant parameters recursively and then uses these estimates to update the controller parameter through some fixed transformation. The controller is to have two loops: an inner or regular loop that is ordinary control loop consisting of plant and regulator and outer or adaptation loop that adjusts the parameter of the regulator in such a way as to minimize the error between the ideal system output β_m and the real system plant output β_p.

The self-turning control to be employed in the model is minimum variance in which k-step prediction of the output machine tool capacity is evaluated. Nigerian Machine tool is represented by a linear discrete time dynamic system with Single Input (Fund) Single Output (Machine tools capacity), (SISO) is described by Equation (4.80).

$A\beta_{it} = Z^{-k}Bv_{it} + Ce_t$ (4.80)

Where

β_{it} and v_{it} are the machine tools capacity and machine tools resources respectively at time instant t.

e_t is the aggregate of random disturbance corrupting the measured machine tool capacity which is uncorrected with the input allocated fund

The operation Z^{-1} is the backward shift operator and is defined as $Z^{-1}y_t = y_{t-1}$

The integer k: k >1 which is the time delay of the system expressed as an integral multiple of the sample time b_o is non zero in the polynomial definitions, polynomials A, B and C are in backward shift operation Z^{-1} and is defined as

$A = 1 + a_1z^{-1} + a_2Z^{-2} + \ldots + a_{na}z^{-na}$

$B = bo + b_1z^{-1} + b_2z^{-2} + \ldots + b_{nb}z^{-nb}$

$C = 1 + c_1z^{-1} + c_2z^{-2} + \ldots + c_{nc}Z^{nc}$ (4.82a)

The argument Z^{-1} is ignored to simplicity. It is assumed A has roots which lie study within the unit circle, and B is non-zero for z^{-1}. na, nb and nc are the orders of the system assigned a prior, as part of the assumptions of the dynamic structure of the model.

The model output at sample instant t+n can be written in vector form as

$k_\beta{}^*{}_{t/t+n} = \theta^T\delta$ (4.82b)

Where n_t is the optimal prediction of the machine tools capacity (β) at sample instant t+n

The parameter vector δ can be estimated on-line at each sample/control instant using the recursive least square algorithm.

The estimation error, which the identification error obtained at each recursion, is

$et_i = k_{\beta t}{}^* - k_{\beta t/t+n}$ (4.83)

$e_{it} = k_{\beta t}{}^* - \theta^T\delta$ (4.84)

where θ^T is the measured output machine tools capacity and input machine tools resources variable defined as $\{ k_{t-1}, k_{t-2}, k_{t-3}, \ldots, k_{t-na}; \beta_{t-1}\ \beta_{t-2}, \ldots, \beta_{t-nb-1} \}$

and δ is the unknown parameters defined by $\delta^T = (-a_1 - a_2, \ldots, a_{na}; b_o, b_1, \ldots, b_{nb})$

The identification of system model given by Equation (4.82) is performed using recursive least square (RLS) estimation.

The above on-line system modeling circuit gives marginal improvement of machine tools with time with corresponding marginal allocation of fund until identified resources error is minimised. Machine Building Technology capacity Resource Upgrading(MBCRU) is repsented by a control circuit shown in Fig. (4.6). The key problem in the scheme is to obtain an adjustment mechanism that minimised the machine tool output error $e_o = \beta_p - \beta_m$ to zero.

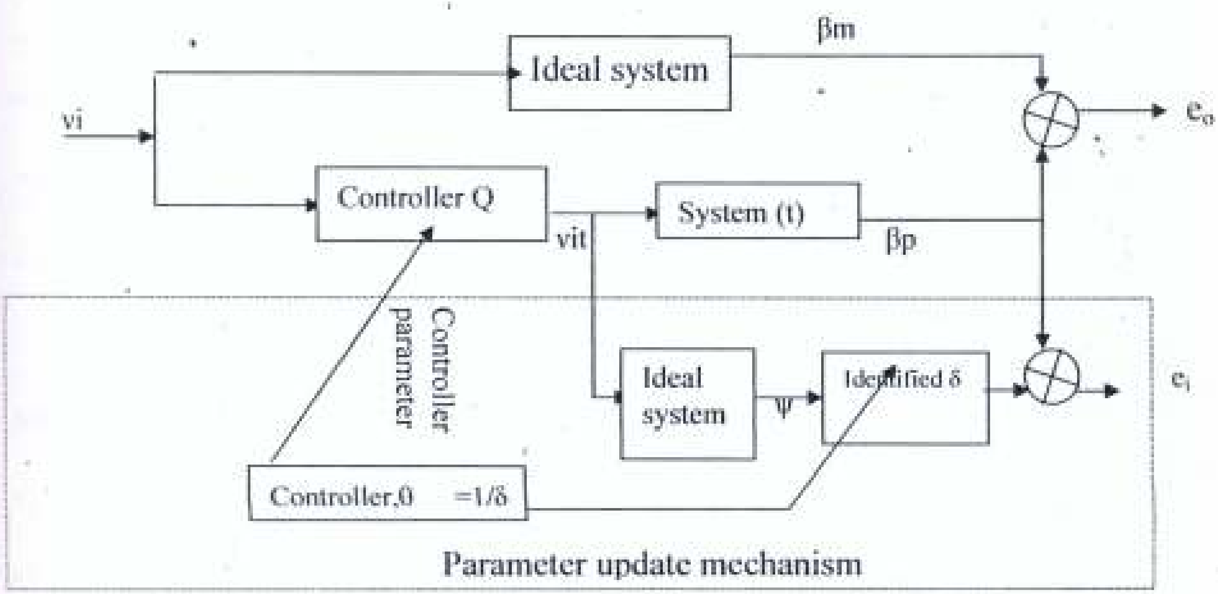


Fig.4.6: Control Circuit for Upgrading Resources.

4.2.1 Control Parameter Determination

The control parameter, which is fund (Q), is a function of economic, environmental and political factors. Fund is allocated to each unit of machine tools resources (υ_i) to achieve improvement in them. At this point the developed model determines improvement in marginal value of contributory factor with addition of a unit sum of money at a particular time. In fund allocation, it is important to know how much fund to allocate to each contributory factor at each stage to ensure meeting of set standards.

Q is a factor of economic trend and economic trend of Nigeria can be based on the present value of Nigeria currency. To get the equivalent value of money for unit development of machine tool capacity as year goes by, method of least square method based on linear regression was asssumed.

$$Q_i = a + b\dot{x}_i \qquad (4.85a)$$

a and b which are the constants of the regression Equation are determined based on the past trend of total amount of money (Qi) (when its equivalent is determined by comparing with dollar value at that particular time) required for unit percentage development of machine (β_{ui}) tools with years (x_i).

Where:

x_i =economic indicator based on the value of Naira when compared with dollar with year frame.

Q_i = total money required for unit percentage development for year i:

The values of parameters a and b are obtained from linear regression coefficient relations:

$$a = \frac{\sum x^2 \sum Q - \sum x \sum xQ}{n\sum x^2 - \left(\sum x\right)^2}, \quad b = \frac{n\sum xQ - \sum x \sum Q}{n\sum x^2 - \left(\sum x\right)^2} \tag{4.85b}$$

Where,

n is the number of years since the establishment of machine tools industry

Amount of Fund Required For Further Development

Amount of fund required for further development can be determined after determining the money for unit development of machine tool as year goes by (Q_{ni})

$$Q_{ni} = a + bxi \tag{4.86}$$

Based on the fact that, the only amount of money budgeted for machine tool development can be known but the amount spent so far is difficult to obtain because of improper recording and mismanagement characterized by many industries in developing countries such as Nigeria. Therefore, Equation 4.87 gives the alternative method of estimation which is based on the total amount of fund for unit development (expressed as a percentage), the machine tool capacity level.

$$Q_{Ri} = 100Qu_i(1 - \beta_i) \tag{4.87}$$

Required fund for further development can also be expressed as Equation (4.88)

$$Q_{Ri} = Q_A - Q_{S_i} \tag{4.88}$$

Where Q_A = actual money for machine tools development

Q_N = amount of money already spent for machine tools development. The spent money (Q_N) is therefore obtained by substituting the value of $Q_{R,i}$, (in Equation 4.87) into Equation (4.88). The new Equation (4.89) is expressed as

$$Q_A - Q_N = Q_R = (100Qui(1-\beta_i)) \qquad (4.89)$$

From which

$$Q_N = Q_A - (100Qu_i(1-\beta_i)) \qquad (4.90)$$

Amount of money spent (Q_N) so far is therefore given in equation (4.91)

$$Q_S = Q_A - (100Qu(1-\beta_i)) \qquad (4.91)$$

Therefore, total amount of money allocated at a specific time (Q_{Ri}) is given by Equation (4.92)

$$Q_{Ri} = \frac{Q_R}{N} \qquad (4.92)$$

Where i = 1 .....N

Where N is the number of year of project implementation

Present value of the required money for machine tools development for a specific year (i)

$$Q_{Ri} = \frac{Q_R}{N}(a + b(x_{T+i})) \qquad (4.93)$$

Where

T = is number of year from the inception/establishment of machine tools industry.

4.2.2 Control Parameter Distribution

Having known the required money for machine tools development for a specific year, the controller parameter is allocated base on two factors:

(i) the weight of each machine tools error with respect to total error in the system reference to the highest machine tools resources

$$\gamma_{ij} = \frac{\ell_{ij}}{\ell_{Tij}} \tag{4.94}$$

where

ℓ_{ij} = error in each resources

$\ell_{ij} = \delta - K_{ij}$

$\ell_{Tij} = \sum \ell_{ij}$ = Total error in the system

Where

δ = level of highest developed resources

k_i = fractional developmental level of other machine tools resources

(i = 1, 2, 3................n-1)

j = counter for developmental stages, i = counter for resources

(ii) the weight of fund per unit marginal value improvement of each resource (Q_{Uv}) with respect to total final fund per unit marginal improvement of the machine tools system ($Q_{Uβ}$)

$$\alpha_i = \frac{Q_{Uvi}}{Q_{U\beta}} \tag{4.95}$$

The distribution pattern of allocation of fund to all the resources is given by Equation (4.96).

$$Q_{Di} = \frac{Q_{Hi}}{\sum_{i=1}^{n} \gamma_{ij}\alpha_i}\left(\gamma_{ij}\alpha_{ij}(v_{ij}),\ldots,\gamma_{m}\alpha_{m}(v_{m})\right) \tag{4.96}$$

$Q_{Di} = Q_{Di1} + Q_{Di2} + Q_{Di3} \ldots\ldots\ldots\ldots Q_{Din}$

$$Q_{Di} = \sum_{j=1}^{n} Q_{Dij} = \sum_{j=1}^{n} \left(\frac{Q_{Ri} \gamma_{ij} \alpha ij}{= \sum_{j=1}^{n} \gamma_{ij} \alpha_{ij}} v_{ij} \right) \tag{4.97}$$

Where i = 1 .....N-1 and

j = 1 .... n.

Where i is the stage of development and j is number of resources

Q_{Di} = distribution money at specific year (i)

Q_{Dij} = distribution money to each resources j at specific year (i)

The controller parameter (Q_{Di}) which is fund required for each resource, is inversely proportional to the level of its development; that is, the more the level of development, the less the fund required for the development (Equation 4.98).

$$Q'_{is} = \frac{1}{k_i} \text{ and } \delta^* = k_i \tag{4.98}$$

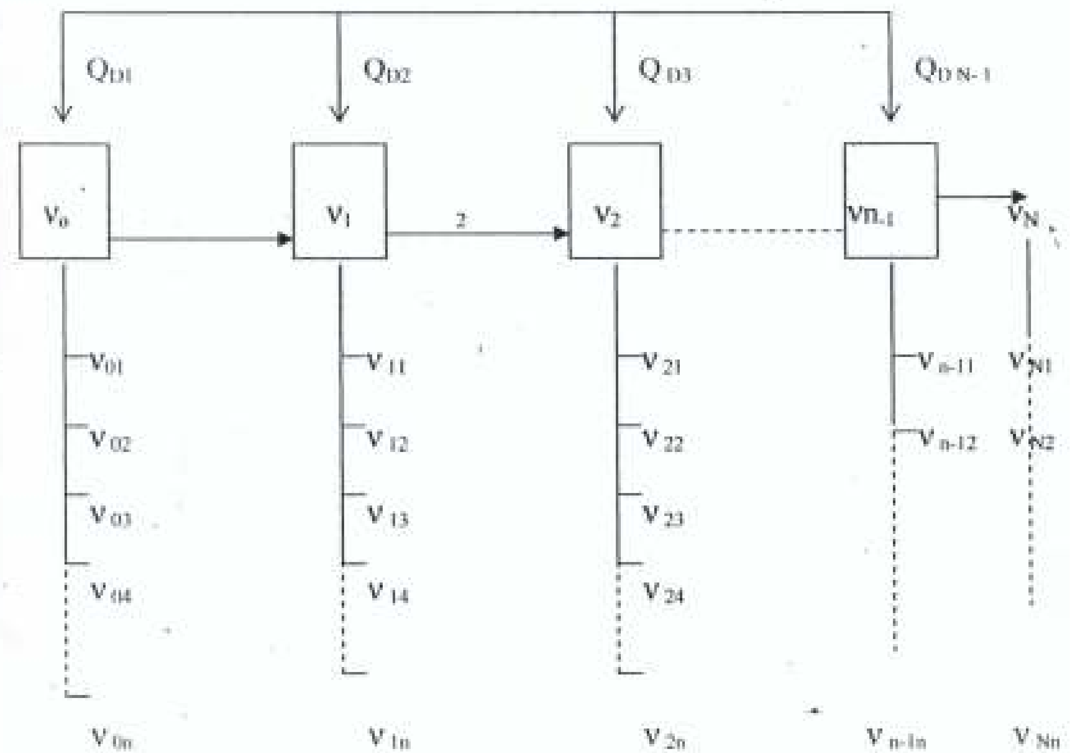
Let

$$Q_{is}(t) = \frac{1}{\delta(t)} \tag{4.99}$$

At the point when

$$t \to \infty \text{ and } \delta \to k_i \text{ then } Q_{is}(t) \to \frac{1}{k} \text{ as } \quad e_{q \to 0}$$

Having determined the pattern of distributing the fund, the model is developed in such a way that the highest developed contributory factor is chosen. The trend of allocation of fund to each resource is illustrated in Fig. 4.7



Q_{D1}, Q_{D2} ... Q_{DN-1} - Allocated fund for different stages of development of machine tools resources,

v_o, v_1, v_2, v_3, ..., v_N - Different stages of development of machine tools resources.

v_{N1}, v_{N2}, v_{N3}, ..., v_{Nn} - Different machine tools resources.

Fig 4.7 : Fund Allocation to Resources

4.2.3 System Identification

The system identification is recursive in which the plant model is periodically updated on the basis of previous estimates and new data. The system identification technique is used to obtain a model of the plant and its environment from input-outputs experiments from which controller is designed (Agee, 2004). The parameter of the controller (fund) is adjusted during the operation of the plant as the value of the machine tools resources increases until all the resources value reach the level of highest identified resources. The objective of this part of the model is to stabilize the system by ensuring that all the resources are in the same level there by converging the diverse error in the system at initial stage before final upgrading to the set up standard. The flow diagram for the system identification is shown Fig. 4.8

In the self-regulator there is an estimator which has adjustment mechanism, which contains an identifier parameter δ (t), which is the resources with highest development value which other resources value (k_i) supposes to be equal. There is also a control parameter in the adjustment mechanism which helps in improving other resources level (k_i). At a point when nominal value of resources with highest development δ* is equal to other resources value (k_i) then $\delta = \delta^* = k_i$ at this point the regulator must have minimised the identifier error (e_{ij}) from the plant resources to zero

The on – line controlled parameter vector which is the resources (v_{ij}) is updated as

New estimate = old estimate + Gain x prediction error

$$v_{ij}+1 = K_i v_{ij} + \frac{\gamma_{ij}\alpha_i}{\left(\sum_{j=1}^{n}\gamma_{ij}\alpha_i\right)}(Q_m)v_{ij} \qquad (4.100)$$

Where,

$\frac{\gamma_{ij}\alpha_i}{\sum_{j=1}^{n}\gamma_{ij}\alpha_i} = e_{ij}$ = Prediction error for each resources (j) at every development stage (i)

Therefore Equation (4.100) can be written as

$$v_{ij}+1 = k_i(v_{ij}) + e_{ij}Q_m(v_{ij}) \qquad (4.101)$$

When $e_i \longrightarrow 0$, then kis $\longrightarrow \delta$

The highest contributory factor has to wait for other factors to get to the same level δ before any fund sharing.

At this stage, the machine tools resources with highest developmental level has nothing as a gain as shown in Equation (4.102)

$$v_{ij(\delta)}+1 = \delta(v_{ij}) + 0 \qquad (4.102)$$

Other resources are upgraded using Equation (4.101)

$$v_{ij}+1 = K_i(v_{ij}) + e_i Q_m(v_{ij})$$

The upgrading will continue until $e_{ij} \longrightarrow$ **0** , kis $\longrightarrow \delta$ the iteration stop for the first stage and this at this point $\delta = k_1 = k_2 = k_3 = \ldots\ldots\ldots\ldots = k_{n-1}$

4.2.4 Machine Tools Resources Upgrading

At this point the second stage of upgrading starts, as all the machine tool resources as attained the same level i.e.

$$\delta = k_1 = k_2 = k_3 = \ldots = k_{N-1} \qquad (4.103)$$

In order to actualize the set point ψ which is the resources with highest value of development is introduced to form an auxiliary error function e_0 (t)

$$e_0(t) = \psi_{(t)} - \delta_{(t)} \qquad (4.104)$$

since the idea to move all the entire machine tools resources to unity (i.e. $\psi = 1$).

The desirable properties of the adaptive controller algorithm is to stabilize the system in the sense of yielding bounded deviation of the output machine tool capacity from the set point and should converge eventually to a control corresponding to underlying design method.

Then, the output ℓ_{ij} error becomes $\ell_{ij} = 1 - \delta_i$ (4.105)

Where i = 1, 2, ...,N (stages of development)

So far all the machine tools resources are in the same level.

The most important factor in distributing the allocation in this stage is the weight of the fund per unit marginal value of each contributory factor with respect to total fund per unit marginal improvement of the machine tools so far all the resources are in the same level of development.

The machine tools resources on – line controlled parameter v_{ij} at this stage is updated as shown in Equation. (4.106)

$$v_{ij} + 1 = \delta_i v_{ij} + \frac{\alpha_{ij}}{\sum_{j=1}^{N} \alpha_{ij}} (Q_{m}) v_{ij} \qquad (4.106)$$

The iteration will stop when δ is $\rightarrow 0$ then When $\ell_{ij} \rightarrow 0$

At this point

$$\delta_i = k_1 = k_2 = k_3 = \ldots = k_N = 1$$

As this processes progress, the machine tools capacity increases concurrently. In order to achieve this, the model is developed in such a way that the controller, which is fund periodically monitors the system transfer function and then modifies it. The flow diagram for self – turning synthesis is shown in Fig. 4.8.

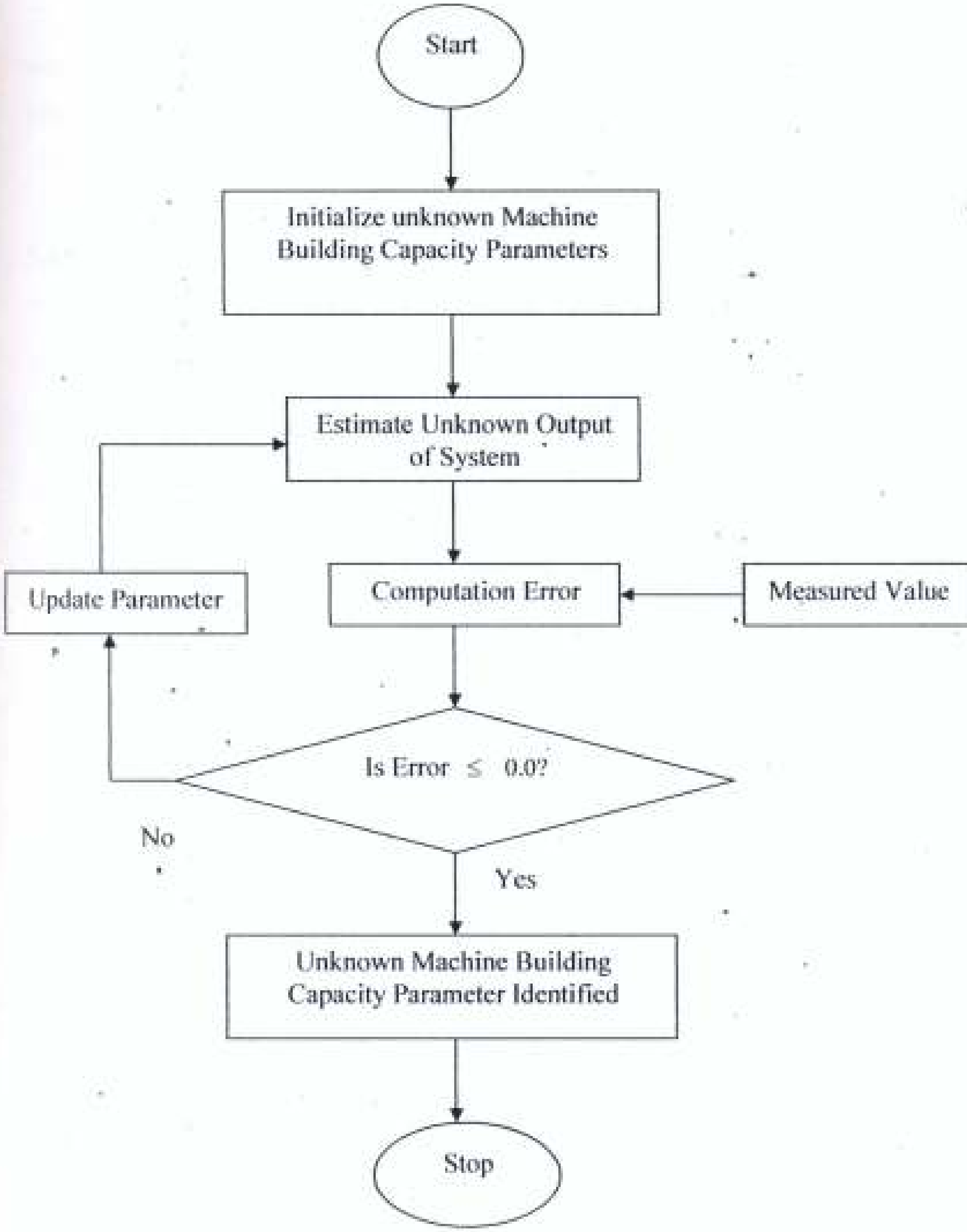


Fig. 4.8: Flow Chart for Capacity Identification

CHAPTER FIVE

SOFTWARE DEVELOPMENT

The flowchart for the software is presented in Fig. 5.1 while the algorithm is given in section 5.1. The flowchart and algorithm enabled computer software coding of the system. The resulting code in Visual Basic is shown in Appendix I. Visual basic was chosen because of its user friendliness and networkability

5.1. Development of Algorithm

Algorithm for the development of technology capacity for machine tools industry in Nigeria is presented as follow:

1. Input various values of machine tools, Elemental resources capacity

ϕ_{mFis} (ϕ_{mFe}, ϕ_{mFx}, ϕ_{mF}, ϕ_{mFex}, ϕ_{mFet}, ϕ_{mFtx}), ϕ_{mDis} (ϕ_{mDe}, ϕ_{mDx}, ϕ_{mDt}, ϕ_{mDex}, ϕ_{mDet}, ϕ_{mDtx}), ϕ_{qFis} (ϕ_{qFN}, ϕ_{qFn}), ϕ_{qDis} (ϕ_{qDN}, ϕ_{qDn}), ϕ_{eFis} (ϕ_{eFQ}, ϕ_{eFq}), ϕ_{eDis} (ϕ_{eDQ}, ϕ_{eDq} ϕ_{rDis} (ϕ_{rDQ}, ϕ_{rDq}), ϕ_{rFis} (ϕ_{rFQ}, ϕ_{rFq})

2. Compute available total manpower for machine tools design and fabrication, respectively.

$$\phi_{TDm} = \sum_{n=1}^{h} \phi_{mDis} \text{ , } \phi_{TFM} = \sum_{n=1}^{h} \phi_{mFis}$$

3. Compute total equipment available for machine tools design and fabrication respectively

$$\phi_{TDq} = \sum_{i=1}^{n} \phi_{qDis} \text{ , } \phi_{TFq} = \sum_{i}^{n} \phi_{qFis}$$

4. Compute available total energy for machine tools design and fabrication, respectively

$$\phi_{TDe} = \sum_{i}^{n} \phi_{eDis} \text{ , } \phi_{TFe} = \sum_{i}^{n} \phi_{eFis}$$

5. Compute available total raw material for machine tool design and fabrication respectively

$$\phi_{TDr} = \sum_{i}^{n} \phi_{rDis} \text{ , } \phi_{TFr} = \sum_{i}^{n} \phi_{rFis} \text{ ,}$$

6.Compute manpower element level for machine tools design

$$\lambda_{mds} = \frac{\phi_{mds}}{\phi_{Tsm}} \left(\lambda_{mIDc}, \lambda_{mIDc}, \lambda_{mIDt}, \lambda_{mIDex}, \lambda_{mIDex} \right)$$

7. Compute manpower element level for machine tools fabrication

$$\lambda mfis = \frac{\phi_{mfis}}{\phi_{TTsm}} \left(\lambda_{mfsfe}, \lambda_{fmfs}, \lambda_{mfex}, \lambda_{mfer}, \lambda_{mfex} \right)$$

8. Compute machine tool design and fabrication equipment elemental level

$$\lambda_{qDs} = \frac{\phi_{qDs}}{\phi_{TDq}} \left(\lambda_{qDN}, \lambda_{qDr} \right)$$

$$\lambda_{qFs} = \frac{\phi_{qFs}}{\phi_{TFq}} \left(\lambda_{qFN}, \lambda_{qFr} \right)$$

9. Compute machine tool design and fabrication equipment elemental level

$$\lambda_{eDs} = \frac{\phi_{eDs}}{\phi_{TDe}} \left(\lambda_{eDQ}, \lambda_{eDq} \right)$$

$$\lambda_{efs} = \frac{\phi_{efs}}{\phi_{Tfe}} \left(\lambda_{efQ}, \lambda_{eFq} \right)$$

10. Compute machine tool design and fabrication energy elemental level

$$\lambda_{eDs} = \frac{\phi_{eDs}}{\phi_{TDe}} \left(\lambda_{eDB}, \lambda_{eDq} \right)$$

$$\lambda_{efs} = \frac{\phi_{efs}}{\phi_{TFe}} \left(\lambda ef\phi, \lambda eFr \right)$$

11.Compute machine tool design and fabrication raw material elemental level

$$\lambda_{Ds} = \frac{\phi_{rDs}}{\phi_{TDr}} \left(\lambda_{rD\phi}, \lambda_{rDq} \right)$$

$$\lambda_{rFs} = \frac{\phi_{rFs}}{\phi_{TFr}} \left(\lambda_{rf\phi}, \lambda_{rFq} \right)$$

12. Compute the actual machine tools resources capacity level α_{s}

13. Compute manpower resources for machine tools design level.

$$\alpha_{mDs} = 1 - \left(\lambda_{mIDc} + \lambda'_{mIDc} + \lambda_{mIDe} \right) + \left(\lambda_{mIDex} + \lambda_{mIDst} + \lambda_{mIDex} \right)$$

14. Compute manpower resources for machine tools fabrication level

$\alpha_{mf} = 1-(\lambda_{mfe} + \lambda_{mfr} + \lambda_{mfl}) + (\lambda_{mfex} + \lambda_{mfet} + \lambda_{mfes})$

15. Compute machine tool design equipment development capacity level $\alpha_{qd} = 1-\lambda_{qdq}$

16. Compute machine tool fabrication equipment development capacity level $\alpha_{qf} = 1-\lambda_{qfq}$

17. Compute machine tool design raw materials development capacity level $\alpha_{rd} = 1-\lambda_{rdq}$

18 Compute machine tool fabrication raw materials development capacity level $\alpha_{rf} = 1-\lambda_{rfq}$

19 compute machine tool design energy requirement development capacity level $\alpha_{ed} = 1-\lambda_{edq}$

20 compute machine tool fabrication energy capacity level $\alpha_{ef} = 1-\lambda_{efq}$

21. Compute real weighted available resources capacity level ψ_{is}

$${}^{\phi_{fis}}\!/_{\phi_{ms}}$$

22 Compute real machine building resources

$\upsilon_{is} = \alpha_{is}.\ \psi_{is}$

23. compute machine building fabrication capacity level;

$$\sigma_{Fis} = \left(\sum_{i=1}^{n=4} \sigma_{fis}.\psi_{is}\right)\Big/ n \quad or \left(\sum_{i=1}^{n=4} v_{is}\right)/n$$

24 compute machine building design capacity level

$$\sigma_{Dis} = \left(\sum_{i=5}^{n=8} \sigma_{fis}.\psi_{is}\right)\Big/ n \quad or \left(\sum_{i=5}^{n=8} v_{is}\right)\Big/ n$$

25. Compute machine building capacity level; $\beta_{is} = \left(\sum_{i=1}^{n=8} v_{is}\right)\Big/ n$

26. Sort out the highest identified resource level = υ_0

27. Compute resources errors base on identified resource level capacity level; $\ell_{is} = v_0 - v_{is}$

28. Compute the total error as in the system; $\ell_T = \sum_{i=1}^{n} \ell_{ii}$

29. Compute weighted error = $\frac{\ell_{ii}}{\ell T} = \gamma_{ii}$

30. Input value of money to improve machine building capacity and each resource by one unit, R_i and r_{is}, respectively

31. Input various values of dollar equivalent of naira (y_i) with respects to year (x_i)

32. Compute constant of the trend of the variation of money value which is assumed to follow linear regression:

$$a = \frac{\sum x^2 \sum y - \sum x \sum xy}{n\sum x^2 - \left(\sum x\right)^2}, \; b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - \left(\sum x\right)^2}$$

33. Compute the trend of variation of the value of money to improve machine building (Mbi) and each resource (Mrij) by one unit and shortfall control fund with years

Mbi = Mb (a+b(xi)

Mrij = Mri(a+b(xi)

34. Compute amount of money required to be spent on the system at specific time

(Msi) = 100Mbi (1-βi)

35. Input the control, fund Mci ≤Msi

36. Compute shortfall of money required to be supplied Mcsi = Msi – Mci

37 If the short fall in control fund s not zero goto 17 else stop.

38 Compute the adaptation factor for each resource

$$\psi_{is} = \left\{ \left(\frac{\ell_{is} + M_{rip}}{\ell_{ti} + Mbi} \right) Mci \right\} \Big/ M_{rip}$$

39. Upgrade the resources capacities; $\upsilon ijs + 1 = \upsilon ijs + \psi_{is}$

40. Compute the identified resources error ; $\ell_{rips} = \nu_{ij} - \nu_{ijs} + 1$

41. If the resources errors are not tends to zeros return to (40) else compute smooth machine tools building resources capacity V_{sis}

42. Compute uniform level machine building capacity level $\beta_{si} = \left(\sum_{i=1}^{n-8} \upsilon_{ni} \right) \Big/ n$

43. Compute the error in the ideal system $\ell_{sis} = 1 - \upsilon_{sis}$

44. Compute the total error in the system $\ell_{sTi} = \sum_{i=1}^{n} \ell_{ms}$

45. Compute the adaptation factor to upgrade the system resources to the required /ideal capacity level; $\mu_{is} = \left\{ \left(\frac{M_{rip}}{M_{bi}} \right) M_{Ci} \right\} M_{rsy}$

46. Upgrade the resource capacity; $\upsilon_{sijs} + 1 = \upsilon_{sijs} + \mu_{n}$

46. Compute resources capacity error; $\ell^{*}_{sijs} = \{1 - V_{sijs} + 1\}$

47. If the resources are not zeros return to (42) else go to 48

48. End.

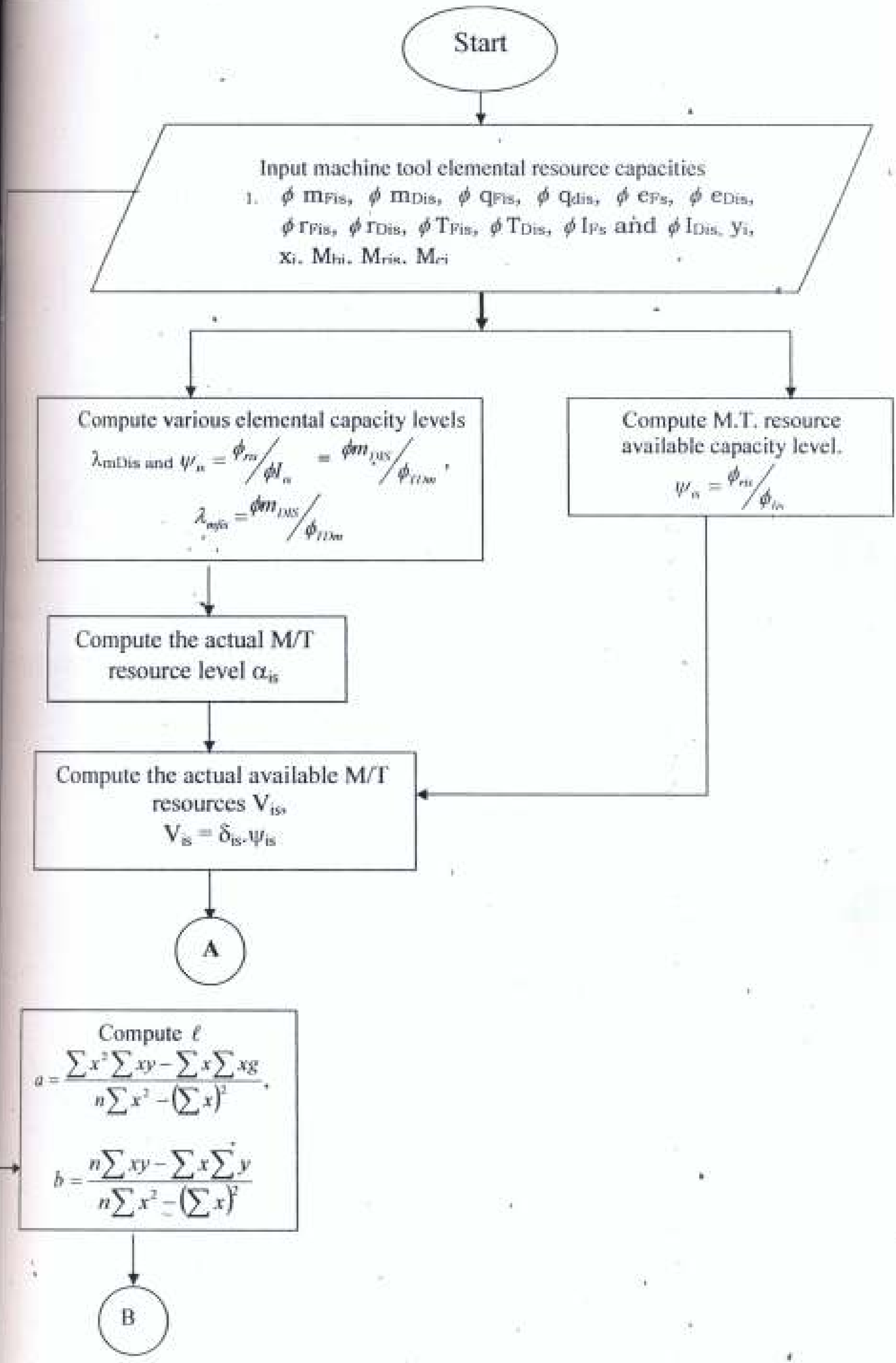


Fig.5.1: Flow Chart for Capacity Development Continued

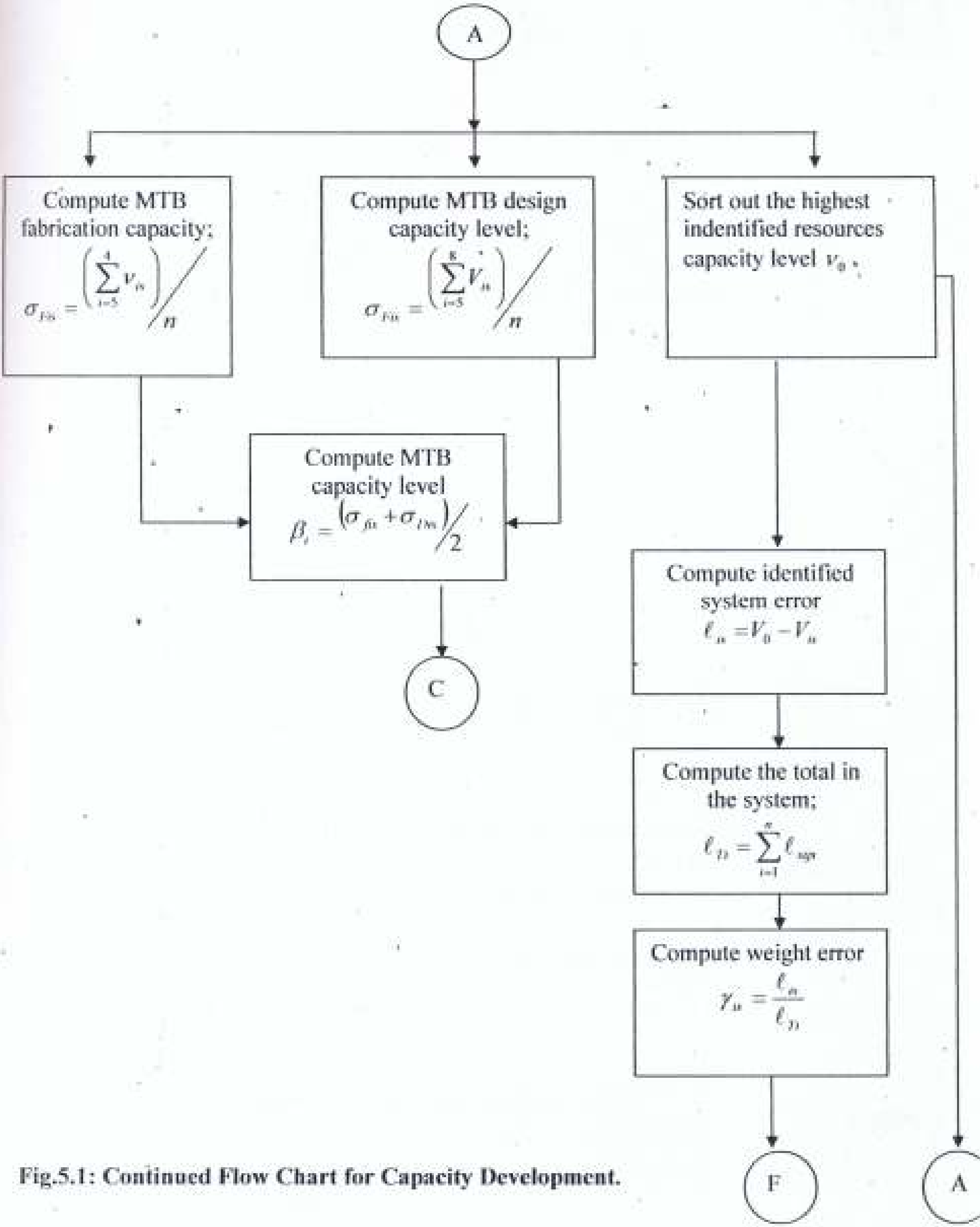


Fig.5.1: Continued Flow Chart for Capacity Development.

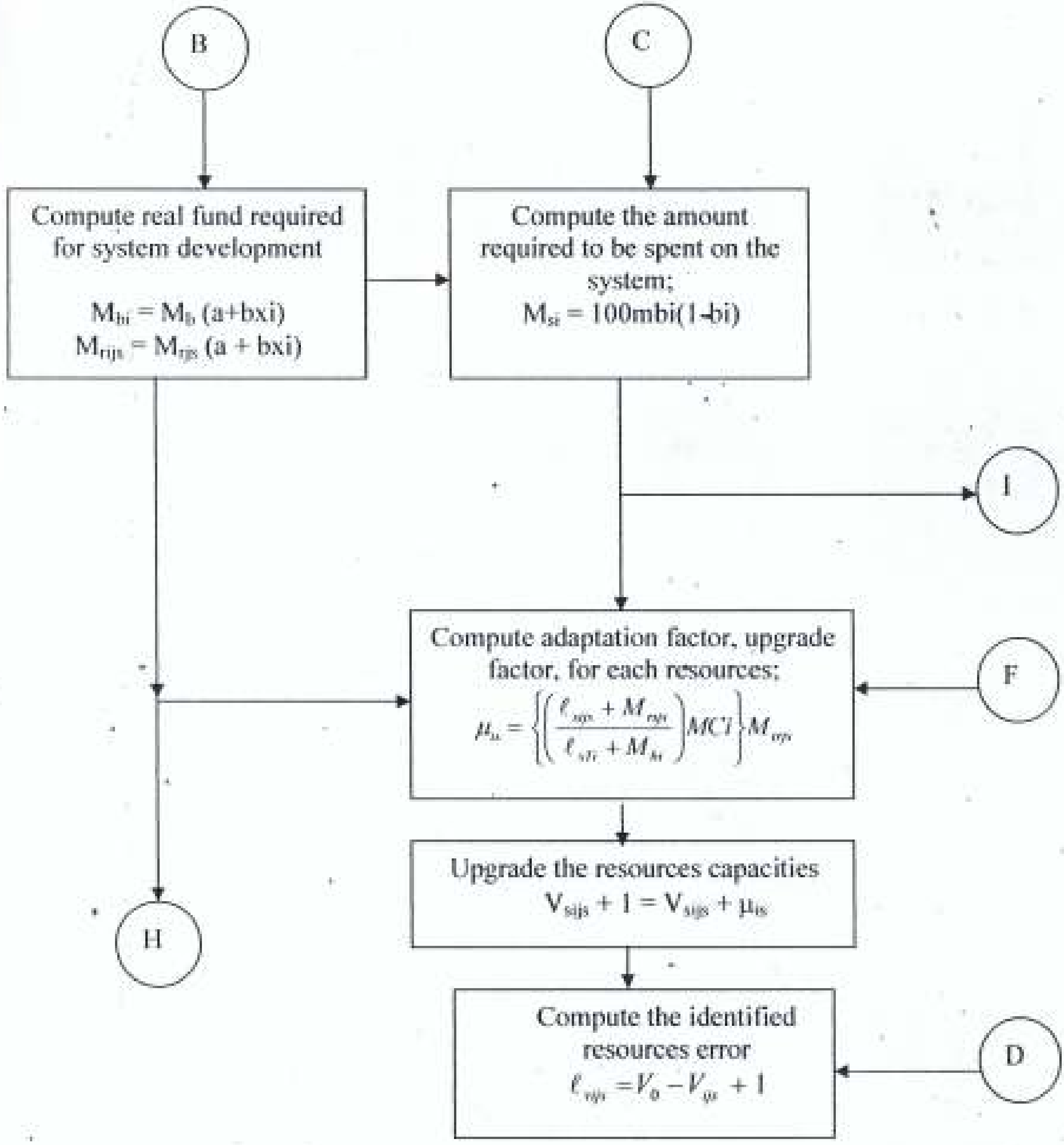


Fig. 5.1: Continued Flow Chart for Capacity Development

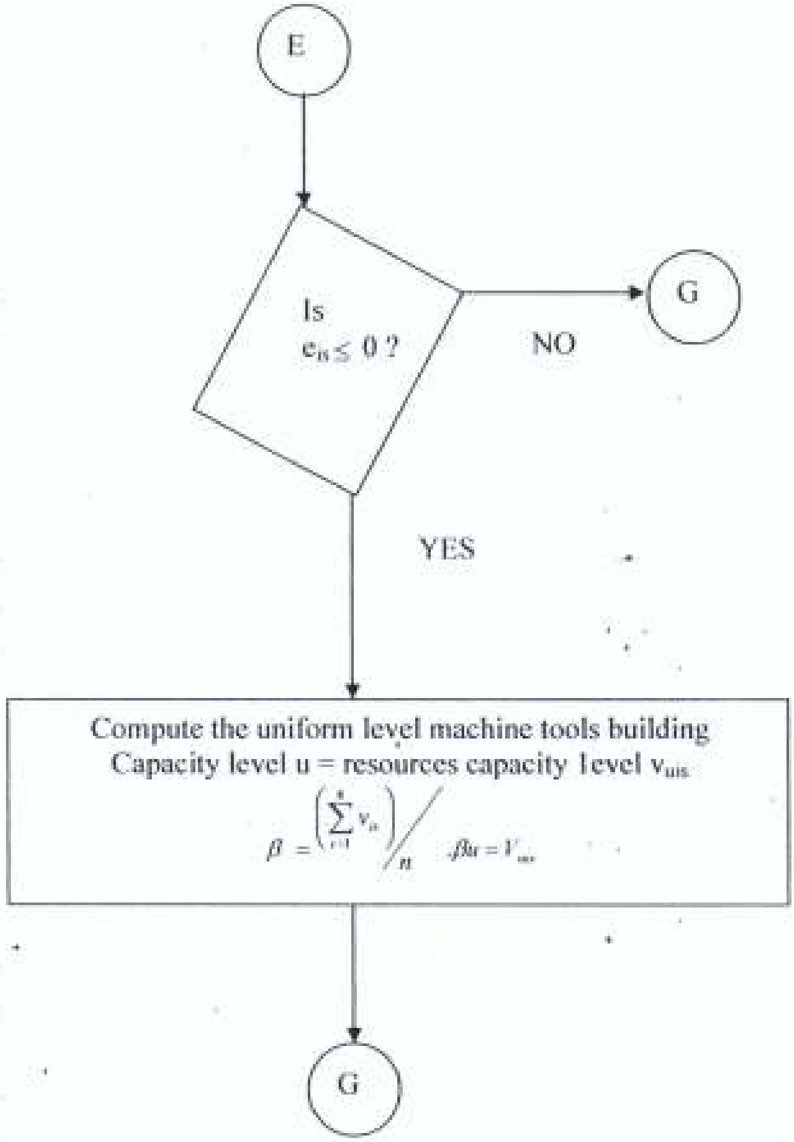


Fig. 5.1: Continued Flow Chart for Capacity Development

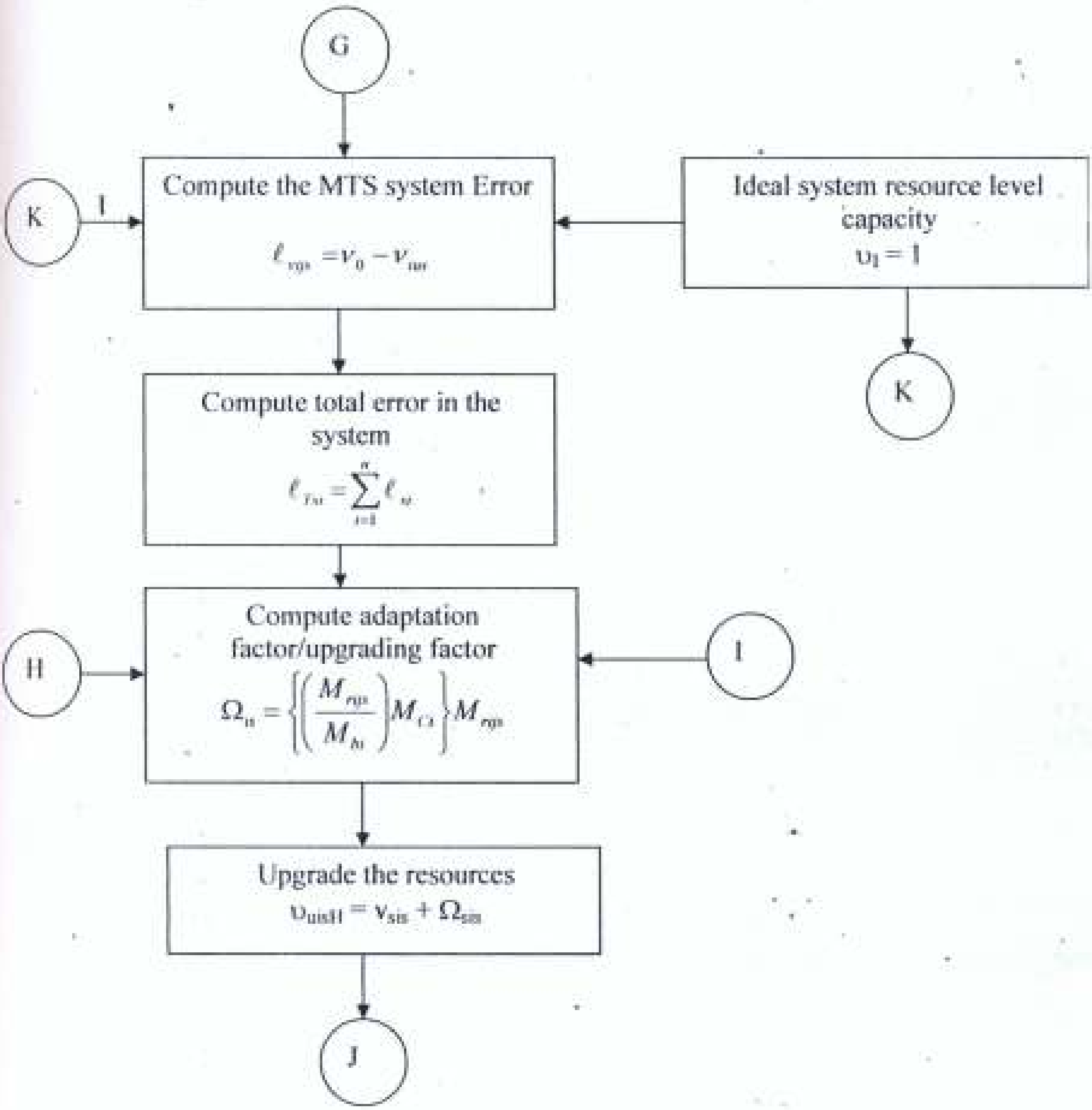


Fig. 5.1: Continued Flow Chart for Capacity Development

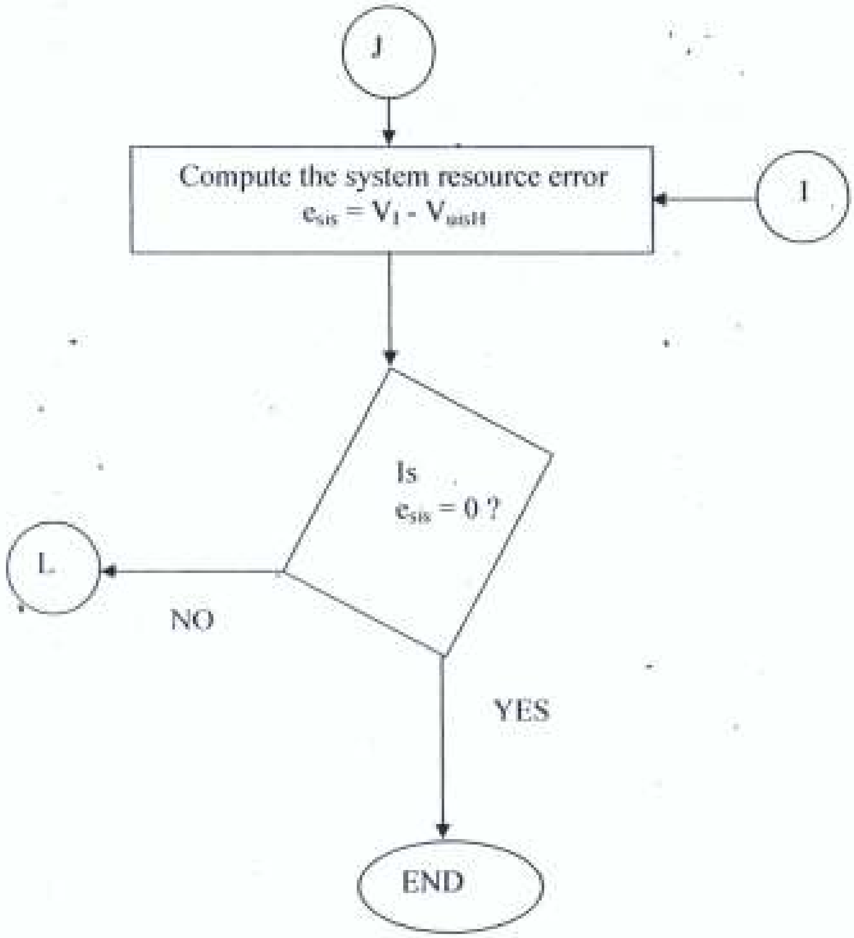


Fig. 5.1: Continued Flow Chart for Capacity Development.

5.2 Design of CAMTCAD-2008 Software

Computer Aided Machine Tools Capacity Development named CAMTCAD- 2008 was developed using Visual Basic 6.0. Visual basic was chosen because of its familiarity, user frendiliness and networkability. CAMTCAD-2008 was designed in the familiar Microsoft windows environment to be interactive and user- friendly through the use of control such as text boxes, command buttons, frames and other appropriate massage boxes. The database and structure of the software is flexible but robust enough to accommodate as many branches of capital goods sector as storage capacity of the computer allows.

5.3 Design of Interfaces

The design/coding of CAMTCAD-2008 software involved the following phases namely; title, data entry, and operation / execution and report phase

5.3.1 Title Phase

This interface welcomes the software user into the system. It contains the name of the software, developer, the supervisors, the essence of the study and the department to which the developer belongs (Fig. 5.2).

5.3.2 Data Entry Phase

The interfaces enters data into the database, the data entry system is very flexible and gives room for data updating. It contains the following sub-interface;(Fig5.3 and 5.5)

Data entry for elemental resource capacity; this enter elemental data for manpower development which include:

Number of people with requisite education;

Number of people with requisite experience;

Number of people with requisite training;

Number of people with requisite education and training;

Number of people with requisite training and experience;

Number of people with requisite education and experience; and

Number of people with requisite education, training and experience.

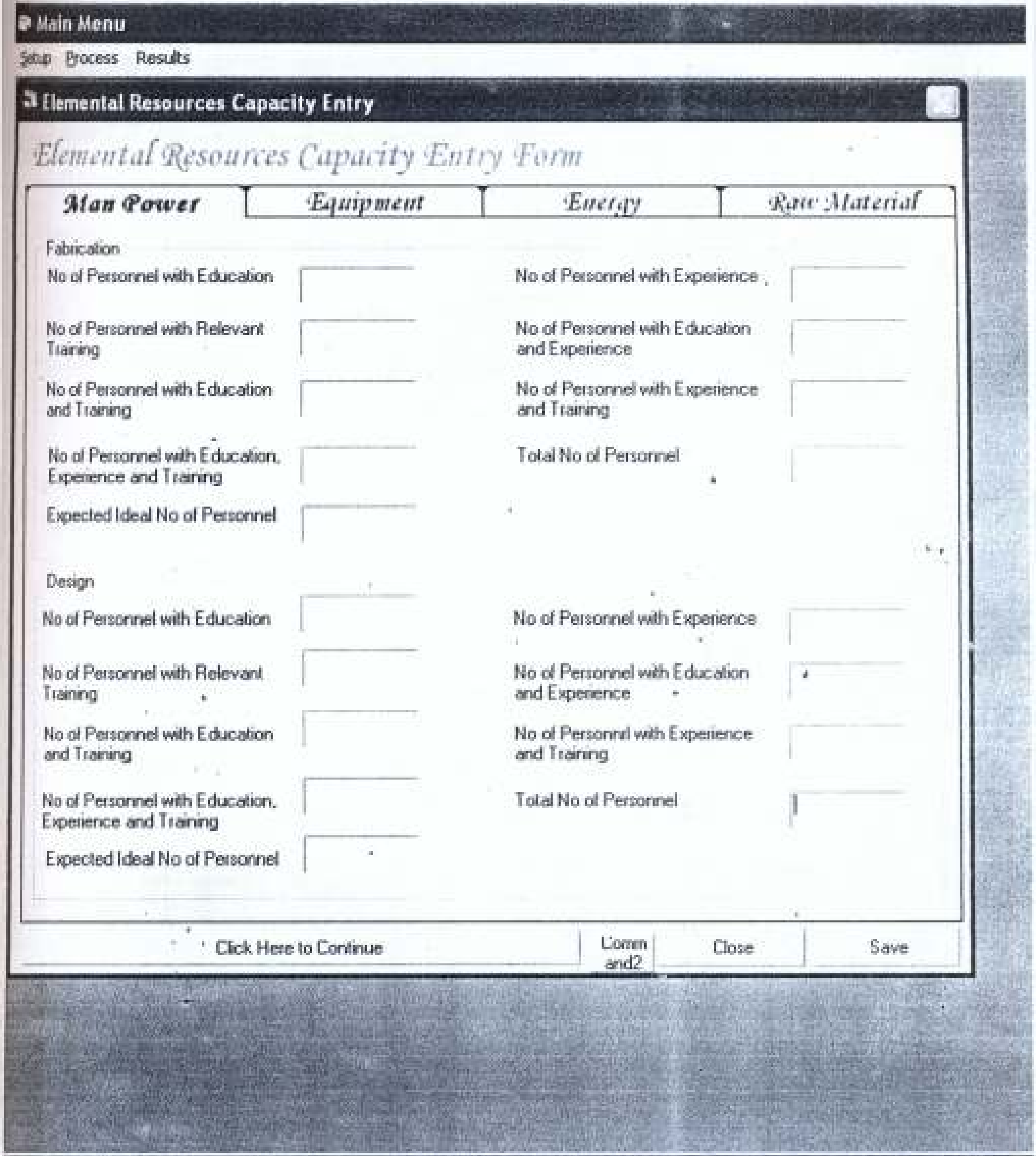


Fig. 5.2: Data Entry for Manpower Resources

Elemental data for equipment development is enterd here which include number of functional and non functional equipment

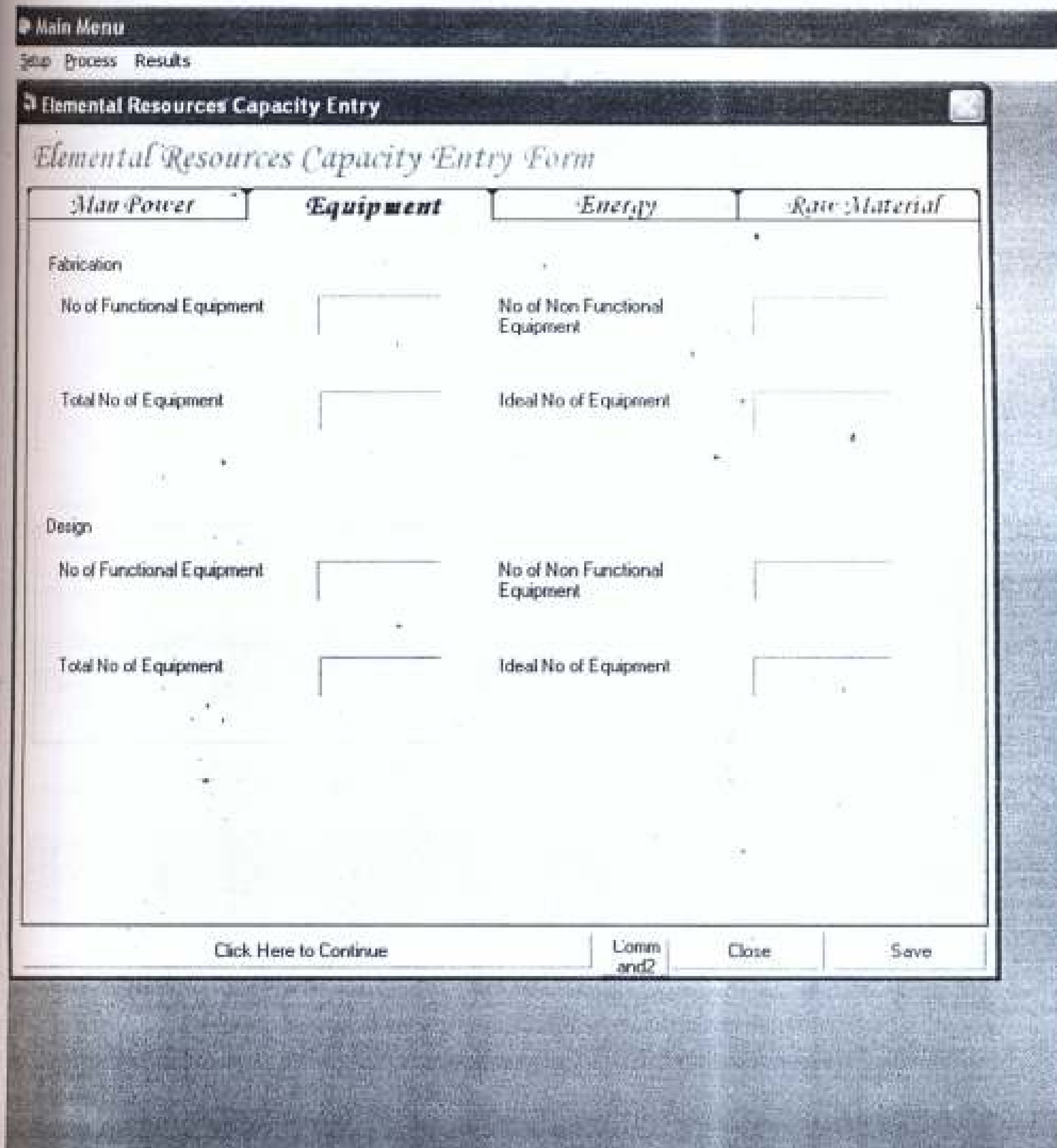


Fig. 5.3: **Data Entry for Equipment Capacity Scheduling**

Quantity of quality and non quality raw material for machine tool is also input here.

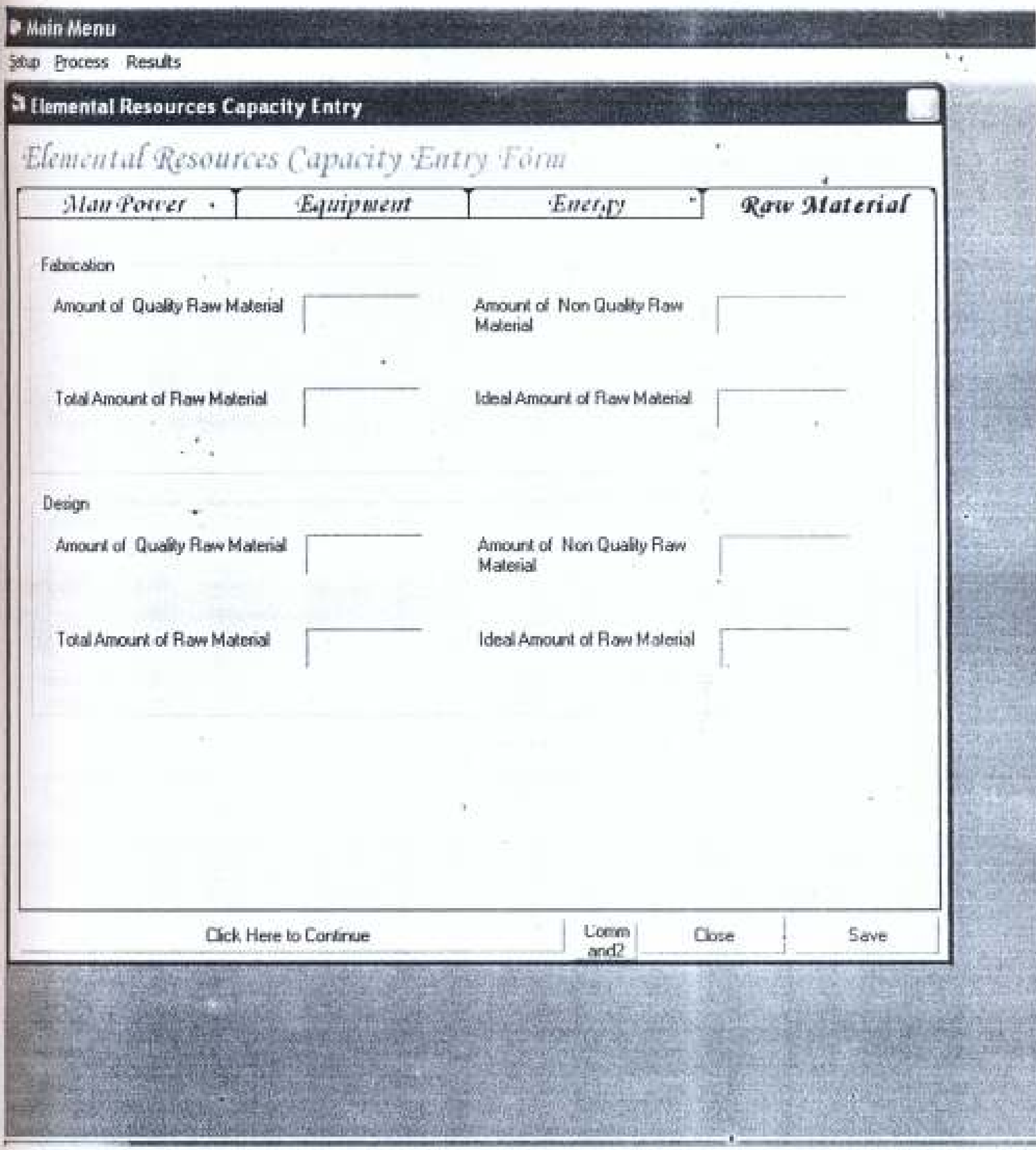


Fig 5.4: **Data Entry for Raw Material Planning**

Moreover, the amount of available quality and non quality energy was entered in this section.

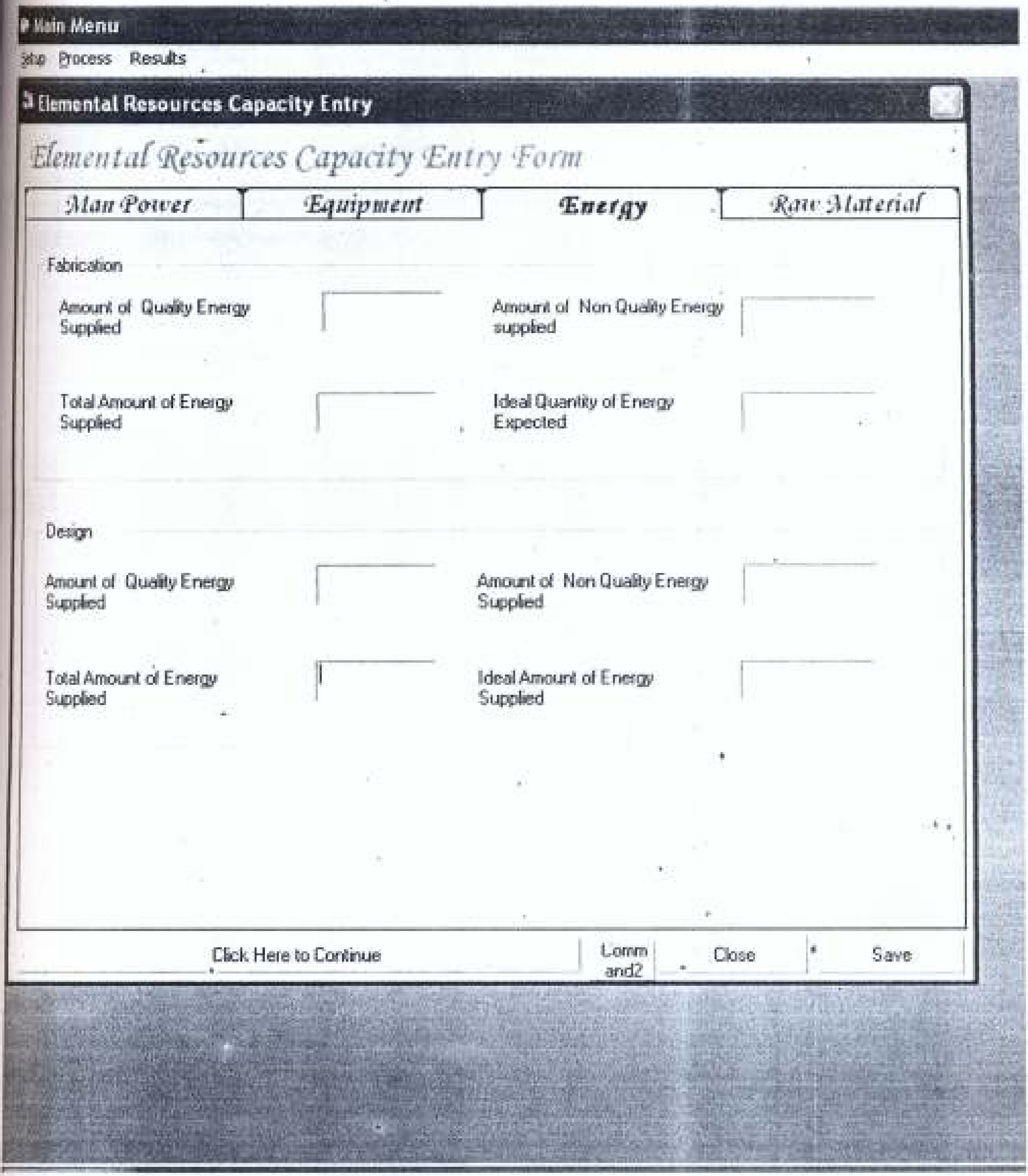


Fig. 5.5: Data entry for Energy Planning

Data entry for system improvement fund; this enters data on the appropriate fund unit development of machine tools capacity and fund for unit development for each resource responsible for machine tools development.

Data entry for year of initiating the project; this make available the time the project is going to start to help in calculating the present value of fund for the development of the system (Fig. 5.6).

Data entry for number of stage of system development; the number of stages of development help in appropriate calculation of fund to be allocated for each resources development and the system in general which varies with number of stages.

5.3.3 Operation/Execution menu

This progamme execution menu leads to the following submenu

Machine Building Benchmark Estimation Determination menu; this menu comprises of the following menu.

Elemental capacity level; It determined the level of quality and quantity of machine tools resources contributory factors.

Resources capacity level; the result of elemental capacity level is used to determine machine tools resources capacity level and also determine the resources that need fresh development from the scratch (Figs 5.7 - 5.14).

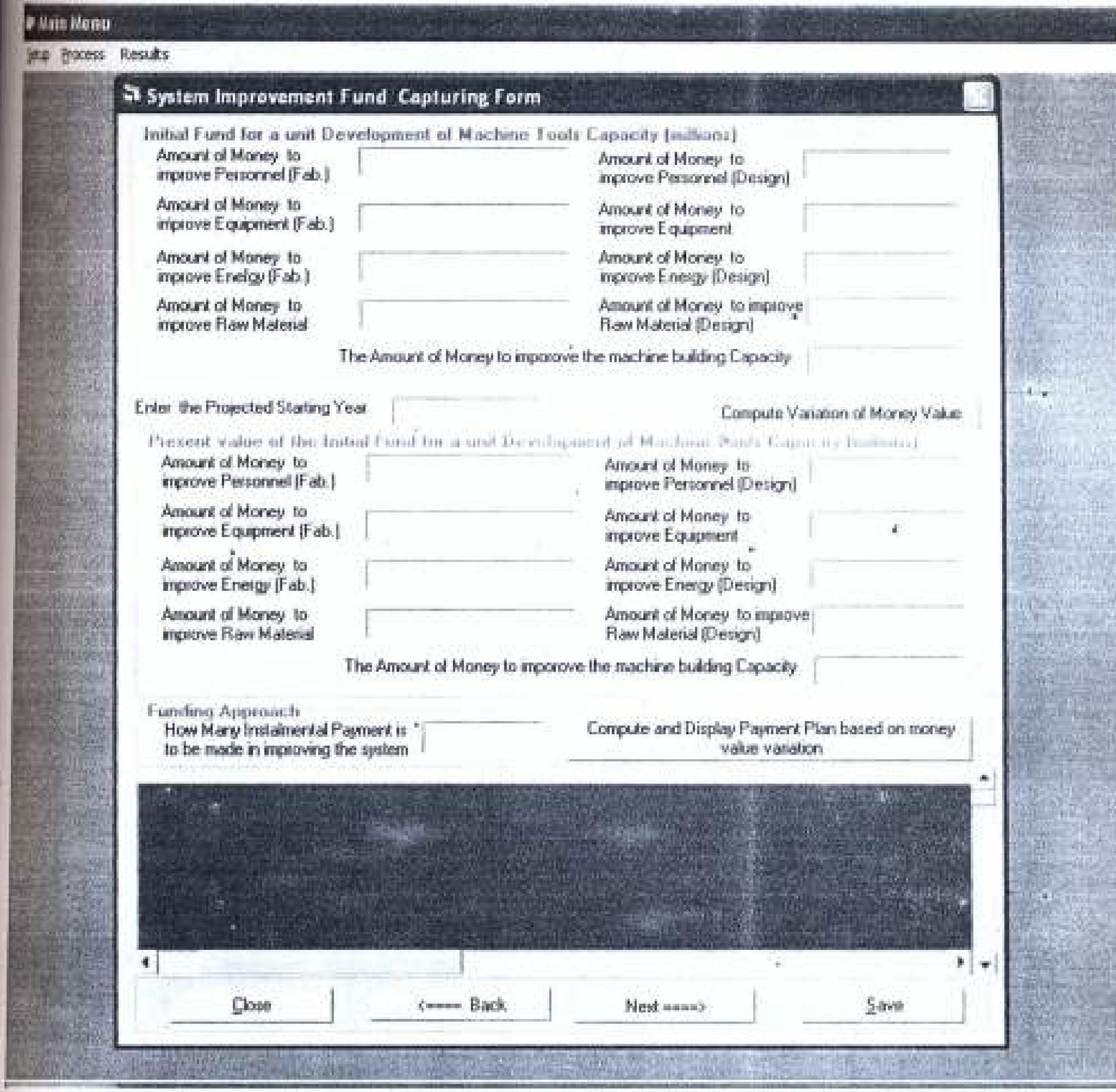


Fig. 5.6: **Data Entry for Funding.**

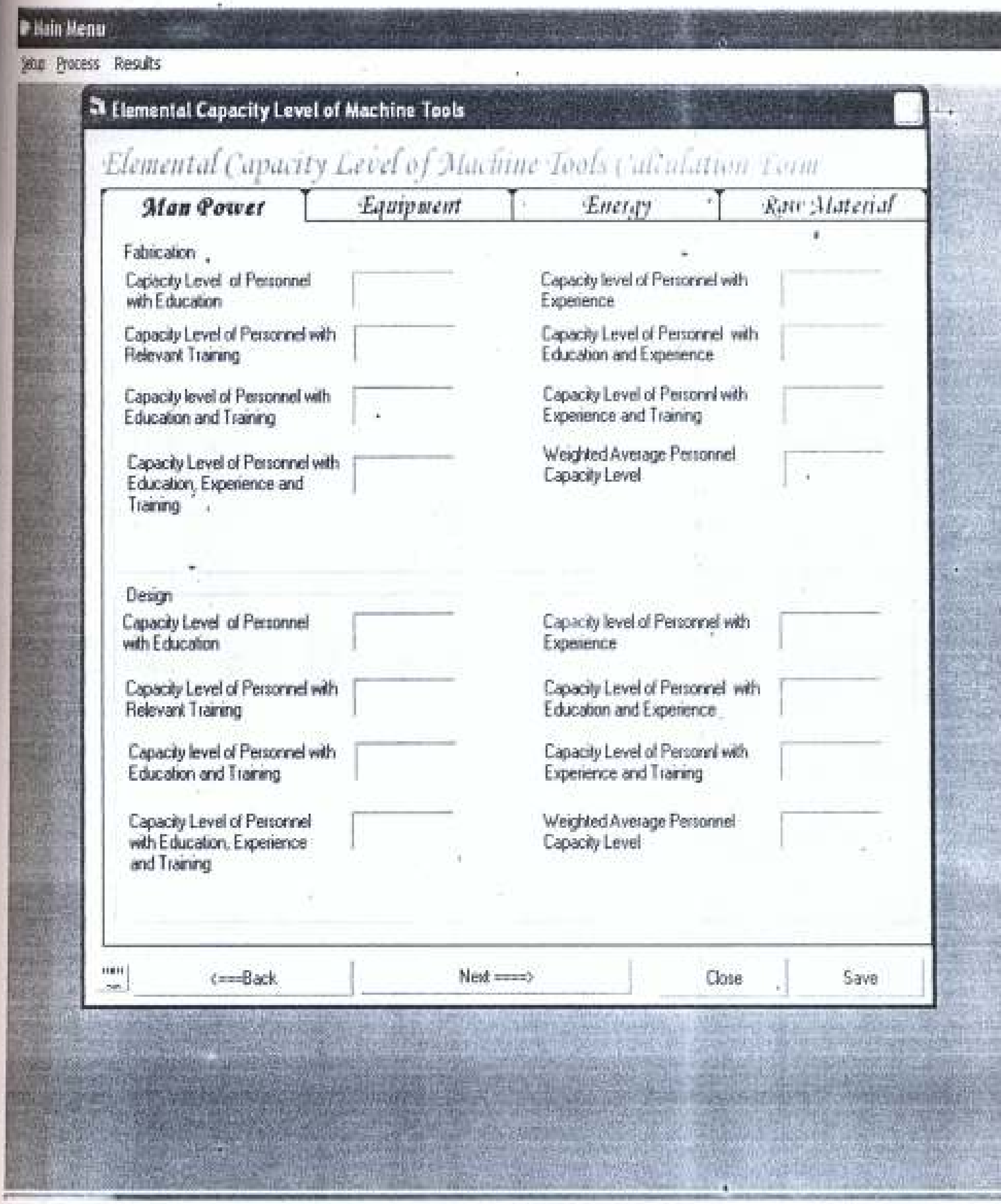


Fig. 5.7: Data Entry for Manpower Level Determination

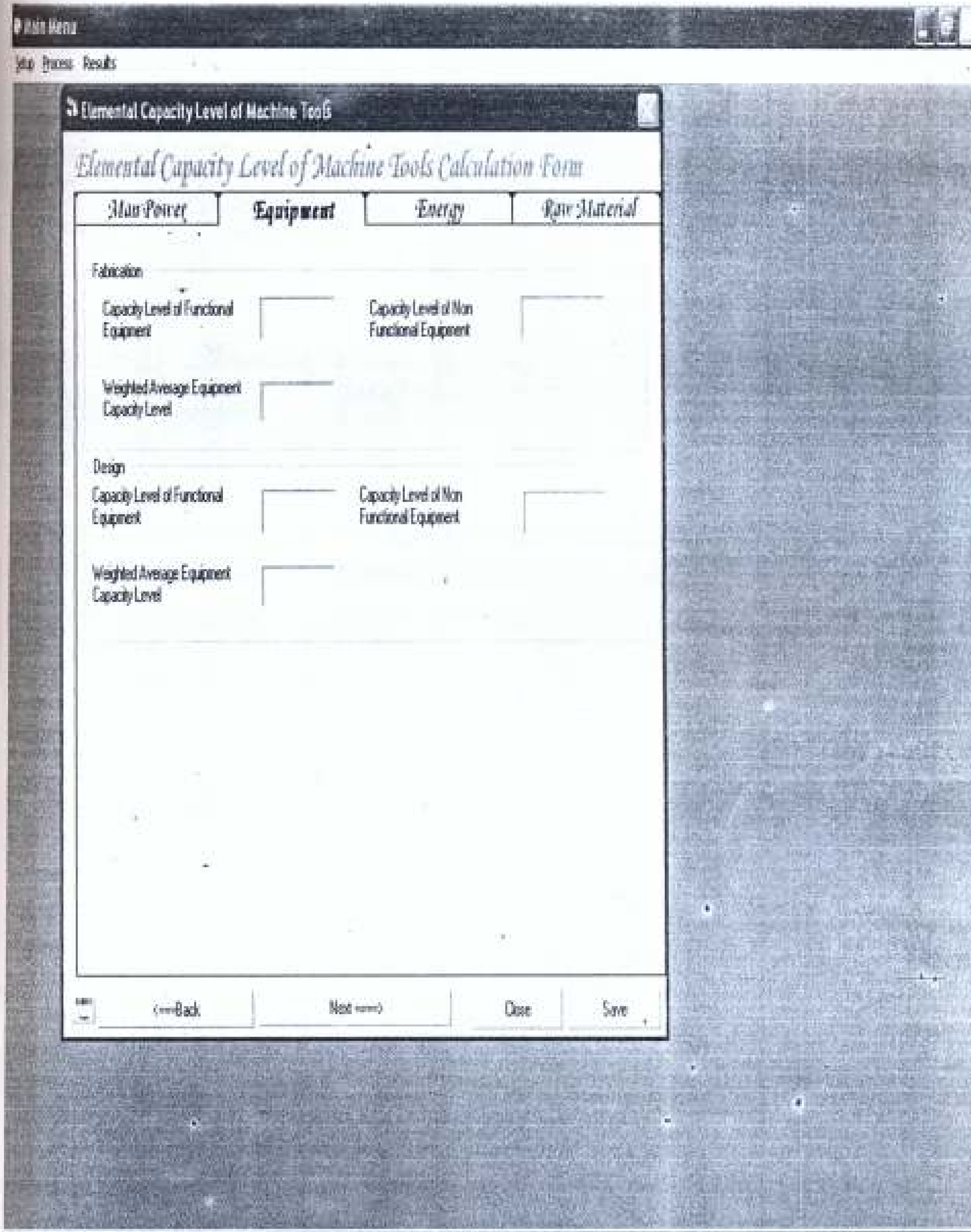


Fig. 5.8: Data Entry for Equipment Planning

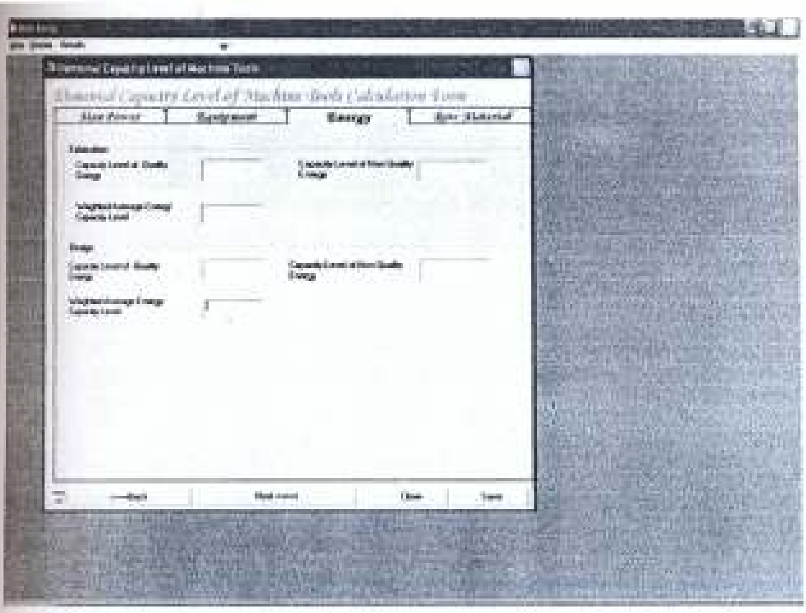


Fig. 5.9: Data Entry for Energy Planning

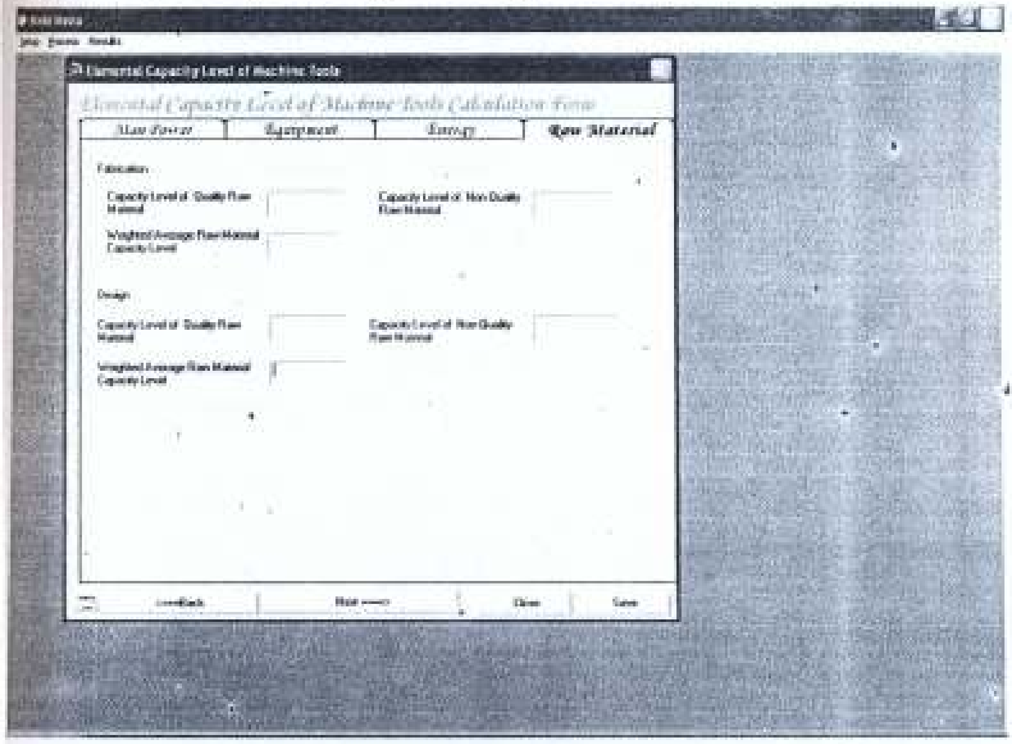


Fig.5.10: Data Entry for Raw Material Planning

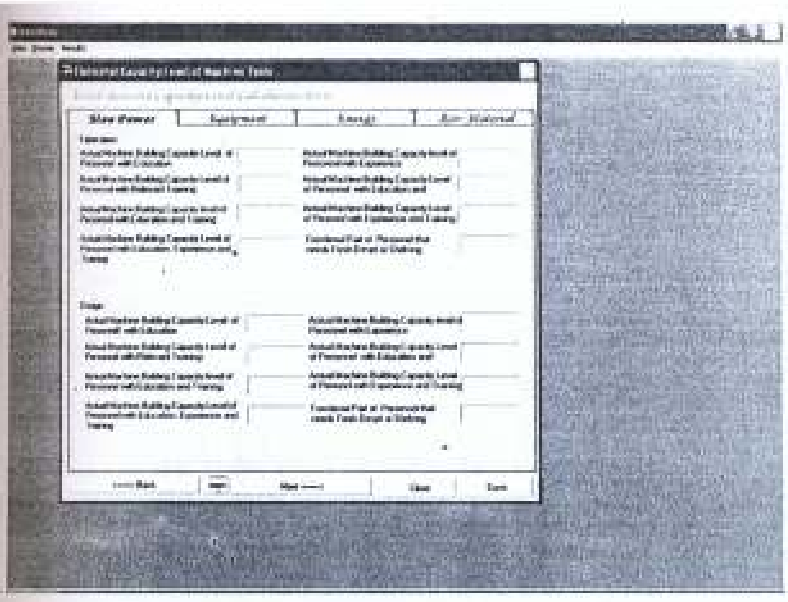


Fig. 5.11: Output for Manpower Determination

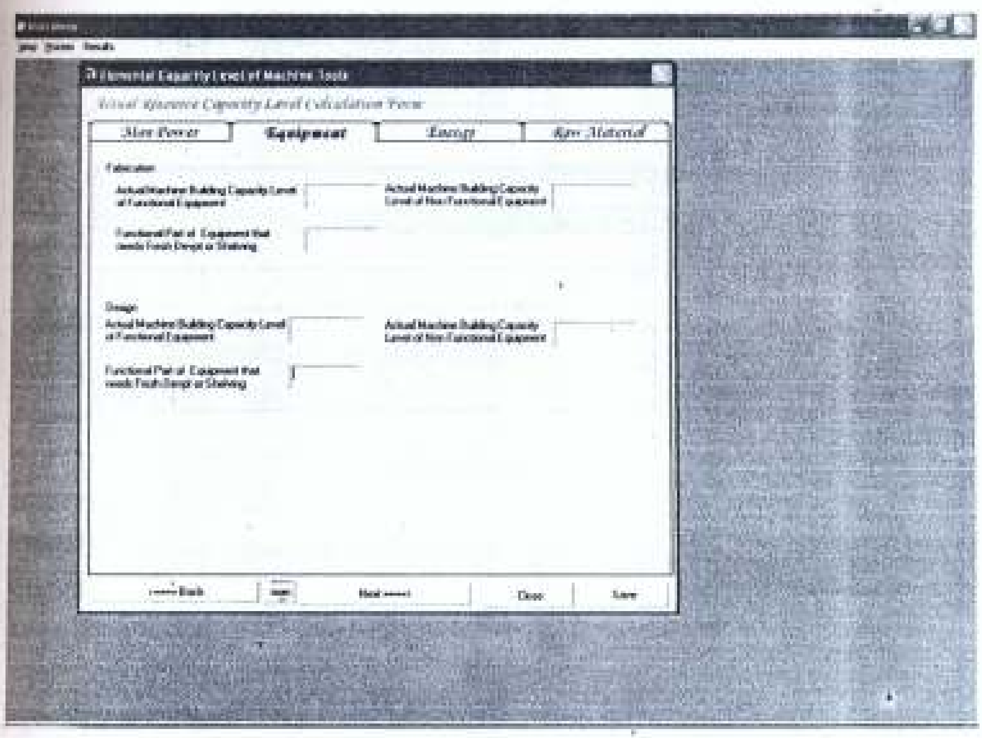


Fig. 5.12: Output for Equipment Determination

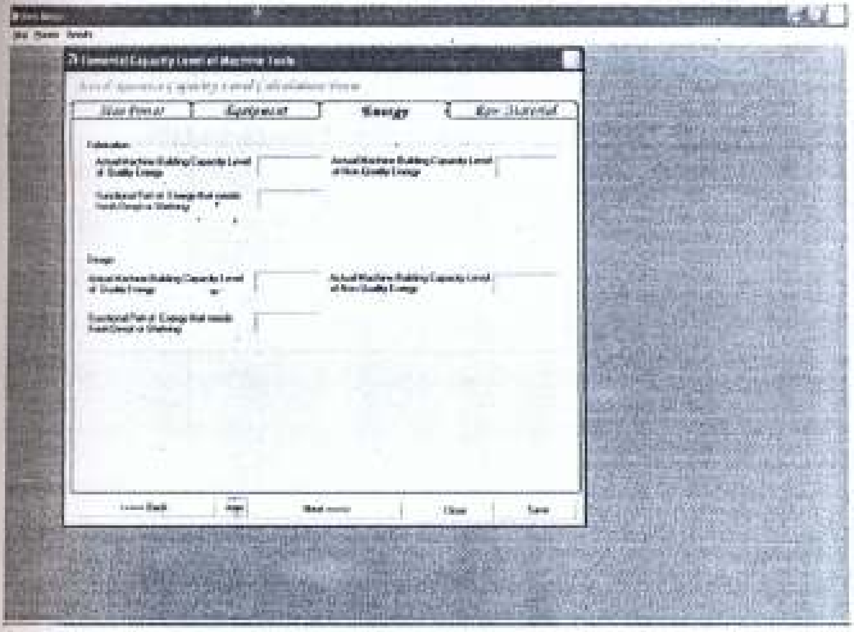


Fig .5.13: Output for Energy Determination

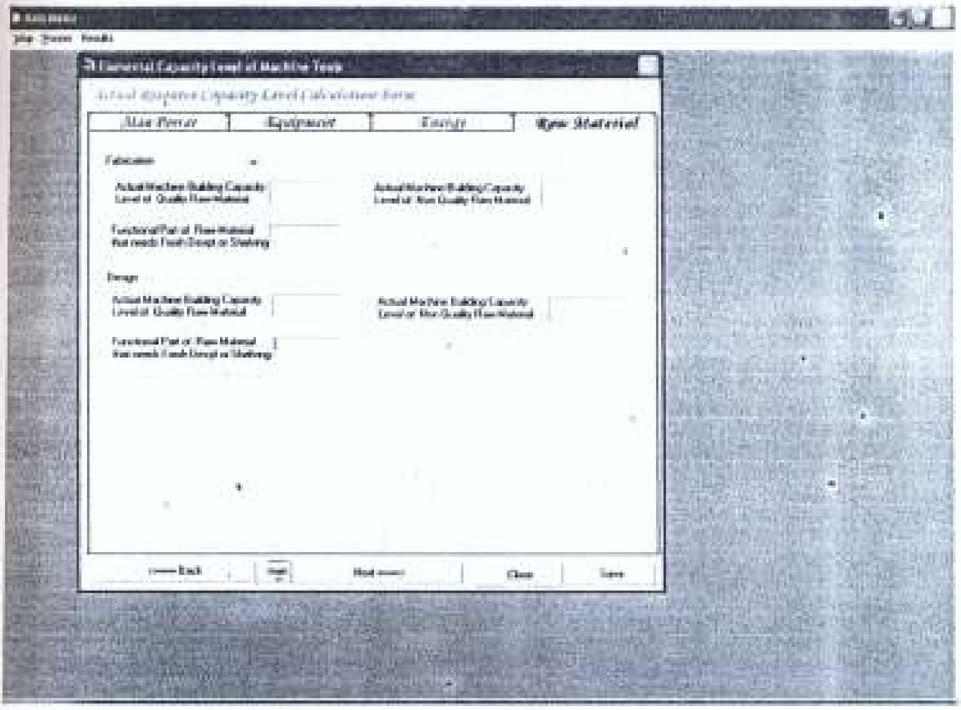


Fig. 5.14 Output for Raw Materials Determination

Machine Building Capacity Level determination.

The result of machine building resources was used to determine Machine tools fabrication and design facilities capabilities level, then machine tools building capacity level and the errors in the system were finally determined with reference to set up standard according to initial implementation plan for machine tools development in Nigeria.

5.3.4 Forecasting menu

This is the second stage of the operation in which the machine tools technological capacity level determined in the first stage is upgraded. The parameters of the resources of machine tools are adjusted during the operation of the system as appropriate fund are made available to the system. This consequently increase the machine tool capacity level until it reached a set up standard according to initial implementation plan for machine tools development in Nigeria.

This interface forecasts the present fund required for the upgrading base on the present value of the money which is a factor of implementation and number of time in which the money is going to be made available. It also forecast the level of development reference to the amount money made available. The interface that shows the forecasting pattern is shown in Fig. 5.15 and Fig.5.16.

Payment/ fund distribution Plan Menu

It calculates exact money required for the development of machine tools with year and simultaneously distributes the money to each resource responsible for machine tools capacity development. The amount made available is factor of number of year to complete the development and the value of money which varies with time. Distribution of the money to each resource is also a factor of the initial level of development of each resources and the amount required for unit development of each resources (Fig. 5.17).

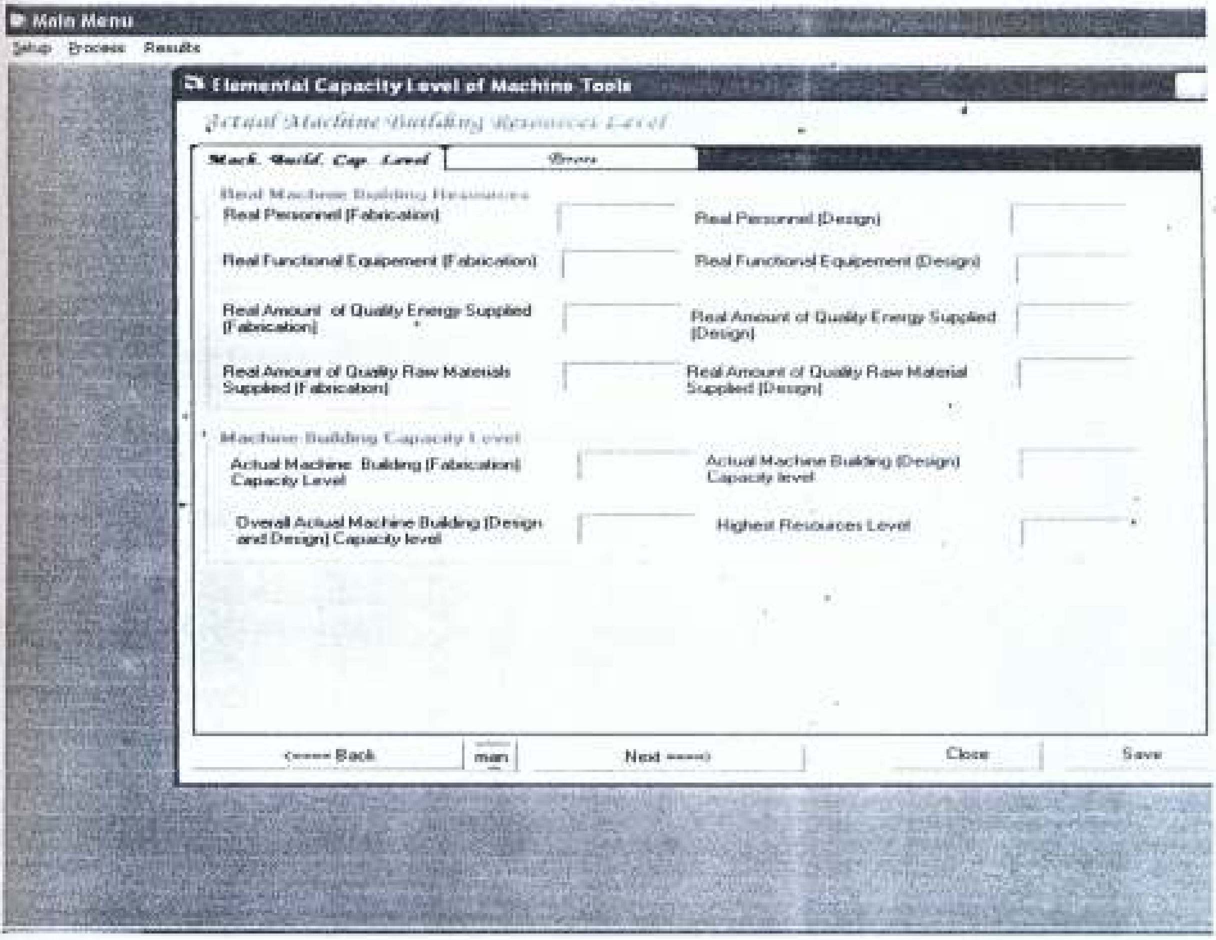


Fig. 5.15: Output for Total Required Resources and Machine Building capacity

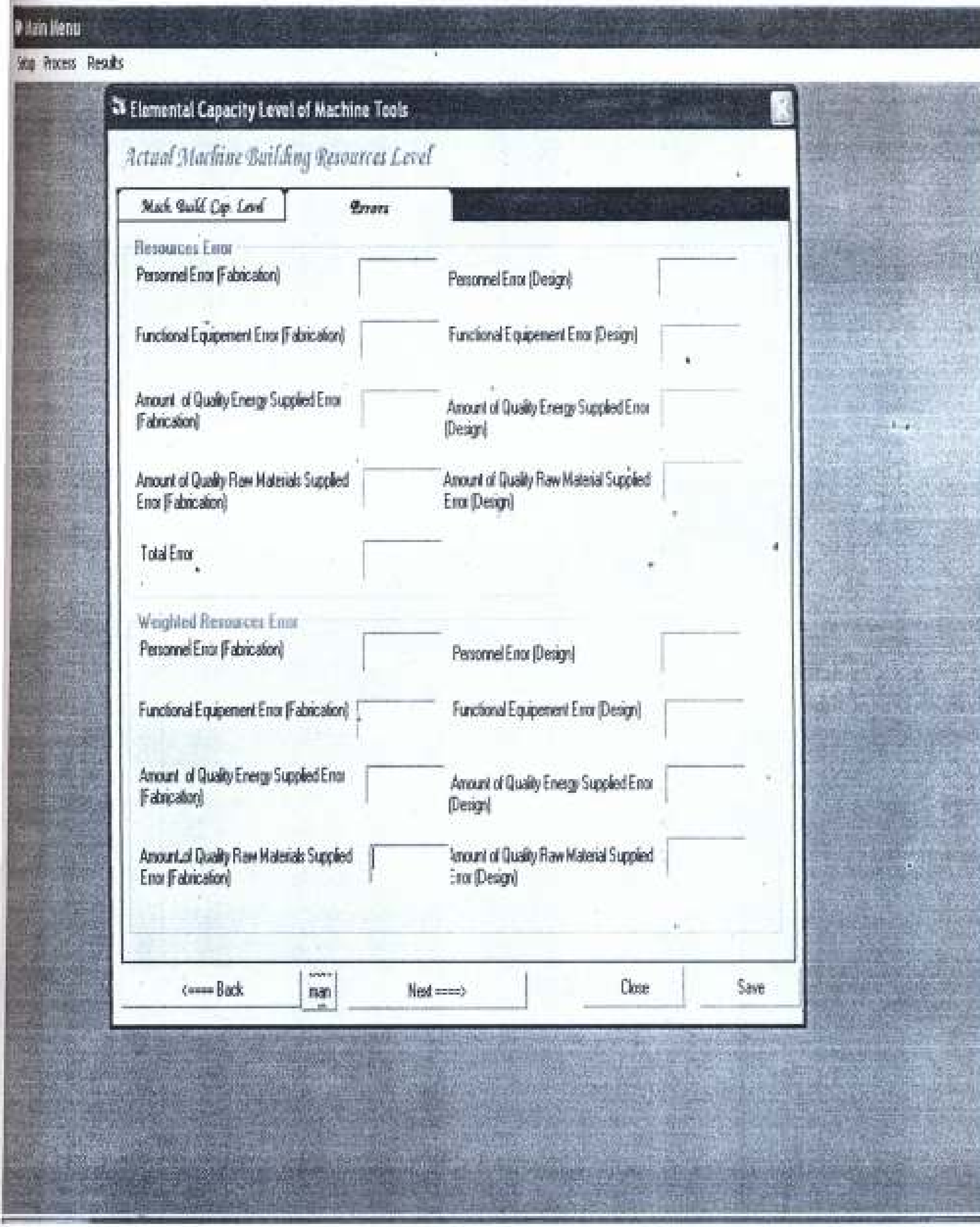


Fig. 5.16: Output for System Errors

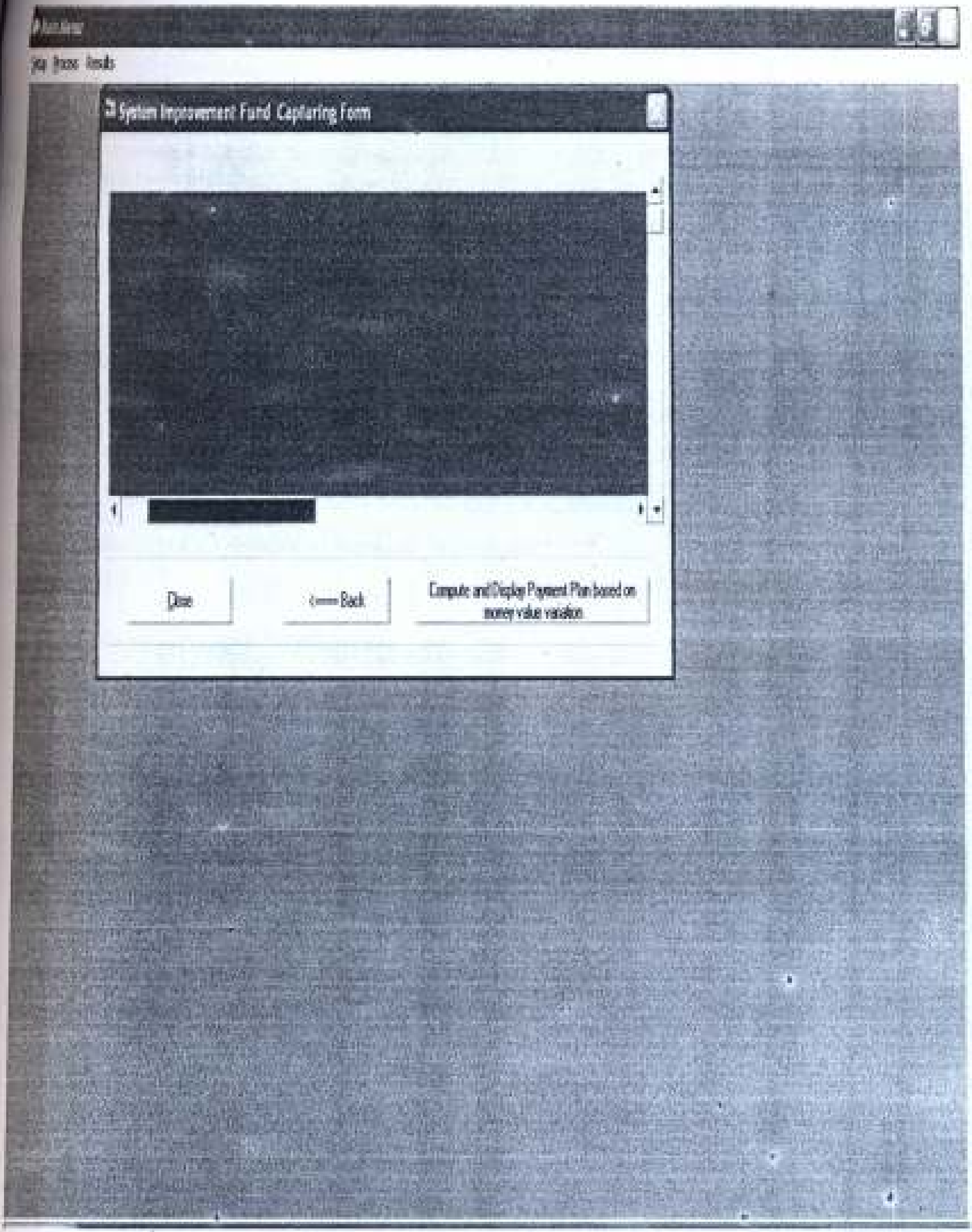


Fig. 5.17: Output for Fund Allocation.

5.3.5 Report Menu

This interface reports the results each and every module of operation currently in use. The developed software is flexible and can effectively validate users input. In the report menu there are;

(i) machine tools resources capacity development;

(ii) machine tools design and fabrication capacity improvement;

(iii) machine tools building capacity development;

(iv) impact of each resource on machine tools capacity development;

(v) resources error reduction;

(iv) impact of each resource on machine tools capacity development;

(v) resources error reduction;

(vi) allocated fund for resources development;

(vii) machine tools building capacity error reduction;

(viii) machine tools fabrication and design error reduction; and

(ix) machine tools resources error reduction.

5.4 Computer Requirements

The computer hardware requirements for the development of Computer Aided Machine Tools Capacity Development (CAMTCAD-2008) are personal computer with at least Dual -Core. It can also be run on computer system of higher grade like Core 2 duo, 2.0GHZ, 400GB hardisk,3GB Ram.

5.5 Areas of General Application

The model is flexible and versatile. It may be applied to other sections of capital goods sector include: manufacture of mechanical machineries and equipment, Manufacture of electrical machinery, apparatus, and appliance, manufacture of transport equipment, manufacture of professional and scientific (measuring and controlling) equipment.

(iv) impact of each resource on machine tools capacity development;

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CHAPTER SIX

MODEL VALIDATION

6.1 Model Validation

The model was validated with data from Oshogbo Machine Tools in Oshogbo, Osun State, Nigeria. The developed software accommodates the data based on the expected facilities in the machine tools industry and the actual facilities. The responses after analysis served as input data for the model which was entered into the data entry interface to determine the benchmark or level of machine tools development as at a particular time and also assist to know the level of acceptability of developed Software named Computer Aided Machine Tools Capacity Development (CAMTCAD-2008) in achieving the aim of upgrading the machine tool within a specified period of time. In validating the model, the model was tested with 5 to 10 years of period of execution of the project starting from 2008. Benefit cost analysis and analysis of variance were used to analyze the results from the model. Regression analysis was also used to determine the strength of the model over the years of system development.

6.2 Nature of Problems of Nigerian Machine Tools Oshogbo

Based on the information gathered, it was discovered that the current production of machine tools remains at a rudimentary level of development. This level of development consists relatively of large-scale assembly type of import-substitution ventures, which incorporate insignificant levels of local content in production. This is as a result of the following problems:

(i) Neglected traditional technologies;

(ii) Over dependence on imported technology;

(iii) No formulated technology strategy;

(iv) Inadequate relationship between Institution, Industrial sector and Government; and

(v)Misappropriation of fund.

6.2.1 Effect of Inability to Develop Machine Tools Building in Nigeria

Based on the irregular development of the resource, the system cannot work and it has to be privatized to indigenous company called Bowell Nigeria Limited. Inability to develop Nigerian machine tools has resulted to Nigerian dependence on imports of machine tools. This problem has meant a rising import bill and vulnerability to international disturbances especially in industrial market economics, which are Nigeria's trading partners. This Massive importation of foreign technology through importation of machine tools has acute negative consequences on the country and these include:

(i) Foreign dependence;

(ii) Drainage of foreign exchange;

(iii) Dumping ground of obsolete machine;

(iv) Low productivity of machine; and

(v) Inhibition of growth of indigenous innovative capabilities.

6.2.2 Proffered Solution to Machine Tools Building in Nigeria

Ariyo (2004) made it known that, an important dimension of self-reliance is technological self-reliance most especially in the area of building machine tools for production and repair of other machinery used for production of goods and services to meet the needs of the citizen. The ideal of developing appropriate technology capacity for machine tools building taking into consideration the needs, resources, environmental factor and lifestyles of the people therefore becomes very important (Laditan, 2000). This technology involves upgrading indigenous technologies and adapting imported ones to meet up with technological capacity or capability of building machine tools for effective use (Gottinger, 1989). Therefore, for an effective machine tools building technological capacity, it is important that a meaningful, concrete and result –oriented strategies has to be devised out to generate and sustain the technological take-off of machine tool building of the nation. The resulting model developed and software is intended to control all the mechanisms for influencing elements and the resources of Nigerian machine tools Oshogbo.

The software package determined the technological capacity level of machine tools as at now based on the existing resources and further determined the future technological capacity development of Nigeria machine tools. This model considers benchmark estimation, development and integration of machine tools technological capacity resources. In other to actualize the above mentioned objectives, data were collected on all the resources that are responsible for the building of machine tools capacity.

6.3 Data Collection

Questionnaires were administered to the Machine Tools Industry Oshogbo to get relevant information required for the model implementation. Besides, interview through phone calls and direct contact with the management of the organizations was conducted for further classification on their Questionnaire responses. The responses after analysis served as input data for the model. The resulting data were used to develop the data bank for the validation of the model. The data collected are shown in Tables 6.1 -6.9.

6.3.1 Manpower Development Table

Table 6.1 shows the number of required worker and actual worker available in machine tools Oshogbo between the year 1980 and 1985. Table 6.5 shows the manpower development trend between 1980 and 2007.

6.3.2 Equipment Development Table

Table 6.3 shows the available tools and equipment between the year 1980 and 1985 and standard tools and equipment that required to be in machine tools Oshogbo. Table 6.8 also shows the available functional and non functional equipment and the trend of development of equipment between 1980 and 2007

6.3.3 Raw materials Development Table

Table 6.2 shows the available raw materials between the year 1980 and 1985 and raw materials that necessary to be in machine tools Oshogbo. Table 6.6 also shows the available raw materials and the trend of raw material between 1980 and 2007.

6.3.4 Energy Development Table

This entail Table 6.4 that shows available energy between the year 1980 and 1985 and energy that necessary to be in machine tools Oshogbo. Table 6.7 also shows the available quality energy and the trend of development of energy between 1980 and 2007

6.3.5 Trend of Financing

The share capital of N20 million was allocated for the development of machine tool within the period of five years, between 1980 to 1985 with 40% allocated as the starting capital while the remaining 60% was evenly distributed over the years. Federal government of Nigeria owns 85% of the capital while the remaining 15% was owned by Hindustan Machine Tools International Limited of India. The money was allotted within the resource in this ratio 5:6:5:4 for manpower, Raw Material, equipment and energy, respectively as shown in Table 6.9 (NMT, 1994)

Table 6.1: Manpower Development Trend from 1980 to 1985

Year	Planned Required workers	1980		1981		1982		1983		1984		1985	
Manpower		No of available workers	skilled workers	No of available workers	skilled workers	No of available workers	skilled workers	No of available workers	skilled workers	No of available workers	skilled workers	No of available workers	skilled workers
Machine Designer	**500**	**350**	**140**	**371**	**171**	**392**	**202**	**413**	**233**	**434**	**264**	**454**	**295**
Engineers	150	106	42	112	52	118	62	124	72	132		138	
Technologist	100	68	27	73	33	76	40	82	45	84	53	88	57
Draught men	80	57	23	60	28	65	33	65	38	68	43	74	48
Administrative	170	119	48	126	56	133	67	142	78	148	90	154	100
Machine fabricator	**1050**	**735**	**294**	**779**	**359**	**823**	**424**	**867**	**487**	**911**	**554**	**955**	**620**
- welder	200	140	53	149	66	158	79	167	95	175	105	184	120

-foundry men	250	175	71	186	86	197	101	208	116	219	132	228	148
- fitting men	200	144	59	151	70	159	83	165	95	172	107	180	117
- Smith men	200	136	56	145	68	154	82	164	92	172	104	182	118
- carpenter	100	70	27	74	33	78	39	182	45	26	53	90	59
Other craftsmen	100	70	28	74	34	77	40	40	81	46	87	52	91

Table 6.2: Raw material Availability Between 1980 and 1985

Fabrication Raw Material	Required Raw material (Tonnes/Annual	1980	1981	1982	1983	1984	1985
Iron ore	2,235	782	714	646	578	510	440
Lime stone	635,050	196,865	182,626	168,187	153848	139509	125168
Dolomite	265,200	82,212	76,224	70236	64258	58260	52,271
Coal	1.6	0.50	0.46	0.43	0.39	0.36	0.32
Refractory clay	63,300	19,623	18194	16765	15336	13907	12,476
Natural gas	-						
Ferro – alloy							
Ferrol-silicon	13,400	4,154	3851	3548	3245	2942	2,641
Ferro – manganese	95, 400	2914	2702	2490	2278	2066	1853
Manganese	85,500	26,505	24574	22643	20712	18781	16852
Bauxites	13,600	4,216	3909	3602	3295	2988	2681
Aluminum	670	208	174	140	106	72	38
TOTAL	1174356.6	337479.5	312968.46	288257.43	263659.39	239035.36	214420.32
DesignRaw material	2,500	795	733	671	609	547	483

Table 6.3: Equipment Availability between 1980 and 1985

Section	Required(A)	Trend of Equipment Capacity Development											
		1980 (B)	B/A%	1981(C)	C/A%	1982(D)	D/A%	1983(E)	E/A%	1984(F)	F/A%	1985(G)	G/A%
Fabrication	351	91	26	118	34	119	34	159	45	194	55	213	61
Foundry	68	17		22		27		32		37		41	
Training centre	42	11		14		17		20		23		25	
Heat treatment	13	4		5		6		6		7		8	
Tool Reconditioning	11	3		4		4		4		5		7	
Metal fabrication shop	14	4		6		6		7		7		9	
Heavy parts some shop	14	4		6		7		7		8		10	
Small part work shop	79	20		26		30		35		41		47	
Electrical	50	13		17		22		25		29		30	
Others	60	15		18		20		23		30		36	
Design	200	80	40	38	44	95	48	100	50	112	56	120	60

Table 6.4: Energy Availability Between 1980 and 1985

Section	Required Energy(GWh)	Years and Percentage Availability											
		1980(B)	B/A%	1981(C)	C/A%	1982(D)	D/A%	1983(E)	E/A	1984 F	F/A%	1985(E)	E/A%
Energy for fabrication	310	206	66	194	63	185	60	178	57	168	54	155	50
Energy for Design	6	2.6	43	2.4	40	2.31	39	2.21	37	2.15	36	2.10	35

Table 6.5: Manpower Projection from 1980 to 2007

Manpower	Total number of worker requires		1980								1985								1990							1995		2000		2007	
			E	X	T	Et	Ex	Xt	Ext		E	X	T	Et	Ex	Xt	Ext		E	X	T	Et	Ex	Xt	Ext		Ext				Ext
Machine Designer	500	350	110	8	35	4	22	4 -	140	454	93	5	15	32	14	-	295	245	13	1	2	6	3	-	220	196	196	206	206	120	120
Engineers	150	106	-	4	-	21	10	-	42	138	25	-		15	8	-	90	74	4	-	-	2	1	-	67	60	60	63	63	38	38
Technologist	100	68	-	-	-	13	6	-	27	88	23	-	6	6	2	-	57	8	2	-	-	2	1	-	43	38	38	40	40	24	24
Draught men	80	57	-	4	4	3	5	-	23	74	13	-	3	3	2	-	48	40	2	-	1	-	1	-	36	32	32	34	34	20	20
Admissive staff	170	119	8	8	10	13	1	-	48	154	32	5	8	8	2	-	100	83	5	1	1	2	-	-	74	66	66	69	69	41	41
Machine Fabricator	1050	735	61	07	279	53	17	24	294	955	45	5	180	36	10	59	620	516	1	-	9	34	-	7	465	415	415	336	336	262	262
Welder	-200	140	15	0	50	10	5	7	53	184	12	-	30	7	2	13	120	98	-	-	2	6	-	2	88	76	76	82	82	41	41
- foundry men	-250	175	19	2	70	09	2	2	71	228	10	2	52	4	1	1	148	123	1	-	1	8	-	2	111	99	99	105	105	63	63
fitternist	-200	144	10	3	62	6	3	1	59	180	10	2	33	5	2	1	117	98	-	-	3	4	-	1	90	78	78	84	84	47	47
-smooth men	-200	136	09	2	52	11	4	2	56	182	6	1	34	12	1	10	118	98	-	-	2	9	-	1	86	80	80	80	80	51	51
-carpenter	-100	70	06		20	9	1	6	28	91	5	-	15	4	2	6	59	49	-	-	1	3	-	1	44	40	40	41	41	23	25
-machinist other craft men	-100	70	02	-	25	8	2	6	27	90	90		16	4	2	8	58	50	-	-	-	4	-	-	46	41		44	44	27	27
Total number of workers available	1550	1085	171	15	30	102	39	24	434	140	10	195	68	24	59	915	761	14	1	11	40	3	7	685		611	611	642	642		

Table 6.5: Manpower Projection from 1980 to 2007

Manpower	Total number of worker requires		1980								1985								1990							1995		2000		2007	
			E	X	T	Et	Ex	Xt	Ext		E	X	T	Et	Ex	Xt	Ext	-	E	X	T	Et	Ex	Xt	Ext		Ext				Ext
Machine Designer	500	350	110	8	35	4	22	4	140	454	93	5	15	32	14	-	295	245	13	1	2	6	3	-	220	196	196	206	206	120	120
Engineers	150	106	-	4	-	21	10	-	42	138	25	-		15	8	-	90	74	4	-	-	2	1	-	67	60	60	63	63	38	38
Technologist	100	68	-	-	-	13	6	-	27	88	23	-	6	6	2	-	57	8	2	-	-	2	1	-	43	38	38	40	40	24	24
Draught men	80	57	-	4	4	3	5	-	23	74	13	-	3	3	2	-	48	40	2	-	1	-	1	-	36	32	32	34	34	20	20
Admissive staff	170	119	8	8	10	13	1	-	48	154	32	5	8	8	2	-	100	83	5	1	1	2	-	-	74	66	66	69	69	41	41
Machine Fabricator	1050	735	61	07	279	53	17	24	294	955	45	5	180	36	10	59	620	516	1	-	9	34	-	7	465	415	415	336	336	262	262
Welder	-200	140	15	0	50	10	5	7	53	184	12	-	30	7	2	13	120	98	-	-	2	6	-	2	88	76	76	82	82	41	41
- foundry men	-250	175	19	2	70	09	2	2	71	228	10	2	52	4	1	1	148	123	1	-	1	8	-	2	111	99	99	105	105	63	63
fitternist	-200	144	10	3	62	6	3	1	59	180	10	2	33	5	2	1	117	98	-	-	3	4	-	1	90	78	78	84	84	47	47
-smooth men	-200	136	09	2	52	11	4	2	56	182	6	1	34	12	1	10	118	98	-	-	2	9	-	1	86	80	80	80	80	51	51
-carpenter	-100	70	06		20	9	1	6	28	91	5	-	15	4	2	6	59	49	-	-	1	3	-	1	44	40	40	41	41	25	25
-machinist other craft men	-100	70	02	- -	25	8	2	6	27	90	90	-	16	4	2	8	58	50	-	-	-	4	-	-	46	41		44	44	27	27
Total number of workers available	1550	1085	171	15	30	102	39	24	434	140	10	195	68	24	59	915	761	14	1	11	40	3	7	683		611	611	642	642		

Table 6.6: Raw Material Projection from 1980 to 2007

Raw Material	Raw Material Tones/, Annual	1980	1985	1990	1995	2000	2007
Fabrication Raw Material	117,4356.6	337,479.5	214,420.32	168,089.22	102,878.28	117,472.34	34,193.34
Iron ore	2,235	78225	440.52	343.97	208.08	247.64	125.16
Limestone	635,050	196,865.5	125168	97734	59123	70363	3356
Dolomite	265,200	82212	52,271	40814	24690	25247	14851
Coal	1.6	0.50	0.32	0.25	0.2	0.26	0.18
Refractory clay	63,300	19,623	12476	9742	5893	7014	3545
Natural gas	-	4154	2641	2062	1248	1485	250
Ferro-alloy							
Ferro-manganese	9,400	2,914	1853	1447	875	1042	4788
Manganese	85,500	26,505	16,852	13,152	7960	9473	4788
Bauxites	13,600	4,216	2681	2756	2845	2567	2456
Alumina	670	208	38	38	36	34	34
Design raw material	2,500	795	483	448	233	250	200

Table 6.7: Energy Projection from 1980 to 2007

Section	Required Energy(GWh) A	1980 B	B/A%	1985 C	C/A%	1990 D	D/A%	1995 E	E./A%	2000 F	F/A%	2007 G	G/A%
Energy for Fabrication	310	206	66	155	50	137	44	140	45	204	66	101	33
Energy for Design	6	2.6	43	2.1	35	1.8	30	1.9	32	2.4	40	1.2	20

Table 6.8: Equipment Projection from 1980 to 2007

	Number equipment Required	1980			1985			1990			1995			2000			2007		
Section		No of available	NF	F		NF	F		NF	F		FN	F		NF	F		NF	F
Foundry	68	17	-	17	43	2	41	41	6	35	41	10	31	50	-	40	50	2	48
Training centre	42	11	-	11	25	-	25	25	4	21	25	7	18	33	-	33	39	-	23
Heat treatment shop	13	4	-	4	08	-	08	08	2	06	08	4	04	10	-	10	12	-	5
Tool reconditioning	11	3	-	3	07	-	07	07	3	04	07	2	05	08	-	08	11	-	5
Metal Fabrication shop	14	4	-	4	10	1	09	09	05	04	09	3	06	12	-	12	11	1	10
Heavy part shop	14	4	-	4	12	2	10	10	04	06	10	3	07	11	-	11	19	2	9
Small parts work	79	20	-	20	51	4	47	47	06	41	47	8	39	61	-	61	61	3	50
Electrical	50	13	-	13	60	-	30	30	03	27	30	7	23	40	-	40	40	1	39
Others	60	15	-	15	36	-	36	36	04	32	36	10	36	26	-	44	44	3	41
Total	**351**	**91**	-	**91**	**222**	**9**	**208**	**206**	**36**	**170**	**213**	**54**	**169**	**274**		**274**	**287**	**12**	**275**
DESIGN	**200**	**80**	-	**80**	**120**	**10**	**110**	**120**	**14**	**106**	**120**	**14**	**106**	**150**	-	**150**	**150**	**3**	**147**

Table 6.9: Trend of Financing for Development from 1980 to 1985

Resources	Ration of allocation	Year					
		1980	1981	1982	1983	1984	1985
		Allocated Money (20 Million)					
		8	2.4	2.4	2.4	2.4	2.4
		Percentage Allocation					
		40%	12%	12%	12%	12%	12%
Manpower (Design)	5	1	0.3	0.3	0.3	0.3	0.3
Manpower (fabrication)	5	1	0.3	0.3	0.3	0.3	0.3
Raw material (Design)	6	1.2	0.36	0.36	0.36	0.36	0.36
Raw material (fabrication)	6	1.2	0.36	0.36	0.36	0.36	0.36
Equipment (Design)	5	1	0.3	0.3	0.3	0.3	0.3
Equipment (fabrication)	5	1	0.3	0.3	0.3	0.3	0.3
Energy (Design)	4	0.8	0.24	0.24	0.24	0.24	0.24
Energy(fabrication)	4	0.8	0.24	0.24	0.24	0.24	0.24

Source: NMT,1994

6.4 Model Application

The data collected was entered into the software data entry interface to determine the benchmark or level of development of resources responsible for machine tools capacity development as at a particular time. Finally the machine tools capacity benchmark was determined from input data which is the first stage of the development. The result obtained from the first stage was worked upon to upgrade the system to the accepted standard.

6.4.1 Manpower Benchmark Determination

The data in Table 6.1 and 6.5 were input in to software data entry interface for manpower capacity determination in Fig. 5.2 to determine level of manpower development in Machine Tools Oshogbo for each year from inception of the project. The interface in Fig. 5.7 helped in determining the level of development of manpower elemental capacity which include: people with requisite education; people with requisite experience; people with requisite training; people with requisite education and training; people with requisite training and experience; people with requisite education and experience; and people with requisite education; training and experience for machine tools design and fabrication. Interface in Fig.5.11 finally determined the level of manpower for machine tools design and fabrication for each year, which is one of the major resources for machine tool capacity development.

6.4.2 Equipment Availability Benchmark Determination.

The data in Tables 6.3 and 6.8 were also used through software data entry interface for equipment capacity determination in Fig.5.3 to determine level of equipment availability development in Machine Tools Oshogbo for each year from inception of the project (1980) to 2007. The interface in Fig. 5.8 determined the level of development of equipment elemental capacity which include; functional and non - functional equipment for machine tools design and fabrication. Finally, the Interface in Fig 5.12 determined the level of equipment availability for machine tools design and fabrication for each year, which is another major resource for machine tool capacity development.

6.4.3 Energy availability Benchmark Determination

The data in Tables 6.4 and 6.7 were input in software data entry interface for energy availability capacity determination in Fig .5.5 to obtain level of energy availability development in Machine Tools Oshogbo for each year from inception of the project 1980 to 2007. The interface in Fig. 5.9 help in determining the level of development of energy elemental capacity which include: regular and irregular available energy for machine tools design and fabrication. Interface in Fig. 5.13 finally determined the level of energy availability for machine tools design and fabrication for each year, which is also one of the major resources for machine tool capacity development.

6.4.4 Raw material Availability Benchmark Determination.

The data in Tables 6.2 and 6.6 were also used through software data entry interface for raw material capacity determination in Fig. 5.4 to determine level of raw materials availability development in Machine Tools Oshogbo for each year from inception of the project 1980 to 2007. The interface in Fig. 5.10 determined the level of development of raw material elemental capacity which include: defective and non - defective raw material for machine tools design and fabrication. Interface in Fig5.14 finally determined the level of raw materials availability for machine tools design and fabrication for each year, which is another major resource for machine tool capacity development.

6.4.5 Machine tools design and fabrication capacity benchmark estimation

The interface in Fig 5.15 determined the actual machine tools fabrication and design capacity from the result from the interface in Figs. 5.11, 5.12. 5.13 and 5.14. Moreover, the overall actual machine tools capacity was eventually determined in this interface.

6.4.6 Machine Tools Design and Fabrication Resources Error Determination

The interface in Fig. 5.16 determined the error in each resource and consequently, the error in the system as a whole.

6.4.7 Resources and System Upgrading

This is the second stage of the operation in which the machine tools technological capacity level determined in the first stage is upgraded. The parameters of the resources of machine tools are adjusted during the operation of the system as appropriate fund are made available to the system. This consequently increased the machine tool capacity level until it reached a set standard according to initial implementation plan for machine tools development in Nigeria.

The interface in Fig. 5.14, determine the amount of money to be made available to each resource, for development to required stage which is a factor of level of development of each resource, time of project completion and amount required for a unit development of each resource.

The time the project is starting is input in this interface which helps in calculating the present value of fund for the development of the system. The completion time determined the number of stages of development. The number of stages of development helped in appropriate calculation of fund to be allocated for each resources development and the system in general which varies with number of stages. Interface in Fig. 5.7 calculate exact money required for the development of machine tools with year and simultaneously distributes the money to each resource responsible for machine tools capacity development. The amount made available is a factor of number of year to complete the development and the value of money and varies with time. Distribution of the money to each resource is also a factor of the initial level of development of each resources and the amount required for unit development of each resources.

The result obtained when the model was validated using the data obtained from Nigerian machine Tools Oshogbo in the second stage include; machine tools resources capacity development, machine tools design and fabrication capacity improvement, machine tools building capacity development, impact of each resource on machine tools capacity development, resources error reduction, allocated fund for resources development, machine tools building capacity error reduction, machine tools fabrication and design error reduction, and machine tools resources error reduction.

CHAPTER SEVEN

RESULTS AND DISCUSSION

The results obtained when the model was tested/ validated using the data obtained from Nigerian Machine Tools Oshogbo are presented here. The results are discussed based on each machine tools resource.

7.1 Benchmark Estimation for Resources

Based on the allocated money to the resources, the machine tools capacity development is expected to follow the same trend. It is shown clearly from Figs 7.1 and 7.2 that the level of development of all the recources did not match up with the ideal plan for each of resources between 1980 and 1985 and further 23 years.

For manpower development, it was observed that manpower increases from 28% as at 1980 to maximum of 59% as at 1985, instead of 100% expected for smooth running of machine tools. The situation get worsened after 1985 as it can be seen in Fig.7.2 that there was a drastic fall in which the level of development in 2007 reduces to 24%.

The raw materials for machine tools fabrication and design have developed to 28% and 32% respectively as at 1980. Further years from 1980 witnessed a reduction in availability of raw materials for fabrication and design of machine tools of 19% and 18% respectively.These were reduced to 0.8% and 0.3% respectively as at 2007.

Moreover, equipment development did not reach the pick of development as planned for 1985, instead it starts with 40% and 26% development for machine tool design and fabrication and ends with 60% and 61%, respectively.

The energy availability to the system for design and fabrication reduced from 43% and 66% as at 1980 to 35% and 50%, respectively as at 1985. The condition gets worsened as at 2007 when energy availability reduced to 20% and 33%, respectively.

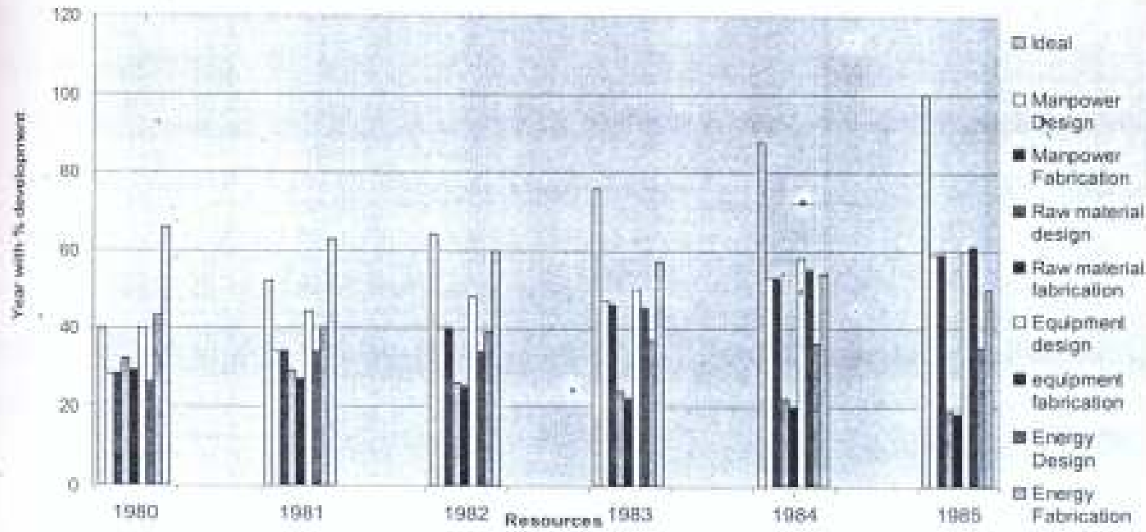

Fig. 7.1: Comparison of Actual and Projected Resources Between 1980 and 1985

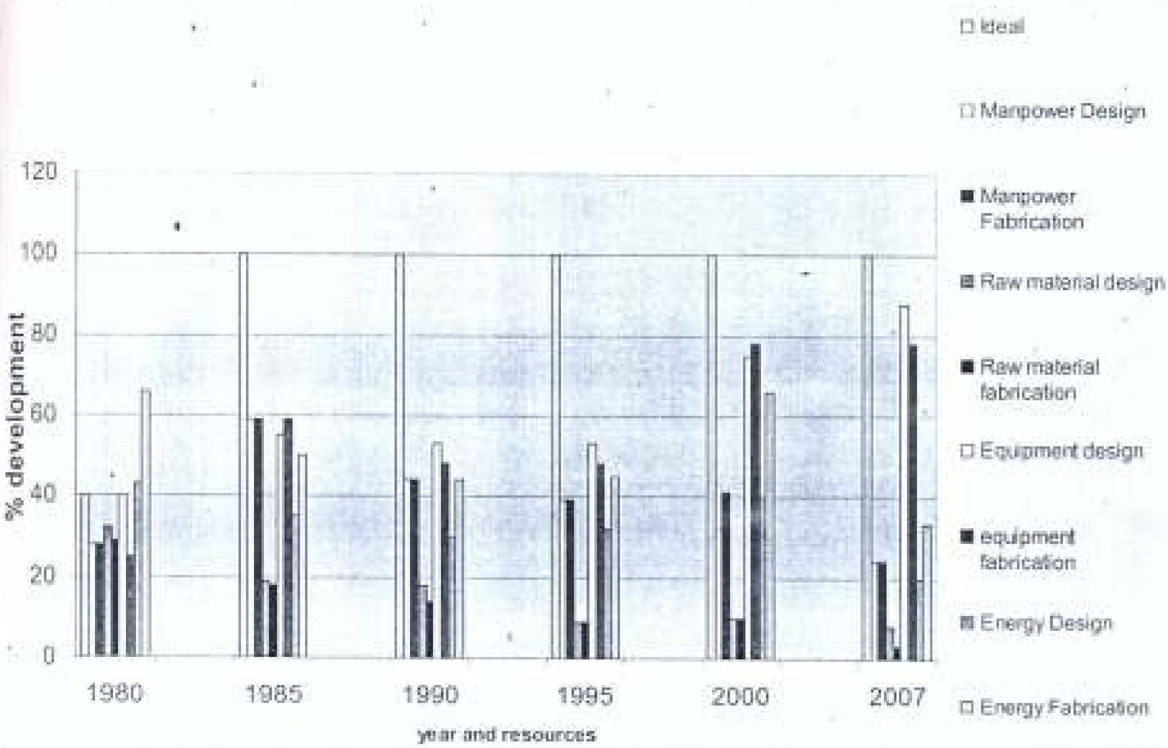

Fig.7.2: Comparison of Actual and Projected Resources Between 1980 and 2007

From Fig.7.2 it can be seen that the equipment for machine tools design has the highest development followed by equipment for machine tools fabrication. Energy availability for machine tools fabrication followed and manpower development later followed by 28% development. Energy for machine tools design was the next and the least developed resources are raw materials for machine tools design and fabrication with 0.8% and 0.3%.

These results of machine tools resources helped in determining the benchmark for the system capacity level as shown in Fig. 7.3 which is 36% developed against 40% developed as at 1980 and later increased to 53% as against 100%. As at 2007 as shown in Fig 7.3, there was drastic reduction in the development to about 37%. This level of development was used as benchmark and the yard stick for development of system to operative condition.

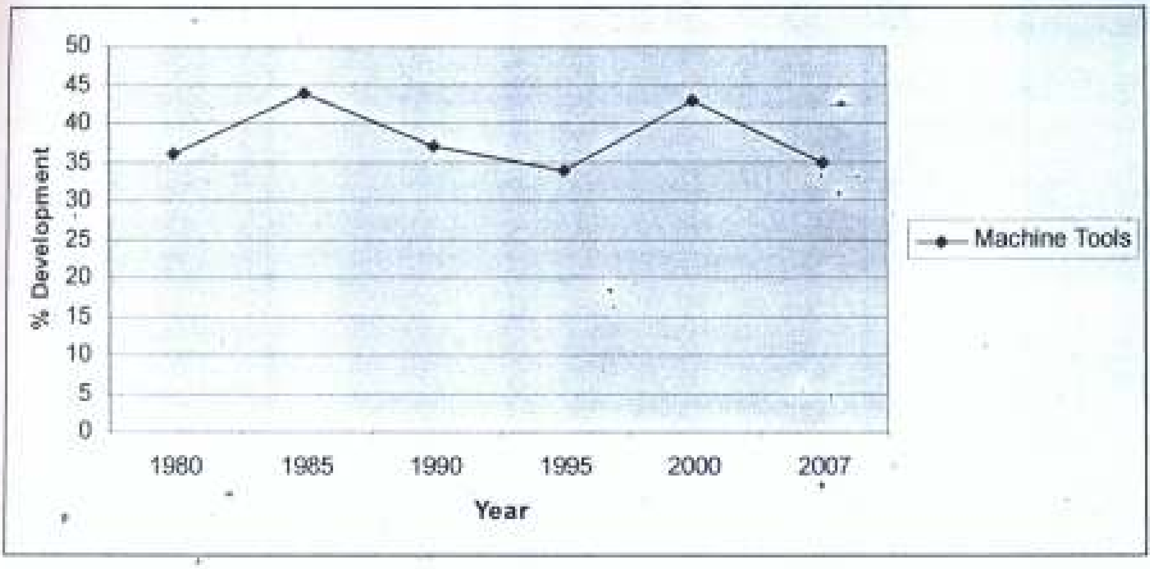

Fig. 7.3: Capacity Development Projection Between 1980 and 2007

7.2 System Error Estimation as at Year 2007

Based on the data available, this model was able to determine the resources and capacity levels for a specific year and in compared them to ideal system. The error in the system resources and capacity levels were determined for a specific year. Therefore, the model was able to determine the error in the system from 1980 to 2007 which was shown in Fig. 7.4. Error in each resource was determined with reference to ideal resource of respective year which is shown in Fig. 7.5 to 7.12. It was discovered in

1980 that a lot of money was spent on energy which adversely affected other resource's development.

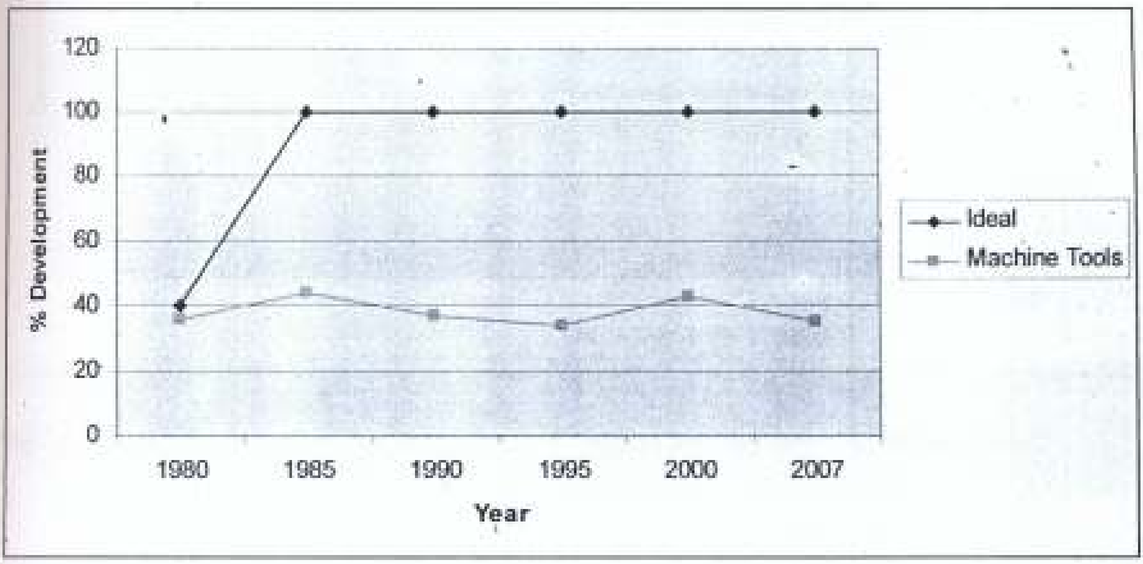

Fig.7.4: Error Estimation for Capacity Development between 1980 and 2007

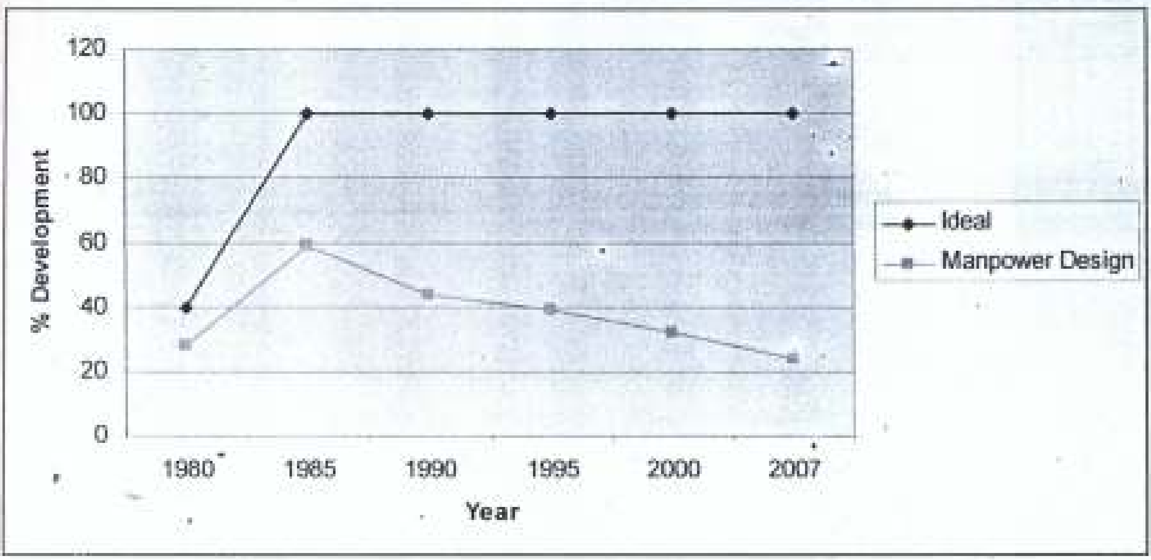

Fig 7.5: Error Estimation for Design Manpower Between 1980 and 2007

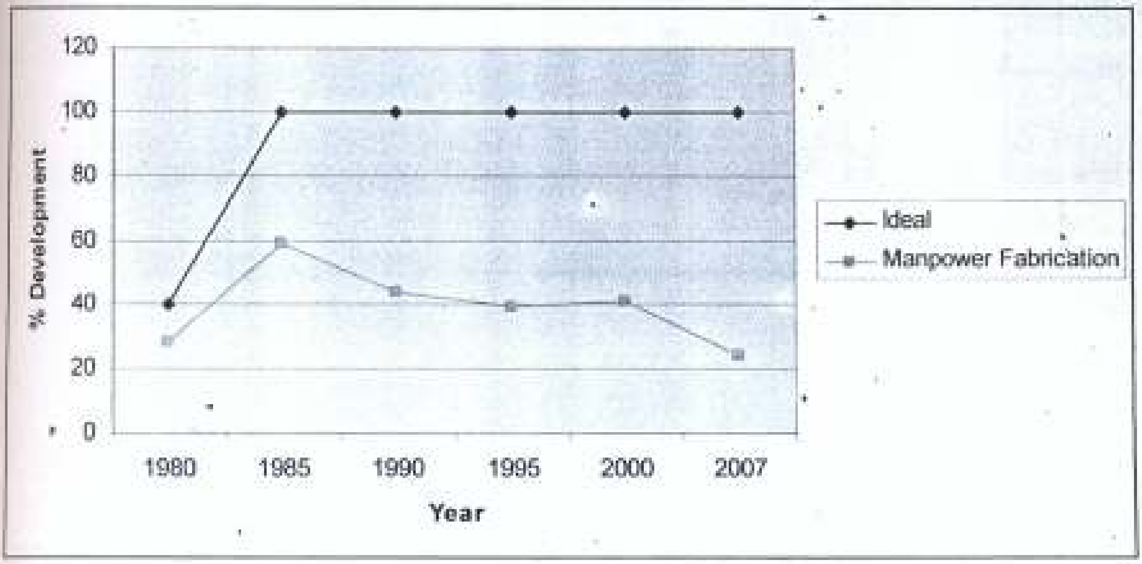

Fig.7.6: Error Estimation forManpower Fabrication Between 1980 and 2007

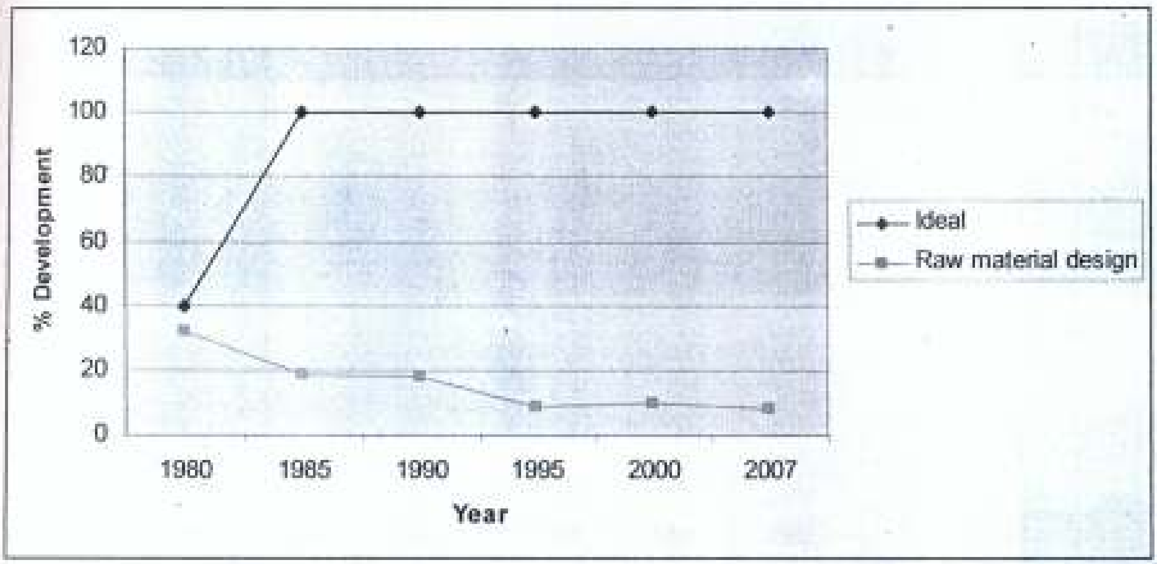

Fig 7.7: Error Estimation for Design Raw Materials Between 1980 and 2007

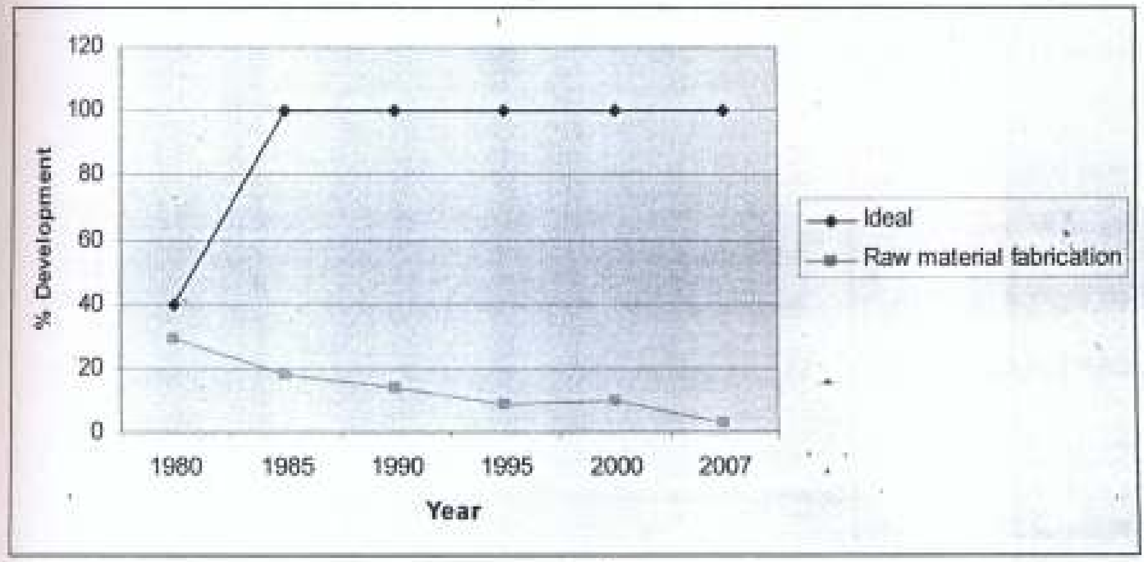

Fig.7.8 Error Estimation for Raw Material Fabrication Between 1980 and 2007

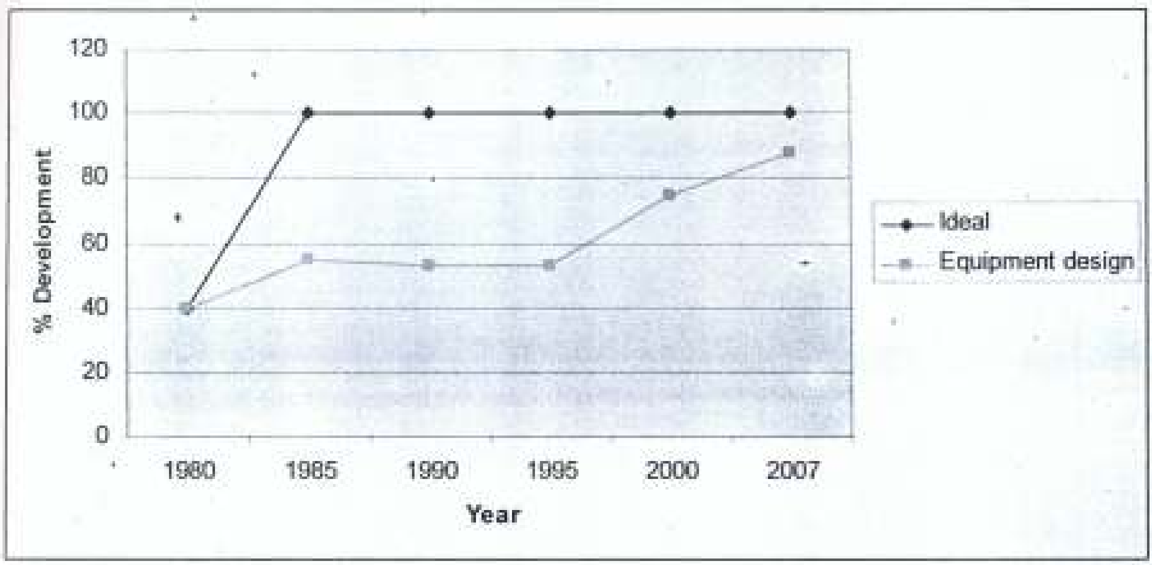

Fig.7.9: Error Estimation for Equpment Design Between 1980 and 2007

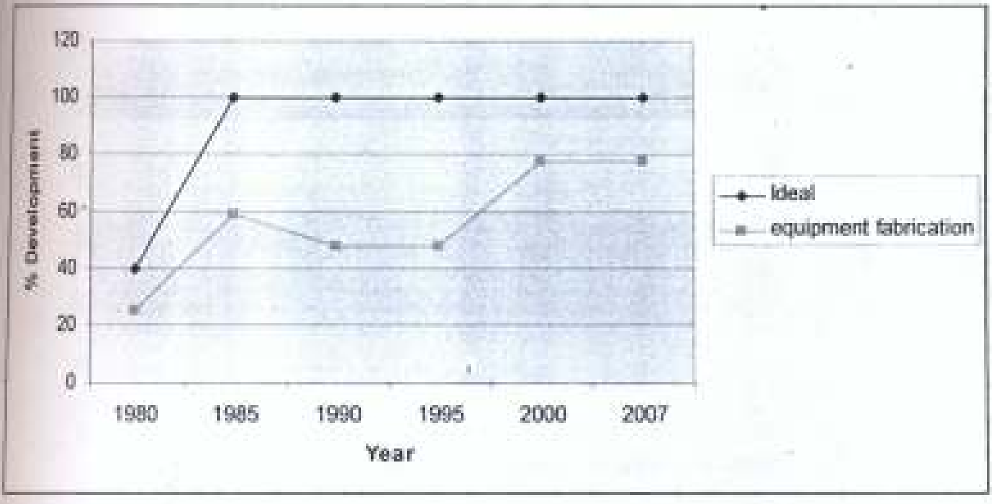

Fig.7.10: Error Estimation for Equipment Fabrication Between 1980 and 2007

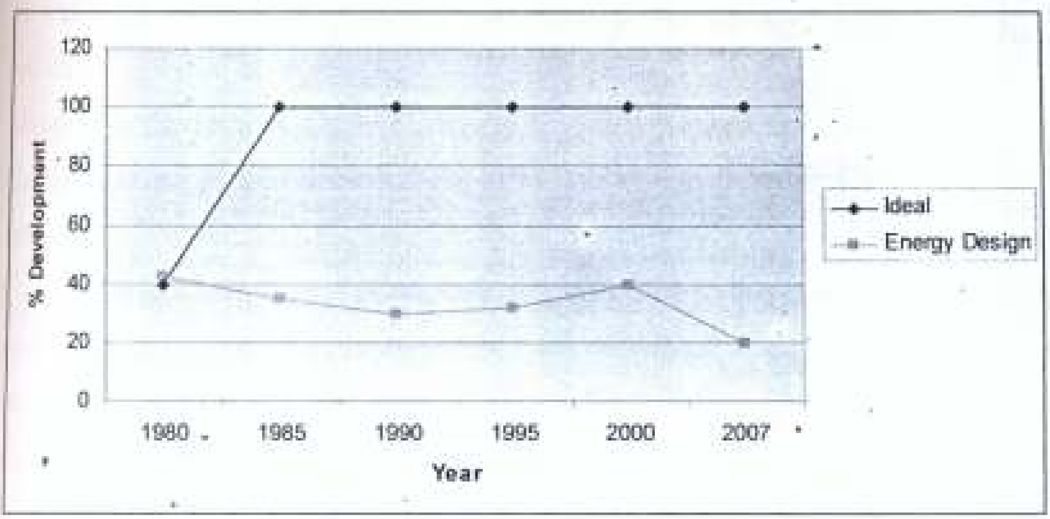

Fig.7.11: Error Estimation for Energy Design Between 1980 and 2007

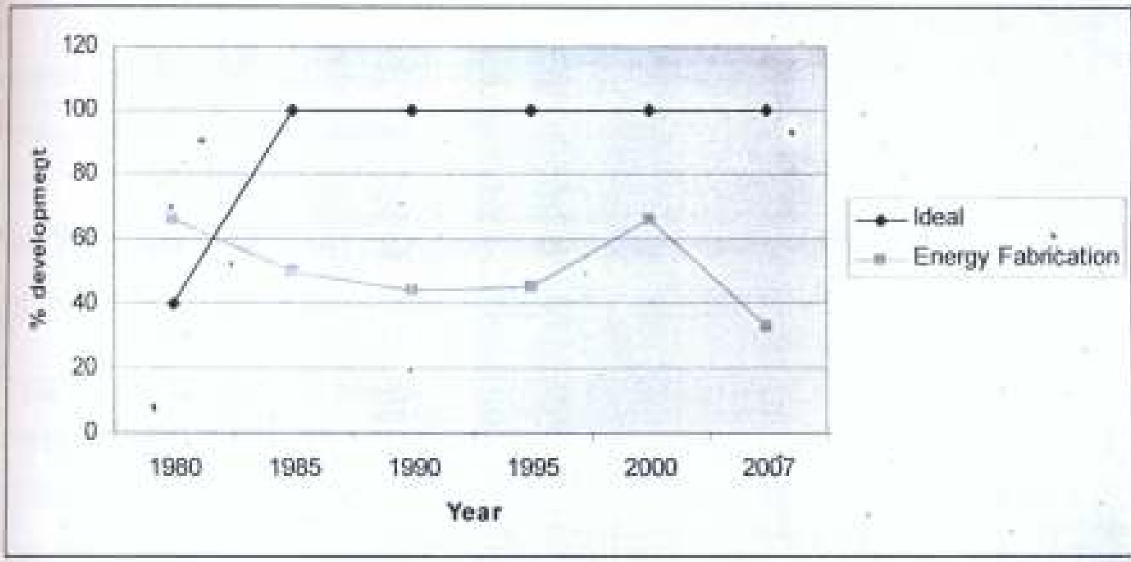

Fig.7.12: Error Estimation for Energy Fabrication Between 1980 and 2007

In 1985 and 1990 the error level of all resources was high until 2000 which witnessed reduction in error as a result of huge money spent on equipment procurement for design and fabrication. Other resources leftout witnessed extremely high error value. Based on this irregular development of resources, the system cannot work well and it has to be privatized to indigenous company called Bowell Nigeria Limited.

The model formulated to upgrade the system therefore, incorporated the level of error in each resource with real amount required for unit development of each resources to help in appropriate distribution of fund to each of resources to enable them developed uniformly for effective performance of the system.

7.3 Financial Implications of the Capacity Planning

The present capacity level helped in determining the amount of fund that is required for the development of the resources of the system. Having determined the present value of money at the inception required for the development of machine tools as at 1980 and the equivalent amount of money required for development of the system (if the system is to be developed now 2008) is obtainable using the model. The fund required to develop each resource was also obtainable by the model. The model determined the real fund required for the development of each resource and the system in general, put it into consideration that, there at least a level of development in each resource and in the system. Based on the level of development of each resources as at

2007, the required amount of money to develop each resources by one unit was estimated by the model and the result presented in Tables 7.1 to 7.6 for 5,6, 7, 8, 9 and 10 years of proposed development.

Table 7.1: Projected Money for Five Years Development (Millons)

[illegible]	IPFMoney	IPDMoney	IEQFMoney	IEQDMoney	IENFMoney	IENDMoney	IRFMoney	IRDMoney
2008	3790.8583	21315.8235	1986.7044	0	3064.763	8004.3092	20171.3917	17644.2817
2009	1776.8566	9991.1836	931.2109		1436.5201	3751.7914	9454.7639	8270.2532
2009	5469.9213	5469.9213	5469.9213	5469.9213	4375.937	4375.937	6563.9056	6563.9056
2010	10345.7211	10345.7211	10345.7211	10345.7211	8276.5769	8276.5769	12414.8653	12414.8653
2011	10769.9484	10769.9484	10769.9484	10769.9484	8615.9587	8615.9587	12923.9381	12923.9381
2012	6351.6718	6351.6718	6351.6718	6351.6718	5081.3375	5081.3375	7622.0062	7622.0062

IPF- fabrication manpower,IPD – Design manpower, IEQF – Fabrication Equipment, IEQD – Design Equipment, IENF – Fabrication Energy ,IEND – Design Energy,1RF - Fabrication Raw Materials,IRD – Design Raw Materials.

Table: 7.2: Projected Money for Six Years Development (Millons)

Year	IPFMoney	IPDMoney	IEQFMoney	IEQDMoney	IENFMoney	IENDMoney	IRFMoney	IRDMoney
2008	3159.0485	17763.1863	1655.587	0	2553.9692	6670.2577	16809.4931	14703.568
2009	2436.6882	13702.5113	1277.1188		1970.1303	5145.4328	12966.833	11342.323
2009	2162.7567	2162.7567	2162.7567	2162.7567	1730.2054	1730.2054	2595.3081	2595.308
2010	8621.4342	8621.4342	8621.4342	8621.4342	6897.1474	6897.1474	10345.7211	10345.721
2011	8974.957	8974.957	8974.957	8974.957	7179.9656	7179.9656	10769.9484	10769.948
2012	9328.4798	9328.4798	9328.4798	9328.4798	7462.7838	7462.7838	11194.1757	11194.175
2013	4655.9816	4655.9816	4655.9816	4655.9816	3724.7852	3724.7852	5587.1779	5587.177

7.5 Upgrading of Capacity

The cumulative effects of the resources development is the enhancement of machine tools design and fabrication capacity which are shown in Tables 7.13 to 7.18. Moreover the cumulative effects of machine tools design and fabrication capacity development is the achievement of machine tool building capacity (Fig. 7.13.)

Table 7.13:Design and Fabrication Development Projection for five years

Year	MBuildD	MBuildF
2007	0.2655	0.378178225
2008	0.448080047	0.482978326
2009	0.53	0.53
2009	0.613085309	0.613085309
2010	0.763787728	0.763787728
2011	0.914490148	0.914490148
2012	1	1

MBuildD – Machine building Design, MBuildF - Machine Fabrication

Table 7.14: Design and Fabrication Development Projection for Six years

Year	MBuildD	MBuildF
2007	0.2655	0.378178225
2008	0.417650039	0.465511643
2009	0.53	0.53
2009	0.562851169	0.562851169
2010	0.688436519	0.688436519
2011	'0.814021868	0.814021868
2012	0.939607218	0.939607218
2013	1	1

Table 7.3: Projected Money for Seven Years Development (Millons)

Years	IPFMoney	IPDMoney	IEQFMoney	IEQDMoney	IENFMoney	IENDMoney	IRFMoney	IRDMoney
2008	3159.0485	17763.1863	1655.587	0	2553.9692	6670.2577	16809.4934	14703.5681
2009	2436.8882	13702.5113	1277.1188		1970.1303	5145.4326	12966.833	11342.3237
2009	2162.7567	2162.7567	2162.7567	2162.7567	1730.2054	1730.2054	2595.3081	2595.3081
2010	8621.4342	8621.4342	8621.4342	8621.4342	6897.1474	6897.1474	10345.7211	10345.7211
2011	8974.957	8974.957	8974.957	8974.957	7179.9656	7179.9656	10769.9484	10769.9484
2012	9328.4798	9328.4798	9328.4798	9328.4798	7462.7838	7462.7838	11194.1757	11194.1757
2013	4655.9816	4655.9816	4655.9816	4655.9816	3724.7852	3724.7852	5587.1779	5587.1779

Table 7.4: Projected Money for Eight Years Development (Millons)

Years	IPFMoney	IPDMoney	IEQFMoney	IEQDMoney	IENFMoney	IENDMoney	IRFMoney	IRDMoney
2008	2369.2864	13322.3897	1241.6902	0	1915.4769	5002.6933	12607.1198	11027.676
2009	2475.1185	13917.479	1297.1545	0	2001.0381	5226.1554	13170.2592	11520.2642
2010	820.4519	4613.3634	429.9805		663.3037	1732.365	4365.6752	3818.7351
2010	4410.5913	4410.5913	4410.5913	4410.5913	3528.4731	3528.4731	5292.7096	5292.7096
2011	6731.2178	6731.2178	6731.2178	6731.2178	5384.9742	5384.9742	8077.4613	8077.4613
2012	6996.3598	6996.3598	6996.3598	6996.3598	5597.0879	5597.0879	8395.6318	8395.6318
2013	7261.5019	7261.5019	7261.5019	7261.5019	5809.2015	5809.2015	8713.8023	8713.8023
2014	7526.644	7526.644	7526.644	7526.644	6021.3152	6021.3152	9031.9728	9031.9728
2015	2398.7309	2398.7309	2398.7309	2398.7309	1918.9847	1918.9847	2878.4771	2878.4771

Table 7.5: Projected Money for Nine Years Development (Millons)

Years	IPFMoney	IPDMoney	IEQFMoney	IEQDMoney	IENFMoney	IENDMoney	IRFMoney	IRDMoney
2008	2106.0324	11842.1242	1103.7246	0	1702.6461	4446.8385	11206.3287	9802.3787
2009	2200.1054	12371.0924	1153.0262	0	1778.7005	4645.4714	11706.8971	10240.2349
2010	1393.9964	7838.3786	730.5625		1126.9925	2943.3912	7417.5415	6488.2579
2010	2255.2328	2255.2328	2255.2328	2255.2328	1804.1862	1804.1862	2706.2793	2706.2793
2011	5983.3047	5983.3047	5983.3047	5983.3047	4786.6437	4786.6437	7179.9656	7179.9656
2012	6218.9865	6218.9865	6218.9865	6218.9865	4975.1892	4975.1892	7462.7838	7462.7838
2013	6454.6683	6454.6683	6454.6683	6454.6683	5163.7347	5163.7347	7745.602	7745.602
2014	6690.3502	6690.3502	6690.3502	6690.3502	5352.2802	5352.2802	8028.4202	8028.4202
2015	6926.032	6926.032	6926.032	6926.032	5540.8256	5540.8256	8311.2384	8311.2384
2016	1585.1417	1585.1417	1585.1417	1585.1417	1268.1133	1268.1133	1902.17	1902.17

Table 7.6: Projected Money for Ten Years Development (Millons)

Year	IPFMoney	IPDMoney	IEQFMoney	IEQDMoney	IENFMoney	IENDMoney	IRFMoney	IRDMoney
2008	1895.4291	10657.9118	993.3522	0	1532.3815	4002.1546	10085.6959	8822.1408
2009	1980.0948	11133.9832	1037.7236	0	1600.8305	4180.9243	10536.2074	9216.2114
2010	1852.8321	10418.3908	971.028		1497.9435	3912.212	9859.0346	8623.8761
2010	530.9459	530.9459	530.9459	530.9459	424.7567	424.7567	637.1351	637.1351
2011	5384.9742	5384.9742	5384.9742	5384.9742	4307.9794	4307.9794	6461.969	6461.969
2012	5597.0879	5597.0879	5597.0879	5597.0879	4477.6703	4477.6703	6716.5054	6716.5054
2013	5809.2015	5809.2015	5809.2015	5809.2015	4647.3612	4647.3612	6971.0418	6971.0418
2014	6021.3152	6021.3152	6021.3152	6021.3152	4817.0521	4817.0521	7225.5782	7225.5782
2015	6233.4288	6233.4288	6233.4288	6233.4288	4986.7431	4986.7431	7480.1146	7480.1146
2016	6445.5425	6445.5425	6445.5425	6445.5425	5156.434	5156.434	7734.651	7734.651
2017	897.5669	897.5669	897.5669	897.5669	718.0535	718.0535	1077.0802	1077.0802

7.4 Upgrading of Resources

The development of each of resources based on the proposed year of development of the system are also shown in Tables 7.7 to 7.12.

Table 7.7: Resources Development Projection for Five Years

	RealMPD	RealFEF	RealFED	RealQEF	RealQED	RealQRD	RealQRF	Year
[illegible]	0.04	0.4843304	0.53	0.4419355	0.3	0.192	0.1435898	2007
[illegible]	0.378239028	0.515855382	0.53	0.502724992	0.458765258	0.425315901	0.410322474	2008
[illegible]	0.53	0.53	0.53	0.53	0.53	0.53	0.53	2009
[illegible]	0.613085309	0.613085309	0.613085309	0.613085309	0.61 3085309	0.613085309	0.613085309	2009
[illegible]	0.763787728	0.763787728	0.763787728	0.763787728	0.763787728	0.763787728	0.763787728	2010
[illegible]	0.914490148	0.914490148	0.914490148	0.914490148	0.914490148	0.914490148	0.914490148	2011
[illegible]	1	1	1	1	1	1	1	2012

Table 7.8: Resources Development Projection for Six Years

MPF	RealMPD	RealFEF	RealFED	RealQEF	RealQED	RealQRD	RealQRF	Year
1428572	0.04	0.4843304	0.53	0.4419355	0.3	0.192	0.1435898	2007
492984914	0.321865856	0.510601218	0.53	0.49259341	0.432304382	0.386429917	0.365867028	2008
0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	2009
562851169	0.562851169	0.562851169	0.562851169	0.562851169	0.562851168	0.562851169	0.562851169	2009
688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	2010
814021868	0.814021868	0.814021868	0.814021868	0.814021868	0.814021868	0.814021868	0.814021868	2011
939607218	0.939607218	0.939607218	0.939607218	0.939607218	0.939607218	0.939607218	0.939607218	2012
1	1	1	1	1	1	1	1	2013

Table 7.9: Resources Development Projection for Seven Years

MPF	RealMPD	RealFEF	RealFED	RealQEF	RealQED	RealQRD	RealQRF	Year
1428572	0.04	0.4843304	0.53	0.4419355	0.3	0.192	0.1435898	2007
492984914	0.321865856	0.510601218	0.53	0.49259341	0.432304382	0.386429917	0.365867028	2008
0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	2009
562851169	0.562851169	0.562851169	0.562851169	0.562851169	0.562851168	0.562851169	0.562851169	2009
688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	2010
814021868	0.814021868	0.814021868	0.814021868	0.814021868	0.814021868	0.814021868	0.814021868	2011
939607218	0.939607218	0.939607218	0.939607218	0.939607218	0.939607218	0.939607218	0.939607218	2012
1	1	1	1	1	1	1	1	2013

Table7.10: Resources Development Projection for Eight Years

eaMPF	RealMPD	RealFEF	RealFED	RealQEF	RealQED	RealQRD	RealQRF	Year
0.4428572	0.04	0.4843304	0.53	0.4419355	0.3	0.192	0.1435898	2007
0.480452986	0.251399392	0.504033514	0.53	0.479928932	0.399228286	0.337822438	0.310297721	2008
0.518048771	0.462798784	0.523736627	0.53	0.517922364	0.498456572	0.483644876	0.477005643	2009
0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	2010
0.594247506	0.594247506	0.594247506	0.594247506	0.594247506	0.594247506	0.594247506	0.594247506	2010
0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	2011
0.782625531	0.782625531	0.782625531	0.782625531	0.782625531	0.782625531	0.782625531	0.782625531	2012
0.876814543	0.876814543	0.876814543	0.876814543	0.876814543	0.876814543	0.876814543	0.876814543	2013
0.971003555	0.971003555	0.971003555	0.971003555	0.971003555	0.971003555	0.971003555	0.971003555	2014
1	1	1	1	1	1	1	1	2015

Table7.11: Resources Development Projection for Nine Years

RealMPF	RealMPD	RealFEF	RealFÊD	RealQEF	RealQED	RealQRD	RealQRF	Year
0.4428572	0.04	0.4843304	0.53	0.4419355	0.3	0.192	0.1435896	2007
0.476275676	0.227910571	0.501844279	0.53	0.47570744	0.388202921	0.321619945	0.291774819	2008
0.509694152	0.415821142	0.519358158	0.53	0.509479379	0.476405842	0.45123989	0.439959438	2009
0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	2010
0.562851169	0.562851169	0.562851169	0.562851169	0.562851169	0.562851169	0.562851169	0.562851169	2010
0.646574735	0.646574735	0.646574735	0.646574735	0.646574735	0.646574735	0.646574735	0.646574735	2011
0.730298302	0.730298302	0.730298302	0.730298302	0.730298302	0.730298302	0.730298302	0.730298302	2012
0.814021868	0.814021868	0.814021868	0.814021868	0.814021868	0.814021868	0.814021868	0.814021868	2013
0.897745435	0.897745435	0.897745435	0.897745435	0.897745435	0.897745435	0.897745435	0.897745435	2014
0.981469001	0.981469001	0.981469001	0.981469001	0.981469001	0.981469001	0.981469001	0.981469001	2015
1	1	1	1	1	1	1	1	2016

Table 7.12: Resources Development Projection for Ten Years

RealMPF	RealMPD	RealFEF	RealFED	RealQEF	RealQED	RealQRD	RealQRF	Year
0.4428572	0.04	0.4843304	0.53	0.4419355	0.3	0.192	0.1435898	2007
0.472933829	0.209119514	0.500092891	0.53	0.472330246	0.379382629	0.30865795	0.276956137	2008
0.503010457	0.378239028	0.515855382	0.53	0.502724992	0.458765258	0.425315901	0.410322474	2009
0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	2010
0.537734099	0.537734099	0.537734099	0.537734099	0.537734099	0.537734099	0.537734099	0.537734099	2010
0.613085309	0.613085309	0.613085309	0.613085309	0.613085309	0.613085309	0.613085309	0.613085309	2011
0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	0.688436519	2012
0.763787728	0.763787728	0.763787728	0.763787728	0.763787728	0.763787728	0.763787728	0.763787728	2013
0.839138938	0.839138938	0.839138938	0.839138938	0.839138938	0.839138938	0.839138938	0.839138938	2014
0.914490148	0.914490148	0.914490148	0.914490148	0.914490148	0.914490148	0.914490148	0.914490148	2015
0.989841357	0.989841357	0.989841357	0.989841357	0.989841357	0.989841357	0.989841357	0.989841357	2016
1	1	1	1	1	1	1	1	2017

7.5 Upgrading of Capacity

The cumulative effects of the resources development is the enhancement of machine tools design and fabrication capacity which are shown in Tables 7.13 to 7.18. Moreover the cumulative effects of machine tools design and fabrication capacity development is the achievement of machine tool building capacity (Fig. 7.13.)

Table 7.13:Design and Fabrication Development Projection for five years

Year	MBuildD	MBuildF
2007	0.2655	0.378178225
2008	0.448080047	0.482978326
2009	0.53	0.53
2009	0.613085309	0.613085309
2010	0.763787728	0.763787728
2011	0.914490148	0.914490148
2012	1	1

MBuildD – Machine building Design, MBuildF - Machine Fabrication

Table 7.14: Design and Fabrication Development Projection for Six years

Year	MBuildD	MBuildF
2007	0.2655	0.378178225
2008	0.417650039	0.465511643
2009	0.53	0.53
2009	0.562851169	0.562851169
2010	0.688436519	0.688436519
2011	0.814021868	0.814021868
2012	0.939607218	0.939607218
2013	1	1

Table 7.15 : Design and Fabrication Development Projection for Seven years

Year	MBuildD	MBuildF
2007	0.2655	0.378178225
2008	0.417650039	0.465511643
2009	0.53	0.53
2009	0.562851169	0.562851169
2010	0.688436519	0.688436519
2011	0.814021868	0.814021868
2012	0.939607218	0.939607218
2013	1	1

Table7.16: Design and Fabrication Development Projection for Eight years

Year	MBuildD	MBuildF
2007	0.2655	0.378178
2008	0.379613	0.443678
2009	0.493725	0.509178
2010	0.53	0.53
2010	0.594248	0.594248
2011	0.688437	0.688437
2012	0.782626	0.782626
2013	0.876815	0.876815
2014	0.971004	0.971004
2015	1	1

Table 7.17: Design and Fabrication Development Projection for Nine years

Year	MBuildD	MBuildF
2007	0.2655	0.378178225
2008	0.366933359	0.436400503
2009	0.468366718	0.494622782
2010	0.53	0.53
2010	0.562851169	0.562851169
2011	0.646574735	0.646574735
2012	0.730298302	0.730298302
2013	0.814021868	0.814021868
2014	0.897745435	0.897745435
2015	0.981469001	0.981469001
2016	1	1

Table 7.18: Design and Fabrication Development Projection for Ten years

Year	MBuildD	MBuildF
2007	0.2655	0.378178225
2008	0.356790023	0.430578276
2009	0.448080047	0.482978326
2010	0.53	0.53
2010	0.537734099	0.537734099
2011	0.613085309	0.613085309
2012	0.688436519	0.688436519
2013	0.763787728	0.763787728
2014	0.839138938	0.839138938
2015	0.914490148	0.914490148
2016	0.989841357	0.989841357
2017	1	1

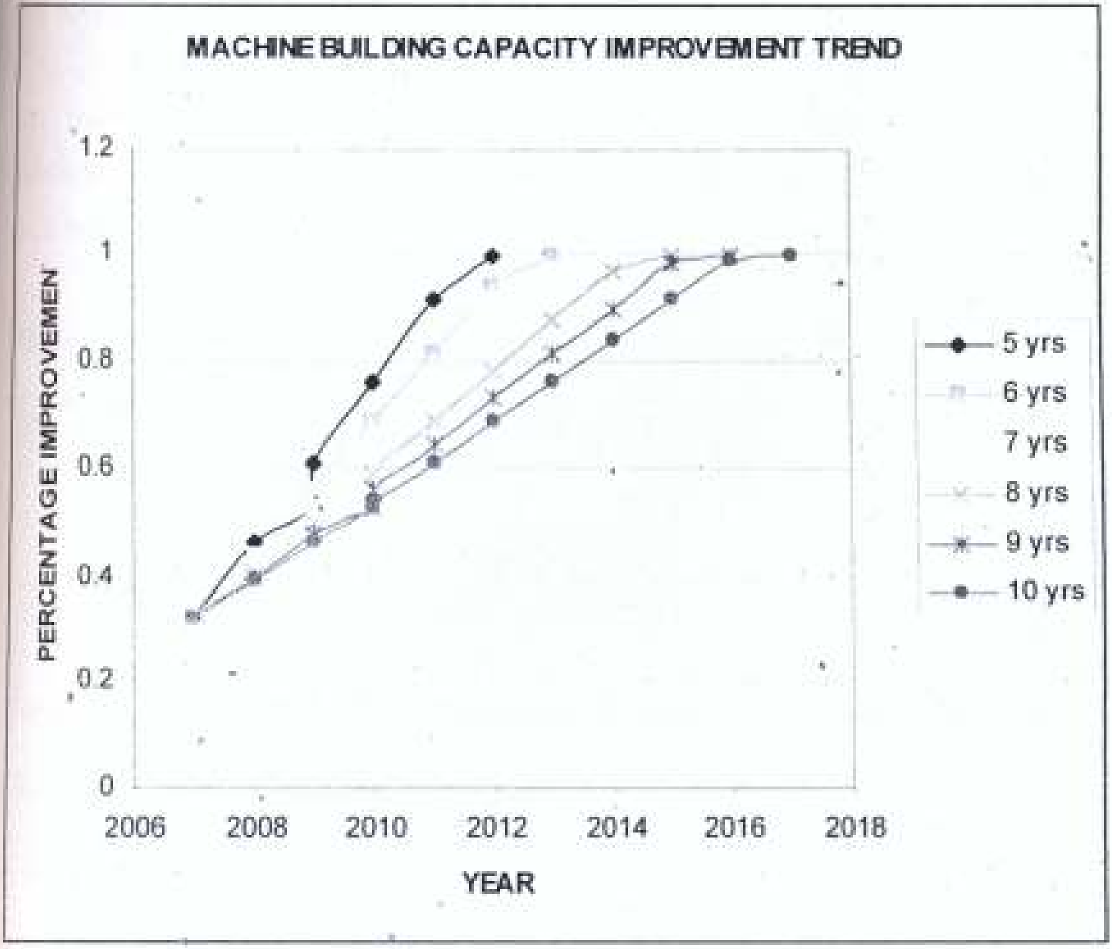

Fig.7.13: Projection for Capacity Development

7.6 System Error Reduction

As the system develops with year, the error in the system reduces gradually until the error tends to zero. The reduction in error for the machine tool resources is shown in Table 7.19 -7.24 .The cumulative effects resulted to reduction in the machine tools building capacity errors (Fig.7.14).

Table 7.19: Resources Error Reduction Projection for Five Years

Year	ErrRealMPF	ErrRealMPD	ErrRealFEF	ErrRealFED	ErrRealQEF	ErrRealQED	ErrRealQRD	ErrRealQRF
2007	0.0871428	0.49	0.0456696	0	0.0880645	0.23	0.338	0.3864102
2008	0.026989543	0.151760972	0.014144618	0	0.027275008	0.071234742	0.104684099	0.119677526
2009	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
2009	0.386914691	0.386914691	0.386914691	0.386914691	0.386914691	0.386914691	0.386914691	0.386914691
2010	0.236212272	0.236212272	0.236212272	0.236212272	0.236212272	0.236212272	0.236212272	0.236212272
2011	0.085509852	0.085509852	0.085509852	0.085509852	0.085509852	0.085509852	0.085509852	0.085509852
2012	0	0	0	0	0	0	0	0

Table 7.20: Resources Error Reduction Projection for Six Years

[illegible]	ErrRealMPF	ErrRealMPD	ErrRealFEF	ErrRealFED	ErrRealQEF	ErrRealQED	ErrRealQRD	ErrRealQRF
[illegible]	0.0871428	0.49	0.0456696	0	0.0880645	0.23	0.338	0.3864102
[illegible]	0.037015086	0.208134144	0.019398782	0	0.03740659	0.097695618	0.143570083	0.164132972
[illegible]	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
[illegible]	0.437148831	0.437148831	0.437148831	0.437148831	0.437148831	0.437148831	0.437148831	0.437148831
[illegible]	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481
[illegible]	0.185978132	0.185978132	0.185978132	0.185978132	0.185978132	0.185978132	0.185978132	0.185978132
[illegible]	0.060392782	0.060392782	0.060392782	0.060392782	0.060392782	0.060392782	0.060392782	0.060392782
[illegible]	0	0	0	0	0	0	0	0

Table7.21: Resources Error Reduction Projection for Seven Years

[illegible]	ErrRealMPF	ErrRealMPD	ErrRealFEF	ErrRealFED	ErrRealQEF	ErrRealQED	ErrRealQRD	ErrRealQRF
[illegible]	0.0871428	0.49	0.0456696	0	0.0880645	0.23	0.338	0.3864102
[illegible]	0.037015086	0.208134144	0.019398782	0	0.03740659	0.097695618	0.143570083	0.164132972
[illegible]	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
[illegible]	0.437148831	0.437148831	0.437148831	0.437148831	0.437148831	0.437148831	0.437148831	0.437148831
[illegible]	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481
[illegible]	0.185978132	0.185978132	0.185978132	0.185978132	0.185978132	0.185978132	0.185978132	0.185978132
[illegible]	0.060392782	0.060392782	0.060392782	0.060392782	0.060392782	0.060392782	0.060392782	0.060392782
[illegible]	0	0	0	0	0	0	0	0

Table7.22: Resources Error Reduction Projection for Eight Years

...MPF	ErrRealMPD	ErrRealFEF	ErrRealFED	ErrRealQEF	ErrRealQED	ErrRealQRD	ErrRealQRF
...871428	0.49	0.0456696	0	0.0880645	0.23	0.338	0.3864102
...647014	0.278600608	0.025966486	0	0.050071068	0.130771714	0.192177562	0.219702279
...61229	0.067201216	0.006263373	0	0.012077636	0.031543428	0.046355124	0.052994357
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
...752494	0.405752494	0.405752494	0.405752494	0.405752494	0.405752494	0.405752494	0.405752494
...563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481
...374469	0.217374469	0.217374469	0.217374469	0.217374469	0.217374469	0.217374469	0.217374469
...185457	0.123185457	0.123185457	0.123185457	0.123185457	0.123185457	0.123185457	0.123185457
...996445	0.028996445	0.028996445	0.028996445	0.028996445	0.028996445	0.028996445	0.028996445
0	0	0	0	0	0	0	0

Table7.23: Resources Error Reduction Projection for Nine Years

...RealMPF	ErrRealMPD	ErrRealFEF	ErrRealFED	ErrRealQEF	ErrRealQED	ErrRealQRD	ErrRealQRF
...0871428	0.49	0.0456696	0	0.0880645	0.23	0.338	0.3864102
...3724324	0.302089429	0.028155721	0	0.05429256	0.141797079	0.208380055	0.238225381
...0305848	0.114178858	0.010641842	0	0.020520621	0.053594158	0.07876011	0.090040562
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
...7148831	0.437148831	0.437148831	0.437148831	0.437148831	0.437148831	0.437148831	0.437148831
...3425265	0.353425265	0.353425265	0.353425265	0.353425265	0.353425265	0.353425265	0.353425265
...9701698	0.269701698	0.269701698	0.269701698	0.269701698	0.269701698	0.269701698	0.269701698
...5978132	0.185978132	0.185978132	0.185978132	0.185978132	0.185978132	0.185978132	0.185978132
...2254565	0.102254565	0.102254565	0.102254565	0.102254565	0.102254565	0.102254565	0.102254565
...18530999	0.018530999	0.018530999	0.018530999	0.018530999	0.018530999	0.018530999	0.018530999
0	0	0	0	0	0	0	0

Table 7.24: Resources Error Reduction Projection for Ten Years

…alMPF	ErrRealMPD	ErrRealFEF	ErrRealFED	ErrRealQEF	ErrRealQED	ErrRealQRD	ErrRealQRF
…871428	0.49	0.0456696	0	0.0880645	0.23	0.338	0.3864102
…066171	0.320880486	0.029907109	0	0.057669754	0.150617371	0.22134205	0.253043863
…989543	0.151760972-	0.014144618	0	0.027275008	0.071234742	0.104684099	0.119677526
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
…2265901	0.462265901	0.462265901	0.462265901	0.462265901	0.462265901	0.462265901	0.462265901
…914691	0.386914691	0.386914691	0.386914691	0.386914691	0.386914691	0.386914691	0.386914691
…1563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481	0.311563481
…212272	0.236212272	0.236212272	0.236212272	0.236212272	0.236212272	0.236212272	0.236212272
…861062	0.160861062	0.160861062	0.160861062	0.160861062	0.160861062	0.160861062	0.160861062
…509852	0.085509852	0.085509852	0.085509852	0.085509852	0.085509852	0.085509852	0.085509852
…158643	0.010158643	0.010158643	0.010158643	0.010158643	0.010158643	0.010158643	0.010158643
0	0	0	0	0	0	0	0

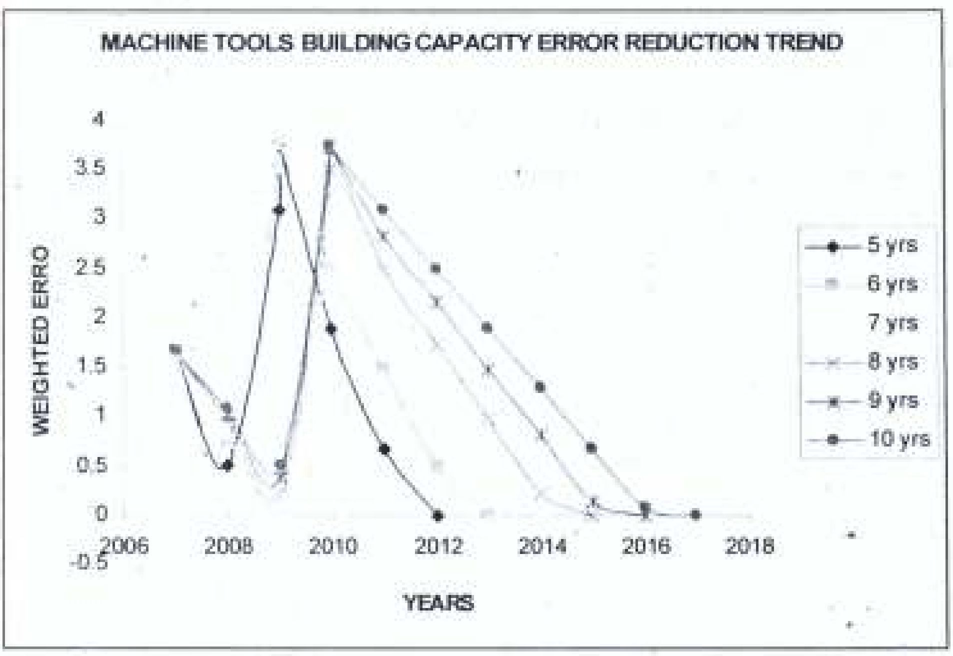

Fig.7.14: Projection for Capacity Errors

7.7 Performance Evaluation

The validity of the results and the sensitivity of the model was tested using Benefit Cost Analysis (BCA), Analysis of Variance (ANOVA) and regression analysis.

7.7.1 Benefit Cost Analysis (BCA)

Benefit cost analysis in this case actually shows whether it is advantageous to use long-term time or short-term time in actualizing the development of machine tools system. Since the model was tested for five to ten years of actualizing the development, benefit of spreading the development over six to ten year was tested over five year. Also the benefit of five years project implementation was tested over other year to know which one is preferable and adaptable.

Benefit cost of spreading the development over six to ten years over five years shown in Fig.7.15 and is obtainable from the ratio of the difference of the cost of project implementation for further years from five years to cost of project implementation of five years. Also benefit cost of spreading the development for five years over six to ten years is obtainable as the ratio of difference of the cost of project implementation of five year from further years to cost of project implementation of the years(Fig. 7.16). It is observed from the result that it is beneficial to spread the development over long period. This action reduces financial stress.Generally, the total cost of executing the development increases with years. It is therefore depend on the practisionner's to choose either to reduce time of execution of the project and spend more or extends time of project execution and spend less.

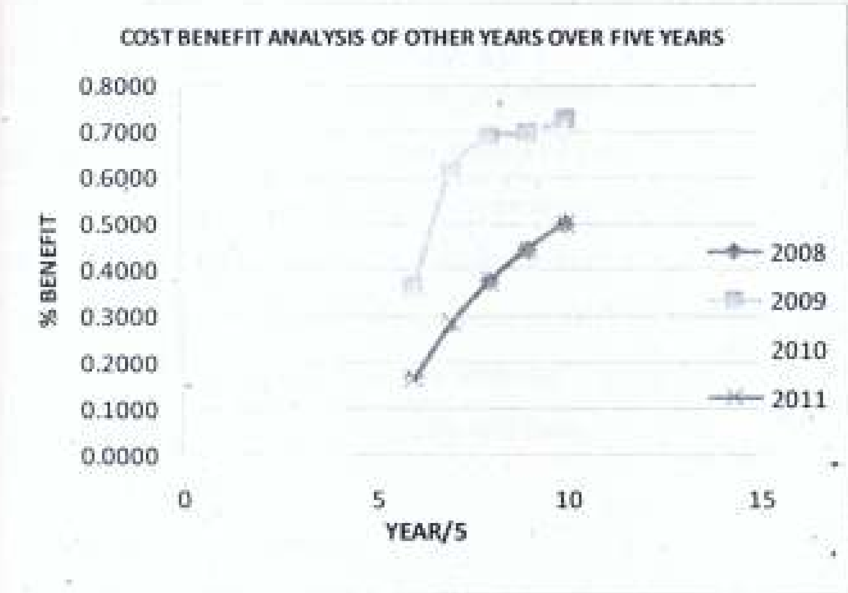

Fig.7.15: Cost Analysis for Five- Year Project Plans

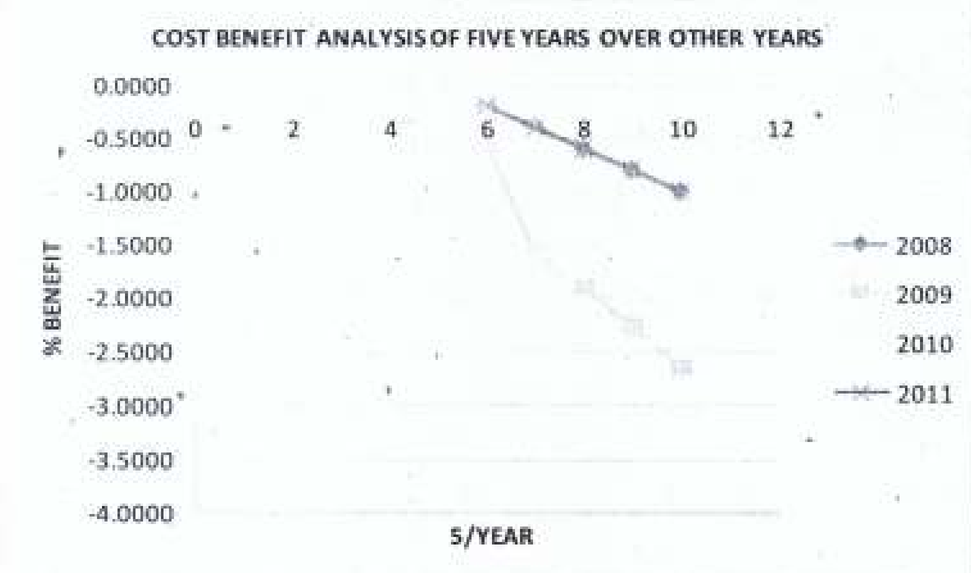

Fig.7.16: Cost Analysis for more than Five Years Project Plans

7.7.2 Analysis of Variance (ANOVA)

This analysis of variance shows whether the year of implementation of machine tool development affects the distribution of fund to each resource, and the total amount of money for each resources development or not (Table.7.25). It is observed that there is significant difference in the distribution of fund with year of development for particular years of development. There is also a significant difference in the total fund required to develop each resource from one year to the other. This means that the model is very sensitive to change of years and fund.

7.7.3 Regression Analysis

Table 7.26 shows the summary of results of regression analysis. It was discovered that the coefficient of determinantion is very high with average value of 96% which shows that 96% of what is happening can be explained by the model.The detailed regression analysis and analysis of variance table are shown in Appendix IV

Table 7.25: Summary of Analysis of Variance

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
IPF	Between Groups	113235487.17	4	28308871.79	7.186	.001
	Within Groups	98490385.345	25	3939615.414		
	Total	211725872.51	29			
IPD	Between Groups	278657413.13	4	69664353.28	6.411	.001
	Within Groups	271658014.22	25	10866320.57		
	Total	550315427.34	29			
IEQF	Between Groups	185904519.01	4	46476129.75	10.521	.000
	Within Groups	110433347.22	25	4417333.889		
	Total	296337866.23	29			
IEQD	Between Groups	286781765.81	4	71695441.45	14.122	.000
	Within Groups	126921654.54	25	5076866.182		
	Total	413703420.36	29			
IENF	Between Groups	71568189.987	4	17892047.50	7.113	.001
	Within Groups	62884942.194	25	2515397.688		
	Total	134453132.18	29			
IEND	Between Groups	9086728.624	4	2271682.156	.926	.465
	Within Groups	61362651.336	25	2454506.053		
	Total	70449379.960	29			
IRF	Between Groups	693397687.03	4	173349421.8	.661	.625
	Within Groups	6553088638.2	25	262123545.5		
	Total	7246486325.2	29			
IRD	Between Groups	77663656.439	4	19415914.11	3.655	.018
	Within Groups	132805864.95	25	5312234.598		
	Total	210469521.39	29			

Table 7.26: Summary for Regression Analysis of the Model

Money Model	R	R. squared	Std Error Estimate	Coefficient	
				Constant (a)	Weight (b)
IPF					
2008	0.980	0.960	158.483569 1	5451.688	-370.705
2009	0.894	0.800	1016.4689	10847.686	-970.516
2070	0.999	0.997	177.2558	18380.580	-16119.344
2011	0.980	0.960	45.2596	15488.415	-1053.184
2072	0.51	0.300	1277.8639	10103.021	-402.882
IPD					
2008	0.980	0.960	891.1508	30654.588	-2084.458
2009	0.833	0.779	1099.0932	21595.480	-987.808
2010	0.354	0.130	1932.566	7381.420	-672.868
2011	0.980	0.960	450.2546	15488.415	-1053.184
2012	0.557	0.303	1277.8639	10103.021	-402.882
IEQF					
2008	0.980	0.960	891.1508	2857.106	-194.278
2009	0.833	0.570	1099.0932	9225.666	-930.069
2010	0.354	0.975	1432.566	19512.917	-930.069
2011	0.980	0.960	450.2546	15488.415	-1053.184
2012	0.557	0.333	1277.8639	10103.021	-402.882

IEQD					
2008	0.980	0.960	101.065	3647.821	-201.345
2009	0.811	0.657	1460.373	8523.087	-966.796
2010	0.996	0.993	367.281	20759.829	-2026.962
2011	0.980	0.960	450.250	15488.415	-1053.184
2012	0.557	0.333	1277.864	10103.021	-402.882
IENF					
2008	0.980	0.968	128.1277	4407.480	-299.701
2009	0.895	0.801	809.3065	8698.0000	-776.458
2010	0.999	0.997	141.652931	14684.319	-1292.026
2011	0.980	0.960	360.2067	12390.733	-842.547
2012	0.133	0.018	286875.86	249328.572	-18415.763
IEND					
2008	0.980	0.960	334.6372	11511.109	-782.734
2009	0.988	0.975	259.6421	11727.286	-781.327
2010	0.967	0.934	421.6375	11584.132	-760.895
2011	0.980	0.960	360.2067	12390.733	-842.547
2012	0.134	0.018	288707.6920	250901.20	-18597.239

Table 7.Cont.

				Coefficient	
Year	**R**	**R. Square**	**Std. Error**	**Constant (a)**	**Weight (b)**
IRD					
2008	0.983	0.967	504.8708	21733.608	-1305.317
2009	0.954	0.919	650.7460	19938.458	-1049.473
2010	0.633	0.401	612.9741	11275.949	-239. 536
2011	0.983	0.967	369.885	25929.252	-956.108
2012	0.983	0.967	384.37014	16543.313	-993.769

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations could be drawn from this research on machine tools building capacity development.

8.1 Conclusions

The idea of developing appropriate technology capacity for machine tools building taking into consideration the needs, resources, environmental factor and lifestyles of the people therefore becomes very important .The research work has established relevant criteria found useful in the development of capital goods sectors, including machine tools industry. These relevant criteria were critical parameters which formed the bedrock of developed model. The conclusions that were drawn from the implementation of the model with the data on relevant parameters obtained from the machine tools and other allied industries are as follows:

(i) The existing level of development of machine tools industry was not adequate. A colossal sum of money is required to meet a sustainable level of operations. It was also established that there is immediate cost benefit in spreading the development of the system over the years. Based on this outcome, financial stress is minimized, effective monitoring and management is achieved as well.

(ii) Financial cumulative effect did not favour long term period of development based on variation in the value of money with year, hence short term planning is advisable. However, the choice of which one to adopt in either of the two (long- and short-terms) in the development of machine tool depends on the available fund.

(iii) Resources that had shortfall or surplus in their capacity levels were established and identified. This gave a clue to what the industry have to put in place to make organization work well to the acceptable standard. Effective and efficient utilization of available resources and infrastructure was enhanced in the machine tool industry depending on available funds.

(iv) The model developed is a strong analytical concept of system analysis, dynamic programming and control theory. The resulting algorithm and software make the model amenable for practical application to planning of the machine tools sector of the Nigeria economy.

(v) The model developed is user-friendly and very flexible. It can be used for other branches of capital goods to yield an articulated, coherent and strong industrial base.

(vi) The software CAMTCAD-2008 developed has quickened the implementation of the model in machine tools industry. The CAMTCAD-2008 runs on Core 2 duo, 2.0GHZ, 400GB hardisk, 3GB Ram. Computer system took 5 minute to complete a single run. Manual computation could be very tiresome and as well cumbersome and can take several hours for a resilient mathematician to compute.

8.2 Recommendations

It is important that a meaningful, concrete and result –oriented strategic model currently developed be employed by the Government and private investors to generate and sustain the technological take-off of effective machine tool building of the nation.

More attention should be paid to the development of technology, manpower, equipment, raw materials and energy availability for machine tools development since the machine tool development cannot succeed in the absence of careful consideration of all these factors. Nigerian Content development strategy for machine tools sector should be put in place as it was done for oil and gas, in order to sustain indigenous technology development for machine tools.

Private or public investor, as the case may be, should make available enough funds as predicted by the model and follow the distribution pattern of funds to all the machine tools building resources for the achievement of sustainable development in machine tools industry.

The developed model is useful to investors in machine tools industry for effective planning and development of all the resources that are responsible for the industry's capacity development.The developed model is also useful for technological forecasting that is of help in managing, financing and upgrading of machine tools capacity in Nigeria.

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APPENDICES

Appendix I: Coding of Software

```
'This Section Displays the various Graphs
Private Sub allocatedmoeb_Click()
Call Closemywndow1

Set CADObject = GetObject(App.Path & "\Book7.xls")
  CADObject.Application.Visible = True
  CADObject.Parent.Windows(1).Visible = True


End Sub

Private Sub allocatedmoney_Click()
Call Closemywndow1

Set CADObject = GetObject(App.Path & "\Book8.xls")
  CADObject.Application.Visible = True
  CADObject.Parent.Windows(1).Visible = True


End Sub

Private Sub capbuild_Click()
EleResourcesCap.Show
End Sub

'Dim CADObject As Object 'Excel.Workbook

Private Sub erred_Click()
Call Closemywndow1

Set CADObject = GetObject(App.Path & "\Book2.xls")
  CADObject.Application.Visible = True
  CADObject.Parent.Windows(1).Visible = True

End Sub

Privatte Sub fab_Click()
Call Closemywndow1

Set CADObject = GetObject(App.Path & "\Book6.xls")
  CADObject.Application.Visible = True
  CADObject.Parent.Windows(1).Visible = True
```

```
End Sub

Private Sub levelimp_Click()
Call Closemywndow1

Set CADObject = GetObject(App.Path & "\Book3.xls")
  CADObject.Application.Visible = True
  CADObject.Parent.Windows(1).Visible = True


End Sub

Private Sub machinetoobiuld_Click()
Call Closemywndow1

Set CADObject = GetObject(App.Path & "\Book5.xls")
  CADObject.Application.Visible = True
  CADObject.Parent.Windows(1).Visible = True


End Sub

Private Sub mhgjhghj_Click()
Call Closemywndow1

Set CADObject = GetObject(App.Path & "\Book4.xls")
  CADObject.Application.Visible = True
  CADObject.Parent.Windows(1).Visible = True
End Sub

Private Sub mnuexit_Click()

Call Closemywndow1
  End
End Sub

Private Sub munairadollar_Click()
DollarNairaEquivalent.Show
End Sub

Private Sub Resdev_Click()

Call Closemywndow1

Set CADObject = GetObject(App.Path & "\Book1.xls")
  CADObject.Application.Visible = True
  CADObject.Parent.Windows(1).Visible = True
End Sub
```

```
Public Sub Closemywndow1()
Set CADObject = GetObject(App.Path & "\Book1.xls")
CADObject.Application.Visible = False
CADObject.Close (True)

Set CADObject = GetObject(App.Path & "\Book2.xls")
CADObject.Application.Visible = False
CADObject.Close (True)

Set CADObject = GetObject(App.Path & "\Book3.xls")
CADObject.Application.Visible = False
CADObject.Close (True)

Set CADObject = GetObject(App.Path & "\Book4.xls")
CADObject.Application.Visible = False
CADObject.Close (True)

Set CADObject = GetObject(App.Path & "\Book5.xls")
CADObject.Application.Visible = False
CADObject.Close (True)

Set CADObject = GetObject(App.Path & "\Book6.xls")
CADObject.Application.Visible = False
CADObject.Close (True)

Set CADObject = GetObject(App.Path & "\Book7.xls")
CADObject.Application.Visible = False
CADObject.Close (True)

Set CADObject = GetObject(App.Path & "\Book8.xls")
CADObject.Application.Visible = False
CADObject.Close (True)
End Sub

Private Sub toolfab_Click()
Call Closemywndow1

Set CADObject = GetObject(App.Path & "\Book7.xls")
   CADObject.Application.Visible = True
   CADObject.Parent.Windows(1).Visible = True


End Sub
Private Sub cmdclose_Click()
Unload Me
End Sub
```

```
'Computation of actual machine tool capacity level starts here
Private Sub cmdsave_Click()
Set myrecordset1 = mydatabase.OpenRecordset("ActualMachCapLevel")
With myrecordset1
   If .RecordCount > 0 Then
      .Edit
   Else
      .AddNew
   End If
   'stop
   !AFabNPE = Val(AFabNPE): !AFabNPX = Val(AFabNPX): !AFabNPT =
Val(AFabNPT)
   !AFabNPEX = Val(AFabNPEX): !AFabNPET = Val(AFabNPET): !AFabNPXT =
Val(AFabNPXT)
   !AFabNPEXT = Val(AFabNPEXT)
   !ADegNPE = Val(ADegNPE): !ADegNPX = Val(ADegNPX): !ADegNPT =
Val(ADegNPT)
   !ADegNPEX = Val(ADegNPEX): !ADegNPET = Val(ADegNPET): !ADegNPXT =
Val(ADegNPXT)
   !ADegNPEXT = Val(ADegNPEXT):
   !AFabFEQ = Val(AFabFEQ): !AFabNFEQ = Val(AFabNFEQ)
   !ADegFEQ = Val(ADegFEQ): !ADegNFEQ = Val(ADegNFEQ)
   !AFabQEN = Val(AFabQEN): !AFabNQEN = Val(AFabNQEN)
   !ADegQEN = Val(ADegQEN): !ADegNQEN = Val(ADegNQEN)
   !AFabQRM = Val(AFabQRM): !AFabNQRM = Val(AFabNQRM)
   !ADegQRM = Val(ADegQRM): !ADegNQRM = Val(ADegNQRM)
   !FMPFab = Val(FMPFab): !FMPDeg = Val(FMPDeg)
   !FEQFab = Val(FEQFab): !FEQDeg = Val(FEQDeg)
   !FENFab = Val(FQENFab): !FENDeg = Val(FENDeg)
   !FRMFab = Val(FRMFab): !FRMDeg = Val(FRMDeg)

   .Update
   Call MsgBox("Updated Successfully", vbOKOnly + vbInformation, App.Title)
End With
End Sub

'displays the machine building resource level form here
Private Sub Command1_Click()
Unload Me
MachineBuildingResLevel.Show
End Sub

'Displays the Elemental Resources Capacity level here
Private Sub Command2_Click()
Unload Me
EleResourcesCapLevel.Show
End Sub
```

```
'Computes the elemental resources capacity level
Private Sub Form_Load()
Me.Top = 0
Call Initialise
'Set myrecordset1 = mydatabase.OpenRecordset("EleResourcesCap")
Set myrecordset1 = mydatabase.OpenRecordset("EleResourcesCapLevelTable")
With myrecordset1
  If .RecordCount > 0 Then

  AFabNPE = !LFabNPE * !WFabTNP: AFabNPX = !LFabNPX * !WFabTNP:
AFabNPT = !LFabNPT * !WFabTNP
  AFabNPEX = !LFabNPEX * !WFabTNP: AFabNPET = !LFabNPET * !WFabTNP:
AFabNPXT = !LFabNPXT * !WFabTNP
  AFabNPEXT = !LFabNPEXT * myrecordset1!WFabTNP
  FMPFab = (Val(AFabNPE) + Val(AFabNPX) + Val(AFabNPT) + Val(AFabNPEX)
+ Val(AFabNPET) + Val(AFabNPXT) + Val(AFabNPEXT)) -
(myrecordset1!LFabNPE + myrecordset1!LFabNPX + myrecordset1!LFabNPT +
myrecordset1!LFabNPEX + myrecordset1!LFabNPET + myrecordset1!LFabNPXT +
myrecordset1!LFabNPEXT)
'  'stop
  ADegNPE = !LDegNPE * myrecordset1!WDegTNP: ADegNPX = !LDegNPX *
myrecordset1!WDegTNP: ADegNPT = !LDegNPT * myrecordset1!WDegTNP
  ADegNPEX = !LDegNPEX * myrecordset1!WDegTNP: ADegNPET = !LDegNPET
* myrecordset1!WDegTNP: ADegNPXT = !LDegNPXT * myrecordset1!WDegTNP
  ADegNPEXT = !LDegNPEXT * myrecordset1!WDegTNP
  FMPDeg = (Val(ADegNPE) + Val(ADegNPX) + Val(ADegNPT) +
Val(ADegNPEX) + Val(ADegNPET) + Val(ADegNPXT) + Val(ADegNPEXT)) -
(myrecordset1!LDegNPE + myrecordset1!LDegNPX + myrecordset1!LDegNPT +
myrecordset1!LDegNPEX + myrecordset1!LDegNPET + myrecordset1!LDegNPXT +
myrecordset1!LDegNPEXT)

  AFabFEQ = !LFabFEQ * myrecordset1!WFabTEQ: AFabNFEQ = !LFabNFEQ *
myrecordset1!WFabTEQ
  FEQFab = (Val(AFabFEQ) + Val(AFabNFEQ)) - (myrecordset1!LFabFEQ -
myrecordset1!LFabNFEQ)

  ADegFEQ = !LDegFEQ * myrecordset1!WDegTEQ: ADegNFEQ = !LDegNFEQ *
myrecordset1!WDegTEQ
  FEQDeg = (Val(ADegFEQ) + Val(ADegNFEQ)) - (myrecordset1!LDegFEQ -
myrecordset1!LDegNFEQ)

  AFabQEN = !LFabQEN * myrecordset1!WFabTEN: AFabNQEN = !LFabNQEN *
myrecordset1!WFabTEN
  FENFab = (Val(AFabQEN) + Val(AFabNQEN)) - (myrecordset1!LFabQEN -
myrecordset1!LFabNQEN)
```

```
  ADegQEN = !LDegQEN * myrecordset1!WDegTEN: ADegNQEN = !LDegNQEN
* myrecordset1!WDegTEN
  FENDeg = (Val(ADegQEN) + Val(ADegNQEN)) - (myrecordset1!LDegQEN -
myrecordset1!LDegNQEN)

  AFabQRM = !LFabQRM * myrecordset1!WFabTRM: AFabNQRM = !LFabNQRM
* myrecordset1!WFabTRM

  FRMFab = (Val(AFabQRM) + Val(AFabNQRM)) - (myrecordset1!LFabQRM -
myrecordset1!LFabNQRM)

  ADegQRM = !LDegQRM * myrecordset1!WDegTRM: ADegNQRM
= !LDegNQRM * myrecordset1!WDegTRM
  FRMDeg = (Val(ADegQRM) + Val(ADegNQRM)) - (myrecordset1!LDegQRM -
myrecordset1!LDegNQRM)

  End If
End With

End Sub


Private Sub Command1_Click()
Unload Me
End Sub

Private Sub DBGrid1_AfterColEdit(ByVal ColIndex As Integer)
If (KeyCode = 13) And (DBGrid1.Col = 1) Then
kk = DBGrid1.Columns(DBGrid1.Col)

End If
'DBGrid1.Columns(DBGrid1.Col + 1) = yy

'Call FindTotals
End Sub

Private Sub DBGrid1_KeyDown(KeyCode As Integer, Shift As Integer)
On Error GoTo handler
If (KeyCode = 13) And (DBGrid1.Col = 1) Then
kk = DBGrid1.Columns(DBGrid1.Col)
'DBGrid1.Columns(DBGrid1.Col + 1) = yy
End If
handler:
If Err.Number = 11 Then
End If
End Sub
Public Sub FindTotals()
On Error Resume Next
```

```
  sumcol1 = 0
  sumcol2 = 0
     For I = 0 To 9
     DBGrid1.Row = I
        sumcol1 = sumcol1 + Val(DBGrid1.Columns(1))
        sumcol2 = sumcol2 + Val(DBGrid1.Columns(2))
     Next
  txtTotal1 = sumcol1
  TxtTotal2 = sumcol2
End Sub

Private Sub Form_Activate()
'Call FindTotals
End Sub


'Opens the database for information storage
Private Sub Form_Load()
Me.Top = 0
Data1.DatabaseName = App.Path + "\MachineToolsCapacityBuildingDbase.mdb"
Data1.RecordSource = "select * from DollarNairarates"
End Sub


'Computation of  elemental resources capacity level starts here
Private Sub cmdclose_Click()
Unload Me
End Sub
Private Sub cmdsave_Click()
Set myrecordset1 = mydatabase.OpenRecordset("EleResourcesCap")
msg = MsgBox("Have You confirmed all your inputs and are they in order (Y/N)",
vbYesNo + vbQuestion, App.Title)
If msg = vbYes Then
With myrecordset1
   If .RecordCount > 0 Then
      .Edit
   Else
      .AddNew
   End If
   !FabNPE = Val(FabNPE): !FabNPX = Val(FabNPX): !FabNPT = Val(FabNPT)
   !FabNPEX = Val(FabNPEX): !FabNPET = Val(FabNPET): !FabNPXT =
Val(FabNPXT)
   !FabNPEXT = Val(FabNPEXT): !FabTNP = Val(FabTNP): !IFabTNP =
Val(IFabTNP)
   !DegNPE = Val(DegNPE): !DegNPX = Val(DegNPX): !DegNPT = Val(DegNPT)
   !DegNPEX = Val(DegNPEX): !DegNPET = Val(DegNPET): !DegNPXT =
Val(DegNPXT)
```

```
  !DegNPEXT = Val(DegNPEXT): !DegTNP = Val(DegTNP): !IDegTNP =
Val(IDegTNP)
  !FabFEQ = Val(FabFEQ): !FabNFEQ = Val(FabNFEQ): !FabTEQ =
Val(FabTEQ): !IFabTEQ = Val(IFabTEQ)
  !DegFEQ = Val(DegFEQ): !DegNFEQ = Val(DegNFEQ): !DegTEQ =
Val(DegTEQ): !IDegTEQ = Val(IDegTEQ)
  !FabQEN = Val(FabQEN): !FabNQEN = Val(FabNQEN): !FabTEN =
Val(FabTEN): !IFabTEN = Val(IFabTEN)
  !DegQEN = Val(DegQEN): !DegNQEN = Val(DegNQEN): !DegTEN =
Val(DegTEN): !IDegTEN = Val(IDegTEN)
  !FabQRM = Val(FabQRM): !FabNQRM = Val(FabNQRM): !FabTRM =
Val(FabTRM): !IFabTRM = Val(IFabTRM)
  !DegQRM = Val(DegQRM): !DegNQRM = Val(DegNQRM): !DegTRM =
Val(DegTRM): !IDegTRM = Val(IDegTRM)
  .Update
  Call MsgBox("Updated Successfully", vbOKOnly + vbInformation, App.Title)
End With
End If
End Sub

Private Sub Command1_Click()
Unload Me
EleResourcesCapLevel.Show
End Sub

Private Sub DegFEQ_Change()
Call AddDegEq
End Sub

Private Sub DegNFEQ_Change()
Call AddDegEq
End Sub

Private Sub DegNPE_Change()
Call Adddeg
End Sub

Private Sub DegNPET_Change()
Call Adddeg
End Sub

Private Sub DegNPEX_Change()
Call Adddeg
End Sub

Private Sub DegNPEXT_Change()
Call Adddeg
End Sub
```

```
Private Sub DegNPT_Change()
Call Adddeg
End Sub

Private Sub DegNPX_Change()
Call Adddeg
End Sub

Private Sub DegNPXT_Change()
Call Adddeg
End Sub

Private Sub DegNQEN_Change()
Call AddDegTEN
End Sub

Private Sub DegNQRM_Change()
Call AddDegTRM
End Sub

Private Sub DegQEN_Change()
Call AddDegTEN
End Sub

Private Sub DegQRM_Change()
Call AddDegTRM
End Sub

Private Sub FabFEQ_Change()
Call AddfabEq
End Sub

Private Sub FabNFEQ_Change()
Call AddfabEq
End Sub

Private Sub FabNPE_Change()
Call Addfab
End Sub

Private Sub FabNPET_Change()
Call Addfab
End Sub

Private Sub FabNPEX_Change()
Call Addfab
End Sub
```

```
Private Sub FabNPEXT_Change()
Call Addfab
End Sub

Private Sub FabNPT_Change()
Call Addfab
End Sub

Private Sub FabNPX_Change()
Call Addfab
End Sub

Private Sub FabNPXT_Change()
Call Addfab
End Sub

Private Sub FabNQEN_Change()
Call AddfabTEN
End Sub

Private Sub FabNQRM_Change()
Call AddfabTRM
End Sub

Private Sub FabQEN_Change()
Call AddfabTEN
End Sub

Private Sub FabQRM_Change()
Call AddfabTRM
End Sub

Private Sub Form_Load()
Me.Top = 0
Call Initialise
Set myrecordset1 = mydatabase.OpenRecordset("EleResourcesCap")
With myrecordset1
   If .RecordCount > 0 Then
   FabNPE = !FabNPE: FabNPX = !FabNPX: FabNPT = !FabNPT
   FabNPEX = !FabNPEX: FabNPET = !FabNPET: FabNPXT = !FabNPXT
   FabNPEXT = !FabNPEXT: FabTNP = !FabTNP: IFabTNP = !IFabTNP
   DegNPE = !DegNPE: DegNPX = !DegNPX: DegNPT = !DegNPT
   DegNPEX = !DegNPEX: DegNPET = !DegNPET: DegNPXT = !DegNPXT
   DegNPEXT = !DegNPEXT: DegTNP = !DegTNP: IDegTNP = !IDegTNP
   FabFEQ = !FabFEQ: FabNFEQ = !FabNFEQ: FabTEQ = !FabTEQ: IFabTEQ
= !IFabTEQ
```

```
  DegFEQ = !DegFEQ: DegNFEQ = !DegNFEQ: DegTEQ = !DegTEQ: IDegTEQ
=!IDegTEQ
  FabQEN = !FabQEN: FabNQEN = !FabNQEN: FabTEN = !FabTEN: IFabTEN
=!IFabTEN
  DegQEN = !DegQEN: DegNQEN = !DegNQEN: DegTEN = !DegTEN: IDegTEN
= !IDegTEN
  FabQRM = !FabQRM: FabNQRM = !FabNQRM: FabTRM = !FabTRM: IFabTRM
= !IFabTRM
  DegQRM = !DegQRM: DegNQRM = !DegNQRM: DegTRM = !DegTRM:
IDegTRM = !IDegTRM
  End If
End With

End Sub

Public Sub Addfab()
FabTNP = Val(FabNPE) + Val(FabNPX) + Val(FabNPT) + Val(FabNPEX) +
Val(FabNPET) + Val(FabNPXT) + Val(FabNPEXT)
End Sub
Public Sub Adddeg()
DegTNP = Val(DegNPE) + Val(DegNPX) + Val(DegNPT) + Val(DegNPEX) +
Val(DegNPET) + Val(DegNPXT) + Val(DegNPEXT)
End Sub
Public Sub AddfabEq()
FabTEQ = Val(FabFEQ) + Val(FabNFEQ)
End Sub
Public Sub AddDegEq()
DegTEQ = Val(DegFEQ) + Val(DegNFEQ)
End Sub
Public Sub AddfabTEN()
FabTEN = Val(FabQEN) + Val(FabNQEN)
End Sub
Public Sub AddDegTEN()
DegTEN = Val(DegQEN) + Val(DegNQEN)
End Sub
Public Sub AddfabTRM()
FabTRM = Val(FabQRM) + Val(FabNQRM)
End Sub
Public Sub AddDegTRM()
'Stop
DegTRM = Val(DegQRM) + Val(DegNQRM)
End Sub

Private Sub cmdclose_Click()

Unload Me
End Sub
Private Sub cmdsave_Click()
```

```
Set myrecordset1 = mydatabase.OpenRecordset("EleResourcesCapLevelTable")
With myrecordset1
   If .RecordCount > 0 Then
      .Edit
   Else
      .AddNew
   End If
   !LFabNPE = Val(LFabNPE): !LFabNPX = Val(LFabNPX): !LFabNPT =
Val(LFabNPT)
   !LFabNPEX = Val(LFabNPEX): !LFabNPET = Val(LFabNPET): !LFabNPXT =
Val(LFabNPXT)
   !LFabNPEXT = Val(LFabNPEXT): !LFabTNP = Val(LFabTNP): !LIFabTNP =
Val(LIFabTNP)
   !WFabTNP = WFabTNP
   !LDegNPE = Val(LDegNPE): !LDegNPX = Val(LDegNPX): !LDegNPT =
Val(LDegNPT)
   !LDegNPEX = Val(LDegNPEX): !LDegNPET = Val(LDegNPET): !LDegNPXT =
Val(LDegNPXT)
   !LDegNPEXT = Val(LDegNPEXT): !LDegTNP = Val(LDegTNP): !LIDegTNP =
Val(LIDegTNP)
   !WDegTNP = WDegTNP
   !LFabFEQ = Val(LFabFEQ): !LFabNFEQ = Val(LFabNFEQ): !LFabTEQ =
Val(LFabTEQ): !LIFabTEQ = Val(LIFabTEQ)
   !WFabTEQ = WFabTEQ
   !LDegFEQ = Val(LDegFEQ): !LDegNFEQ = Val(LDegNFEQ): !LDegTEQ =
Val(LDegTEQ): !LIDegTEQ = Val(LIDegTEQ)
   !WDegTEQ = WDegTEQ
   !LFabQEN = Val(LFabQEN): !LFabNQEN = Val(LFabNQEN): !LFabTEN =
Val(LFabTEN): !LIFabTEN = Val(LIFabTEN)
   !WFabTEN = WFabTEN
   !LDegQEN = Val(LDegQEN): !LDegNQEN = Val(LDegNQEN): !LDegTEN =
Val(LDegTEN): !LIDegTEN = Val(LIDegTEN)
   !WDegTEN = WDegTEN
   !LFabQRM = Val(LFabQRM): !LFabNQRM = Val(LFabNQRM): !LFabTRM =
Val(LFabTRM): !LIFabTRM = Val(LFabTRM)
   !WFabTRM = WFabTRM
   !LDegQRM = Val(LDegQRM): !LDegNQRM = Val(LDegNQRM): !LDegTRM =
Val(LDegTRM): !LIDegTRM = Val(LIDegTRM)
   !WDegTRM = WDegTRM
   .Update
   Call MsgBox("Updated Successfully", vbOKOnly + vbInformation, App.Title)
End With
End Sub

Private Sub Command1_Click()
Unload Me
ActualMachBuildCapLevel.Show
End Sub
```

```
Private Sub Command2_Click()
Unload Me
EleResourcesCap.Show
End Sub

Private Sub Form_Load()
Me.Top = 0
Call Initialise
Set myrecordset1 = mydatabase.OpenRecordset("EleResourcesCap")
With myrecordset1
   If .RecordCount > 0 Then
   LFabNPE = !FabNPE / !FabTNP: LFabNPX = !FabNPX / !FabTNP: LFabNPT
= !FabNPT / !FabTNP
   LFabNPEX = !FabNPEX / !FabTNP: LFabNPET = !FabNPET / !FabTNP:
LFabNPXT = !FabNPXT / !FabTNP
   LFabNPEXT = !FabNPEXT / !FabTNP
   WFabTNP = !FabTNP / !!FabTNP

   LDegNPE = !DegNPE / !DegTNP: LDegNPX = !DegNPX / !DegTNP: LDegNPT
= !DegNPT / !DegTNP
   LDegNPEX = !DegNPEX / !DegTNP: LDegNPET = !DegNPET / !DegTNP:
LDegNPXT = !DegNPXT / !DegTNP
   LDegNPEXT = !DegNPEXT / !DegTNP
   WDegTNP = !DegTNP / !!DegTNP

   LFabFEQ = !FabFEQ / !FabTEQ: LFabNFEQ = !FabNFEQ / !FabTEQ
   WFabTEQ = !FabTEQ / !!FabTEQ
   LDegFEQ = !DegFEQ / !DegTEQ: LDegNFEQ = !DegNFEQ / !DegTEQ
   WDegTEQ = !DegTEQ / !!DegTEQ
   LFabQEN = !FabQEN / !FabTEN: LFabNQEN = !FabNQEN / !FabTEN
   WFabTEN = !FabTEN / !!FabTEN
   LDegQEN = !DegQEN / !DegTEN: LDegNQEN = !DegNQEN / !DegTEN
   WDegTEN = !DegTEN / !!DegTEN
   LFabQRM = !FabQRM / !FabTRM: LFabNQRM = !FabNQRM / !FabTRM
   WFabTRM = !FabTRM / !!FabTRM
   LDegQRM = !DegQRM / !DegTRM: LDegNQRM = !DegNQRM / !DegTRM
   WDegTRM = !DegTRM / !!DegTRM
   End If
End With

End Sub

Private Sub cmdclose_Click()
Unload Me
End Sub

'Computation of Machine Building Resources Level starts here
```

```
Private Sub cmdsave_Click()
Set myrecordset1 = mydatabase.OpenRecordset("MachineBuildResLevel")
With myrecordset1
'stop
  If .RecordCount > 0 Then
     .Edit
  Else
     .AddNew
  End If
  !RealMPF = Val(RealMPF): !RealMPD = Val(RealMPD): !RealFEF = Val(RealFEF)
  !RealFED = Val(RealFED): !RealQEF = Val(RealQEF): !RealQED = Val(RealQED)
  !RealQRD = Val(RealQRD): !RealQRF = Val(RealQRF): !MBuildF = Val(MBuildF)
  !MBuildD = Val(MBuildD): !MBuild = Val(MBuild)
  !HighResLev = HighResLev

  !ErrRealMPF = Val(ErrRealMPF): !ErrRealMPD = Val(ErrRealMPD): !ErrRealFEF
= Val(ErrRealFEF)
  !ErrRealFED = Val(ErrRealFED): !ErrRealQEF = Val(ErrRealQEF): !ErrRealQED
= Val(ErrRealQED)
  !ErrRealQRD = Val(ErrRealQRD): !ErrRealQRF = Val(ErrRealQRF)
  !Totalerr = Val(Totalerr)
  !WErrRealMPF = Val(WErrRealMPF): !WErrRealMPD =
Val(WErrRealMPD): !WErrRealFEF = Val(WErrRealFEF)
  !WErrRealFED = Val(WErrRealFED): !WErrRealQEF =
Val(WErrRealQEF): !WErrRealQED = Val(WErrRealQED)
  !WErrRealQRD = Val(WErrRealQRD): !WErrRealQRF = Val(WErrRealQRF)
  .Update
  Call MsgBox("Updated Successfully", vbOKOnly + vbInformation, App.Title)
End With
End Sub

Private Sub Command1_Click()
Unload Me
SystemImproveFund.Show
End Sub

Private Sub Command2_Click()
Unload Me
ActualMachBuildCapLevel.Show
End Sub

'Computation of Actual machine Capacity level stars here
Private Sub Form_Load()
Me.Top = 0
On Error Resume Next
Call Initialise
Set myrecordset1 = mydatabase.OpenRecordset("ActualMachCapLevel")
With myrecordset1
```

```
If.RecordCount > 0 Then


RealMPF = !AFabNPEXT
THigh = Val(RealMPF)
'stop
RealMPD = Val(!ADegNPEXT)
If THigh < Val(RealMPD) Then THigh = Val(RealMPD)
RealFEF = Val(!AFabFEQ)
If THigh < Val(RealFEF) Then THigh = Val(RealFEF)
RealFED = !ADegFEQ
If THigh < Val(RealFED) Then THigh = Val(RealFED)
RealQEF = !AFabQEN
If THigh < Val(RealQEF) Then THigh = Val(RealQEF)
RealQED = !ADegQEN
If THigh < Val(RealQED) Then THigh = Val(RealQED)
RealQRF = !AFabQRM
If THigh < Val(RealQRF) Then THigh = Val(RealQRF)
RealQRD = !ADegQRM
If THigh < Val(RealQRD) Then THigh = Val(RealQRD)
End If
'stop
MBuildF = (Val(RealMPF) + Val(RealFEF) + Val(RealQEF) + Val(RealQRF)) / 4
MBuildD = (Val(RealMPD) + Val(RealFED) + Val(RealQED) + Val(RealQRD)) / 4
MBuild = (Val(MBuildF) + Val(MBuildD)) / 2
HighResLev = THigh
'stop
'Resource Error
ErrRealMPF = Val(HighResLev) - Val(RealMPF)
ErrRealMPD = Val(HighResLev) - Val(RealMPD)
ErrRealFEF = Val(HighResLev) - Val(RealFEF)
ErrRealFED = Val(HighResLev) - Val(RealFED)
ErrRealQEF = Val(HighResLev) - Val(RealQEF)
ErrRealQED = Val(HighResLev) - Val(RealQED)
ErrRealQRF = Val(HighResLev) - Val(RealQRF)
ErrRealQRD = Val(HighResLev) - Val(RealQRD)
'stop
Totalerr = Val(ErrRealMPF) + Val(ErrRealMPD) + Val(ErrRealFEF) +
Val(ErrRealFED) + Val(ErrRealQEF) + Val(ErrRealQED) + Val(ErrRealQRF) +
Val(ErrRealQRD)
'stop
'Weighted Error

WErrRealMPF = Format(Val(ErrRealMPF) / Val(Totalerr), "#0.0000")
WErrRealMPD = Val(ErrRealMPD) / Val(Totalerr)
WErrRealFEF = Val(ErrRealFEF) / Val(Totalerr)
WErrRealFED = Val(ErrRealFED) / Val(Totalerr)
WErrRealQEF = Format(Val(ErrRealQEF) / Val(Totalerr), "#0.0000")
```

```
   'stop
   WErrRealQED = Val(ErrRealQED) / Val(Totalerr)
   WErrRealQRF = Val(ErrRealQRF) / Val(Totalerr)
   WErrRealQRD = Val(ErrRealQRD) / Val(Totalerr)

End With

End Sub

Dim a, B As Double
Dim Iy As Integer
Dim InitialY
Dim Nyear As Integer
Const Inch = 1440
Private Sub cmdclose_Click()
Unload Me
End Sub

Private Sub cmdsave_Click()

If Syear = Empty Then
Call MsgBox("Enter the Projected Starting Year")
Syear.SetFocus
Exit Sub
End If

Call CmdVariation_Click

If Payments = Empty Then
Call MsgBox("Enter Number of Instalmental Payments")
Payments.SetFocus
Exit Sub
End If

Call Command1_Click

'System improvement fund computation starts here
Set myrecordset1 = mydatabase.OpenRecordset("SystemImprovementFund")
With myrecordset1
   If .RecordCount > 0 Then
      .Edit
   Else
      .AddNew
   End If
   !TMOney = Val(TMOney)
   !PFMoney = Val(PFMoney)
   !PDMoney = Val(PDMoney)
   !EQFMoney = Val(EQFMoney)
```

```
    !EQDMoney = Val(EQDMoney)
    !ENFMoney = Val(ENFMoney)
    !ENDMoney = Val(ENDMoney)
    !RFMoney = Val(RFMoney)
    !RDMoney = Val(RDMoney)
    .Update
End With

Set myrecordset1 = mydatabase.OpenRecordset("PSystemImprovementFund")
With myrecordset1
    If .RecordCount > 0 Then
        .Edit
    Else
        .AddNew
    End If
    !PTMoney = Val(PTMoney)
    !PPFMoney = Val(PPFMoney)
    !PPDMoney = Val(PPDMoney)
    !PEQFMoney = Val(PEQFMoney)
    !PEQDMoney = Val(PEQDMoney)
    !PENFMoney = Val(PENFMoney)
    !PENDMoney = Val(PENDMoney)
    !PRFMoney = Val(PRFMoney)
    !PRDMoney = Val(PRDMoney)
    .Update
    Call MsgBox("Updated Successfully", vbOKOnly + vbInformation, App.Title)
End With

End Sub

Private Sub CmdVariation_Click()
If Syear = Empty Then
Call MsgBox("Enter the Projected Starting Year")
Syear.SetFocus
Exit Sub
End If
If Not IsNumeric(Syear) Then
Call MsgBox("Please Enter a Numeric Value for Projected Starting Year")
Syear.SetFocus
Exit Sub
End If

Call Variation_Trend

'Calculating Present values
    Nyear = Val(Syear) - Iy + 1
    y = a + B * (Nyear)
    InitialY = y
```

```
  PTMoney = y / 0.5 * Val(TMOney)
  PPFMoney = y / 0.5 * Val(PFMoney)
  PPDMoney = y / 0.5 * Val(PDMoney)
  PEQFMoney = y / 0.5 * Val(EQFMoney)
  PEQDMoney = y / 0.5 * Val(EQDMoney)
  PENFMoney = y / 0.5 * Val(ENFMoney)
  PENDMoney = y / 0.5 * Val(ENDMoney)
  PRFMoney = y / 0.5 * Val(RFMoney)
  PRDMoney = y / 0.5 * Val(RDMoney)

End Sub
Private Sub Command1_Click()
If Syear = Empty Then
Call MsgBox("Enter the Projected Starting Year")
Syear.SetFocus
Exit Sub
End If

Call CmdVariation_Click

If Payments = Empty Then
Call MsgBox("Enter Number of Instalmental Payments")
Payments.SetFocus
Exit Sub
End If

If Not IsNumeric(Payments) Then
Call MsgBox("Please Enter a Numeric Value for Number of Installmental Payment")
Payments.SetFocus
Exit Sub
End If

Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlan")
With myrecordset1
   If .RecordCount > 0 Then
      While Not .EOF
         .Delete
         .MoveNext
      Wend
   End If
.Close
End With

Text1 = Empty


DisplayMe.Cls
```

```
DisplayMe.Print Tab(2); "Year"; Tab(12); "Total Amount"; Tab(28); "Pers. Fab.";
Tab(42); "Pers. Degn."; Tab(56); "Equip. Fab."; Tab(69); "Equip. Degn."; Tab(85);
"Energy Fab."; Tab(99); "Energy. Degn."; Tab(115); "Raw Mat. Fab."; Tab(133); "Raw
Mat. Degn."
DisplayMe.Print Tab(2); String(140, "=")
'First Year Payments
'stop

   ITMoney = Val(PTMoney) * 100 '/ Val(Payments)
   IPFMoney = Val(PPFMoney) * 100 ' / Val(Payments)
   IPDMoney = Val(PPDMoney) * 100 '/ Val(Payments)
   IEQFMoney = Val(PEQFMoney) * 100 ' / Val(Payments)
   IEQDMoney = Val(PEQDMoney) * 100 '/ Val(Payments)
   IENFMoney = Val(PENFMoney) * 100 '/ Val(Payments)
   IENDMoney = Val(PENDMoney) * 100 '/ Val(Payments)
   IRFMoney = Val(PRFMoney) * 100 '/ Val(Payments)
   IRDMoney = Val(PRDMoney) * 100 '/ Val(Payments)

DisplayMe.Print Tab(2); Syear; Tab(12); Format(ITMoney, "#0.00"); Tab(28);
Format(IPFMoney, "#0.00"); Tab(42); Format(IPDMoney, "#0.00"); Tab(56);
Format(IEQFMoney, "#0.00"); Tab(69); Format(IEQDMoney, "#0.00"); Tab(85);
Format(IENFMoney, "#0.00"); Tab(99); Format(IENDMoney, "#0.00"); Tab(115);
Format(IRFMoney, "#0.00"); Tab(133); Format(IRDMoney, "#0.00")

Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlan")
With myrecordset1
   .AddNew
      !ITMoney = Val(ITMoney)
      !IPFMoney = Val(IPFMoney)
      !IPDMoney = Val(IPDMoney)
      !IEQFMoney = Val(IEQFMoney)
      !IEQDMoney = Val(IEQDMoney)
      !IENFMoney = Val(IENFMoney)
      !IENDMoney = Val(IENDMoney)
      !IRFMoney = Val(IRFMoney)
      !IRDMoney = Val(IRDMoney)
      !Syear = Syear
   .Update
   .Close
End With
Yearcount = Nyear
NextYear = Syear
'msgbox Nyear


'stop
Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlan")
With myrecordset1
```

```
For j = 1 To Payments - 1
   Yearcount = Yearcount + 1
   NextYear = NextYear + 1
   'msgbox ITMoney
   y = a + B * (Yearcount)
   'msgbox Yearcount
   ITMoney = ITMoney * y / InitialY
   IPFMoney = IPFMoney * y / InitialY
   IPDMoney = IPDMoney * y / InitialY
   IEQFMoney = IEQFMoney * y / InitialY
   IEQDMoney = IEQDMoney * y / InitialY
   IENFMoney = IENFMoney * y / InitialY
   IENDMoney = IENDMoney * y / InitialY
   IRFMoney = IRFMoney * y / InitialY
   IRDMoney = IRDMoney * y / InitialY

   .AddNew
   !ITMoney = Val(ITMoney)
   !IPFMoney = Val(IPFMoney)
   !IPDMoney = Val(IPDMoney)
   !IEQFMoney = Val(IEQFMoney)
   !IEQDMoney = Val(IEQDMoney)
   !IENFMoney = Val(IENFMoney)
   !IENDMoney = Val(IENDMoney)
   !IRFMoney = Val(IRFMoney)
   !IRDMoney = Val(IRDMoney)
   !Syear = NextYear
   .Update
   InitialY = y
DisplayMe.Print Tab(1); NextYear; Tab(12); Format(ITMoney, "#0.00"); Tab(28);
Format(IPFMoney, "#0.00"); Tab(42); Format(IPDMoney, "#0.00"); Tab(56);
Format(IEQFMoney, "#0.00"); Tab(69); Format(IEQDMoney, "#0.00"); Tab(85);
Format(IENFMoney, "#0.00"); Tab(99); Format(IENDMoney, "#0.00"); Tab(115);
Format(IRFMoney, "#0.00"); Tab(133); Format(IRDMoney, "#0.00")
Next
End With
End Sub



Private Sub Command2_Click()
startyear = Val(Syear)
Unload Me
Systemimprovementpattern.Show
End Sub

Private Sub Command3_Click()
```

```
Unload Me
MachineBuildingResLevel.Show
End Sub

Private Sub ENDMoney_Change()
TMOney = Compute_Total
End Sub

Private Sub ENFMoney_Change()
TMOney = Compute_Total
End Sub

Private Sub EQDMoney_Change()
TMOney = Compute_Total
End Sub

Private Sub EQFMoney_Change()
TMOney = Compute_Total
End Sub

Private Sub Form_Load()
Me.Top = 0
Initializeform
Call Initialise
Set myrecordset1 = mydatabase.OpenRecordset("SystemImprovementFund")
With myrecordset1
  If .RecordCount > 0 Then
  TMOney = !TMOney
  PFMoney = !PFMoney
  PDMoney = !PDMoney
  EQFMoney = !EQFMoney
  EQDMoney = !EQDMoney
  ENFMoney = !ENFMoney
  ENDMoney = !ENDMoney
  RFMoney = !RFMoney
  RDMoney = !RDMoney
  End If
End With

End Sub
Private Sub FontSetting(N As String, B As Boolean, I As Boolean, S As Single, C As
Single)
 With DisplayMe
  If N <> "" Then .FontName = N
  .FontBold = B
  .FontItalic = I
  If S > 0 Then .FontSize = S
  If C >= 0 Then .ForeColor = QBColor(C)
```

```
End With
End Sub
Private Sub PFontSetting(N As String, B As Boolean, I As Boolean, S As Single, C As
Single)
 With Printer
  If N <> "" Then .FontName = N
  .FontBold = B
  .FontItalic = I
  If S > 0 Then .FontSize = S
  If C >= 0 Then .ForeColor = QBColor(C)
End With
End Sub
Public Function Compute_Total()
  j = Val(PFMoney) + Val(PDMoney) + Val(EQFMoney) + Val(EQDMoney) +
Val(ENFMoney) + Val(ENDMoney) + Val(RFMoney) + Val(RDMoney)
  Compute_Total = j
End Function

Private Sub PDMoney_Change()
TMOney = Compute_Total
End Sub

Private Sub PFMoney_Change()
TMOney = Compute_Total
End Sub

Private Sub RDMoney_Change()
TMOney = Compute_Total
End Sub
Public Sub HeaderReport()
center "": center "": center ""
FontSetting "Times New Roman", True, True, 18, 0
'center "Seven-Up Bottling Company PLC,"
'center "--------------------------------------"
'
'center "Oluyole Industrial Estate, Moshood Abiola Way Ibadan"
'center "----------------------------------------------------------------------"

center ""
FontSetting "Arial Black", False, False, 12, 0
center "Transportation Cost Table"
center "---,------------------------------------------------------------"
center ""
End Sub

'for printer
Private Sub PXSone(t)
  Printer.CurrentX = t * Inch * 8
```

```
End Sub
Private Sub PCenter(ByVal Txt As String)
   Printer.CurrentX = (8 * Inch - (Printer.TextWidth(Txt))) / 2
   Printer.Print Txt
End Sub
Private Sub Initializeform()
DisplayMe.Width = 11 * Inch
DisplayMe.Height = 8.5 * Inch
HScroll1.Max = (5 * Inch - (Me.Width * 0.5))
HScroll1.Min = -0.15 * Inch
HScroll1.LargeChange = Inch
HScroll1.SmallChange = Inch / 2
VScroll1.Max = (10 * Inch)
VScroll1.Min = -0.15 * Inch
VScroll1.LargeChange = Inch
VScroll1.SmallChange = Inch / 2
DisplayMe.Left = 15   '0.15 * Inch
DisplayMe.Top = 150 '0.15 * Inch
DisplayMe.BackColor = QBColor(3)
End Sub
Private Sub RFMoney_Change()
TMOney = Compute_Total
End Sub
Public Sub Variation_Trend()
sum_xsqr = 0: sumy = 0: sumx = 0: sumxy = 0
Set myrecordset1 = mydatabase.OpenRecordset("DollarNairaRates")
With myrecordset1
Iy = !Year
.MoveLast
N = !x
.MoveFirst
While Not .EOF
x = !x
y = !Y_Naira_Equiv_of_One_Dollar
sum_xsqr = sum_xsqr + x ^ 2
sumy = sumy + y
sumx = sumx + x
sumxy = sumxy + (x * y)
.MoveNext
Wend
End With
a = Format(((sum_xsqr * sumy) - (sumx * sumxy)) / ((N * sum_xsqr) - (sumx ^ 2)),
"#0.00")
B = Format(((N * sumxy) - (sumx * sumy)) / ((N * sum_xsqr) - (sumx ^ 2)), "#0.00")

End Sub

Private Sub Text10_Change()
```

```
End Sub
Private Sub HScroll1_Change()
''stop
DisplayMe.Left = HScroll1.Value * -1
End Sub
Private Sub VScroll1_Change()
''stop
DisplayMe.Top = VScroll1.Value * -1
End Sub
Private Sub RgtAlig(Txt As String)
 DisplayMe.CurrentX = (8 * Inch - (DisplayMe.TextWidth(Txt)))
 DisplayMe.Print Txt
End Sub


'Option Explicit
Dim a As Double
Dim B As Double
Dim Iy As Integer
Dim InitialY
Dim Mynyear As Integer
Dim Nyear As Integer
Dim MBI As Double
Dim MSI As Double
Dim ITMoney As Double
Const Inch = 1440
Private Sub cmdclose_Click()
Unload Me
End Sub

Private Sub cmdsave_Click()
Set myrecordset1 = mydatabase.OpenRecordset("SystemImprovementFund")
With myrecordset1
   If .RecordCount > 0 Then
      .Edit
   Else
      .AddNew
   End If
   !TMOney = Val(TMOney)
   !PFMoney = Val(PFMoney)
   !PDMoney = Val(PDMoney)
   !EQFMoney = Val(EQFMoney)
   !EQDMoney = Val(EQDMoney)
   !ENFMoney = Val(ENFMoney)
   !ENDMoney = Val(ENDMoney)
   !RFMoney = Val(RFMoney)
   !RDMoney = Val(RDMoney)
```

```
  .Update
End With

Set myrecordset1 = mydatabase.OpenRecordset("PSystemImprovementFund")
With myrecordset1
  If .RecordCount > 0 Then
    .Edit
  Else
    .AddNew
  End If
  !PTMoney = Val(PTMoney)
  !PPFMoney = Val(PPFMoney)
  !PPDMoney = Val(PPDMoney)
  !PEQFMoney = Val(PEQFMoney)
  !PEQDMoney = Val(PEQDMoney)
  !PENFMoney = Val(PENFMoney)
  !PENDMoney = Val(PENDMoney)
  !PRFMoney = Val(PRFMoney)
  !PRDMoney = Val(PRDMoney)
  .Update
  Call MsgBox("Updated Successfully", vbOKOnly + vbInformation, App.Title)
End With

End Sub



'Payment Plan computation starts here

Private Sub Command1_Click()
On Error Resume Next
Dim MyFlag, MyFlag2 As Boolean
MyFlag = False
 InitInstalPay = MSI / Mynyear
 'msgbox Mynyear
  'msgbox "initial pay =" & InitInstalPay

 'InitInstalPay = InitInstalPay * 1 / 0.94242899925

Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlanTotal")
With myrecordset1
While Not .EOF
  .Delete
  .MoveNext
Wend
End With

Set myrecordset1 = mydatabase.OpenRecordset("MachineBuildResLevel")
With myrecordset1
```

```
If .RecordCount > 0 Then .MoveNext
While Not .EOF
  .Delete
  .MoveNext
Wend
End With
DisplayMe.Cls
DisplayMe.Print Tab(2); "Year"; Tab(12); "Total Amount"; Tab(28); "Pers. Fab.";
Tab(42); "Pers. Degn."; Tab(56); "Equip. Fab."; Tab(69); "Equip. Degn."; Tab(85);
"Energy Fab."; Tab(99); "Energy. Degn."; Tab(115); "Raw Mat. Fab."; Tab(133); "Raw
Mat. Degn."
DisplayMe.Print Tab(2); String(140, "=")

'Exit Sub
Call Variation_Trend
Syear = startyear

Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlan")
smallest1 = 500000000
With myrecordset1
For j = 0 To 8
If (smallest1 >= .Fields(j)) And (.Fields(j) <> 0) Then
smallest1 = .Fields(j)
End If
Next
'      !ITMoney = Val(ITMoney)
      OIPFMoney = !IPFMoney
      OIPDMoney = !IPDMoney
      OIEQFMoney = !IEQFMoney
      OIEQDMoney = !IEQDMoney
      OIENFMoney = !IENFMoney
      OIENDMoney = !IENDMoney
      OIRFMoney = !IRFMoney
      OIRDMoney = !IRDMoney


  ITMoney = InitInstalPay
  WIPFMoney = !IPFMoney / smallest1: WIPDMoney = !IPDMoney / smallest1
  WIEQFMoney = !IEQFMoney / smallest1: WIEQDMoney = !IEQDMoney /
smallest1
  WIENFMoney = !IENFMoney / smallest1: WIENDMoney = !IENDMoney /
smallest1
  WIRFMoney = !IRFMoney / smallest1: WIRDMoney = !IRDMoney / smallest1
End With

Set myrecordset1 = mydatabase.OpenRecordset("MachineBuildResLevel")
smallest2 = 5000000000#
With myrecordset1
```

```
For j = 12 To 19
If (smallest2) >= .Fields(j) And (.Fields(j) <> 0) Then
'stop
smallest2 = .Fields(j)
End If
Next

   MWErrRealMPF = !ErrRealMPF / smallest2: MWErrRealMPD = !ErrRealMPD /
smallest2
   MWErrRealFEF = !ErrRealFEF / smallest2: MWErrRealFED = !ErrRealFED /
smallest2
   MWErrRealQEF = !ErrRealQEF / smallest2: MWErrRealQED = !ErrRealQED /
smallest2
   MWErrRealQRD = !ErrRealQRD / smallest2: MWErrRealQRF = !ErrRealQRF /
smallest2

   SumMachErr = WIPFMoney * MWErrRealMPF + WIPDMoney * MWErrRealMPD
+ WIEQFMoney *
   MWErrRealFEF + WIEQDMoney * MWErrRealFED + WIENFMoney *
MWErrRealQEF + WIENDMoney *
   MWErrRealQED + WIRFMoney * MWErrRealQRD + WIRDMoney *
MWErrRealQRF

   IPFMoney = ((WIPFMoney * MWErrRealMPF) / SumMachErr) * InitInstalPay
   AdapIPFMoney = IPFMoney / OIPFMoney
   NRealMPF = !RealMPF + AdapIPFMoney
   NErrRealMBF = !HighResLev - NRealMPF


   IPDMoney = ((WIPDMoney * MWErrRealMPD) / SumMachErr) * InitInstalPay
   AdapIPDMoney = IPDMoney / OIPFMoney
   NRealMPD = !RealMPD + AdapIPDMoney
   NErrRealMPD = !HighResLev - NRealMPD

   IEQFMoney = ((WIEQFMoney * MWErrRealFEF) / SumMachErr) * InitInstalPay
   AdapIEQFMoney = IEQFMoney / OIEQFMoney
   NRealFEF = !RealFEF + AdapIEQFMoney
   NErrRealFEF = !HighResLev - NRealFEF

   IEQDMoney = ((WIEQDMoney * MWErrRealFED) / SumMachErr) * InitInstalPay
   AdapIEQDMoney = IEQDMoney / OIEQFMoney
   NRealFED = !RealFED + AdapIEQDMoney
   NErrRealFED = !HighResLev - NRealFED

   IENFMoney = ((WIENFMoney * MWErrRealQEF) / SumMachErr) * InitInstalPay
   AdapIENFMoney = IENFMoney / OIENFMoney
   NRealQEF = !RealQEF + AdapIENFMoney
   NErrRealQEF = !HighResLev - NRealQEF
```

```
  IENDMoney = ((WIENDMoney * MWErrRealQED) / SumMachErr) * InitInstalPay
  AdapIENDMoney = IENDMoney / OIENDMoney
  NRealQED = !RealQED + AdapIENDMoney
  NErrRealQED = !HighResLev - NRealQED

  IRFMoney = ((WIRFMoney * MWErrRealQRF) / SumMachErr) * InitInstalPay
  AdapIRFMoney = IRFMoney / OIRFMoney
  NRealQRF = !RealQRF + AdapIRFMoney
  NErrRealQRF = !HighResLev - NRealQRF

  IRDMoney = ((WIRDMoney * MWErrRealQRD) / SumMachErr) * InitInstalPay
  AdapIRDMoney = IRDMoney / OIRDMoney
  NRealQRD = !RealQRD + AdapIRDMoney
  NErrRealQRD = !HighResLev - NRealQRD


  MBuildF = (Val(NRealMPF) + Val(NRealFEF) + Val(NRealQEF) +
Val(NRealQRF)) / 4
  MBuildD = (Val(NRealMPD) + Val(NRealFED) + Val(NRealQED) +
Val(NRealQRD)) / 4
  MBuild = (Val(MBuildF) + Val(MBuildD)) / 2
  THigh = !HighResLev

  Totalerr = Val(NErrRealMPF) + Val(NErrRealMPD) + Val(NErrRealFEF) +
Val(NErrRealFED) + Val(NErrRealQEF) + Val(NErrRealQED) + Val(NErrRealQRF)
+ Val(NErrRealQRD)


  WErrRealMPF = Format(Val(NErrRealMPF) / Val(Totalerr), "#0.0000")
  WErrRealMPD = Val(NErrRealMPD) / Val(Totalerr)
  WErrRealFEF = Val(NErrRealFEF) / Val(Totalerr)
  WErrRealFED = Val(NErrRealFED) / Val(Totalerr)
  WErrRealQEF = Format(Val(NErrRealQEF) / Val(Totalerr), "#0.0000")
  'stop
  WErrRealQED = Val(NErrRealQED) / Val(Totalerr)
  WErrRealQRF = Val(NErrRealQRF) / Val(Totalerr)
  WErrRealQRD = Val(NErrRealQRD) / Val(Totalerr)

Set myrecordset3 = mydatabase.OpenRecordset("MachineBuildResLevel")
With myrecordset3
  .AddNew
  !RealMPF = Val(NRealMPF): !RealMPD = Val(NRealMPD): !RealFEF =
Val(NRealFEF)
  !RealFED = Val(NRealFED): !RealQEF = Val(NRealQEF): !RealQED =
Val(NRealQED)
  !RealQRD = Val(NRealQRD): !RealQRF = Val(NRealQRF): !MBuildF =
Val(MBuildF)
```

```
   !MBuildD = Val(MBuildD): !MBuild = Val(MBuild)
   !HighResLev = THigh

   !ErrRealMPF = Val(NErrRealMPF): !ErrRealMPD =
Val(NErrRealMPD): !ErrRealFEF = Val(NErrRealFEF)
   !ErrRealFED = Val(NErrRealFED): !ErrRealQEF =
Val(NErrRealQEF): !ErrRealQED = Val(NErrRealQED)
   !ErrRealQRD = Val(NErrRealQRD): !ErrRealQRF = Val(NErrRealQRF)
   !Totalerr = Val(Totalerr)
   !WErrRealMPF = Val(WErrRealMPF): !WErrRealMPD =
Val(WErrRealMPD): !WErrRealFEF = Val(WErrRealFEF)
   !WErrRealFED = Val(WErrRealFED): !WErrRealQEF =
Val(WErrRealQEF): !WErrRealQED = Val(WErrRealQED)
   !WErrRealQRD = Val(WErrRealQRD): !WErrRealQRF = Val(WErrRealQRF)
   'stop
   !Year = Syear
   'stop
   .Update
  .Close
End With
End With

Syear = startyear
DisplayMe.Print Tab(2); Syear; Tab(12); Format(ITMoney, "#0.00"); Tab(28);
Format(IPFMoney, "#0.00"); Tab(42); Format(IPDMoney, "#0.00"); Tab(56);
Format(IEQFMoney, "#0.00"); Tab(69); Format(IEQDMoney, "#0.00"); Tab(85);
Format(IENFMoney, "#0.00"); Tab(99); Format(IENDMoney, "#0.00"); Tab(115);
Format(IRFMoney, "#0.00"); Tab(133); Format(IRDMoney, "#0.00")
Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlanTotal")
With myrecordset1
   .AddNew
      !ITMoney = Val(ITMoney)
      !IPFMoney = Val(IPFMoney)
      !IPDMoney = Val(IPDMoney)
      !IEQFMoney = Val(IEQFMoney)
      !IEQDMoney = Val(IEQDMoney)
      !IENFMoney = Val(IENFMoney)
      !IENDMoney = Val(IENDMoney)
      !IRFMoney = Val(IRFMoney)
      !IRDMoney = Val(IRDMoney)
      !Syear = Syear
   .Update
   .Close
End With


Nyear = 29
Yearcount = Nyear
```

```
NextYear = Syear

   y = a + B * (Nyear)
   InitialY = y

'msgbox "Initia Y " & InitialY

'Exit Sub
'Stop
Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlanTotal")
With myrecordset1
For j = 2 To Mynyear
If j = Mynyear Then
'msgbox "This is the last Iteration"
''stop
End If
   Yearcount = Yearcount + 1
   NextYear = NextYear + 1
   y = a + B * (Yearcount)
   ITMoney = ITMoney * y / InitialY
   InitInstalPay = ITMoney
 'newly inserted
 InitialY = y
''stop


Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlan")
smallest1 = 500000000

With myrecordset1
.Move j - 1


For m = 0 To 8
If (smallest1 >= .Fields(m)) And (.Fields(m) <> 0) Then
smallest1 = .Fields(m)
End If
Next

''stop
'       !ITMoney = Val(ITMoney)
       OIPFMoney = !IPFMoney
       OIPDMoney = !IPDMoney
       OIEQFMoney = !IEQFMoney
       OIEQDMoney = !IEQDMoney
       OIENFMoney = !IENFMoney
       OIENDMoney = !IENDMoney
       OIRFMoney = !IRFMoney
```

```
    OIRDMoney = !IRDMoney

  ITMoney = ITMoney

  WIPFMoney = !IPFMoney / smallest1: WIPDMoney = !IPDMoney / smallest1
  WIEQFMoney = !IEQFMoney / smallest1: WIEQDMoney = !IEQDMoney /
smallest1
  WIENFMoney = !IENFMoney / smallest1: WIENDMoney = !IENDMoney /
smallest1
  WIRFMoney = !IRFMoney / smallest1: WIRDMoney = !IRDMoney / smallest1
End With

Syear = Syear + 1
Spreadrest:

'Machine tool Building Resource Level
Set myrecordset1 = mydatabase.OpenRecordset("MachineBuildResLevel")
smallest2 = 5000000000#
Tsmallest2 = smallest2
With myrecordset1
''msgbox "value of j = " & j
'Stop
If MyFlag = True Then
'msgbox "check what is happening here"
'Stop
  .MoveLast
  '.Move j
Else
.MoveLast
'.Move j - 1
End If
For m = 12 To 19
''msgbox .Fields(m)
If (smallest2) >= .Fields(m) And (.Fields(m) <> 0) Then
''stop
smallest2 = .Fields(m)
End If
Next

If smallest2 = Tsmallest2 Then
  smallest2 = 0
End If

  MWErrRealMPF = !ErrRealMPF / smallest2: MWErrRealMPD = !ErrRealMPD /
smallest2

  MWErrRealFEF = !ErrRealFEF / smallest2: MWErrRealFED = !ErrRealFED /
smallest2
```

```
   MWErrRealQEF = !ErrRealQEF / smallest2: MWErrRealQED = !ErrRealQED /
smallest2
   MWErrRealQRD = !ErrRealQRD / smallest2: MWErrRealQRF = !ErrRealQRF /
smallest2

   SumMachErr = WIPFMoney * MWErrRealMPF + WIPDMoney * MWErrRealMPD
+ WIEQFMoney * _
   MWErrRealFEF + WIEQDMoney * MWErrRealFED + WIENFMoney *
MWErrRealQEF + WIENDMoney * _
   MWErrRealQED + WIRFMoney * MWErrRealQRD + WIRDMoney *
MWErrRealQRF

  If !HighResLev = 1 Then
' Stop
  End If


   IPFMoney = ((WIPFMoney * MWErrRealMPF) / SumMachErr) * InitInstalPay

   If (!RealMPF = !HighResLev) And (!HighResLev = 1) Then
  ' Stop
     Exit Sub
   End If

   AdapIPFMoney = IPFMoney / OIPFMoney
   NRealMPF = !RealMPF + AdapIPFMoney

   If NRealMPF >= !HighResLev Then
   ITMoneyHold = 0
   MyFlag = True
'   Stop
   TIPFMoney = (!HighResLev - !RealMPF) / AdapIPFMoney * IPFMoney
   ITMoneyHold = ITMoneyHold + TIPFMoney
   TAdapIPFMoney = TIPFMoney / OIPFMoney
   TNRealMPF = !RealMPF + TAdapIPFMoney
   TNErrRealMPF = !HighResLev - TNRealMPF
   'Stop

   If TNErrRealMPF >= 0 Then
   MyFlag2 = True
   Else
   MyFlag2 = False
   End If

   Else
   MyFlag = False
   NErrRealMPF = !HighResLev - NRealMPF
   End If
```

```
IPDMoney = ((WIPDMoney * MWErrRealMPD) / SumMachErr) * InitInstalPay
AdapIPDMoney = IPDMoney / OIPFMoney
NRealMPD = !RealMPD + AdapIPDMoney

If NRealMPD >= !HighResLev Then
MyFlag = True
TIPDMoney = (!HighResLev - !RealMPD) / AdapIPDMoney * IPDMoney
ITMoneyHold = ITMoneyHold + TIPDMoney
TAdapIPDMoney = TIPDMoney / OIPFMoney
TNRealMPD = !RealMPD + TAdapIPDMoney
TNErrRealMPD = !HighResLev - TNRealMPD

If TNErrRealMPD >= 0 Then
MyFlag2 = True
Else
MyFlag2 = False
End If

Else
MyFlag = False
NErrRealMPD = !HighResLev - NRealMPD
End If

IEQFMoney = ((WIEQFMoney * MWErrRealFEF) / SumMachErr) * InitInstalPay
AdapIEQFMoney = IEQFMoney / OIEQFMoney
NRealFEF = !RealFEF + AdapIEQFMoney

If NRealFEF >= !HighResLev Then
MyFlag = True
TIEQFMoney = (!HighResLev - !RealFEF) / AdapIEQFMoney * IEQFMoney
ITMoneyHold = ITMoneyHold + TIEQFMoney
TAdapIEQFMoney = TIEQFMoney / OIEQFMoney
TNRealFEF = !RealFEF + TAdapIEQFMoney
TNErrRealFEF = !HighResLev - TNRealFEF
'msgbox "New Level " & TNRealFEF
'msgbox "Total Error" & TNErrRealFEF

If TNErrRealFEF >= 0 Then
MyFlag2 = True
Else
MyFlag2 = False
End If

Else
MyFlag = False
NErrRealFEF = !HighResLev - NRealFEF
End If
```

```
IEQDMoney = ((WIEQDMoney * MWErrRealFED) / SumMachErr) * InitInstalPay
AdapIEQDMoney = IEQDMoney / OIEQFMoney
NRealFED = !RealFED + AdapIEQDMoney

If NRealFED >= !HighResLev Then
"  Stop
MyFlag = True
TIEQDMoney = (!HighResLev - !RealFED) / AdapIEQDMoney * IEQDMoney
ITMoneyHold = ITMoneyHold + TIEQDMoney
TAdapIEQDMoney = TIEQDMoney / OIEQFMoney
TNRealFED = !RealFED + IIf(TAdapIEQDMoney <> Empty, TAdapIEQDMoney,
0)
'  Stop
TNErrRealFED = !HighResLev - TNRealFED

If TNErrRealFED >= 0 Then
MyFlag2 = True
Else
MyFlag2 = False
End If

Else
MyFlag = False
NErrRealFED = !HighResLev - NRealFED
End If

IENFMoney = ((WIENFMoney * MWErrRealQEF) / SumMachErr) * InitInstalPay
AdapIENFMoney = IENFMoney / OIENFMoney
NRealQEF = !RealQEF + AdapIENFMoney

If NRealQEF >= !HighResLev Then
Flag = True
TIENFMoney = (!HighResLev - !RealQEF) / AdapIENFMoney * IENFMoney
ITMoneyHold = ITMoneyHold + TIENFMoney
TAdapIENFMoney = TIENFMoney / OIENFMoney
TNRealQEF = !RealQEF + Val(TAdapIENFMoney)
TNErrRealQEF = !HighResLev - TNRealQEF

If TNErrRealQEF >= 0 Then
MyFlag2 = True
Else
MyFlag2 = False
End If

Else
MyFlag = False
NErrRealQEF = !HighResLev - NRealQEF
```

```
End If

IENDMoney = ((WIENDMoney * MWErrRealQED) / SumMachErr) * InitInstalPay
AdapIENDMoney = IENDMoney / OIENDMoney
NRealQED = !RealQED + AdapIENDMoney

If NRealQED >= !HighResLev Then
Flag = True
TIENDMoney = (!HighResLev - !RealQED) / AdapIENDMoney * IENDMoney
ITMoneyHold = ITMoneyHold + TIENDMoney
TAdapIENDMoney = TIENDMoney / OIENDMoney
TNRealQED = !RealQED + TAdapIENDMoney
TNErrRealQED = !HighResLev - TNRealQEF

If TNErrRealQED >= 0 Then
MyFlag2 = True
Else
MyFlag2 = False
End If

Else
MyFlag = False
NErrRealQED = !HighResLev - NRealQED
End If

IRFMoney = ((WIRFMoney * MWErrRealQRF) / SumMachErr) * InitInstalPay
AdapIRFMoney = IRFMoney / OIRFMoney
NRealQRF = !RealQRF + AdapIRFMoney

If NRealQRF >= !HighResLev Then
MyFlag = True
TIRFMoney = (!HighResLev - !RealQRF) / AdapIRFMoney * IRFMoney
ITMoneyHold = ITMoneyHold + TIRFMoney
TAdapIRFMoney = TIRFMoney / OIRFMoney
TNRealQRF = !RealQRF + TAdapIRFMoney
TNErrRealQRF = !HighResLev - TNRealQRF

If TNErrRealQRF >= 0 Then
MyFlag2 = True
Else
MyFlag2 = False
End If

Else
MyFlag = False
NErrRealQRF = !HighResLev - NRealQRF
End If
```

```
IRDMoney = ((WIRDMoney * MWErrRealQRD) / SumMachErr) * InitInstalPay
AdapIRDMoney = IRDMoney / OIRDMoney
NRealQRD = !RealQRD + AdapIRDMoney

If NRealQRD >= !HighResLev Then
MyFlag = True
TIRDMoney = (!HighResLev - !RealQRD) / AdapIRDMoney * IRDMoney
ITMoneyHold = ITMoneyHold + TIRDMoney
TAdapIRDMoney = TIRDMoney / OIRDMoney
TNRealQRD = !RealQRD + TAdapIRDMoney
TNErrRealQRD = !HighResLev - TNRealQRD

If TNErrRealQRD >= 0 Then
MyFlag2 = True
Else
MyFlag2 = False
End If

Else
MyFlag = False
NErrRealQRD = !HighResLev - NRealQRD
End If
' Stop
If (MyFlag = True) And (MyFlag2 = True) Then
'Stop
    MBuildF = (Val(TNRealMPF) + Val(TNRealFEF) + Val(TNRealQEF) +
Val(TNRealQRF)) / 4
    MBuildD = (Val(TNRealMPD) + Val(TNRealFED) + Val(TNRealQED) +
Val(TNRealQRD)) / 4
    MBuild = (Val(MBuildF) + Val(MBuildD)) / 2
    THigh = 1
    UniformError = THigh - !HighResLev
    TNErrRealMPF = UniformError: TNErrRealMPD = UniformError:
TNErrRealFEF = UniformError
    TNErrRealFED = UniformError: TNErrRealQEF = UniformError:
TNErrRealQED = UniformError:
    TNErrRealQRF = UniformError: TNErrRealQRD = UniformError

'    'stop
    'Resource Error
    ''stop

    Totalerr = Val(TNErrRealMPF) + Val(TNErrRealMPD) + Val(TNErrRealFEF) +
Val(TNErrRealFED) + Val(TNErrRealQEF) + Val(TNErrRealQED) +
Val(TNErrRealQRF) + Val(TNErrRealQRD)
'    'stop
    'Weighted Error
```

```
    WErrRealMPF = Format(Val(TNErrRealMPF) / Val(Totalerr), "#0.0000")
    WErrRealMPD = Val(TNErrRealMPD) / Val(Totalerr)
    WErrRealFEF = Val(TNErrRealFEF) / Val(Totalerr)
    WErrRealFED = Val(TNErrRealFED) / Val(Totalerr)
    WErrRealQEF = Format(Val(TNErrRealQEF) / Val(Totalerr), "#0.0000")
'   'stop
    WErrRealQED = Val(TNErrRealQED) / Val(Totalerr)
    WErrRealQRF = Val(TNErrRealQRF) / Val(Totalerr)
    WErrRealQRD = Val(TNErrRealQRD) / Val(Totalerr)
  Else
  ' Stop
    MBuildF = (Val(NRealMPF) + Val(NRealFEF) + Val(NRealQEF) +
Val(NRealQRF)) / 4
    MBuildD = (Val(NRealMPD) + Val(NRealFED) + Val(NRealQED) +
Val(NRealQRD)) / 4
    MBuild = (Val(MBuildF) + Val(MBuildD)) / 2
    THigh = !HighResLev

'    'stop
    'Resource Error
    ''stop
    Totalerr = Val(NErrRealMPF) + Val(NErrRealMPD) + Val(NErrRealFEF) +
Val(NErrRealFED) + Val(NErrRealQEF) + Val(NErrRealQED) + Val(NErrRealQRF)
+ Val(NErrRealQRD)
    ''stop
    'Weighted Error

    WErrRealMPF = Format(Val(NErrRealMPF) / Val(Totalerr), "#0.0000")
    WErrRealMPD = Val(NErrRealMPD) / Val(Totalerr)
    WErrRealFEF = Val(NErrRealFEF) / Val(Totalerr)
    WErrRealFED = Val(NErrRealFED) / Val(Totalerr)
    WErrRealQEF = Format(Val(NErrRealQEF) / Val(Totalerr), "#0.0000")
'   'stop
    WErrRealQED = Val(NErrRealQED) / Val(Totalerr)
    WErrRealQRF = Val(NErrRealQRF) / Val(Totalerr)
    WErrRealQRD = Val(NErrRealQRD) / Val(Totalerr)
  End If

Set myrecordset3 = mydatabase.OpenRecordset("MachineBuildResLevel")
With myrecordset3
  .AddNew
If MyFlag = True Then

  !RealMPF = Val(TNRealMPF): !RealMPD = Val(TNRealMPD): !RealFEF =
Val(TNRealFEF)
  !RealFED = Val(TNRealFED): !RealQEF = Val(TNRealQEF): !RealQED =
Val(TNRealQED)
```

```
   !RealQRD = Val(TNRealQRD): !RealQRF = Val(TNRealQRF): !MBuildF =
Val(MBuildF)
   !MBuildD = Val(MBuildD): !MBuild = Val(MBuild)
   !HighResLev = 1#

   !ErrRealMPF = Val(TNErrRealMPF): !ErrRealMPD =
Val(TNErrRealMPD): !ErrRealFEF = Val(TNErrRealFEF)
   !ErrRealFED = Val(TNErrRealFED): !ErrRealQEF =
Val(TNErrRealQEF): !ErrRealQED = Val(TNErrRealQED)
   !ErrRealQRD = Val(TNErrRealQRD): !ErrRealQRF = Val(TNErrRealQRF)
   !Totalerr = Val(Totalerr)

   !WErrRealMPF = Val(WErrRealMPF): !WErrRealMPD =
Val(WErrRealMPD): !WErrRealFEF = Val(WErrRealFEF)
   !WErrRealFED = Val(WErrRealFED): !WErrRealQEF =
Val(WErrRealQEF): !WErrRealQED = Val(WErrRealQED)
   !WErrRealQRD = Val(WErrRealQRD): !WErrRealQRF = Val(WErrRealQRF)
Else
   !RealMPF = Val(NRealMPF): !RealMPD = Val(NRealMPD): !RealFEF =
Val(NRealFEF)
   !RealFED = Val(NRealFED): !RealQEF = Val(NRealQEF): !RealQED =
Val(NRealQED)
   !RealQRD = Val(NRealQRD): !RealQRF = Val(NRealQRF): !MBuildF =
Val(MBuildF)
   !MBuildD = Val(MBuildD): !MBuild = Val(MBuild)
   !HighResLev = THigh

   !ErrRealMPF = Val(NErrRealMPF): !ErrRealMPD =
Val(NErrRealMPD): !ErrRealFEF = Val(NErrRealFEF)
   !ErrRealFED = Val(NErrRealFED): !ErrRealQEF =
Val(NErrRealQEF): !ErrRealQED = Val(NErrRealQED)
   !ErrRealQRD = Val(NErrRealQRD): !ErrRealQRF = Val(NErrRealQRF)
   !Totalerr = Val(Totalerr)
   !WErrRealMPF = Val(WErrRealMPF): !WErrRealMPD =
Val(WErrRealMPD): !WErrRealFEF = Val(WErrRealFEF)
   !WErrRealFED = Val(WErrRealFED): !WErrRealQEF =
Val(WErrRealQEF): !WErrRealQED = Val(WErrRealQED)
   !WErrRealQRD = Val(WErrRealQRD): !WErrRealQRF = Val(WErrRealQRF)
End If
   !Year = Syear
   .Update
   .Close
End With
''stop
End With


If MyFlag = True Then
```

```
"stop
DisplayMe.Print Tab(2); Syear; Tab(12); Format(ITMoneyHold, "#0.00"); Tab(28);
Format(TIPFMoney, "#0.00"); Tab(42); Format(TIPDMoney, "#0.00"); Tab(56);
Format(TIEQFMoney, "#0.00"); Tab(69); Format(TIEQDMoney, "#0.00"); Tab(85);
Format(TIENFMoney, "#0.00"); Tab(99); Format(TIENDMoney, "#0.00"); Tab(115);
Format(TIRFMoney, "#0.00"); Tab(133); Format(TIRDMoney, "#0.00")
Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlanTotal")
With myrecordset1
   .AddNew
      !ITMoney = Val(ITMoneyHold)
      !IPFMoney = Val(TIPFMoney)
      !IPDMoney = Val(TIPDMoney)
      !IEQFMoney = Val(TIEQFMoney)
      !IEQDMoney = Val(TIEQDMoney)
      !IENFMoney = Val(TIENFMoney)
      !IENDMoney = Val(TIENDMoney)
      !IRFMoney = Val(TIRFMoney)
      !IRDMoney = Val(TIRDMoney)
      !Syear = Syear
   .Update
   .Close
End With

InitInstalPay = InitInstalPay - ITMoneyHold


GoTo Spreadrest
Exit Sub
Else
DisplayMe.Print Tab(2); Syear; Tab(12); Format(InitInstalPay, "#0.00"); Tab(28);
Format(IPFMoney, "#0.00"); Tab(42); Format(IPDMoney, "#0.00"); Tab(56);
Format(IEQFMoney, "#0.00"); Tab(69); Format(IEQDMoney, "#0.00"); Tab(85);
Format(IENFMoney, "#0.00"); Tab(99); Format(IENDMoney, "#0.00"); Tab(115);
Format(IRFMoney, "#0.00"); Tab(133); Format(IRDMoney, "#0.00")
Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlanTotal")
With myrecordset1
   .AddNew
      !ITMoney = Val(InitInstalPay)
      !IPFMoney = Val(IPFMoney)
      !IPDMoney = Val(IPDMoney)
      !IEQFMoney = Val(IEQFMoney)
      !IEQDMoney = Val(IEQDMoney)
      !IENFMoney = Val(IENFMoney)
      !IENDMoney = Val(IENDMoney)
      !IRFMoney = Val(IRFMoney)
      !IRDMoney = Val(IRDMoney)
      !Syear = Syear
   .Update
```

```
   .Close
End With

End If


Next
End With
End Sub

Private Sub Command2_Click()
Unload Me
SystemImproveFund.Show
End Sub

Private Sub Command3_Click()
 InitInstalPay = MSI / Mynyear
 'msgbox Mynyear
   'msgbox "initial pay =" & InitInstalPay

Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlanTotal")
With myrecordset1
While Not .EOF
   .Delete
   .MoveNext
Wend
End With
DisplayMe.Cls
DisplayMe.Print Tab(2); "Year"; Tab(12); "Total Amount"; Tab(28); "Pers. Fab.";
Tab(42); "Pers. Degn."; Tab(56); "Equip. Fab."; Tab(69); "Equip. Degn."; Tab(85);
"Energy Fab."; Tab(99); "Energy. Degn."; Tab(115); "Raw Mat. Fab."; Tab(133); "Ra
Mat. Degn."
DisplayMe.Print Tab(2); String(140, "=")

'Exit Sub
Call Variation_Trend

Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlan")
smallest1 = 500000000
With myrecordset1
For j = 0 To 8
If (smallest1 >= .Fields(j)) And (.Fields(j) <> 0) Then
smallest1 = .Fields(j)
End If
Next
'      !ITMoney = Val(ITMoney)
      OIPFMoney = !IPFMoney
      OIPDMoney = !IPDMoney
```

```
    OIEQFMoney = !IEQFMoney
    OIEQDMoney = !IEQDMoney
    OIENFMoney = !IENFMoney
    OIENDMoney = !IENDMoney
    OIRFMoney = !IRFMoney
    OIRDMoney = !IRDMoney


  ITMoney = InitInstalPay
  WIPFMoney = !IPFMoney / smallest1: WIPDMoney = !IPDMoney / smallest1
  WIEQFMoney = !IEQFMoney / smallest1: WIEQDMoney = !IEQDMoney /
smallest1
  WIENFMoney = !IENFMoney / smallest1: WIENDMoney = !IENDMoney /
smallest1
  WIRFMoney = !IRFMoney / smallest1: WIRDMoney = !IRDMoney / smallest1
End With

Set myrecordset1 = mydatabase.OpenRecordset("MachineBuildResLevel")
smallest2 = 5000000000#
With myrecordset1
For j = 12 To 19
'msgbox .Fields(j)
If (smallest2) >= .Fields(j) And (.Fields(j) <> 0) Then
'stop
smallest2 = .Fields(j)
End If
Next

  MWErrRealMPF = !ErrRealMPF / smallest2: MWErrRealMPD = !ErrRealMPD /
smallest2
  MWErrRealFEF = !ErrRealFEF / smallest2: MWErrRealFED = !ErrRealFED /
smallest2
  MWErrRealQEF = !ErrRealQEF / smallest2: MWErrRealQED = !ErrRealQED /
smallest2
  MWErrRealQRD = !ErrRealQRD / smallest2: MWErrRealQRF = !ErrRealQRF /
smallest2

  SumMachErr = WIPFMoney * MWErrRealMPF + WIPDMoney * MWErrRealMPD
+ WIEQFMoney * _
  MWErrRealFEF + WIEQDMoney * MWErrRealFED + WIENFMoney *
MWErrRealQEF + WIENDMoney * _
  MWErrRealQED + WIRFMoney * MWErrRealQRD + WIRDMoney *
MWErrRealQRF

  IPFMoney = ((WIPFMoney * MWErrRealMPF) / SumMachErr) * InitInstalPay
  AdapIPFMoney = IPFMoney / OIPFMoney
  NRealMPF = !RealMPF + AdapIPFMoney
  NErrRealMPF = !HighResLev - NRealMPF
```

```
IPDMoney = ((WIPDMoney * MWErrRealMPD) / SumMachErr) * InitInstalPay
AdapIPDMoney = IPDMoney / OIPFMoney
NRealMPD = !RealMPD + AdapIPDMoney
NErrRealMPD = !HighResLev - NRealMPD

IEQFMoney = ((WIEQFMoney * MWErrRealFEF) / SumMachErr) * InitInstalPay
AdapIEQFMoney = IEQFMoney / OIEQFMoney
NRealFEF = !RealFEF + AdapIEQFMoney
NErrRealFEF = !HighResLev - NRealFEF

IEQDMoney = ((WIEQDMoney * MWErrRealFED) / SumMachErr) * InitInstalPay
AdapIEQDMoney = IEQDMoney / OIEQFMoney
NRealFED = !RealFED + IIf(AdapIEQDMoney <> Empty, AdapIEQDMoney, 0)
NErrRealFED = !HighResLev - NRealFED

IENFMoney = ((WIENFMoney * MWErrRealQEF) / SumMachErr) * InitInstalPay
AdapIENFMoney = IENFMoney / OIENFMoney
NRealQEF = !RealQEF + AdapIENFMoney
NErrRealQEF = !HighResLev - NRealQEF

IENDMoney = ((WIENDMoney * MWErrRealQED) / SumMachErr) * InitInstalPay
AdapIENDMoney = IENDMoney / OIENDMoney
NRealQED = !RealQED + AdapIENDMoney
NErrRealQED = !HighResLev - NRealQED

IRFMoney = ((WIRFMoney * MWErrRealQRF) / SumMachErr) * InitInstalPay
AdapIRFMoney = IRFMoney / OIRFMoney
NRealQRF = !RealQRF + AdapIRFMoney
NErrRealQRF = !HighResLev - NRealQRF

IRDMoney = ((WIRDMoney * MWErrRealQRD) / SumMachErr) * InitInstalPay
AdapIRDMoney = IRDMoney / OIRDMoney
NRealQRD = !RealQRD + AdapIRDMoney
NErrRealQRD = !HighResLev - NRealQRD


MBuildF = (Val(NRealMPF) + Val(NRealFEF) + Val(NRealQEF) +
Val(NRealQRF)) / 4
MBuildD = (Val(NRealMPD) + Val(NRealFED) + Val(NRealQED) +
Val(NRealQRD)) / 4
MBuild = (Val(MBuildF) + Val(MBuildD)) / 2
THigh = !HighResLev
'stop
'Resource Error
'msgbox THigh
'stop
```

```
   Totalerr = Val(NErrRealMPF) + Val(NErrRealMPD) + Val(NErrRealFEF) +
Val(NErrRealFED) + Val(NErrRealQEF) + Val(NErrRealQED) + Val(NErrRealQRF)
+ Val(NErrRealQRD)
   'stop
   'msgbox "Total Error " & Totalerr
   'Weighted Error
   'stop

   WErrRealMPF = Format(Val(NErrRealMPF) / Val(Totalerr), "#0.0000")
   WErrRealMPD = Val(NErrRealMPD) / Val(Totalerr)
   WErrRealFEF = Val(NErrRealFEF) / Val(Totalerr)
   WErrRealFED = Val(NErrRealFED) / Val(Totalerr)
   WErrRealQEF = Format(Val(NErrRealQEF) / Val(Totalerr), "#0.0000")
   'stop
   WErrRealQED = Val(NErrRealQED) / Val(Totalerr)
   WErrRealQRF = Val(NErrRealQRF) / Val(Totalerr)
   WErrRealQRD = Val(NErrRealQRD) / Val(Totalerr)

Set myrecordset3 = mydatabase.OpenRecordset("MachineBuildResLevel")
With myrecordset3
   .AddNew
   !RealMPF = Val(NRealMPF): !RealMPD = Val(NRealMPD): !RealFEF =
Val(NRealFEF)
   !RealFED = Val(NRealFED): !RealQEF = Val(NRealQEF): !RealQED =
Val(NRealQED)
   !RealQRD = Val(NRealQRD): !RealQRF = Val(NRealQRF): !MBuildF =
Val(MBuildF)
   !MBuildD = Val(MBuildD): !MBuild = Val(MBuild)
   !HighResLev = THigh

   !ErrRealMPF = Val(NErrRealMPF): !ErrRealMPD =
Val(NErrRealMPD): !ErrRealFEF = Val(NErrRealFEF)
   !ErrRealFED = Val(NErrRealFED): !ErrRealQEF =
Val(NErrRealQEF): !ErrRealQED = Val(NErrRealQED)
   !ErrRealQRD = Val(NErrRealQRD): !ErrRealQRF = Val(NErrRealQRF)
   !Totalerr = Val(Totalerr)
   !WErrRealMPF = Val(WErrRealMPF): !WErrRealMPD =
Val(WErrRealMPD): !WErrRealFEF = Val(WErrRealFEF)
   !WErrRealFED = Val(WErrRealFED): !WErrRealQEF =
Val(WErrRealQEF): !WErrRealQED = Val(WErrRealQED)
   !WErrRealQRD = Val(WErrRealQRD): !WErrRealQRF = Val(WErrRealQRF)
   .Update
  .Close
End With
End With
Syear = startyear
DisplayMe.Print Tab(2); Syear; Tab(12); Format(ITMoney, "#0.00"); Tab(28);
Format(IPFMoney, "#0.00"); Tab(42); Format(IPDMoney, "#0.00"); Tab(56);
```

```
Format(IEQFMoney, "#0.00"); Tab(69); Format(IEQDMoney, "#0.00"); Tab(85);
Format(IENFMoney, "#0.00"); Tab(99); Format(IENDMoney, "#0.00"); Tab(115);
Format(IRFMoney, "#0.00"); Tab(133); Format(IRDMoney, "#0.00")
Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlanTotal")
With myrecordset1
  .AddNew
    !ITMoney = Val(ITMoney)
    !IPFMoney = Val(IPFMoney)
    !IPDMoney = Val(IPDMoney)
    !IEQFMoney = Val(IEQFMoney)
    !IEQDMoney = Val(IEQDMoney)
    !IENFMoney = Val(IENFMoney)
    !IENDMoney = Val(IENDMoney)
    !IRFMoney = Val(IRFMoney)
    !IRDMoney = Val(IRDMoney)
    !Syear = Syear
  .Update
  .Close
End With


Nyear = 29
Yearcount = Nyear
NextYear = Syear

  y = a + B * (Nyear)
  InitialY = y

'msgbox "Initia Y " & InitialY

'Exit Sub

Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlanTotal")
With myrecordset1
For j = 2 To 2 'Mynyear

   Yearcount = Yearcount + 1
   NextYear = NextYear + 1
   y = a + B * (Yearcount)
   ITMoney = ITMoney * y / InitialY

   'msgbox "Total Next Money " & ITMoney

'Payment plan computation starts here
Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlan")
smallest1 = 500000000

With myrecordset1
```

```
.Move j - 1
'msgbox "The next total money" & !ITMoney

For m = 0 To 8
If (smallest1 >= .Fields(m)) And (.Fields(m) <> 0) Then
smallest1 = .Fields(m)
End If
Next
'msgbox "Smallest1 " & smallest1
'stop
        !ITMoney = Val(ITMoney)
        OIPFMoney = !IPFMoney
        OIPDMoney = !IPDMoney
        OIEQFMoney = !IEQFMoney
        OIEQDMoney = !IEQDMoney
        OIENFMoney = !IENFMoney
        OIENDMoney = !IENDMoney
        OIRFMoney = !IRFMoney
        OIRDMoney = !IRDMoney

    ITMoney = ITMoney
    'msgbox "Money to be distributed " & ITMoney
    WIPFMoney = !IPFMoney / smallest1: WIPDMoney = !IPDMoney / smallest1
    WIEQFMoney = !IEQFMoney / smallest1: WIEQDMoney = !IEQDMoney /
smallest1
    WIENFMoney = !IENFMoney / smallest1: WIENDMoney = !IENDMoney /
smallest1
    WIRFMoney = !IRFMoney / smallest1: WIRDMoney = !IRDMoney / smallest1
End With

Set myrecordset1 = mydatabase.OpenRecordset("MachineBuildResLevel")
smallest2 = 5000000000#
With myrecordset1
'msgbox "value of j = " & j
.Move j - 1
For m = 12 To 19
'msgbox .Fields(m)
If (smallest2) >= .Fields(m) And (.Fields(m) <> 0) Then
''stop
smallest2 = .Fields(m)
End If
Next

'msgbox "Smallest2 " & smallest2
  'stop
    MWErrRealMPF = !ErrRealMPF / smallest2: MWErrRealMPD = !ErrRealMPD /
smallest2
```

```
    MWErrRealFEF = !ErrRealFEF / smallest2: MWErrRealFED = !ErrRealFED /
smallest2
    MWErrRealQEF = !ErrRealQEF / smallest2: MWErrRealQED = !ErrRealQED /
smallest2
    MWErrRealQRD = !ErrRealQRD / smallest2: MWErrRealQRF = !ErrRealQRF /
smallest2

    SumMachErr = WIPFMoney * MWErrRealMPF + WIPDMoney * MWErrRealMPD
+ WIEQFMoney * _
    MWErrRealFEF + WIEQDMoney * MWErrRealFED + WIENFMoney *
MWErrRealQEF + WIENDMoney * _
    MWErrRealQED + WIRFMoney * MWErrRealQRD + WIRDMoney *
MWErrRealQRF

    IPFMoney = ((WIPFMoney * MWErrRealMPF) / SumMachErr) * InitInstalPay
    AdapIPFMoney = IPFMoney / OIPFMoney
    NRealMPF = !RealMPF + AdapIPFMoney
    NErrRealMPF = !HighResLev - NRealMPF

    IPDMoney = ((WIPDMoney * MWErrRealMPD) / SumMachErr) * InitInstalPay
    AdapIPDMoney = IPDMoney / OIPFMoney
    NRealMPD = !RealMPD + AdapIPDMoney
    NErrRealMPD = !HighResLev - NRealMPD

    IEQFMoney = ((WIEQFMoney * MWErrRealFEF) / SumMachErr) * InitInstalPay
    AdapIEQFMoney = IEQFMoney / OIEQFMoney
    NRealFEF = !RealFEF + AdapIEQFMoney
    NErrRealFEF = !HighResLev - NRealFEF

    IEQDMoney = ((WIEQDMoney * MWErrRealFED) / SumMachErr) * InitInstalPay
    AdapIEQDMoney = IEQDMoney / OIEQFMoney
    NRealFED = !RealFED + AdapIEQDMoney
    NErrRealFED = !HighResLev - NRealFED

    IENFMoney = ((WIENFMoney * MWErrRealQEF) / SumMachErr) * InitInstalPay
    AdapIENFMoney = IENFMoney / OIENFMoney
    NRealQEF = !RealQEF + AdapIENFMoney
    NErrRealQEF = !HighResLev - NRealQEF

    IENDMoney = ((WIENDMoney * MWErrRealQED) / SumMachErr) * InitInstalPay
    AdapIENDMoney = IENDMoney / OIENDMoney
    NRealQED = !RealQED + AdapIENDMoney
    NErrRealQED = !HighResLev - NRealQED

    IRFMoney = ((WIRFMoney * MWErrRealQRF) / SumMachErr) * InitInstalPay
    AdapIRFMoney = IRFMoney / OIRFMoney
    NRealQRF = !RealQRF + AdapIRFMoney
    NErrRealQRF = !HighResLev - NRealQRF
```

```
   IRDMoney = ((WIRDMoney * MWErrRealQRD) / SumMachErr) * InitInstalPay
   AdapIRDMoney = IRDMoney / OIRDMoney
   NRealQRD = !RealQRD + AdapIRDMoney
   NErrRealQRD = !HighResLev - NRealQRD

'start
   MBuildF = (Val(NRealMPF) + Val(NRealFEF) + Val(NRealQEF) +
Val(NRealQRF)) / 4
   MBuildD = (Val(NRealMPD) + Val(NRealFED) + Val(NRealQED) +
Val(NRealQRD)) / 4
   MBuild = (Val(MBuildF) + Val(MBuildD)) / 2
   THigh = !HighResLev
   'stop
   'Resource Error
   'stop
   Totalerr = Val(NErrRealMPF) + Val(NErrRealMPD) + Val(NErrRealFEF) +
Val(NErrRealFED) + Val(NErrRealQEF) + Val(NErrRealQED) + Val(NErrRealQRF)
+ Val(NErrRealQRD)
   'stop
   'Weighted Error

   WErrRealMPF = Format(Val(NErrRealMPF) / Val(Totalerr), "#0.0000")
   WErrRealMPD = Val(NErrRealMPD) / Val(Totalerr)
   WErrRealFEF = Val(NErrRealFEF) / Val(Totalerr)
   WErrRealFED = Val(NErrRealFED) / Val(Totalerr)
   WErrRealQEF = Format(Val(NErrRealQEF) / Val(Totalerr), "#0.0000")
   'stop
   WErrRealQED = Val(NErrRealQED) / Val(Totalerr)
   WErrRealQRF = Val(NErrRealQRF) / Val(Totalerr)
   WErrRealQRD = Val(NErrRealQRD) / Val(Totalerr)

Set myrecordset3 = mydatabase.OpenRecordset("MachineBuildResLevel")
With myrecordset3
   .AddNew
   !RealMPF = Val(NRealMPF): !RealMPD = Val(NRealMPD): !RealFEF =
Val(NRealFEF)
   !RealFED = Val(NRealFED): !RealQEF = Val(NRealQEF): !RealQED =
Val(NRealQED)
   !RealQRD = Val(NRealQRD): !RealQRF = Val(NRealQRF): !MBuildF =
Val(MBuildF)
   !MBuildD = Val(MBuildD): !MBuild = Val(MBuild)
   !HighResLev = THigh

   !ErrRealMPF = Val(NErrRealMPF): !ErrRealMPD =
Val(NErrRealMPD): !ErrRealFEF = Val(NErrRealFEF)
   !ErrRealFED = Val(NErrRealFED): !ErrRealQEF =
Val(NErrRealQEF): !ErrRealQED = Val(NErrRealQED)
```

```
   !ErrRealQRD = Val(NErrRealQRD): !ErrRealQRF = Val(NErrRealQRF)
   !Totalerr = Val(Totalerr)
   !WErrRealMPF = Val(WErrRealMPF): !WErrRealMPD =
Val(WErrRealMPD): !WErrRealFEF = Val(WErrRealFEF)
   !WErrRealFED = Val(WErrRealFED): !WErrRealQEF =
Val(WErrRealQEF): !WErrRealQED = Val(WErrRealQED)
   !WErrRealQRD = Val(WErrRealQRD): !WErrRealQRF = Val(WErrRealQRF)
   .Update
  .Close
End With
"stop
End With
Syear = Syear + 1
DisplayMe.Print Tab(2); Syear; Tab(12); Format(ITMoney, "#0.00"); Tab(28);
Format(IPFMoney, "#0.00"); Tab(42); Format(IPDMoney, "#0.00"); Tab(56);
Format(IEQFMoney, "#0.00"); Tab(69); Format(IEQDMoney, "#0.00"); Tab(85);
Format(IENFMoney, "#0.00"); Tab(99); Format(IENDMoney, "#0.00"); Tab(115);
Format(IRFMoney, "#0.00"); Tab(133); Format(IRDMoney, "#0.00")
Set myrecordset1 = mydatabase.OpenRecordset("PaymentPlanTotal")
With myrecordset1
   .AddNew
      !ITMoney = Val(ITMoney)
      !IPFMoney = Val(IPFMoney)
      !IPDMoney = Val(IPDMoney)
      !IEQFMoney = Val(IEQFMoney)
      !IEQDMoney = Val(IEQDMoney)
      !IENFMoney = Val(IENFMoney)
      !IENDMoney = Val(IENDMoney)
      !IRFMoney = Val(IRFMoney)
      !IRDMoney = Val(IRDMoney)
      !Syear = Syear
   .Update
   .Close
End With

"stops here
Next
End With

End Sub

Private Sub Command4_Click()
a = Shell("c:\machinetoolscapacitybuilding\book1.xls", vbMaximizedFocus)
End Sub

Private Sub Form_Load()
Me.Top = 0
Initializeform
```

```
Call Initialise

Set myrecordset1 = mydatabase.OpenRecordset("Paymentplan")
With myrecordset1
'Stop
   Mynyear = .RecordCount
End With

Set myrecordset1 = mydatabase.OpenRecordset("PSystemImprovementFund")
With myrecordset1
   MBI = !PTMoney
End With

Set myrecordset1 = mydatabase.OpenRecordset("PSystemImprovementFund")
With myrecordset1
   MBI = !PTMoney
End With

Set myrecordset1 = mydatabase.OpenRecordset("ActualMachCapLevel")
With myrecordset1
   If .RecordCount > 0 Then



   RealMPF = Val(!AFabNPEXT)
   RealMPD = Val(!ADegNPEXT)
   RealFEF = Val(!AFabFEQ)
   RealFED = Val(!ADegFEQ)
   RealQEF = Val(!AFabQEN)
   RealQED = Val(!ADegQEN)
   RealQRF = Val(!AFabQRM)
   RealQRD = Val(!ADegQRM)

   MBuildF = (Val(RealMPF) + Val(RealFEF) + Val(RealQEF) + Val(RealQRF)) / 4
   MBuildD = (Val(RealMPD) + Val(RealFED) + Val(RealQED) + Val(RealQRD)) / 4
   MBuild = (MBuildF + MBuildD) / 2
   End If
End With
'stop
   'msgbox "MBI= " & MBI
   MSI = (100 * MBI * (1 - MBuild)) * 1 / 0.9 '4 '242899925 '* (1 / 0.915)
   'msgbox "machine build cap = " & MBuild
   'msgbox "msi=" & MSI
'stop
End Sub
Private Sub FontSetting(N As String, B As Boolean, I As Boolean, S As Single, C As
Single)
  With DisplayMe
   If N <> "" Then .FontName = N
```

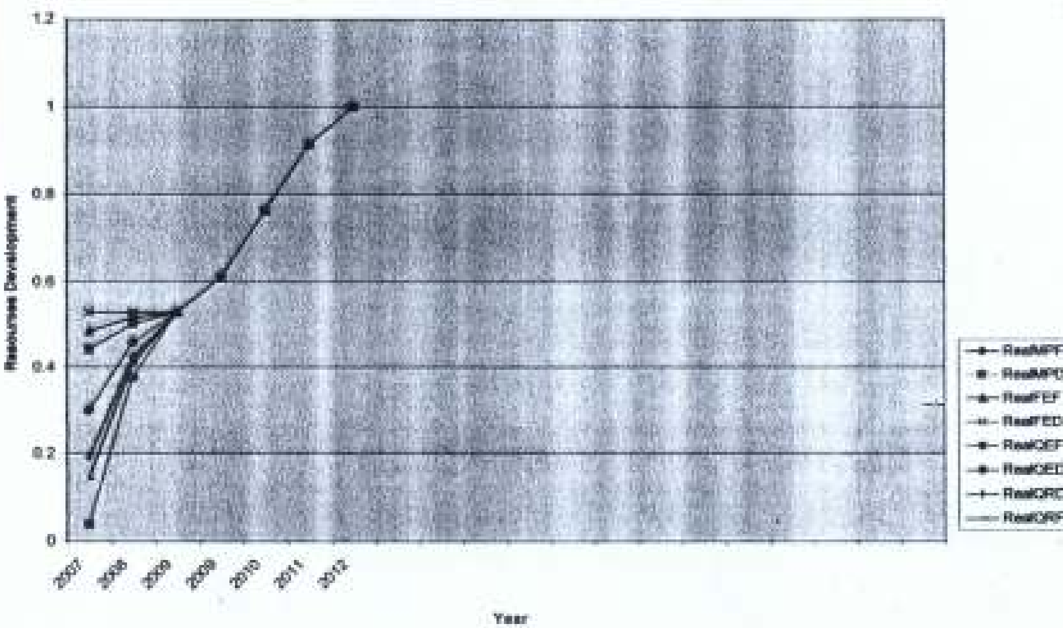
```
  .FontBold = B
  .FontItalic = I
  If S > 0 Then .FontSize = S
  If C >= 0 Then .ForeColor = QBColor(C)
End With
End Sub
Private Sub PFontSetting(N As String, B As Boolean, I As Boolean, S As Single, C As
Single)
 With Printer
  If N <> "" Then .FontName = N
  .FontBold = B
  .FontItalic = I
  If S > 0 Then .FontSize = S
  If C >= 0 Then .ForeColor = QBColor(C)
End With
End Sub
Public Function Compute_Total()
  j = Val(PFMoney) + Val(PDMoney) + Val(EQFMoney) + Val(EQDMoney) +
Val(ENFMoney) + Val(ENDMoney) + Val(RFMoney) + Val(RDMoney)
  Compute_Total = j
End Function

Private Sub PDMoney_Change()
TMOney = Compute_Total
End Sub

Private Sub PFMoney_Change()
TMOney = Compute_Total
End Sub

Private Sub RDMoney_Change()
TMOney = Compute_Total
End Sub
Public Sub HeaderReport()
center "": center "": center ""
FontSetting "Times New Roman", True, True, 18, 0
'center "Seven-Up Bottling Company PLC."
'center "-----------------------------------------"
'
'center "Oluyole Industrial Estate, Moshood Abiola Way Ibadan"
'center "-----------------------------------------------------------------"

center ""
FontSetting "Arial Black", False, False, 12, 0
center "Transportation Cost Table"
center "------------------------------------------------------------------"
center ""
End Sub
```

```
Public Sub PHeaderReport()
PCenter "": PCenter "": PCenter ""
PFontSetting "Times New Roman", False, False, 18, 0

PCenter "Seven-Up Bottling Company PLC,"
PCenter "-------------------------------------------"

PCenter "Oluyole Industrial Estate, Moshood Abiola Way Ibadan"
PCenter "------------------------------------------------------------------------"

DisplayMe.Print
PFontSetting "Arial Black", False, False, 10, 0
PCenter ""
FontSetting "Arial Black", False, False, 12, 0
PCenter "Transportation Cost Table"
PCenter "---------------------------------------------------------------------"
PCenter ""
End Sub
Private Sub XSone(t)
 DisplayMe.CurrentX = t * Inch * 8
End Sub
Private Sub center(ByVal Txt As String)
   DisplayMe.CurrentX = (8 * Inch - (DisplayMe.TextWidth(Txt))) / 2
   DisplayMe.Print Txt
End Sub

'for printer
Private Sub PXSone(t)
 Printer.CurrentX = t * Inch * 8
End Sub
Private Sub PCenter(ByVal Txt As String)
   Printer.CurrentX = (8 * Inch - (Printer.TextWidth(Txt))) / 2
   Printer.Print Txt
End Sub
Private Sub Initializeform()
DisplayMe.Width = 11 * Inch
DisplayMe.Height = 8.5 * Inch
HScroll1.Max = (5 * Inch - (Me.Width * 0.5))
HScroll1.Min = -0.15 * Inch
HScroll1.LargeChange = Inch
HScroll1.SmallChange = Inch / 2
VScroll1.Max = (10 * Inch)
VScroll1.Min = -0.15 * Inch
VScroll1.LargeChange = Inch
VScroll1.SmallChange = Inch / 2
DisplayMe.Left = 15   '0.15 * Inch
DisplayMe.Top = 150 '0.15 * Inch
DisplayMe.BackColor = QBColor(3)
```

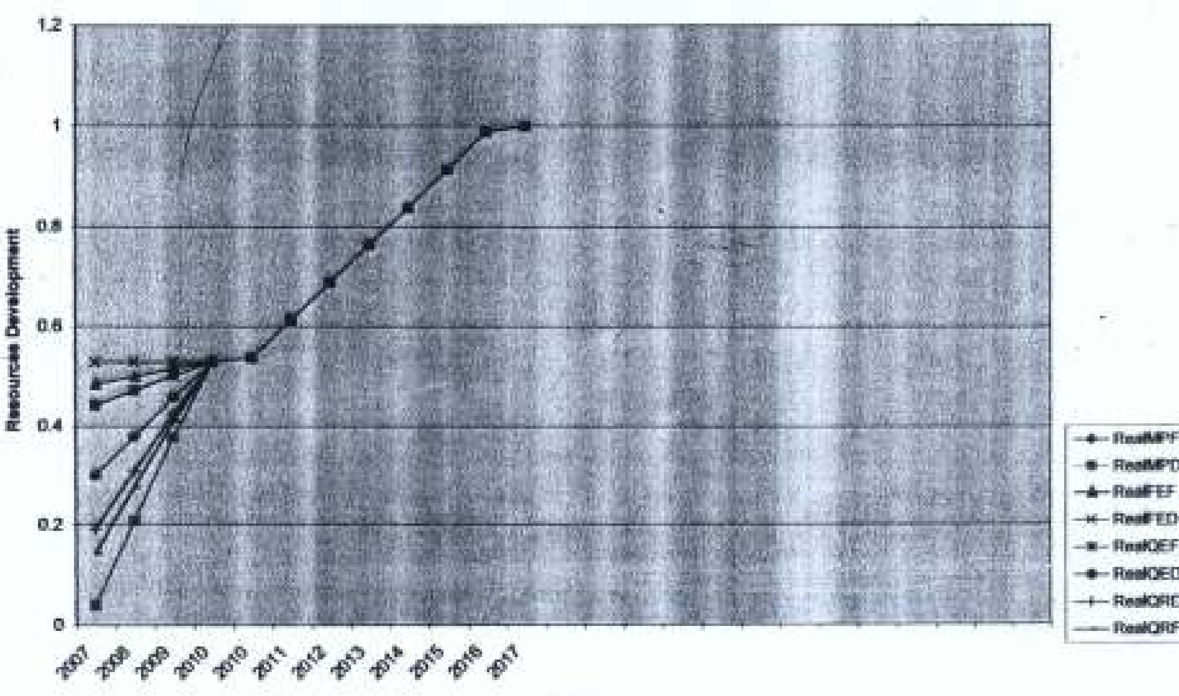
```
'Set Inventory = Workspaces(0).OpenDatabase(App.Path & "\inventory.mdb")
End Sub
Private Sub RFMoney_Change()
TMOney = Compute_Total
End Sub
Public Sub Variation_Trend()
sum_xsqr = 0: sumy = 0: sumx = 0: sumxy = 0
Set myrecordset1 = mydatabase.OpenRecordset("DollarNairaRates")
With myrecordset1
Iy = !Year
.MoveLast
N = !x
.MoveFirst
While Not .EOF
x = !x
y = !Y_Naira_Equiv_of_One_Dollar
sum_xsqr = sum_xsqr + x ^ 2
sumy = sumy + y
sumx = sumx + x
sumxy = sumxy + (x * y)
.MoveNext
Wend
End With
a = Format(((sum_xsqr * sumy) - (sumx * sumxy)) / ((N * sum_xsqr) - (sumx ^ 2)),
"#0.00")
B = Format(((N * sumxy) - (sumx * sumy)) / ((N * sum_xsqr) - (sumx ^ 2)), "#0.00")

End Sub

Private Sub Text10_Change()

End Sub
Private Sub HScroll1_Change()
"stop
DisplayMe.Left = HScroll1.Value * -1
End Sub
Private Sub VScroll1_Change()
"stop
DisplayMe.Top = VScroll1.Value * -1
End Sub
Private Sub RgtAlig(Txt As String)
  DisplayMe.CurrentX = (8 * Inch - (DisplayMe.TextWidth(Txt)))
  DisplayMe.Print Txt
End Sub
```

APPENDIX II: Graph for the Result of Validation of Model
Machine Building Resources Capacity Development Pattern for 5 and 10 Years

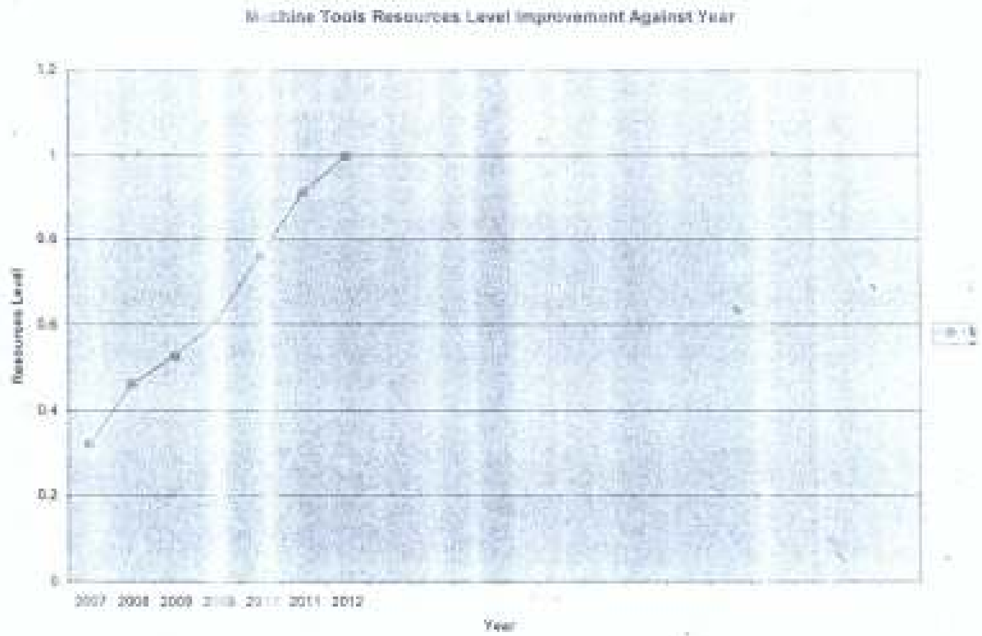
Machine Tools Building Resources Development pattern against year

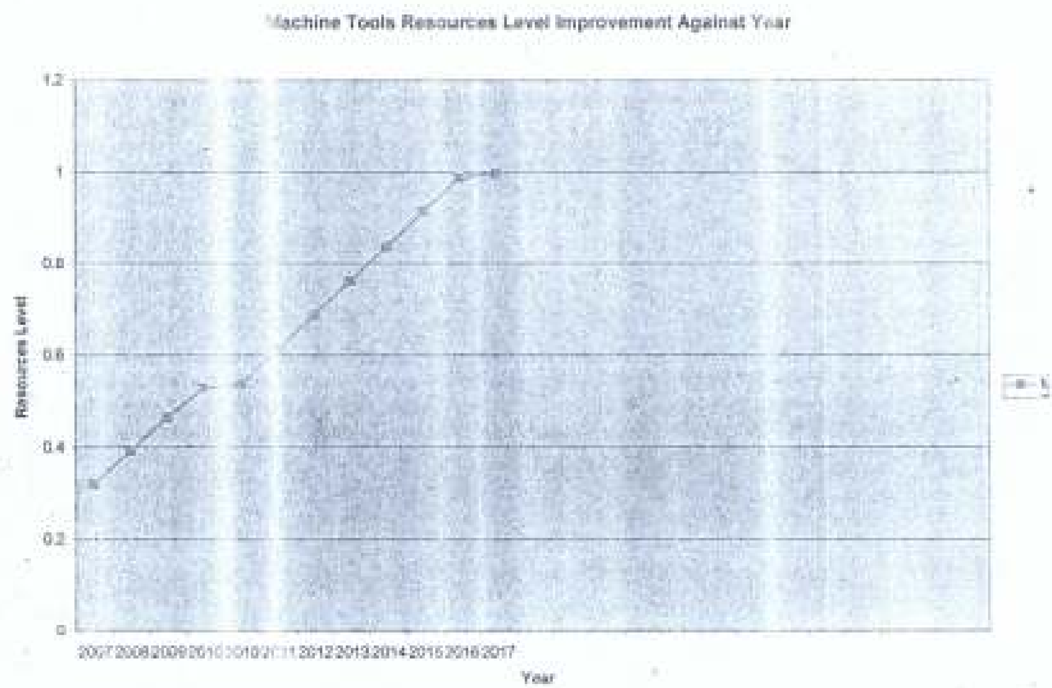


Machine Tools Building Resources Development pattern against year

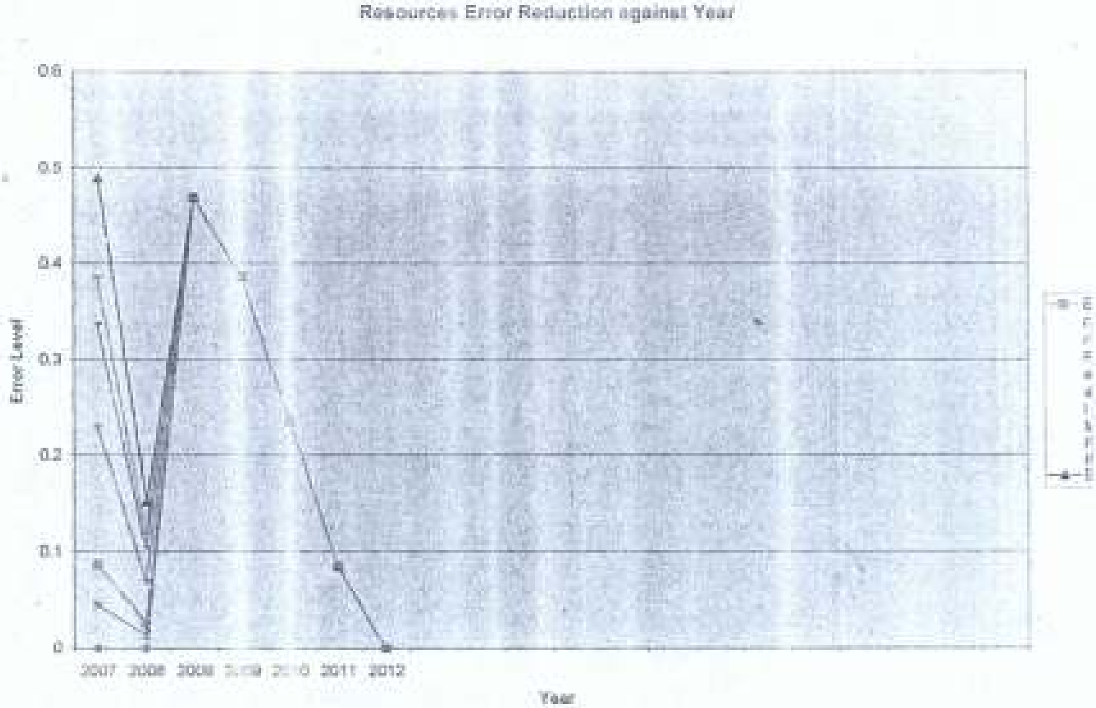


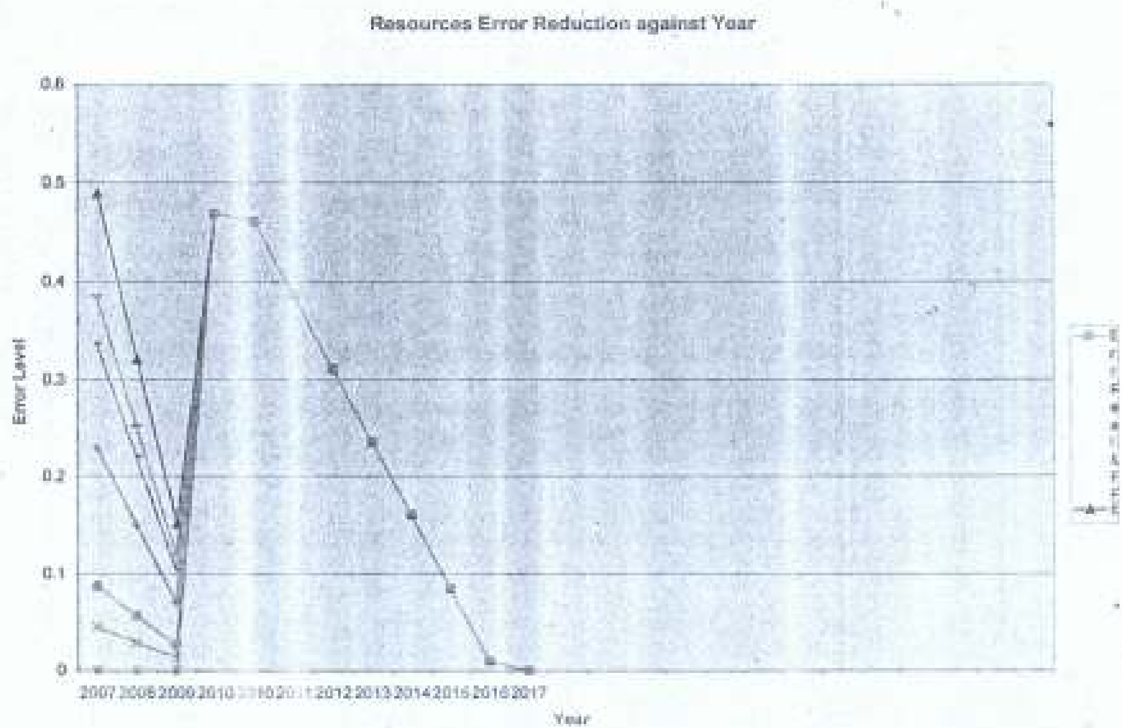
Machine Building Capacity Level Development Pattern for 5 and 10 Years



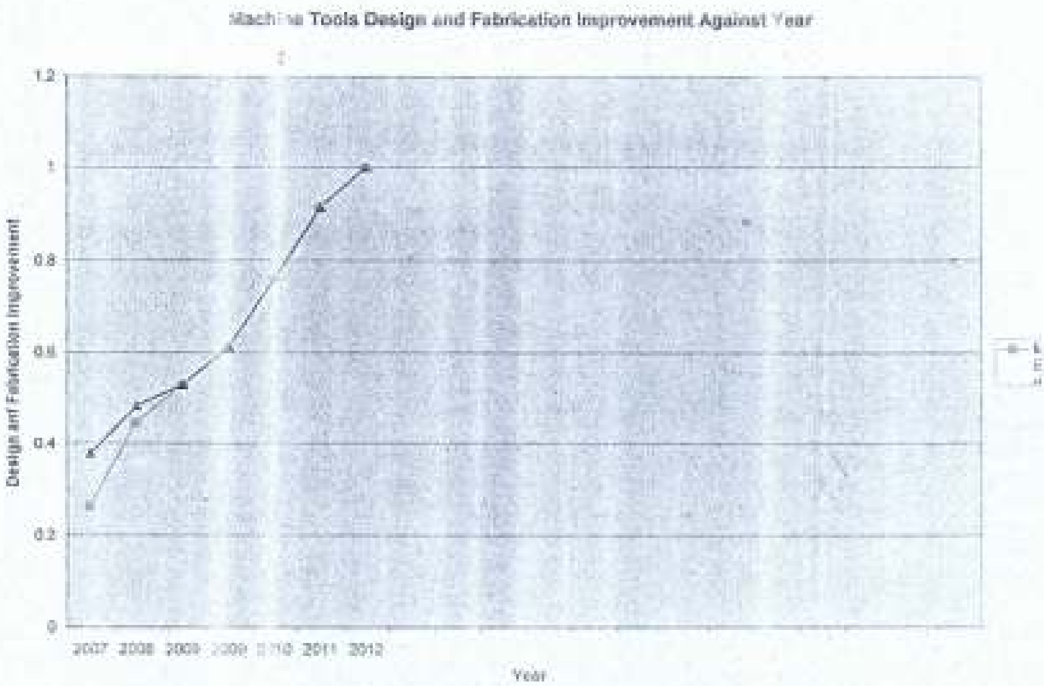


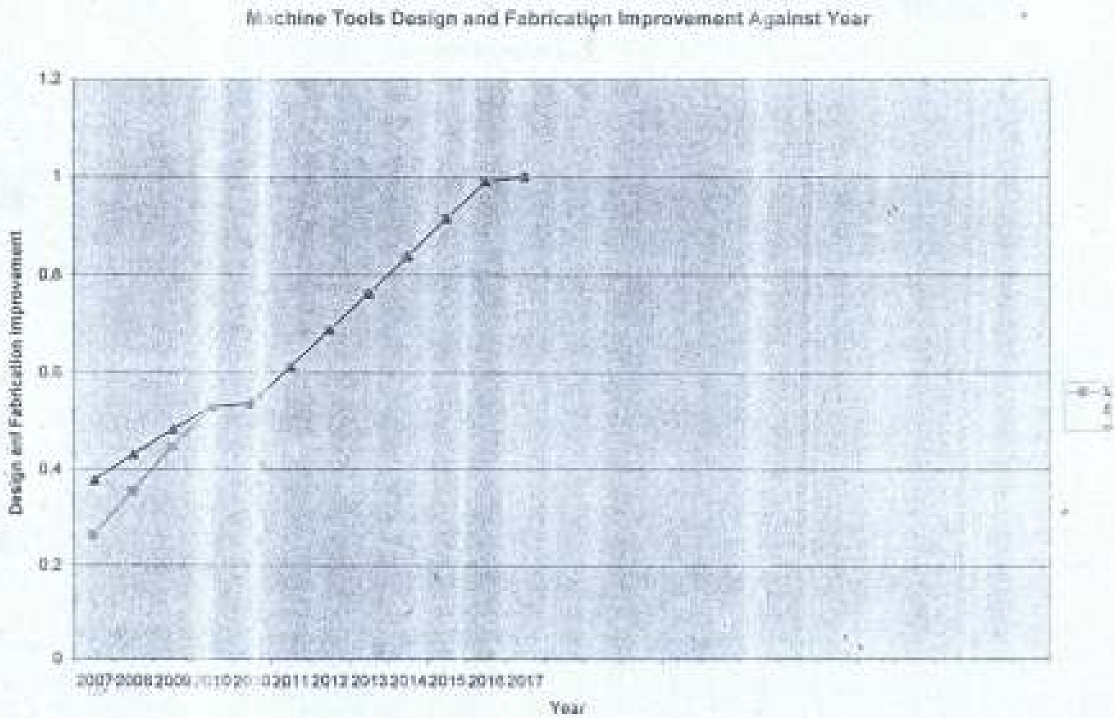
Resources capacity Error Reduction Pattern for 5 And 10 Years





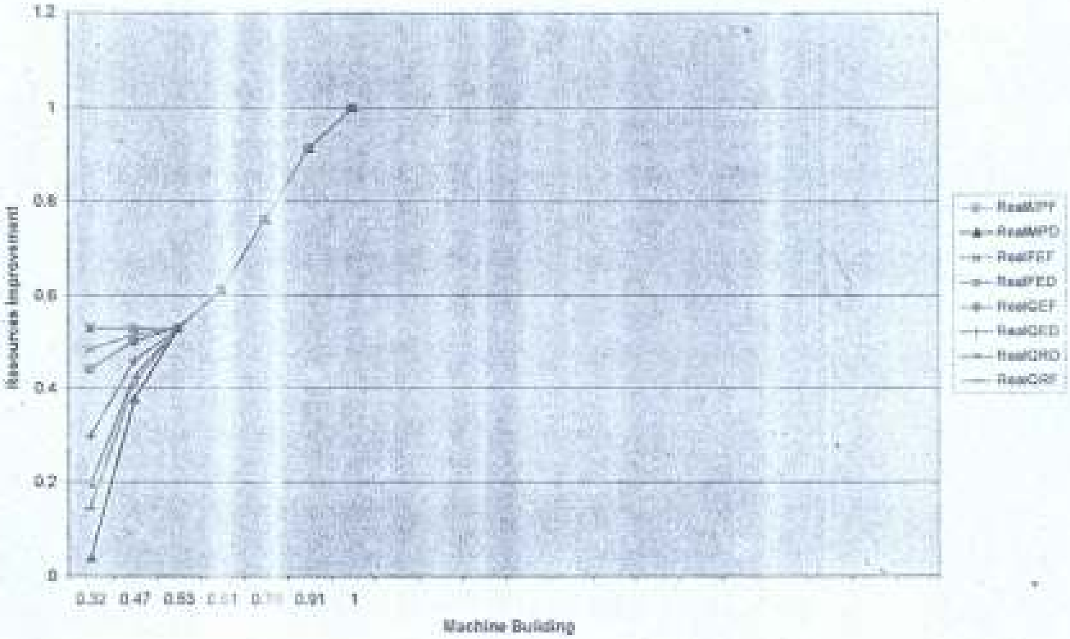
Machine Tools Building Design and Fabrication Capacity Level Development Pattern for 5 and 10 Years



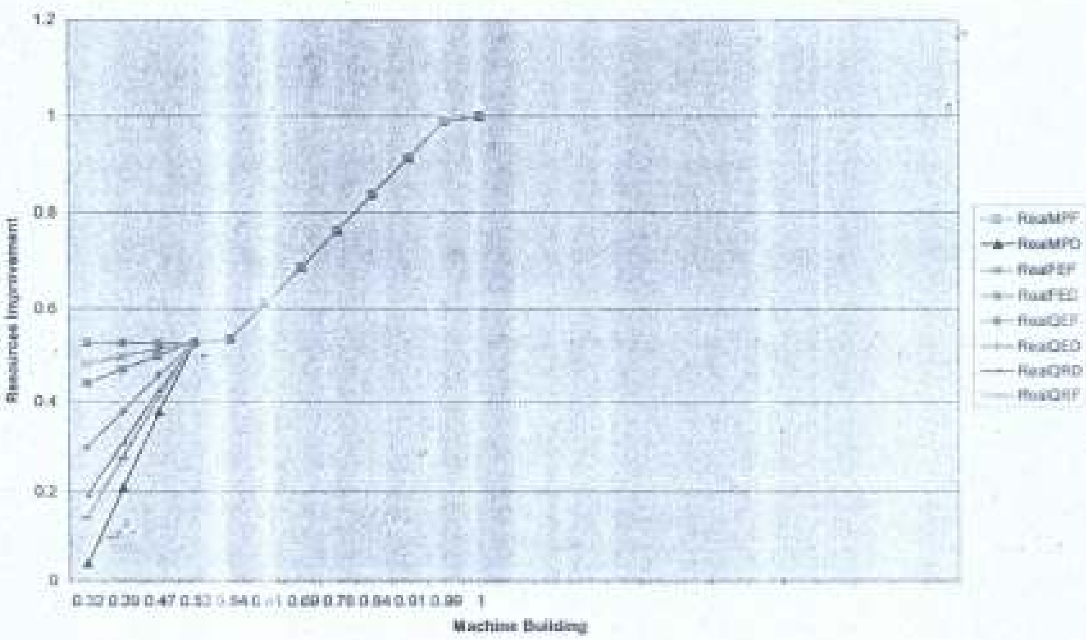


Impact of Each Machine Resources on Overall Machine Tools Capacity Development Level

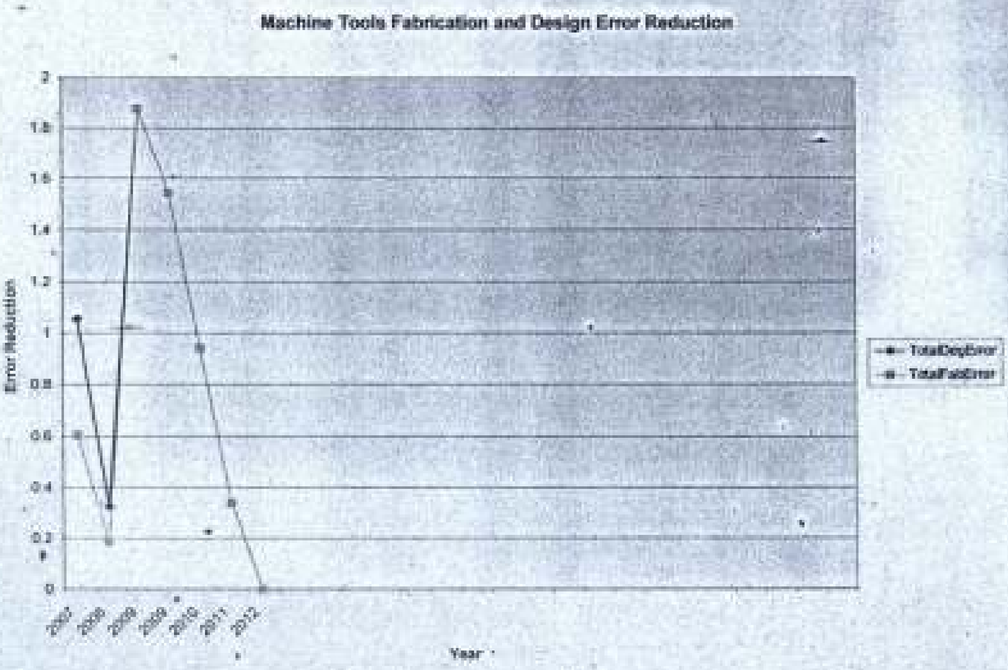
Impact of each resources on Machine Tools buiding resources against year

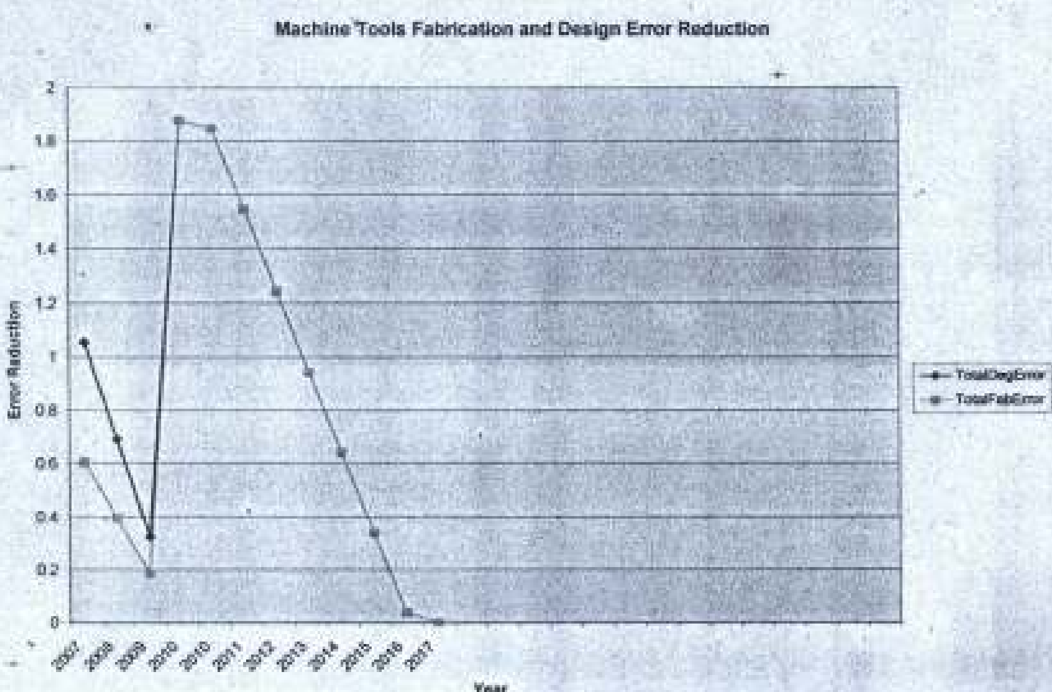


Impact of each resources on Machine Tools buiding resources against year



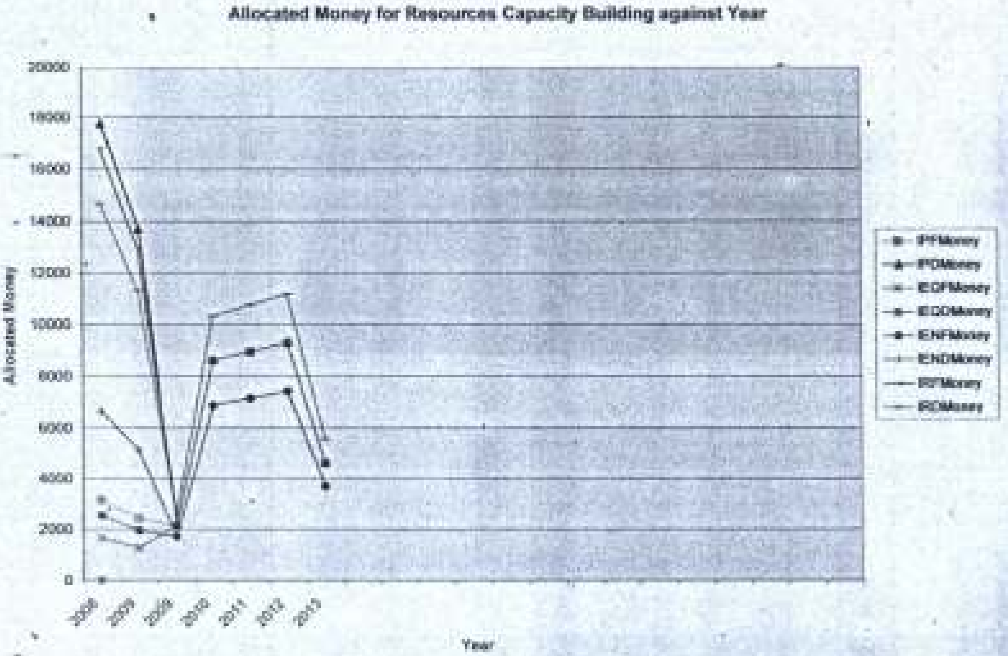
Machine Tools Fabrication and Design Capacity Error Reduction Pattern for 5 and 10 Years

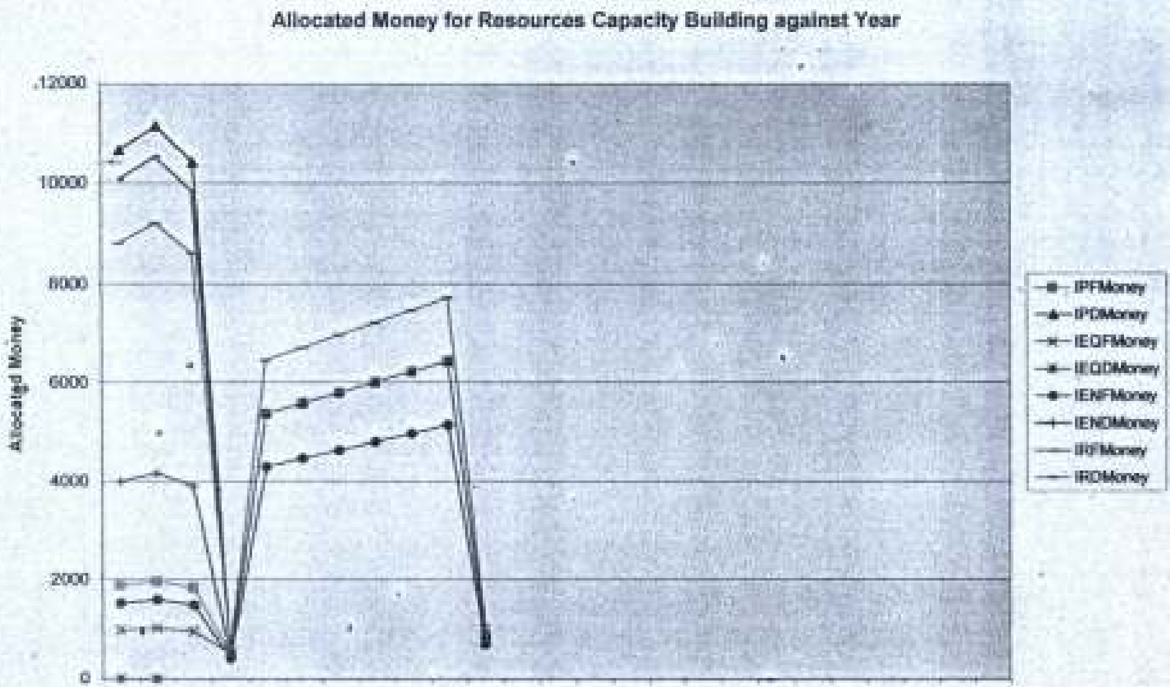




Machine Tools Building Capacity Error Reduction Pattern for 5 and 10 Years

Allocated Money for machine tools Resources Capacity Development for 5 and 10 years





Appendix III: Regression Analysis and Stepwise ANOVA of the Model Developed

IPF MONEY

Model Summary (2008)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2008 (Selected)	Year = 2008 (Selected)	Year ~= 2008 (Unselected)	Year = 2008 (Selected)
1	.980(a)	.960	.950	158.4835691

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2404885.816	1	2404885.816	95.747	.001(a)
	Residual	100468.167	4	25117.042		
	Total	2505353.983	5			

a Predictors: (Constant), Weight
b Dependent Variable: IPFMoney
c Selecting only cases for which Year = 2008

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	5451.688	291.410		18.708	.000
	Weight	-370.705	37.885	-.980	-9.785	.001

a Dependent Variable: IPFMoney
b Selecting only cases for which Year = 2008

Model Summary (2009)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2009 (Selected)	Year = 2009 (Selected)	Year ~= 2009 (Unselected)	Year = 2009 (Selected)
1	.894(a)	.800	.749	1016.4689258

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	16483278.197	1	16483278.197	15.953	.016(a)
	Residual	4132836.309	4	1033209.077		
	Total	20616114.506	5			

a Predictors: (Constant), Weight
b Dependent Variable: IPFMoney
c Selecting only cases for which Year = 2009

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Er Ror	Beta	B	Std. Error
1	(Constant)	10847.686	1869.019		5.804	.004
	Weight	-970.516	242.983	-.894	-3.994	.016

a Dependent Variable: IPFMoney
b Selecting only cases for which Year = 2009

Model Summary (2010)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2010 (Selected)	Year = 2010 (Selected)	Year ~= 2010 (Unselected)	Year = 2010 (Selected)
1	.999(a)	.997	.997	177.2558491

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	45889840.346	1	45889840.346	1460.547	.000(a)
	Residual	125678.544	4	31419.636		
	Total	46015518.890	5			

a Predictors: (Constant), Weight
b Dependent Variable: IPFMoney
c Selecting only cases for which Year = 2010

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	18380.580	325.927		56.395	.000
	Weight	-1619.344	42.372	-.999	-38.217	.000

a Dependent Variable: IPFMoney
b Selecting only cases for which Year = 2010

Model Summary (2011)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2011 (Selected)	Year = 2011 (Selected)	Year ~= 2011 (Unselected)	Year = 2011 (Selected)
1	.980(a)	.960	.950	450.2596006

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	19410928.986	1	19410928.986	95.746	.001(a)
	Residual	810934.832	4	202733.708		
	Total	20221863.818	5			

a Predictors: (Constant), Weight
b Dependent Variable: IPFMoney
c Selecting only cases for which Year = 2011

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	15488.415	827.909		18.708	.000
	Weight	-1053.184	107.633	-.980	-9.785	.001

a Dependent Variable: IPFMoney
b Selecting only cases for which Year = 2011

Model Summary (2012)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2012 (Selected)	Year = 2012 (Selected)	Year ~= 2012 (Unselected)	Year = 2012 (Selected)
1	.551(a)	.303	.129	1277.8639850

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2840497.221	1	2840497.221	1.740	.258(a)
	Residual	6531745.456	4	1632936.364		
	Total	9372242.678	5			

a Predictors: (Constant), Weight
b Dependent Variable: IPFMoney
c Selecting only cases for which Year = 2012

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	10103.021	2349.655		4.300	.013
	Weight	-402.882	305.468	-.551	-1.319	.258

a Dependent Variable: IPFMoney
b Selecting only cases for which Year = 2012

IPD MONEY

Model Summary (2008)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2008 (Selected)	Year = 2008 (Selected)	Year ~= 2008 (Unselected)	Year = 2008 (Selected)
1	.980(a)	.960	.950	891.150831294445000

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	76036713.220	1	76036713.220	95.746	.001(a)
	Residual	3176599.216	4	794149.804		
	Total	79213312.437	5			

a Predictors: (Constant), Weight
b Dependent Variable: IPDMoney
c Selecting only cases for which Year = 2008

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	30654.588	1638.592		18.708	.000
	Weight	-2084.456	213.026	-.980	-9.785	.001

a Dependent Variable: IPDMoney
b Selecting only cases for which Year = 2008

Model Summary (2009)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2009 (Selected)	Year = 2009 (Selected)	Year ~= 2009 (Unselected)	Year = 2009 (Selected)
1	.883(a)	.779	.724	1099.093219725343000

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	17075867.752	1	17075867.752	14.136	.020(a)
	Residual	4832023.623	4	1208005.906		
	Total	21907891.375	5			

a Predictors: (Constant), Weight
b Dependent Variable: IPDMoney
c Selecting only cases for which Year = 2009

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	21595.480	2020.943		10.686	.000
	Weight	-987.808	262.734	-.883	-3.760	.020

a Dependent Variable: IPDMoney
b Selecting only cases for which Year = 2009

Model Summary (2010)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2010 (Selected)	Year = 2010 (Selected)	Year ~= 2010 (Unselected)	Year = 2010 (Selected)
1	.361(a)	.130	-.087	1432.5660751 21768000

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1229413.0 35	1	1229413.035	.599	.482(a)
	Residual	8208982.2 38	4	2052245.560		
	Total	9438395.2 74	5			

a Predictors: (Constant), Weight
b Dependent Variable: IPDMoney
c Selecting only cases for which Year = 2010

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	7381.420	2634.112		2.802	.049
	Weight	265.051	342.449	.361	.774	.482

a Dependent Variable: IPDMoney
b Selecting only cases for which Year = 2010

Model Summary (2011)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2011 (Selected)	Year = 2011 (Selected)	Year ~= 2011 (Unselected)	Year = 2011 (Selected)
1	.980(a)	.960	.950	450.259600556979400

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	19410928.986	1	19410928.986	95.746	.001(a)
	Residual	810934.832	4	202733.708		
	Total	20221863.818	5			

a Predictors: (Constant), Weight
b Dependent Variable: IPDMoney
c Selecting only cases for which Year = 2011

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	15488.415	827.909		18.708	.000
	Weight	-1053.184	107.633	-.980	-9.785	.001

a Dependent Variable: IPDMoney
b Selecting only cases for which Year = 2011

Model Summary(2012)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2012 (Selected)	Year = 2012 (Selected)	Year ~= 2012 (Unselected)	Year = 2012 (Selected)
1	.551(a)	.303	.129	1277.863984978347000

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2840497.221	1	2840497.221	1.740	.258(a)
	Residual	6531745.456	4	1632936.364		
	Total	9372242.678	5			

a Predictors: (Constant), Weight
b Dependent Variable: IPDMoney
c Selecting only cases for which Year = 2012

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	10103.021	2349.655		4.300	.013
	Weight	-402.882	305.468	-.551	-1.319	.258

a Dependent Variable: IPDMoney
b Selecting only cases for which Year = 2012

IEQF MONEY

Model Summary (2008)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2008 (Selected)	Year = 2008 (Selected)	Year ~= 2008 (Unselected)	Year = 2008 (Selected)
1	.980(a)	.960	.950	83.0592928

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	660518.584	1	660518.584	95.743	.001(a)
	Residual	27595.384	4	6898.846		
	Total	688113.968	5			

a Predictors: (Constant), Weight
b Dependent Variable: IEQFMoney
c Selecting only cases for which Year = 2008

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	2857.106	152.724		18.708	.000
	Weight	-194.278	19.855	-.980	-9.785	.001

a Dependent Variable: IEQFMoney
b Selecting only cases for which Year = 2008

Model Summary (2009)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2009 (Selected)	Year = 2009 (Selected)	Year ~= 2009 (Unselected)	Year = 2009 (Selected)
1	.755(a)	.570	.463	1688.8422095

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	15137997.335	1	15137997.335	5.308	.083(a)
	Residual	11408752.035	4	2852188.009		
	Total	26546749.370	5			

a Predictors: (Constant), Weight
b Dependent Variable: IEQFMoney
c Selecting only cases for which Year = 2009

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	9225.666	3105.336		2.971	.041
	Weight	-930.069	403.711	-.755	-2.304	.083

a Dependent Variable: IEQFMoney
b Selecting only cases for which Year = 2009

Model Summary (2010)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2010 (Selected)	Year = 2010 (Selected)	Year ~= 2010 (Unselected)	Year = 2010 (Selected)
1	.998(a)	.996	.995	238.0887734

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	57543445.188	1	57543445.188	1015.121	.000(a)
	Residual	226745.056	4	56686.264		
	Total	57770190.244	5			

a Predictors: (Constant), Weight
b Dependent Variable: IEQFMoney
c Selecting only cases for which Year = 2010

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	19512.917	437.783		44.572	.000
	Weight	-1813.339	56.914	-.998	-31.861	.000

a Dependent Variable: IEQFMoney
b Selecting only cases for which Year = 2010

Model Summary (2011)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2011 (Selected)	Year = 2011 (Selected)	Year ~= 2011 (Unselected)	Year = 2011 (Selected)
1	.980(a)	.960	.950	450.2596006

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	19410928.986	1	19410928.986	95.746	.001(a)
	Residual	810934.832	4	202733.708		
	Total	20221863.818	5			

a Predictors: (Constant), Weight
b Dependent Variable: IEQFMoney
c Selecting only cases for which Year = 2011

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	15488.415	827.909		18.708	.000
	Weight	-1053.184	107.633	-.980	-9.785	.001

a Dependent Variable: IEQFMoney
b Selecting only cases for which Year = 2011

IEQD MONEY

Model Summary (2009)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2009 (Selected)	Year = 2009 (Selected)	Year ~= 2009 (Unselected)	Year = 2009 (Selected)
1	.811(a)	.657	.572	1460.373

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	16357169.897	1	16357169.897	7.670	.050(a)
	Residual	8530756.766	4	2132689.191		
	Total	24887926.663	5			

a Predictors: (Constant), Weight
b Dependent Variable: IEQDMoney
c Selecting only cases for which Year = 2009

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	8523.087	2685.241		3.174	.034
	Weight	-966.796	349.096	-.811	-2.769	.050

a Dependent Variable: IEQDMoney
b Selecting only cases for which Year = 2009

Model Summary (2010)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2010 (Selected)	Year = 2010 (Selected)	Year ~= 2010 (Unselected)	Year = 2010 (Selected)
1	.996(a)	.993	.991	367.281

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1.	Regression	71900039.116	1	71900039.116	533.005	.000(a)
	Residual	539582.267	4	134895.567		
	Total	72439621.383	5			

a Predictors: (Constant), Weight
b Dependent Variable: IEQDMoney
c Selecting only cases for which Year = 2010

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	20759.829	675.334		30.740	.000
	Weight	-2026.962	87.797	-.996	-23.087	.000

a Dependent Variable: IEQDMoney
b Selecting only cases for which Year = 2010

Model Summary (2011)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2011 (Selected)	Year = 2011 (Selected)	Year ~= 2011 (Unselected)	Year = 2011 (Selected)
1	.980(a)	.960	.950	450.260

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	19410928.986	1	19410928.986	95.746	.001(a)
	Residual	810934.832	4	202733.708		
	Total	20221863.818	5			

a Predictors: (Constant), Weight
b Dependent Variable: IEQDMoney
c Selecting only cases for which Year = 2011

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	15488.415	827.909		18.708	.000
	Weight	-1053.184	107.633	-.980	-9.785	.001

a Dependent Variable: IEQDMoney
b Selecting only cases for which Year = 2011

Model Summary (2012)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2012 (Selected)	Year = 2012 (Selected)	Year ~= 2012 (Unselected)	Year = 2012 (Selected)
1	.551(a)	.303	.129	1277.864

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2840497.221	1	2840497.221	1.740	.258(a)
	Residual	6531745.456	4	1632936.364		
	Total	9372242.678	5			

a Predictors: (Constant), Weight
b Dependent Variable: IEQDMoney
c Selecting only cases for which Year = 2012

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	10103.021	2349.655		4.300	.013
	Weight	-402.882	305.468	-.551	-1.319	.258

a Dependent Variable: IEQDMoney
b Selecting only cases for which Year = 2012

IENF MONEY

Model Summary (2008)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2008 (Selected)	Year = 2008 (Selected)	Year ~= 2008 (Unselected)	Year = 2008 (Selected)
1	.980(a)	.960	.950	128.127788

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1571857.539	1	1571857.539	95.747	.001(a)
	Residual	65666.920	4	16416.730		
	Total	1637524.459	5			

a Predictors: (Constant), Weight
b Dependent Variable: IENFMoney
c Selecting only cases for which Year = 2008

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2840497.221	1	2840497.221	1.740	.258(a)
	Residual	6531745.456	4	1632936.364		
	Total	9372242.678	5			

a Predictors: (Constant), Weight
b Dependent Variable: IEQDMoney
c Selecting only cases for which Year = 2012

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	10103.021	2349.655		4.300	.013
	Weight	-402.882	305.468	-.551	-1.319	.258

a Dependent Variable: IEQDMoney
b Selecting only cases for which Year = 2012

IENF MONEY

Model Summary (2008)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2008 (Selected)	Year = 2008 (Selected)	Year ~= 2008 (Unselected)	Year = 2008 (Selected)
1	.980(a)	.960	.950	128.127788

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1571857.539	1	1571857.539	95.747	.001(a)
	Residual	65666.920	4	16416.730		
	Total	1637524.459	5			

a Predictors: (Constant), Weight
b Dependent Variable: IENFMoney
c Selecting only cases for which Year = 2008

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	4407.480	235.593		18.708	.000
	Weight	-299.701	30.628	-.980	-9.785	.001

a Dependent Variable: IENFMoney
b Selecting only cases for which Year = 2008

Model Summary (2009)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2009 (Selected)	Year = 2009 (Selected)	Year ~= 2009 (Unselected)	Year = 2009 (Selected)
1	.895(a)	.801	.751	809.306557

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	10550523.339	1	10550523.339	16.108	.016(a)
	Residual	2619908.411	4	654977.103		
	Total	13170431.750	5			

a Predictors: (Constant), Weight
b Dependent Variable: IENFMoney
c Selecting only cases for which Year = 2009

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	8698.000	1488.102		5.845	.004
	Weight	-776.458	193.461	-.895	-4.014	.016

a Dependent Variable: IENFMoney
b Selecting only cases for which Year = 2009

Model Summary (2010)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2010 (Selected)	Year = 2010 (Selected)	Year ~= 2010 (Unselected)	Year = 2010 (Selected)
1	.999(a)	.997	.997	141.652731

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	29213312.270	1	29213312.270	1455.898	.000(a)
	Residual	80261.985	4	20065.496		
	Total	29293574.254	5			

a Predictors: (Constant), Weight
b Dependent Variable: IENFMoney
c Selecting only cases for which Year = 2010

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	14684.329	260.462		56.378	.000
	Weight	-1292.026	33.861	-.999	-38.156	.000

a Dependent Variable: IENFMoney
b Selecting only cases for which Year = 2010

Model Summary (2011)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2011 (Selected)	Year = 2011 (Selected)	Year ~= 2011 (Unselected)	Year = 2011 (Selected)
1	.980(a)	.960	.950	360.206752

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	12422997.854	1	12422997.854	95.746	.001(a)
	Residual	518995.617	4	129748.904		
	Total	12941993.471	5			

a Predictors: (Constant), Weight
b Dependent Variable: IENFMoney
c Selecting only cases for which Year = 2011

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	12390.733	662.325		18.708	.000
	Weight	-842.547	86.106	-.980	-9.785	.001

a Dependent Variable: IENFMoney
b Selecting only cases for which Year = 2011

Model Summary(2012)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2012 (Selected)	Year = 2012 (Selected)	Year ~= 2012 (Unselected)	Year = 2012 (Selected)
1	.133(a)	.018	-.228	286875.863233

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	5934955663.174	1	5934955663.174	.072	.802(a)
	Residual	329191043622.583	4	82297760905.646		
	Total	335125999285.757	5			

a Predictors: (Constant), Weight
b Dependent Variable: IENFMoney
c Selecting only cases for which Year = 2012

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	249328.512	527489.157		.473	.661
	Weight	-18415.763	68576.448	-.133	-.269	.802

a Dependent Variable: IENFMoney
b Selecting only cases for which Year = 2012

IEND MONEY

Model Summary (2008)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2008 (Selected)	Year = 2008 (Selected)	Year ~= 2008 (Unselected)	Year = 2008 (Selected)
1	.980(a)	.960	.950	334.6372447

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	10721774.722	1	10721774.722	95.745	.001(a)
	Residual	447928.342	4	111982.086		
	Total	11169703.064	5			

a Predictors: (Constant), Weight
b Dependent Variable: IENDMoney
c Selecting only cases for which Year = 2008

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	11511.109	615.310		18.708	.000
	Weight	-782.734	79.994	-.980	-9.785	.001

a Dependent Variable: IENDMoney
b Selecting only cases for which Year = 2008

Model Summary (2009)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2009 (Selected)	Year = 2009 (Selected)	Year ~= 2009 (Unselected)	Year = 2009 (Selected)
1	.988(a)	.975	.969	259.6421092

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	10683258.307	1	10683258.307	158.472	.000(a)
	Residual	269656.100	4	67414.025		
	Total	10952914.406	5			

a Predictors: (Constant), Weight
b Dependent Variable: IENDMoney
c Selecting only cases for which Year = 2009

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	11727.286	477.413		24.564	.000
	Weight	-781.327	62.066	-.988	-12.589	.000

a Dependent Variable: IENDMoney
b Selecting only cases for which Year = 2009

Model Summary (2010)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2010 (Selected)	Year = 2010 (Selected)	Year ~= 2010 (Unselected)	Year = 2010 (Selected)
1	.967(a)	.934	.918	421.6375129

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	10131819.420	1	10131819.420	56.991	.002(a)
	Residual	711112.769	4	177778.192		
	Total	10842932.189	5			

a Predictors: (Constant), Weight
b Dependent Variable: IENDMoney
c Selecting only cases for which Year = 2010

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	11584.132	775.280		14.942	.000
	Weight	-760.895	100.791	-.967	-7.549	.002

a Dependent Variable: IENDMoney
b Selecting only cases for which Year = 2010

Model Summary (2011)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2011 (Selected)	Year = 2011 (Selected)	Year ~= 2011 (Unselected)	Year = 2011 (Selected)
1	.980(a)	.960	.950	360.2067520

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	12422997.854	1	12422997.854	95.746	.001(a)
	Residual	518995.617	4	129748.904		
	Total	12941993.471	5			

a Predictors: (Constant), Weight
b Dependent Variable: IENDMoney
c Selecting only cases for which Year = 2011

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	12390.733	662.325		18.708	.000
	Weight	-842.547	86.106	-.980	-9.785	.001

a Dependent Variable: IENDMoney
b Selecting only cases for which Year = 2011

Model Summary(2012)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2012 (Selected)	Year = 2012 (Selected)	Year ~= 2012 (Unselected)	Year = 2012 (Selected)
1	.134(a)	.018	-.227	286707.6920408

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	605250287 8.621	1	6052502878.6 21	.074	.800(a)
	Residual	328805202 701.547	4	82201300675. 387		
	Total	334857705 580.168	5			

a Predictors: (Constant), Weight
b Dependent Variable: IENDMoney
c Selecting only cases for which Year = 2012

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	250901.30 6	527179.93 4		.476	.659
	Weight	- 18597.239	68536.247	-.134	-.271	.800

a Dependent Variable: IENDMoney
b Selecting only cases for which Year = 2012

IRF MONEY

Model Summary(2008)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2008 (Selected)	Year = 2008 (Selected)	Year ~= 2008 (Unselected)	Year = 2008 (Selected)
1	.983(a)	.967	.959	577.1811654

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	38970294.394	1	38970294.394	116.979	.000(a)
	Residual	1332552.391	4	333138.098		
	Total	40302846.785	5			

a Predictors: (Constant), Weight
b Dependent Variable: IRFMoney
c Selecting only cases for which Year = 2008

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	24846.414	1061.284		23.412	.000
	Weight	-1492.271	137.973	-.983	-10.816	.000

a Dependent Variable: IRFMoney
b Selecting only cases for which Year = 2008

Model Summary(2009)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2009 (Selected)	Year = 2009 (Selected)	Year ~= 2009 (Unselected)	Year = 2009 (Selected)
1	.944(a)	.891	.864	815.5559794

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	21749426.164	1	21749426.164	32.699	.005(a)
	Residual	2660526.222	4	665131.555		
	Total	24409952.386	5			

a Predictors: (Constant), Weight
b Dependent Variable: IRFMoney
c Selecting only cases for which Year = 2009

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	22033.022	1499.593		14.693	.000
	Weight	-1114.820	194.955	-.944	-5.718	.005

a Dependent Variable: IRFMoney
b Selecting only cases for which Year = 2009

Model Summary(2010)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2010 (Selected)	Year = 2010 (Selected)	Year ~= 2010 (Unselected)	Year = 2010 (Selected)
1	.085(a)	.007	-.241	787.4670891

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	18138.483	1	18138.483	.029	.873(a)
	Residual	2480417.666	4	620104.416		
	Total	2498556.148	5			

a Predictors: (Constant), Weight
b Dependent Variable: IRFMoney
c Selecting only cases for which Year = 2010

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	9689.864	1447.945		6.692	.003
	Weight	32.194	188.241	.085	.171	.873

a Dependent Variable: IRFMoney
b Selecting only cases for which Year = 2010

Model Summary (2011)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2011 (Selected)	Year = 2011 (Selected)	Year ~= 2011 (Unselected)	Year = 2011 (Selected)
1	.983(a)	.967	.959	369.8035888

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	15997478.682	1	15997478.682	116.979	.000(a)
	Residual	547018.777	4	136754.694		
	Total	16544497.459	5			

a Predictors: (Constant), Weight
b Dependent Variable: IRFMoney
c Selecting only cases for which Year = 2011

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	15919.252	679.971		23.412	.000
	Weight	-956.108	88.400	-.983	-10.816	.000

a Dependent Variable: IRFMoney
b Selecting only cases for which Year = 2011

Model Summary(2012)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2012 (Selected)	Year = 2012 (Selected)	Year ~= 2012 (Unselected)	Year = 2012 (Selected)
1	.983(a)	.967	.959	384.3701395

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	17282584.904	1	17282584.904	116.979	.000(a)
	Residual	590961.617	4	147740.404		
	Total	17873546.520	5			

a Predictors: (Constant), Weight
b Dependent Variable: IRFMoney
c Selecting only cases for which Year = 2012

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	16546.313	706.755		23.412	.000
	Weight	-993.769	91.882	-.983	-10.816	.000

a Dependent Variable: IRFMoney
b Selecting only cases for which Year = 2012

IRD MONEY

Model Summary(2008)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2008 (Selected)	Year = 2008 (Selected)	Year ~= 2008 (Unselected)	Year = 2008 (Selected)
1	.983(a)	.967	.959	504.8708176

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	29817410.010	1	29817410.010	116.979	.000(a)
	Residual	1019578.170	4	254894.542		
	Total	30836988.180	5			

a Predictors: (Constant), Weight
b Dependent Variable: IRDMoney
c Selecting only cases for which Year = 2008

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	21733.608	928.324		23.412	.000
	Weight	-1305.317	120.687	-.983	-10.816	.000

a Dependent Variable: IRDMoney
b Selecting only cases for which Year = 2008

Model Summary(2009)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2009 (Selected)	Year = 2009 (Selected)	Year ~= 2009 (Unselected)	Year = 2009 (Selected)
1	.959(a)	.919	.899	650.7460541

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	19274370.294	1	19274370.294	45.515	.003(a)
	Residual	1693881.707	4	423470.427		
	Total	20968252.001	5			

a Predictors: (Constant), Weight
b Dependent Variable: IRDMoney
c Selecting only cases for which Year = 2009

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	19938.458	1196.551		16.663	.000
	Weight	-1049.473	155.558	-.959	-6.747	.003

a Dependent Variable: IRDMoney
b Selecting only cases for which Year = 2009

Model Summary (2010)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2010 (Selected)	Year = 2010 (Selected)	Year ~= 2010 (Unselected)	Year = 2010 (Selected)
1	.633(a)	.401	.251	612.9741423

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1004110.120	1	1004110.120	2.672	.177(a)
	Residual	1502949.197	4	375737.299		
	Total	2507059.317	5			

a Predictors: (Constant), Weight
b Dependent Variable: IRDMoney
c Selecting only cases for which Year = 2010

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	11275.949	1127.098		10.004	.001
	Weight	-239.536	146.529	-.633	-1.635	.177

a Dependent Variable: IRDMoney
b Selecting only cases for which Year = 2010

Model Summary (2011)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2011 (Selected)	Year = 2011 (Selected)	Year ~= 2011 (Unselected)	Year = 2011 (Selected)
1	.983(a)	.967	.959	369.8035888

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	15997478.682	1	15997478.682	116.979	.000(a)
	Residual	547018.777	4	136754.694		
	Total	16544497.459	5			

a Predictors: (Constant), Weight
b Dependent Variable: IRDMoney
c Selecting only cases for which Year = 2011

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Coηstant)	15919.252	679.971		23.412	.000
	Weight	-956.108	88.400	-.983	-10.816	.000

a Dependent Variable: IRDMoney
b Selecting only cases for which Year = 2011

Model Summary (2012)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	Year = 2012 (Selected)	Year = 2012 (Selected)	Year ~= 2012 (Unselected)	Year = 2012 (Selected)
1	.983(a)	.967	.959	384.3701395

a Predictors: (Constant), Weight

ANOVA(b,c)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	17282584.904	1	17282584.904	116.979	.000(a)
	Residual	590961.617	4	147740.404		
	Total	17873546.520	5			

a Predictors: (Constant), Weight
b Dependent Variable: IRDMoney
c Selecting only cases for which Year = 2012

Coefficients(a,b)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	16546.313	706.755		23.412	.000
	Weight	-993.769	91.882	-.983	-10.816	.000

a Dependent Variable: IRDMoney
b Selecting only cases for which Year = 2012

Stepwise Analysis of Variance

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
IPF	2008	6	2715.2781	673.11728	274.79898	2008.8849	3421.6714
	2009	6	3568.9153	2030.53321	828.96171	1438.0013	5699.8292
	2010	6	6235.4959	3033.66178	1238.487	3051.8632	9419.1287
	2011	6	7589.5370	2011.06260	821.01287	5479.0563	9700.0178
	2012	6	7081.4043	1369.10501	558.93478	5644.6167	8518.1919
	Total	30	5438.1261	2702.01631	493.31843	4429.1767	6447.0756
IPD	2008	6	15267.88	3784.90778	1545.182	11295.8647	19239.8989
	2009	6	12086.92	5674.46699	2316.591	6131.9350	18041.9108
	2010	6	9369.3047	1373.92833	560.90389	7927.4553	10811.1540
	2011	6	7589.5370	2011.06260	821.01287	5479.0563	9700.0178
	2012	6	7081.4043	1369.10501	558.93478	5644.6167	8518.1919
	Total	30	10279.01	4356.19031	795.32790	8652.3820	11905.6383
IEQF	2008	6	1423.0157	352.76579	144.01603	1052.8107	1793.2207
	2009	6	2475.8153	2118.81250	865.00158	252.2580	4699.3727
	2010	6	5912.8777	3399.12313	1387.686	2345.7168	9480.0387
	2011	6	7589.5370	2011.06260	821.01287	5479.0563	9700.0178
	2012	6	7081.4043	1369.10501	558.93478	5644.6167	8518.1919
	Total	30	4896.5300	3196.64623	583.62508	3702.8827	6090.1773
IEQD	2008	6	.0000	.00000	.00000	.0000	.0000
	2009	6	1272.1130	2231.05028	910.82246	-1069.2307	3613.4567
	2010	6	5557.6159	3806.30060	1553.916	1563.1484	9552.0834
	2011	6	7589.5370	2011.06260	821.01287	5479.0563	9700.0178
	2012	6	7081.4043	1369.10501	558.93478	5644.6167	8518.1919
	Total	30	4300.1340	3776.98758	689.58043	2889.7837	5710.4844
IENF	2008	6	2195.1979	544.18940	222.16439	1624.1062	2766.2897
	2009	6	2874.5653	1622.98686	662.58161	1171.3451	4577.7856
	2010	6	4994.1317	2420.47823	988.15610	2453.9955	7534.2678
	2011	6	6071.6303	1608.85012	656.81031	4383.2456	7760.0149
	2012	6	5665.1231	1095.28373	447.14771	4515.6933	6814.5529
	Total	30	4360.1297	2153.21037	393.12063	3556.1077	5164.1516
IEND	2008	6	4532.5780	2031.08735	829.18794	2401.0826	6664.0735
	2009	6	5867.3330	1480.06178	604.23269	4314.1034	7420.5625
	2010	6	5877.4198	1472.61211	601.19138	4332.0081	7422.8314
	2011	6	6071.6303	1608.85012	656.81031	4383.2456	7760.0149
	2012	6	5665.1231	1095.28373	447.14771	4515.6933	6814.5529
	Total	30	5602.8168	1558.61765	284.56335	5020.8194	6184.8142
IRF	2008	6	14214.78	3766.50411	1537.669	10262.0762	18167.4835
	2009	6	13747.96	2293.88577	936.47495	11340.6719	16155.2429
	2010	6	10276.18	1247.49778	509.28884	8967.0116	11585.3489
	2011	6	9257.0264	2294.81701	936.85512	6848.7636	11665.2891
	2012	6	22895.20	35837.78490	14630.71	-14714.2482	60504.6492
	Total	30	14078.23	15807.55638	2886.052	8175.5903	19980.8674
IRD	2008	6	12435.52	3293.84899	1344.708	8978.8350	15892.2001
	2009	6	12216.84	2235.68576	912.71489	9870.6269	14563.0435
	2010	6	9766.8166	1428.99977	583.38671	8267.1733	11266.4599
	2011	6	9107.4437	2413.27510	985.21543	6574.8668	11640.0206
	2012	6	8548.1855	1687.45488	688.90057	6777.3102	10319.0608
	Total	30	10414.96	2693.98770	491.85261	9409.0082	11420.9112

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
IPF	Between Groups	113235487.17	4	28308871.79	7.186	.001
	Within Groups	98490385.345	25	3939615.414		
	Total	211725872.51	29			
IPD	Between Groups	278657413.13	4	69664353.28	6.411	.001
	Within Groups	271658014.22	25	10866320.57		
	Total	550315427.34	29			
IEQF	Between Groups	185904519.01	4	46476129.75	10.521	.000
	Within-Groups	110433347.22	25	4417333.889		
	Total	296337866.23	29			
IEQD	Between Groups	286781765.81	4	71695441.45	14.122	.000
	Within Groups	126921654.54	25	5076866.182		
	Total	413703420.36	29			
IENF	Between Groups	71568189.987	4	17892047.50	7.113	.001
	Within Groups	62884942.194	25	2515397.688		
	Total	134453132.18	29			
IEND	Between Groups	9086728.624	4	2271682.156	.926	.465
	Within Groups	61362651.336	25	2454506.053		
	Total	70449379.960	29			
IRF	Between Groups	693397687.03	4	173349421.8	.661	.625
	Within Groups	6553088638.2	25	262123545.5		
	Total	7246486325.2	29			
IRD	Between Groups	77663656.439	4	19415914.11	3.655	.018
	Within Groups	132805864.95	25	5312234.598		
	Total	210469521.39	29			

Post Hoc Tests

Homogeneous Subsets

IPF

Duncan[a]

Years	N	Subset for alpha = .05 1	2
2008	6	2715.2781	
2009	6	3568.9153	
2010	6		6235.4959
2012	6		7081.4043
2011	6		7589.5370
Sig.		.463	.275

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

IPD

Duncan[a]

Years	N	Subset for alpha = .05		
		1	2	3
2012	6	7081.4043		
2011	6	7589.5370		
2010	6	9369.3047	9369.3047	
2009	6		12086.92	12086.92
2008	6			15267.88
Sig.		.267	.166	.107

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

IEQF

Duncan[a]

Years	N	Subset for alpha = .05	
		1	2
2008	6	1423.0157	
2009	6	2475.8153	
2010	6		5912.8777
2012	6		7081.4043
2011	6		7589.5370
Sig.		.394	.203

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

IEQD

Duncan[a]

Years	N	Subset for alpha = .05	
		1	2
2008	6	.0000	
2009	6	1272.1130	
2010	6		5557.6159
2012	6		7081.4043
2011	6		7589.5370
Sig.		.337	.152

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

IENF

Duncan[a]

Years	N	Subset for alpha = .05	
		1	2
2008	6	2195.1979	
2009	6	2874.5653	
2010	6		4994.1317
2012	6		5665.1231
2011	6		6071.6303
Sig.		.465	.277

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

IEND

Duncan[a]

Years	N	Subset for alpha = .05
		1
2008	6	4532.5780
2012	6	5665.1231
2009	6	5867.3330
2010	6	5877.4198
2011	6	6071.6303
Sig.		.139

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

IRF

Duncan[a]

Years	N	Subset for alpha = .05
		1
2011	6	9257.0264
2010	6	10276.18
2009	6	13747.96
2008	6	14214.78
2012	6	22895.20
Sig.		.203

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

IRD

Duncan[a]

Years	N	Subset for alpha = .05	
		1	2
2012	6	8548.1855	
2011	6	9107.4437	
2010	6	9766.8166	9766.8166
2009	6		12216.84
2008	6		12435.52
Sig.		.396	.068

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 6.000.

Correlations

Correlations

		IPF	IPD	IEQF	IEQD	IENF	IEND	IRF	IRD
IPF	Pearson Correlation	1	-.325	.993**	.979**	1.000**	.647**	.128	-.049
	Sig. (2-tailed)		.079	.000	.000	.000	.000	.500	.797
	N	30	30	30	30	30	30	30	30
IPD	Pearson Correlation	-.325	1	-.415*	-.482**	-.323	-.065	.075	.801*
	Sig. (2-tailed)	.079		.023	.007	.082	.733	.693	.000
	N	30	30	30	30	30	30	30	30
IEQF	Pearson Correlation	.993**	-.415*	1	.996**	.993**	.616**	.110	-.164
	Sig. (2-tailed)	.000	.023		.000	.000	.000	.564	.387
	N	30	30	30	30	30	30	30	30
IEQD	Pearson Correlation	.979**	-.482**	.996**	1	.978**	.586**	.094	-.253
	Sig. (2-tailed)	.000	.007	.000		.000	.001	.621	.178
	N	30	30	30	30	30	30	30	30
IENF	Pearson Correlation	1.000**	-.323	.993**	.978**	1	.648**	.129	-.046
	Sig. (2-tailed)	.000	.082	.000	.000		.000	.498	.809
	N	30	30	30	30	30	30	30	30
IEND	Pearson Correlation	.647**	-.065	.616**	.586**	.648**	1	.108	.196
	Sig. (2-tailed)	.000	.733	.000	.001	.000		.569	.300
	N	30	30	30	30	30	30	30	30
IRF	Pearson Correlation	.128	.075	.110	.094	.129	.108	1	.166
	Sig. (2-tailed)	.500	.693	.564	.621	.498	.569		.380
	N	30	30	30	30	30	30	30	30
IRD	Pearson Correlation	-.049	.801**	-.164	-.253	-.046	.196	.166	1
	Sig. (2-tailed)	.797	.000	.387	.178	.809	.300	.380	
	N	30	30	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix IV: Design of Questionnaire

Questionnaire on Benchmark Estimation of Machine Tools Building Technological Capacity in Nigeria.

1.00 objectives

This questionnaire is designed as part of a research project to study the bench mark of machine tools building capacity using available resources in Nigeria and correlating with an ideal situation. The data provided through this questionnaire will only be used for research purposes particularly for the development of technology for machine building in Nigeria. No information of confidential nature will be disclosed to a third party.

2.0 Company/ shop details :

2.01 Name of the company/ shop ....

2.02Year of establishment...

2.03Address of the company

2.04 Purpose of establishing the company:

2.05 What type of machines do you produce in your company?

i. Agricultural machineries
ii. Process machine and equipment
iii. Precision machineries e.g. lathe, drilling etc...
iv. Others
v. If others, please specify

....

3.0 Raw materials

3.01 What is the implication of imported raw materials on the quality and cost of production?

i. It improved the quality
ii. It reduced the cost of production

iii. It increased the cost of production

iv. It increased the quantity of production

v. It reduced the quantity of the production

vi. It affects the quality of production

3.2 How do you improve on the quality of the raw materials?

i. Alloying

ii. Heat treatment

iii. Power metallurgy

iv. Sintering

3.3 If the quality of raw materials is not improved, what is the effect on quality of the product?

i. Reduced quality of the products

ii. No effect

iii. It affects the physical appearance of the produce

iv. If others, specify

....

....

4.0 Equipment

4.1 What is the effect of locally made equipment on the quality and cost of the end product?

i. It reduced the cost of production

ii. It proved the quality of the product

iii. It Increased the cost of production]

4.2 Is the equipment available for use most of the time?

Yes No

4.3(a) can it be easily operated?

Yes No

(b) If No, is there any end for special training on the equipment/tools? If yes, where is the location of the training?

Nigeria Abroad

4.4. Is there any alternative for these sophisticated equipment?

Yes No

If yes, please specify below:

List of sophisticated equipment	Alternative available equipment/tools

5.0 Manpower

5.1 How do you assess the performance of indigenous workers in the company?

i. Excellent

ii. Very good

iii. Good

iv. Fair

v. Poor

5.2 what is the effect of importing assistance of expatriate on:

i. quality

ii. cost of production

iii. Completion time

4.4. Is there any alternative for these sophisticated equipment?

Yes No

If yes, please specify below:

List of sophisticated equipment	Alternative available equipment/tools

5.0 Manpower

5.1 How do you assess the performance of indigenous workers in the company?

i. Excellent

ii. Very good

iii. Good

iv. Fair

v. Poor

5.2 what is the effect of importing assistance of expatriate on:

i. quality

ii. cost of production

iii. Completion time

6.0 Energy

6.1 What is the power at peak of the year in Nigeria machine tools?

6.2 Is the power supply to the complex equal to 66 kV step down to 440 V 50 cycle for three phase supply to

230V?

Yes No

If no. please specify

6.3 How many days do you experience power

failure in a month

i. 2-5

ii. 5 – 10

iii. 10-15

iv. 15 – 20

v. 20.25

6.4 How do you augment for the power outage?

AC generator solar wind turbine

Others, specify

6.5 What is the effect of power on the equipment.....................................

6.6 What is the quality of the power supplied?

Excellent very good good average

below average

6.7 What are the working hours per day for producing these machines?

6-8 8-10 10-12 12-16 16-24

7.0 Finance

What is the source of finance for machine production?

i. Individual

ii. Government

iii. Financial institutions

iv. Co-operative bodies

v. Industries

vi. Tax

If other, please specify

....

8.1. RAW MATERIALS

Name	Qty	Quality %	Source	Method of improvement	Trend of improvement %				
					1980-1985	1986-1990	1991-1995	1996-2000	2001-2005
Ferrous metal									
Wrought iron Cast iron Gray iron White cast iron Alloy cast iron									
Steel Plain carbon steel Low carbon steel Medium carbon Steel Alloy steel									
Stainless steel									
Non ferrous									

8.2. PRODUCT OUT PUT

S/N	Name of product	Quality	List of parts produced	Reasons for not producing
1	Power hack was			
2	Lathes			
3	Milling machines-bench & pillar type			
4	Shaping machine			
5	Drilling machine			
6	Pedestal grinders			

7 8	Guillotine shears Press brakes			

8.3. ELECTRICAL EQUIPMENT

s/n	Name	Qty	Trend in Capacity development (years)				
			1980-1985	1986-1990	1991-1995	1996-2000	2001-2007
1	Power transformer (66000/1 1000 V) 300 KVA						
2	Power transformer (66000/1 1000 V) 200 KVA						
3	Distribution transformer 1000KVA						
4	Distribution transformer 2000KVA						
5	H.T panels with complete switch gear						
6	L.T panels with complete switch gear						
7	Main distribution boards						
8	Distribution boxes						

7 s/n	Green sand moulding lsystem(small) t name	Table size 75()x500mm Pattern dr N aw 80mm Jolt capacity 4500N Dynamic squeeze pressure 10000	2 qty	trend of capacity dev (procurement)					category of operator	Prof Cadre of operator	year of Exp.
1	Melting section Coreless induction melting furnace	Power: 100kw 2000gk/hr melting rate 50 Hz frequency	2	1980-1985	1986-1990	1991-1995	1996-2000	2001-2005			
2	Cureless induction melting furnace	Power : 250k\v 250kg/hr. 50hz	1								
3	Crucible furnace	Capacity crucible 200kg " Fuel tank 600 liters	2								
4	Immersion thermometer	Temp. 1800	7								
5	Furan sand mixer	Nominal capacity:									
		20 tons/hr Mixing arm length: 100mm Primary arms length : 2800mm Total max. reach : 4200mm									
6	Furan sand mixer Floor molding	Nominal capacity: 1 2 tons/hr Mixing arm length: 1 800mm Outlet height 1700mm	1								

8.4. FOUNDRY SECTION

Medium size molding machine	Table size 920x580mm Suitable for flask 1000x700mm Pattern draw 350 mm Squeeze stroke 230 mm Jolt capacity 11000N	1								
Die casting machine	Casting weight : 0.3 to 1 kg (zinc) Metal pot capacity 68kg (zinc) Die size 150x150x1000mm	2								
Forklift truck	Lifting capacity 2500kg Load arm 1220mm Max lifting height 3300mm	2								
Pail loader	Capacity 1200kg 300 liters	3								
Shot blasting machine Monorail	Capacity: 2 Tons/p Chamber size 1.6\2.0\2.3mm	1								
Shot blasting machine	1 able diameter 1000mm Capacity: 2 Tons/hr	1								

Pedestal grinding 'machine	Peripheral velocity 60 m/s Wheel dial. 600 mm Wheel width. 60 mm Power: 11k W Spindle speed 1900rpm	1							
Pendulum cut oil' machine	Wheel dia. 40 mm Power 8.5 kW Spindle speeds 381 rpm Cutting speed 80 in/s"	1							
Electric welding equipment	Secondary capacity : 45-300 A"								
Gas welding set	Weld up to 10 mm								

8.5. LABORATORIES

s/n	Equipment name	capacity	qty	trend of capacity dev.(procurement) years					category of operator	Prof Cadre of operator	of
				1980-1985	1986-1990	1991-1995	1996-2000	2001-2007			
1	Electronic weighing balance	heading accuracy 001kg Capacity 1 200 g	1								
2	Rammer device		1								
3	Strength tester										
4	Permeability tester										
5	Moisture tester										
6	Compatibility tester										
7	Laboratory sifter										
8	Rapid sand washer										
9	Drying cabinet	Inside diameter : 300 x 300 x 300 mm Temp, control range 40 - 240°C	1								
10	Annealing furnace	Inside diameter : 1 50 x 1 50 x 1 50 mm Temp, control range	1								

8.6: TRAINING CENTRE

s/n	Equipment name	capacity	qty	trend of capacity dev.(procurement)					category of operator	Prof Cadre of operator	years of Exp.
				1980-1985	1986-1990	1991-1995	1996-2000	2001-2007			
L	Center lathe	Center height : 260 x 1000mm between centers	1								
2	Center lathe (vikram-750)	Center height : 190x 1250mm between centers	10								
3	Pedestal grinder GG-300	Wheel dia: 300 mm	1								
4	Tool & cutter	Swing dia: 280 mm	1								
5	Power hack saw HS-20	Max. dia: 20()mm of Materials	1								
6	Pillar drill	Max. drill dia :25mm	1								
7	Bench drill	Max drill dia: 13 mm	2								
8	Universal cylindrical grinding Machine	Max. dia : 125 mm Max length : 550mm Height : 130mm	2								
9	Internal grinding machine	Max bore dia: 30 mm Grinding spindle: 45 x 160mm long	1								

		Spindle speed: 4000rpm Work head : 250 rpm								
10	Ram type milling machine(MITR)	Trail verse longitudinal 760 mm	1							
11	Shaping machine CSM	Max stroke: 630&500	2							
12	Vertical milling machine	Taper ISC.) 40	3							
13	Horizontal milling machine FN2H		2							
14	Universal milling machine FN2U		3							
15	Cylindrical grinding machine G 9 U	Max grinding dia: 30mm Center height : 90mm	1							
16	Surface grinding machine SEW1	Working surface : 100x250 mm Max traverse of grinding wheel : 320mm Max longitudinal traverse of table: 11 5mm Max grinding length traverse : 1 1 00 mm Max grinding height : 400mm	1							

8.7. TOOL RECONDITIONING & RE SHAPENING

s/n	Equipment name	capacity	qty	trend of capacity dev.(procurement)					category of operator	Prof Cadre of operator	years of exp.
				1980-1985	1986-1990	1991-1995	1996-2000	2001-2007			
1	Tool & cutter	Swing dia: 280mm	3								
2	Tool & cutter grinder	Dist btw. Tail stock centre : 600mm	1								
3	Automatic sharpener for circular saw	Min / Max twist drill dia : 200 mm	1								
4	Twist drill grinder (BSA 40)	Min / max drill dia: 8/40 mm	1								
5	Twist drill grinder (BSA 80)	Max grinding wheel dia: 300 mm	1								
6	Gear hob sharpener	Work length : 400mm	1								
7	Tape & die grinder	Center height above table : 180mm Max grinding dia : 125x25x32mm	1								
8	Engraving miller	Work table 500x300mm	1								
9	Engraving cutter sharpener	Taper angle 0-1 80° Back angle: 0-140°	1								

8.8 TOOL & MEASURING ROOM

s/n	equipment name	capacity	qty	trend of capacity,dev.(procurement)					category of operator	Prof Cadre of operator	years of Exp.
				1980-1985	1986-1990	1991-1995	1996-2000	2001-2007			
1	Jig boring machine Microtnat 9B	Table traverse x-axis: 1120 Table size : 1400x1 900mm	1								
2	Universal tool & cutter milling machine FNGJ 32	Working distance (XYZ) axes 800 x 400 x 400mm	1								
3	Linear circular dividing machine	Table travels X,Y,Z: 800 x 360 x 460mm	1								
4	Mechanical platform scale	Capacity : 500 Resolution : 500	1								
5	Electronic counting scale										
6	Linear height measuring instrument	Measuring range : 0-600mm	1								
7	Ultrasonic flaw detector	Pulse shift : 0-25mm Steel	1								
8	Taper checking machine	Max taper angle : 45 Weight: 14kg	1								

8.9. METAL FABRICATION SHOP

s/n	equipment name	capacity	qty	trend of capacity dev. (procurement)					category of operator	Prof Cadre of operator	Num of Exp.
				1980-1985	1986-1990	1991-1995	1996-2000	2001-2007			
1	ASE guillotine shear		1								
2	Morgan press brake-86 10-003	Max plate thickness : 6mm	1								
3	Morgan 50 threaded manual guillotine shear	Max plate thickness : 1.5mm	1								
4	Manual rolling machine	Max plate thickness : 2mm	1								
5	Hand operated guillotine	Max plate thickness : 1.5 mm	1								
6	Mechanical eccentric press	Tonnage : 63 tons	I								
7	Morgan press brake	Max thickness : 6mm of plate	1								
8	Power rolling machine										
9	Spot welding machine	Max thickness of plate : 2mm	1								
10	Gross carriage profile flame cutting machine: 1800x 1500	Working width : 1 x 1500mm	I								
11	Welding bending machine	Max thickness of plate: 1,5mm	I								
12	Hydraulic pipe blender										

8.11 HEAVY PARTS WORK-SHOP

s/n	equipment name	capacity	qty	trend of capacity dev.(procurement)					category of operator	Prof Cadre of operator	years of Exp.
				1980-1985	1986-1990	1991-1995	1996-2000	2001-2007			
1	Heavy duty centre lathe L-45	Swing-900mm Length of work between center	1								
2	Vertical turret lathe	Max turning diameter: 850mm	1								
3	Ra4ial drilling machine	Max hole diameter : 60mm in steel	2								
4	Single column bed milling machine	Load : 3500kg Taper in spindle : ISO 50	1								
5	Vertical machining center	Working surface of table : 630x220	1								
6	Universal column and knee type milling machine	Mounting table : 630x1400mm	1								
7	Turret lathe NC control SU 1 63 CNC	Center height: 220mm Swing ; 530mm	1								
8	Heavy duty vertical surface grinder BPV 80A-3000	Working surface of table : 800x3000mm	1								

9	Vertical hydraulic honing machine VZH 160 800F	Table size: 700x500mm Stroke length : 800mm	1								
10	Vertical milling M/CEM 4V	Longitudinal traverse: 1400mm Cross traverse; 360mm	1								
11	Horizontal boring / milling machine WHN 13,8 CNC	Mounting table : 800x1 600mm	2								
12	Horizontal boring / milling machine W100A	Largest drill depth: 900mm Mounting table: 1250x1 250mm	1								
13	Horizontal milling EM 4H	Longitudinal traverse: 1400mm Cross traverse; 360mm Vertical traverse: 475mm	1								

8.12 SMALL PARTS SHOP

s/n	Equipment name	capacity	qty	trend of capacity dev.(procurement)					category of operator	Prof Cadre of operator	years of Exp.
				1980-1985	1986-1990	1991-1995	1996-2000	2001-2007			
L	Capstan lathe	Swing over carriage: 260mm	3								
2	Center lathe NH22/1 00	Center height 220mm	8								
3	Center lathe NH22/ 1500	Center height 220mm	5								
4	Center lathe NH22/ 1000	Center height 260mm Dist btw center: 1000mm	1								
5	Center lathe NH22/1 500	Center height 260mm Dust btw center: 1500mm	2								
6	Center lathe NH26/2QOO		5								
7	Copying lathe SUMO		2								
8	Dram turret lathe		1								
9	Facing & centering machine		1								
10	Universal numerically controlled lathe. SPT 32 CMC		1								

11	Automatic cold circular metal sawing machine-PKA 13		1							
12	Automatic cold circular metal sawing machine-PKA 25		1							
13	Power hack saw CH20		1							
14	Power hack saw CH30		1							
15	Horizontal milling machine FN2H		3							
16	Horizontal milling machine FN3H		2							
17	vertical milling machine FN2H		5							
18	vertical milling machine FN3H		1							
19	Ram type milling machine. MITR		1							
20	Universal milling machine. FN		4							
21	keyway milling machine		1							
22	slotting machine-CH25		1							
23	bench drilling machine DB 13		2							
24	Pillar drilling machine		1							
25	Radial drilling machine -RD 61		3							
26	radial drilling machine -RD 63		5							
27	Pedestal grinder. OP -25		1							
28	Pedestal grinder. OP -30		2							
29	Surface grinding machine-SFW 1		3							

30	Surface grinding machine-SFW 1 1		1							
31	Tool & cutter grinder GTC28		2							
32	Drilling machine for polyangular holes -FNK 25A		1							
33	Universal internal grinder BDU 250A		1							
34	Multi-spline hobbing and thread milling machine		1							
35	Gear shaping machine- OHA 50A	Max helix angle : 45°	1							
36	Gear shaping machine- OI IA 50A	Largest helix angle ; 41°	1 2							
37	Gear nobbing machine. H-400		1							
38	Gear tooth rounding & chamfering Machine		1							
39	Hydraulic straightening press		2							

9.0:. FINANCE TREND OF FINANCING

Period of years 1980-1985			Period of years 1986-1990			Period of years 1991-1995			Period of years 1996-2000			Period of years 2001-2007		
nount	% allotted		Amount	% allotted		Amount	% allotted		Amount	%allotted		Amount	% allotted	
	Manpower			Manpower			Manpower			Manpower			Manpower	
	Raw Material			Raw Material			Raw Material			Raw Material			Raw Material	
	Equipment			Equipment			Equipment			Equipment			Equipment	
	Energy			Energy			Energy			Energy			Energy	

9.0:. FINANCE TRFND OF FINANCING

Period of years 1980-1985			Period of years 1986-1990			Period of years 1991-1995			Period of years 1996-2000			Period of years 2001-2007		
nount	% allotted		Amount	% allotted		Amount	% allotted		Amount	%allotted		Amount	% allotted	
	Manpower			Manpower			Manpower			Manpower			Manpower	
	Raw Material			Raw Material			Raw Material			Raw Material			Raw Material	
	Equipment			Equipment			Equipment			Equipment			Equipment	
	Energy			Energy			Energy			Energy			Energy	