MODELLING OUTPUT AND DEMAND CHANGES IN MANUFACTURING INDUSTRIES WITH TECHNOLOGY AND INFORMATION CONSTRAINTS

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CERTIFICATION

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

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2. By the Supervisor:

I certify that this work has been carried out by **Mr. Odion Osayande Edmund** in the Department of Mechanical Engineering of the Federal University of Technology, Akure.

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DEDICATION

This work is dedicated to The Almighty God for His mercies and goodness to me.

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I am most grateful to God Almighty for His mercies, guidance and protection throughout the duration of this programme. My sincere appreciation also goes to my parents, Mr. and Mrs. Francis Odion; my siblings Stella, Chris, Dolly, Austin, Vivian and Livinus for their unalloyed support, encouragement and financial assistance during this period. I must not fail to express my indebtedness to a brother and friend, Osas of the Department of Computer Science and Mr. Agbeyomi Moses of Goodluck Int'l High School, Akure for their support throughout this period. I wish to also thank my uncle, Dr. Pat Otaigbe who was a father to me during this time.

I will also seize this opportunity to express my profound gratitude to my indefatigable and industrious supervisor, Dr. B. Kareem. His technical input, well guided criticism and fatherly advice were invaluable to me during this period. Lastly, I wish to thank the HOD, staff and students of the Department of Mechanical Engineering who in one way or the other contributed to the success of this work. God bless you all. Amen.

ABSTRACT

The importance of information and modern technology to an organization cannot be over emphasized. This work is aimed at developing a model that can be useful in ascertaining when output will meet demand at any particular technology and information/awareness level, which is found missing in many organizational operations. The parameters of the model: manpower, machines, infrastructural facilities and raw materials were used together with information and machine technology available during the process of determining the expected output that will meet forecasted demand. The model developed was tested with data from two production companies. It was discovered that at low technology and information levels the outputs were low. Demand could not be satisfied. This results in importation to satisfy demand which has a negative effect on the economy. At high technology and information levels, demand is met with leftovers which results in some inventory cost . An optimal point was obtained in which output equals demand for a particular level of technology and information. The optimality points were further analyzed using SPSS 15.0, from which a linear multiple regression model relating output and demand to information and technology acquisition probabilities and the year under schedule was developed. This gave a concise model that was used to develop a computer programme in

Visual Basic 6.0 software that predicted for the organizations the optimal production strategy. The model was tested and found to be very reliable for any organization that aim at getting the best output from the available resources.

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CHAPTER ONE

INTRODUCTION

Nigeria has had a steady growth in her industrial development. This development has been in terms of technology input, growth and advancement (Ighalo, 1989). It is very obvious that this growth and development comes as a result of the technological innovation of the developed nations in addition to Nigeria's indigenous ingenuity. The question now is to what extent has the developed nations influenced Nigeria's industrial development?

Industrialization is a process of social and economic change whereby a human group is transformed from a pre-industrial society into an industrial one (Ake, 2008). Industrialization also refers to the establishment and subsequent growth of industrial production in a country (Ajayi, 2007). It is part of a wider modernization process, where social change and economic development are closely related with technological innovation, particularly with the development of large-scale energy and metallurgical production.

1.1 BACKGROUND OF THE STUDY

Most organizations tend to produce less than their capacity as a result they have recourse to importation to supplement their total output in order to meet demand. This not only has its negative effects on the companies themselves, it also has an overall effect on the Nigerian economy. This is largely has a result of low technology acquisition and little or no information on the latest technology available for their operations (Vremudia, 2005; and Ayeni, 1981).

Basically, every enterprise in industry requires as one of the composite input items used for the production of goods and services to meet demand in specified markets (Ajayi, 2007). Nigeria remains a major industrial (manufacturing) country in the West African sub-region and Africa south of the Sahara. Although many studies have considered manufacturing activities within the country, most of these have largely focused on some aspects of small-scale manufacturing and handicrafts. The aspects touched include growth and performance (Lewis, 1974; Ighalo, 1989; and Arikawe, 1986). However, few, if any, have focus on evaluating the effect on change in technology and information on the industrial growth in Nigeria. This thesis is aimed at developing a model that will be useful in evaluating the effect of change in technology and information on the development of Nigeria manufacturing industry.

1.2 SIGNIFICANCE OF THE STUDY

The study will help in providing a basic solution of producing optimally in manufacturing industries. It will help in studying the future and trend in production engineering. It will also access how the development of industrial companies has affected the engineering profession in Nigeria. This research work will give a base from which Nigeria's technology policy makers can be advised on issues related to information and technology advancement in Nigeria. It will also help to give a good insight into the trends of industrial development in Nigeria and how varying technology and information levels can affect the organizational outputs.

1.3 OBJECTIVES OF THE STUDY

The objectives of this project are to:

i. develop a system model for evaluating the influence of change in technology and information on output and demand in Nigeria's Manufacturing Industries;

ii. develop a strategy for absorbing the influence of change in technology and information on output and demand in Nigeria's Manufacturing Industry; and

iii. evaluate the model developed using data obtained from selected Manufacturing Industries.

1.4 THE SCOPE OF THE STUDY

The research is carried out primarily with the Nigeria manufacturing industry in mind. The factors considered to affect output in this work are manpower, machines, raw materials and infrastructural facilities. The model developed was tested with data from two production companies. The model can also apply to any organization whose aim is to maximize production output and meet consumers' needs.

1.5 METHOD OF APPROACH

In other to effectively achieve the stated objectives of the project extensive knowledge was acquired through in-depth study and review of past and current works on industrial development in Nigeria. This involved the following activities: literature survey; model development; data collection and analysis; model validation/testing; and computer programme development.

The methods of approach also involved evaluating how technology can be affected by availability of information from various aspects of manufacturing. The aspects include manpower, machine, raw materials and infrastructural facility.

CHAPTER TWO

LITERATURE REVIEW

This section will look into the various literatures that have examined Nigeria's industrial development and technological advancement. The areas covered include: the history of Nigeria's industrial development; technological development; import substitution as a means of developing indigenous companies; investment; and technology promotion.

2.1 HISTORY OF NIGERIA'S INDUSTRIAL DEVELOPMENT

Nigeria is West Africa's most populous country and one of the most developed industrially. She has a chequered history of industrial development. The growth of industrial activities in Nigeria can be looked into from two perspectives viz: the pre-colonial era, and the post colonial era.

2.1.1. The Pre-Colonial Era

The pre-colonial era that is the pre 1900 Nigeria economy featured mainly the craft industries in the various kingdoms. According to Ajayi (2003), modern factory activity was then hardly known. The Benin kingdom excelled in wood and bronze working. The Igbo-Ukwu area of the East was famous for pottery, wood carving and blacksmithing. The Oyo Empire was noted for calabash carving and textile dyeing. One major characteristic of these craft industries was that they featured in different location a close link with the available local material.

The craft industry has declined considerably following the superior competition from industry activities, especially manufacturing. The first widely recognized form of modern industrialization was brought by the Europeans. Nigeria then embraced the factory form of industrialization as the main panacea to her underdevelopment.

2.1.2. The Post-Colonial Era

The early post-colonial era was characterized by import substitution. This policy led in the direction of mere assemblage of foreign produced items rather than local manufacturing. According to Ajayi (2003), at independence, there were only one hundred and fifty plants of medium and large scale size in the industrial sector, majority of which were established in the late 1950s, and by 1965, the number of firms has increased to three hundred and eighty. It can be seen that the Nigeria manufacturing industry has had a steady growth rate right from the pre-colonial time to the present.

2.2 TECHNOLOGICAL DEVELOPMENTS

The major technological developments in Nigeria over the years impinge on three broad areas namely: Artisan technology, technological re-organization and the capital goods sub-sector of manufacturing.

2.2.1 Artisan Technology

This involves visible development in low-level techniques associated with the small-scale enterprise based on local raw materials. This helped in the local fabrication of spare parts for the local industries. An example as cited by Osifo (1982), is the case of the Nigeria railway corporation (NRC), whose central workshop in Ebute Metta, Lagos was reactivated to produce spare parts for different machines and equipment. However, the immense capability of this workshop was abandoned and emphasis was rather laid on importation because of the oil boom. Artisan technology also involves the assembling locally of agricultural machineries like tractor, shellers etc.

2.2.2. Technological Re-Organization

This involves the re-organization of existing technological establishments. According to Aboyade (1986), this re-organization was carried out base on four inter-related phases.

First is the re-organization of the country's technological institute by the Federal Ministry of Science and Technology in order to make them more effective. The second phase involved a national survey of science and technology through the Federal Office of Statistics. This is aimed at providing a technological database required for technological planning. In the third place, a decision was reached that multinational corporations should pay a levy of one to two percent of their after tax profit for technological development within this country. With the implementation of this policy, it will re-direct some of the research and development activities (which are usually based in their foreign headquarters), to Nigeria.

Lastly, the technological re-organization involves the re-evaluation of the country's vehicle assembly plants. The world's bank's Structural Adjustment Programme (SAP) would want them scraped. As it is a waste of foreign exchange on importation of components. It opines that Nigeria should rather specialize in direct manufacturing (Babawale, 1996).

2.2.3. Capital Goods Sub-Sector of Manufacturing

This involves the threat to the capital goods sub-sector of manufacturing with respect to the scraping of the country's escrow account meant for funding the integrated iron and steel industry. The money meant for this project was diverted to service foreign debt. Nigeria's escrow account should stay for the development of the crucial capital goods sub-sector (Ake, 1989).

2.3. IMPORT SUBSTITUTION

This is a development strategy based on the planned substitution of domestically produced goods for imports. According to Mabogunje (1973), it is a logical out growth of the declining terms of trade thesis generally accepted by most developing countries import substitution seems to promise very rapid growth of domestic demand but also be the potential for replacing imports.

According to a report by the Federal Ministry of Labour and Productivity (2009); after independence and during the oil boom of the 1970s, Nigeria invested in seven cement plants as part of an import substitution, industrialization policy designed to increased local value-added production capacity and to reduce an over reliance on imported products.

By 1986 local cement production capacity in Nigeria was recorded at 3.5 million tonnes per annum (accounting for 81.4 percent of total supply in Nigeria). In the same year, 800,000 tonnes of cement were imported into the country (accounting for 18.6 percent of supply). Nigeria had a local cement industry that met over 80 percent of local demand and created value and wealth for our country and its people.

The country then threw open its doors to the indiscriminate importation of cement into the country. She wilfully and irresponsibly flooded the market with imported cement, causing the collapse of the local cement manufacturing industry. By 2003, local cement manufacturing capacity had collapsed to an all time low of 1.98 million tonnes, meeting only 23.53 percent of local supply, while 8.4 million tonnes of cement were imported, accounting for over 70 percent of supply.

In 1999, Nigeria entered a new era of democratic government and in 2002, that government introduced an import substitution policy designed to re-energise her manufacturing sector and to once again, reduce our over reliance on importation.

2008, six years after the institution of the import substitution policy, marked the highest per annum cement consumption in Nigeria on record, at 13.04 million tonnes. But by this time local production had increased to 6.06million tonnes representing 46.50 percent of total supply, with the balance of 53.50 percent supplied through imports (6.98million metric tonnes). In 2008, the 6.06 million tonnes of cement that were produced locally in Nigeria would have cost us US$770 million to import at an average import price of $127.50 per tonne. That is money that would have been paid into the accounts of foreign cement suppliers and that would never have been seen again.

Projections for 2009 suggest that local production of cement is expected to be between 10 million and 11 million tonnes and is expected to meet significantly more than 50 percent of the national supply. Government has been taking the right approach to the progressive replacement of cement imports with locally manufactured products. The fact that local demand for cement in Nigeria currently exceeds local production capacity is well acknowledged. But the progressive reduction in the level of imports as new production capacity comes on stream is the right approach to solving the problem of supply. Therefore, government should not fall for the antics of those who for selfish reasons, are calling for unbridled importation but remain steadfast in its constructive approach to local cement capacity expansion.

However, this trend will continue only if the implementation of the import substitution policy is maintained and sustained. The sudden change in 2007 with multiple issuances of licenses for imports to trading companies has the potential to reverse this trend and local manufacturing capacity will be once again run down in the same way it was in the late 1980s and 1990s (Odiase-Alegimenlen, 2003).

Recent media reports have accused the cement manufacturing industry of operating a 'cartel' designed to control cement sales in Nigeria and explicitly stated that cement manufacturers had failed to utilise the import quota allocated to them by government as part of the progressive 'substitution' process. Those who are familiar with the Nigeria cement market will confirm that this allegation cannot be true. Reports from the ports confirm that all cement manufacturers that have associated companies with import terminals utilized their quota and delivered import volumes to the market. The import figures for 2008 are: Dangote Cement, 3,179,000 metric tonnes; Burham Flour Mills, 1,720,000 metric tonnes; Lafarge/Atlas, 481,000 metric tonnes and Eagle Cement 530,000 metric tonnes.

In 2008, local manufacturers imported a total of 5.91 million metric tonnes of cement into Nigeria. These facts go to confirm that indeed, local cement manufacturers are actually working in support of government goals of making cement available and actively working to meet local demand through imports complementary to local manufacturing volumes and are substantially increasing local production levels to meet demand. There are wider consequences of allowing the widespread importation of cement and the subsequent degradation of the local manufacturing sector. Cement manufacturers in Nigeria today employ thousands of people, contribute significantly through tax and other revenues to government, help develop significant infrastructure for local communities, including health, electricity, education and other services and ultimately ensure that the money involved in producing and selling of cement in Nigeria, remains in Nigeria. Importation provides a short term glut in supply, and significant capital flight.

The lesson from history is clear. It is impossible to dispute the difference in value between local production of cement and the importation of the product. The value added nature of local production ensures revenue is generated and spent internally and that jobs, infrastructure and expertise is created. Nigeria is moving towards a point where she will become self-sufficient in cement through local production, something that she should aspire to.

2.4. INVESTMENT AND TECHNOLOGY PROMOTION

Economic growth required for eradication of poverty and the achievement of the other associated Millennium Development Goals (MDGs) depends on capital accumulation (investment) and technical change (technological advancement) going hand in hand (Ogbuagu, 1998). Investment in plants and machinery, with its impulse of new ideas and technologies, contributes to productivity growth as do technical progress, upgrading and diffusion. Foreign Direct Investment (FDI) in particular is an important driver of industrial performance, as it is expected to improve direct industrial productivity growth by infusing new capital, technologies and managerial know-how and improving the average skills and efficiency levels of industry. In order to attain growth, the developing countries and those with economics in transition need to mobilize investment (both domestic and foreign) as well as modern technologies, to expand their productive assets and increase their competencies and competitiveness (Dauda, 2003). However, the flow of investment and technology to developing countries has not materialized to the extent expected. This situation largely reflects the problems arising from government and market failures and weaknesses in institutional capacity, which together make for a business climate not conducive to investment and technology promotion.

2.5 MANPOWER DEVELOPMENT IN NIGERIA

The development of indigenous manpower to serve as the propelling force for national growth and development is no doubt a key to Nigeria's socio-economic and political development (Ake, 1989). This is quite indispensable considering the argument of the concept of transfer of technology as a propelling force for the development of the developing countries of which Nigeria is one (Ake, 1989). However, it is important to state that the lack of adequate emphasis on manpower development as a tool for development in Nigeria on the part of government as well as the organized private sector could not be far-fetched from the lack of understanding of both the concept and methods for manpower development in a post-colonial Nigerian State (Reinhart, 1989). Thus, manpower development became an elitist design that was geared to favour capitalist mode of production in which labour was relegated to the background among the factors of production. From the above background, one could therefore argue that there were distortions in both the concept and method of manpower development in the Nigerian State as it was oriented towards serving capitalist interest. This no doubt account for the discrepancies in the educational system, a mechanism designed for manpower development meant to serve national interest.

2.5.1 Tools for Manpower Development in Organizations

The tools and methods for manpower development in organizations differs, and it is largely determined by the objectives of organizations, the idiosyncrasy of management staff or the chief executive, the organizational policy, as well as the organizational environment to mention a few. Thus, it is a common feature to see methods for manpower development varying from one organization to the other, just as a given organization can be tailored at adopting different methods at different times or a combination of techniques at the same time. However, some methods for manpower development are stated as follows:

Orientation: This method of manpower development could be said to be an integral part of the recruitment exercise in that once an employee has been found appointable, it is expected that such an employee need to be positively oriented in line with the vision and aspiration of the organization for effective discharge of function. And since employee function in an organization is basically affected by his perception of the organization vis-à-vis the rules and principles that exist in the organization, it therefore follows that an employee undergoes formal and informal orientation in a place of work. While the formal orientation focuses on job specification and occupational demands placed on the employee, the informal orientation involve the social interaction that take place in the place of work which could either boost productivity or be detrimental to it (Drucker, 1999; and Hamza, 1989). Orientation as a method of manpower development is quite indispensable because it helps in boosting the productivity of workers which is needed for competing in the global market of the 21st century.

On the Job Method of Manpower Development: This method is basically different from the orientation method in that while orientation is at the point of entry into the organization or a new assignment; on the job method is a process through which knowledge and experience are acquired over a period of time either formally or informally. This process involves the following:

Coaching: This is a method of on the job training and development in which a young employee is attached to a senior employee with the purpose of acquiring knowledge and experience needed for the performance of tasks (Yalokwu, 2000).

Job Rotation: This method either involve the movement of an employee from one official assignment or department to the other, in order for the employee to be acquainted with the different aspects of the work process or through job enlargement – That is given additional responsibility to an employee who has been uplifted as a result of the acquisition of additional skill or knowledge (Yalokwu, 2000; Lawal, 2006).

In House Training: This involve a formal method of on the job training in which skills and knowledge are acquired by employees through internally organized seminars and workshops geared toward updating the workers with new techniques or skills associated with the performance of their jobs (Lawal, 2006).

In Service Training: This method involves training outside the organization or workplace in higher institution of learning or vocational centres under the sponsorship of the organization or on terms that may be agreed upon between the organization and the worker (Harbison, 1973).

Committee/Work Group Method: This method entails manpower development through the involvement of employees in meetings, committees and work group discussion geared towards injecting inputs in form of decision making as regard solving organizational problem. This method is quite indispensable, especially in the aspect of training employees for managerial functions or heading organizational units.

Vestibule Training Method: This is a method of manpower development through the acquisition of skills in a related working environment (Olutola, 2003). Under this method the trainee practices his skill with identical equipment that he uses or he is expected to use in his actual place of work. This method is most suitable for sensitive operations where maximal perfection is expected. The purpose is therefore to enable perfection at work place.

Apprenticeship Method: This method of manpower development involves the acquisition of skill through extensive practice for over a period of time by the trainee. This type of manpower development device could either be formal or informal. In the informal environments the trainee is attached to the trainer, and he/she is expected to pay for an agreed period of apprenticeship (Olutola, 2003). In the formal environment on the other hand, an employee of an organization could be placed under apprenticeship in the organization with pay.

2.5.2 The Relevance of Manpower Development in Nigeria

Economic Development: The relevance of manpower development in Nigeria could be situated vis-à-vis economic development. This is because manpower development captures the actual meaning of development in that it is people centred (Taylor, 1992). In addition, it involves the building of capacity and harnessing the State's human resource which constitute a sine-qua-non for development.

Political Stability: There is no doubt that a country which fails to adequately develop her manpower would be doing so at the expense of her socio-economic and political stability. In the aspect of political stability, Baikie (2002) stressed the dysfunctional use of the nation's human resource among the youths in propelling political instability when he stated that: *...there have been situations in which the Nigerian youth especially, those of poor family background were used as tools for disrupting the political democratic system through rigging,* *thuggery and ethnic conflicts. These factors of rigging, thuggery in addition to economic mismanagement, personal ambition or selfishness among others, were the factors that terminated the First and Second Republic.*

Thus, manpower development could help the youths in the development of self and in improving the quality of their political participation.

Poverty Alleviation: It has been argued that effective poverty alleviation scheme must involve the development and utilization of local resource including human for solving local problems (Teriba et al, 1977). Thus, manpower development is central to solving the present problem of poverty in Nigeria.

2.6 SURVEY OF PAST ECONOMETRIC MODELS ON NIGERIA'S PRODUCTION INDUSTRY.

There have been quite an appreciable number of individual or Institutional models of the Nigerian economy. Each of these models was developed for some specific purpose after which it is invariably allowed to go obsolete (Olofin, 1999). Some of the models included that of Ojo in 1997 and Uwujareen in 1998.

Ojo's model was a result of research work by the author for a doctoral thesis (Olofin, 1999). The model was intended as a medium term planning for the Nigerian economy. The model is shown thus:

$$Y_t^A = f(Y_{t-1}, P_{t-1}^A) \qquad (2.1)$$

where

Y_t^A is output in agriculture at time, t.

Y_{t-1} is income lagged one period and

P_{t-1}^A is agricultural price lagged one period

Given the relatively small size of the model it was possible using a 2SLS method based on annual data for over a period of ten years (1987-1997) (Olofin, 1999).

The Uwujareen's model is disaggregated into four sectors viz, primary or agriculture sector, secondary or manufacturing sector, tertiary or services sector and petroleum and mining sector (Olofin, 1999). The model was summarized as:

$$Y_t^i = a_o + a_1 k_{t-1}^i + \mu_t \qquad (2.2)$$

where Y^i is the output of the sector i

and k^i is the stock of sector i and μ^i the error term.

The models discussed above are geared towards ascertaining the level of development of the Nigerian economy through their various parameters. The shortcoming of the models is that it did not put into consideration the various factors that affect production directly. These factors include: manpower, machines, raw materials and infrastructural facilities. In addition, it did not consider how varying technology and information acquisition level can affect an organisation's output.

The model developed in this research work is aimed at putting these factors into consideration

2.7 COMPUTER SOFTWARE

Computer software is a set of written instructions, procedures and rules that direct the operation of their computer (Adejuyigbe, 2002). Software includes the instructions which enable the computer hardware to carry out specific task. It is the set of instructions that tell the computer how to process data. The set of instructions that a computer follows to solve a problem is called a computer program (Kareem, 2008). A computer program is usually written in a programming language. Programming languages include: FORTRAN, Q BASIC, MAT LAB, C ++, Visual Basic and PASCAL (Leestma, 2000).

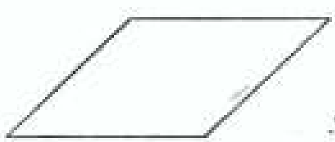
2.7.1 Algorithm

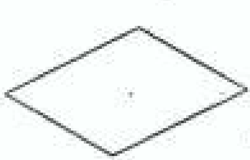
An algorithm is an unambiguous set of instructive or executable actions or steps that must be taken in order to solve a particular problem (Adejuyigbe 2002). It involves development of instructions in a logical manner so that execution of the instructions results in the solution of the problem. It is the set of instruction that shows how a set of data should be manipulated.

2.7.2 Flow Chart

A flow chart is a useful aid to avoid algorithmic ambiguities. It is a diagrammatic representation of the sequence of operation to be performed by the computer. It helps the detection of flows in the programme and enhances logical thinking process during the design phase of a programme. It consists of symbols and flow lines. Some of the symbols include the following:

1.  This is a terminal symbol. It signifies the start or end of a programme or a sub-routine.

2.  This symbol is used as a generalised output and input symbol. It plays two roles. The first is that it signifies that at that stage data can be inputted. Secondly, it is use at the stage where results are to be displayed.

3.  This symbol is mainly used for decision-making situations. It is also used for comparison and asking of questions.

4. → This is the flow symbol. It is used to show the direction of flow of the programme. It also helps in connecting other symbols in the flow chart (Adejuyigbe, 2002).

CHAPTER THREE

METHODOLOGY

The method of achieving the stated objectives involved evaluating how an organisation's output can be affected by varying technology levels and the availability of information from various aspects of manufacturing. These aspects include manpower, machine, raw materials and infrastructural facility. The study involves model development; model validation and testing with data from selected production industry.

3.1 MODEL DEVELOPMENT

When there is available information, our manpower (Skilled, Semi-skilled) can be trained to meet the demands of the manufacturing industry. In like manner, the availability of information can help in the procurement of modern machine, development of infrastructural facility and effective raw materials location, processing and utilization. It can be represented diagrammatically thus:

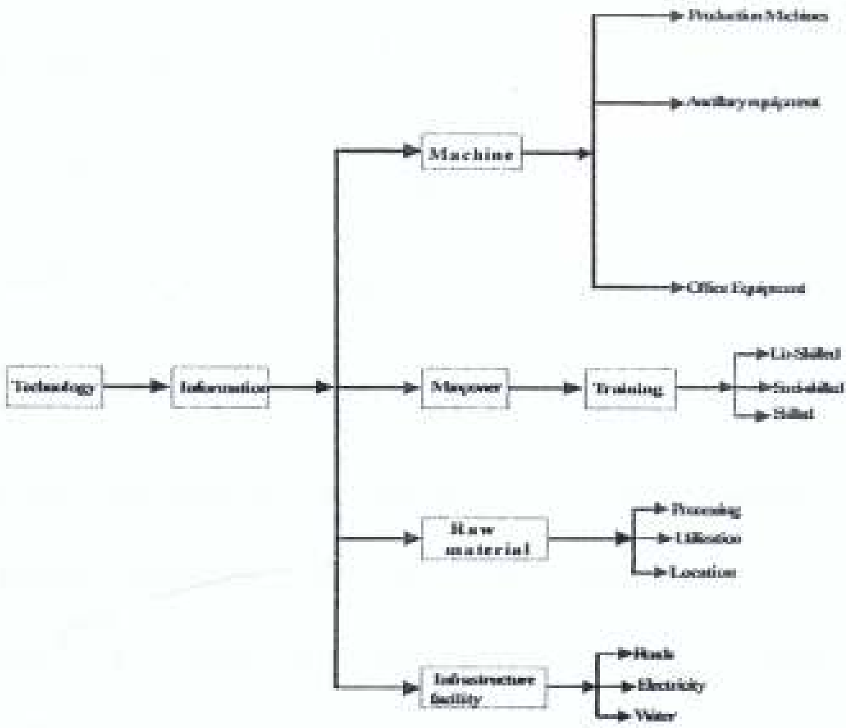


Fig. 3.1 Output Evaluation Parameters' Relationships

From the diagram it can be seen that the quantity of product output from the Nigeria industries at any time, {P(t)}, is a function of the level of experience of manpower, machine, raw materials (location, processing and utilization) and the infrastructural facility available. This can be represented with a mathematical model

Thus:

$$P(t) = \text{f (Machine, Manpower, Raw Material, Infrastructural facility)}$$

$$P(t) = f(Mc, Ma, R, I) \qquad (3.1)$$

Where;

Mc = the number of machines available;

Ma = the number of manpower available;

R = the level of raw material availability;

I = the level of development of the infrastructural facilities.

The successful operation of a system under changing conditions often requires control system (Williams, 1983). A control system was thus developed to enable one have a check as to the difference in the quantity of products manufactured and the quantity consumed. That is

$$E(t) = Q(t) - P(t) \tag{3.2}$$

Where:

$Q(t)$ = the quantity consumed;

$P(t)$ = the quantity produced;

$E(t)$ = the Error (difference between supply and demand). This is also equal to the quantity of goods imported to supplement demand.

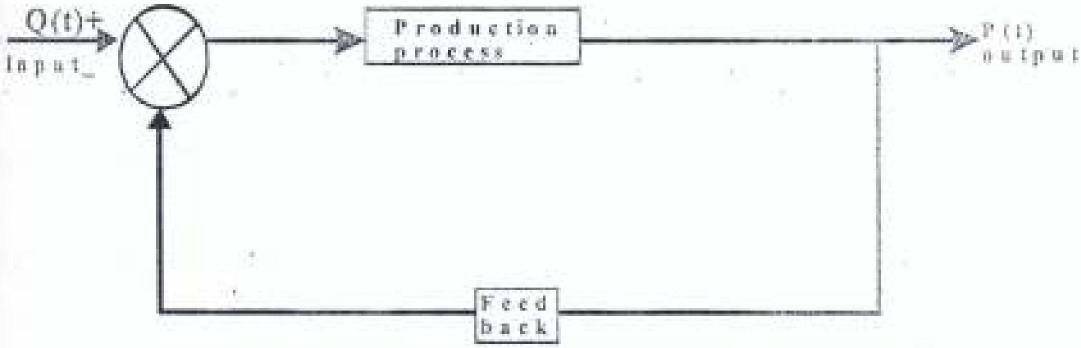


Fig. 3.2 Output and Demand Control System

Hence, evaluation can be made with regards to how foreign goods have affected the Nigeria local industries. The improvement in the technology and information system of the local industries will minimize the error, E(t). The quantity of output from any industry at any time, t is a function of the level of development of the manpower, the utilisation of the machines, the infrastructure facility at their disposal and the availability of information. At any other time, if there is advancement in these elements, then the quantity of output will also increase.

Based on normal distribution, the probability of future change or advancement in technology, P(T) and the probability of acquisition of new information, P(F) were embedded into the production system. Then, the quantity of output expected in a particular year under normal conditions, in future moving from one to the other years (1,2,...n) of production will result into increment in production output as expressed in equation 3.3:

$$P(t_1) = f(Mc, Ma, R, I) + P(T)P(F)f(Mc, Ma, R, I)$$

$$P(t_2) = f(Mc, Mp, R, I) + P(T)P(F)f(Mc, Mp, R, I)xP(T)P(F)f(Mc, Mp, R, I)$$

$$P(t_2) = f(Mc, Mp, R, I)\{1 + P(T)P(F)\}^2$$

$$P(t_n) = f(Mc, Mp, R, I)\{1 + P(T)P(F)\}^n \quad (3.3)$$

Equation 3.3 is a general expression of the expected output of the industry at any time, t.

As can be seen from the diagrammatic representation (Fig 3.1), the four main elements also have sub elements on which they depend.

The level of performance of machines, Mc(t) is a function of the sub element under it. That is

$$Mc(t) = f(Mcp, Mca, Mco) \quad (3.4)$$

Where;

Mcp = production machines;

Mca = Ancillary machines; and

Mco = Office equipment

For future years changes will take place on machine capacity as a result of change in technology and information.

$$Mc(t_1) = f(Mcp, Mca, Mco) + P(T)P(F)f(Mcp, Mca, Mco)$$

$$Mc(t_1) = f(Mcp, Mca, Mco)\{1 + P(T)P(F)\}$$

For further years,

$$Mc(t_2) = f(Mcp, Mca, Mco)\{1 + P(T)P(F)\}.\{1 + P(T)P(F)\}$$

$$Mc(t_n) = f(Mcp, Mca, Mco)\{1 + P(F)P(T)\}^n \qquad (3.5)$$

Manpower, Mp

The level of contribution of manpower to over all output is function of the skills of the work force and the training received

Let Mps = skilled manpower

Mpt = training

$$Mp(t_0) = f(Mpt, Mps)$$

As the number of years increase, level of development of the manpower will also increase.

$$Mp(t_1) = f(Mpt, Mps) + P(T)P(F)f(Mpt, Mps) \qquad (3.6)$$

$$Mp(t_1) = f(Mpt, Mps)\{1 + P(T)P(F)\}$$

$$Mp(t_2) = f(Mpt, Mps)\{1 + P(T)P(F)\}.\{1 + P(T)P(F)\}$$

$$Mp(t_2) = f(Mpt, Mps)\{1 + P(T)P(F)\}^2$$

This trend also continues to the nth year

$$Mp(t_n) = f(Mpt, Mps)\{1 + P(T)P(F)\}^n \tag{3.7}$$

Raw Materials,

The output performance from raw materials is dependent on availability of information on the optimal processing method, the raw materials utilization and its location.

Mathematically,

$$R(t_0) = f(Rp, Ru, Rl)$$

Where;

Rp = Raw materials processing

Ru = Raw materials utilization

Rl = Raw materials location

$$R(t_1) = f(Rp, Ru, Rl) + P(T)P(F)f(Rp, Ru, Rl) \tag{3.8}$$

$$R(t_1) = f(Rp, Ru, Rl)\{1 + P(T)P(F)\}$$

$$R(t_2) = f(Rp, Ru, Rl)\{1 + P(T)P(F)\}.\{1 + P(T)P(F)\}$$

$$R(t_2) = f(Rp, Ru, Rl)\{1 + P(T)P(F)\}^2$$

At the nth year, we have;

$$R(t_n) = f(Rp, Ru, Rl)\{1 + P(T)P(F)\}^n \tag{3.9}$$

Infrastructural facility

The over all performance of an organization depends a lot on the infrastructural facility at her disposal. The factor of infrastructural facility itself is dependent on certain factors of which the road networks, electricity and water supply are the major ones.

Thus:

$I(t_o) = f(Ir, Ie, Iw)$

Where; Ir = Roads

Ie = Electricity

Iw = Water

$$I(t_1) = f(Ir, Ie, Iw).\{1 + P(T)P(F)\} \qquad (3.10)$$

As the number of year increases, the expected contribution of infrastructural facilities to output also increase,

$$I(t_2) = f(Ir, Ie, Iw).\{1 + P(T)P(F)\}^2$$

And at the nth year, we have;

$$I(t_n) = f(Ir, Ie, Iw).\{1 + P(T)P(F)\}^n \qquad (3.11)$$

Recall that the overall total output, P(t) depends on four elements, machines, manpower, raw materials and infrastructural facility. That is;

$$P(t) = f(Mc, Mp, R, I)$$

$$P(t_n) = f(Mp, Mc, I, R)\{1 + P(T)P(F)\}^n$$

Substituting Equations 3.5, 3.7, 3.9 and 3.11 into (3.3) gives;

$$P(t_n) = f(Mcp, Mca, Mco)\{1 + P(F)P(T)\}^n . f(Mpt, Mps)\{1 + P(F)P(T)\}^n . f(Rp, Ru, Rt)\{1 + P(F)P(T)\}^n$$
$$. f(Ir, Ie, Iw).\{1 + P(F)P(T)\}^n$$

Factorizing

$$P(t_n) = f(Mcp, Mca, Mco).f(Mpt, Mps).f(Rp, Ru, Rt).f(Ir, Ie, Iw).\{1 + P(F)P(T)\}^{4n} \quad (3.12)$$

In other to arrive at a concise solution the differential equation (3.12), the four factors that affect the output will have to be split into two thus;

$$\frac{\partial^2 P}{\partial Mc \partial Mp} = McMp \qquad and \qquad \frac{\partial^2 P}{\partial I \partial R} = IR \qquad (3.13)$$

That is, machine and manpower were grouped as one function while infrastructural facility and raw materials are classified as another function. Manpower was grouped with machines because the workforce or manpower in any organization works directly with the machines. Whereas, raw materials and infrastructure are linked because when it comes to preservation, transportation and utilization of raw materials the infrastructure available in the organization comes into play.

As with all differential equations, the arbitrary constants or arbitrary function in any particular case are determined from the additional facts given concerning the variables of the equation. These are the initial conditions. In the above case

$$Manpower, Ma = Mpt + Mps \text{ when } \frac{\partial P}{\partial Mc} = 3Mc \quad (3.14)$$

and for Machines, $Mc = 3, P(tn) = 2Mp$

$$\frac{\partial^2 P}{\partial Mc \partial Mp} = McMp \quad (3.15)$$

Integrating equation 3.15 partially with respect to Mp gives;

$$\frac{\partial P(t_n)}{\partial Mc} = \frac{McMp^2}{2} + \phi Mc \quad (3.16)$$

Recall (Equation 3.14) that $Manpower, Ma = Mpt + Mps$ when $\frac{\partial P}{\partial Mc} = 3Mc$

Substituting into equation 3.16 gives;

$$3Mc = \frac{Mc(Mpt + Mps)^2}{2} + \phi Mc \quad (3.17)$$

Making ϕMc the subject of the formula, we have;

$$\phi Mc = 3Mc - \frac{Mc(Mpt + Mps)^2}{2} \quad (3.18)$$

Equation 3.19 is gotten by substituting for ϕMc in equation 3.18

$$\frac{\partial P(t_n)}{\partial Mc} = \frac{McMp^2}{2} + 3Mc - \frac{Mc(Mpt + Mps)^2}{2} \qquad (3.19)$$

Integrating further with respect to Mc we have:

$$P(t_n) = \frac{Mp^2Mc^2}{4} + \frac{3Mc^2}{2} - \frac{Mc^2(Mpt + Mps)}{2} + \phi Mp_1 \qquad (3.20)$$

Applying the second initial condition for Machines, $Mc = 3, P(tn) = 2Mp$; gives

$$2Mp = \frac{9Mp^2}{4} - 27/2 + \frac{9(Mpt + Mps)^2}{2} + \phi Mp \qquad (3.21)$$

Rearranging and Substituting for the integral constant gives

$$P(tn)_1 = \frac{Mp^2Mc^2}{4} + \frac{3Mc}{2} - \frac{Mc^2(Mpt + Mps)^2}{2} + 2Mp - \frac{9Mp^2}{4} - 27 + \frac{9}{2}(Mpt + Mps)^2 \qquad (3.22)$$

This equation gives the total expected output from manpower and machines.

Determining that for infrastructure facility and Raw materials, we have

$\frac{\partial^2 P}{\partial I \partial R} = IR$ where $I = Iw + Ie + Ir$ when $\frac{\partial P}{\partial R} = 3R$

and R = 3 when $P(tn)_2 = 3I$ (3.23)

Integrating $\frac{\partial^2 P}{\partial I \partial R} = IR$

$$\frac{\partial P(I)_2}{\partial R} = \frac{I^2R}{2} + \phi R \qquad (3.24)$$

Recall that from equation 3.23 the initial conditions are;

$I = Iw + Ie + Ir$ when $\frac{\partial P}{\partial R} = 3R$

Substituting this into equation 3.24 and rearranging gives;

$$\phi R = 3R - \frac{(Ie + Iw + Ir)^2 R}{2} \tag{3.25}$$

Substituting equation 3.25 into equation 3.24 gives

$$\frac{\partial P(tn)_2}{\partial R} = \frac{I^2 R}{2} + 3R - \frac{(Ie + Iw + Ir)^2 R}{2} \tag{3.26}$$

Integrating equation 3.26 further with respect to R gives;

$$P(tn)_2 = \frac{I^2 R^2}{4} + \frac{3R^2}{2} - \frac{R^2 (Ie + Iw + Ir)^2}{2} + \phi I \tag{3.27}$$

From the initial conditions we have that;

$R = 3$ when $P(tn)_2 = 3I$

Substituting this into equation 3.27 and rearranging gives

$$\phi I = 3I - \frac{9I}{4} - 27/2 - \frac{9(Ie + Iw + Ir)^2}{4}$$

Substituting for ϕI in 3.27 gives

$$P(tn)_2 = \frac{I^2 R^2}{4} + \frac{3R^2}{2} - \frac{R^2}{2}(Ie + Ir + Iw)^2 + 3I - \frac{9I^2}{4} - \frac{27}{2} - \frac{9}{2}(Ie + Ir + Iw)^2 \tag{3.28}$$

The total output expected can be gotten by combining the two partial outputs which are given by equations 3.22 and 3.28, thus

$$P(tn) = P(tn_1) + P(tn_2)$$

$$\begin{aligned} P(tn) = {} & \frac{Mp^2 Mc^2}{4} + \frac{3Mc}{2} - \frac{Mc^2 (Mpt + Mps)^2}{2} + 2Mp - \frac{9Mp^2}{4} - 27 + \frac{9}{2}(Mpt + Mps)^2 \\ & + \frac{I^2 R^2}{4} + \frac{3R^2}{2} - \frac{R^2}{2}(Ie + Ir + Iw)^2 + 3I - \frac{9I^2}{4} - \frac{27}{2} - \frac{9}{2}(Ie + Ir + Iw)^2 \{1 + P(F)P(T)\}^n \end{aligned} \tag{3.29}$$

3.2 MODEL VALIDATION, IMPLEMENTATION AND TESTING

The performance of the developed model was evaluated using data from two companies in different sectors of the Nigerian production industry. The data collected were in terms of:

i. The number of operational production machines available in the company

ii. The number of manpower needed to operate the machines and process the raw materials

iii. The quantity of raw materials needed to yield the expected output.

iv. The number of functional infrastructural facilities available to support the production process.

v. The level of information and technology involved in the production process

3.2.1 Collection of Data

Data were collected from two companies located in Benin City. The first is a mattress producing company while the second is a building materials manufacturing company.

The data collected from the mattress producing company shows that they have a manpower force of 32 1operating 16 functional machines. The company uses raw materials of 250 tons per month this gives a total of 3000 tons per year. There are 6 infrastructures available for the production process. These included road, water, electricity, blocks of offices, warehouse and workshop. The mean output is 235.5tons per month, at the information and technology level of 0.3 as compared to the global information and technology standard.

While for the building materials manufacturing company, they have a manpower force of 25, the number of machines 10 and the infrastructure available for the production process is 6. The raw materials needed for production activities is about 660 tons per year. While mean output is 600 tons per year at the same level of information and technology as for the former manufacturing industry.

Recall from Equation 3.29 the expected output is given as:

$$P(tn) = \frac{Mp^2Mc^2}{4} + \frac{3Mc}{2} - \frac{Mc^2(Mpt+Mps)^2}{2} + 2Mp - \frac{9Mp^2}{4} - 27 + \frac{9}{2}(Mpt+Mps)^2$$
$$+\frac{I^2R^2}{4} + \frac{3R^2}{2} - \frac{R^2}{2}(Ie+Ir+Iw)^2 + 3I - \frac{9I^2}{4} - \frac{27}{2} - \frac{9}{2}(Ie+Ir+Iw)^2\{1+P(F)P(T)\}^n$$

Substituting the data collected into this equation and simplifying gives:

$$Ptn = \{2294336.82\}\{1+P(T)P(F)\}^n \qquad (3.30)$$

$$P_m = \{314480.5\}\{1 + P(T)P(F)\}^n \tag{3.31}$$

Equation 3.30 can be used to predict the expected output at any technology and information levels for the mattress producing company while equation 3.31 can be use for the building materials manufacturing company.

From this simplified model the output for any given year, at any information and technology. levels can be obtained. The varying values of Expected Output for different values of technology and information acquisition probability levels are shown in Table 3.1.

Table 3.1: Expected Output for the Mattress Producing Company (in tons).

P(F) × P(T) / n	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1	2317.28	2386.11	2500.83	2661.43	2867.96	3120.30	3418.57	3762.7	4152.76	4588.60
2	2340.6	2431.56	2726.01	3087.26	3564.91	4243.61	5093.66	6170.88	7516.49	9177.36
3	2363.88	2580.82	2971.23	3581.23	4481.13	5771.31	7509.56	10,120.2	13604.8	18354.7
4	2387	2684.1	3238.65	4164.22	5601.4	7848.9	11305.4	16597.14	24624.8	36709.44
5	2411.37	2791.4	3530.13	4818.90	7001.77	10674.6	16849	27219	44575.8	73418.88
6	2435.5	2903.1	3847.8	5589.9	8752.2	14517	25105.9	44639.7	80673.19	146837.76
7	2459.84	3019.19	4194.14	6484.31	10940.3	19743.7	37407.8	73209.0	146018.5	293675.52
8	2484.44	3139.96	4571.6	7521.8	13675.33	26851.5	55737.6	120062	264293	587351.04
9	2509.29	3265.6	4983.1	8725.3	17094.2	36518	83048.9	196903	478371.1	1174702.08
10	2534.38	3396.18	5431.6	10121.33	21367.7	49664.5	123743	322921	865851.7	2349404.16
11	2559.7	3532.03	5920.4	11740.74	26709.6	67543.8	184376.9	5295904	1567191.8	4698808.32
12	2585.32	3673.3	6453.21	13619.26	33387.04	91859.6	274721.7	868528	2836617	9397616.64

ACTUAL OUTPUT PER YEAR = 2826 TONS PER YEAR

The quarterly demand for goods from the mattress producing company is shown in Table 3.2. This table is used to derive the trend equation.

Table 3.2: Quarterly Demand of Goods from the Mattress Producing Company (in tons).

Year	97	98	99	00	01	02	03	04	05	06	07	08
1	600	550	700	650	800	1000	850	1000	1200	1100	1250	1400
2	520	479	700	850	1100	1300	1100	1230	1400	1400	1450	1600
3	398	650	600	810	900	1100	950	900	900	1100	1150	1250
4	780	800	900	900	1400	1100	1450	1500	1600	1650	1600	1850
Total	2298	2479	2900	3110	4300	4400	4350	4630	5100	5250	5450	6100

The trend equation to forecast demand for this organization was derived using regression analysis (see Appendix A). It is given as;

$$Q(t) = 573.28 + 19.77t \qquad (3.32)$$

Equation 3.32 was used to determine the trend of demand for the mattress producing company. It is shown in Table 3.3

Table 3.3: Trend of Demand Using The Trend Equation $Q(t) = 573.28 + 19.77t$

Quarter	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	1542	1621	1700	1779	1858	1937	2016	2095	2174	2253	2332	2412
2	1562	1640	1716	1799	1878	1957	2036	2115	2194	2273	2352	2431
3	1581	1660	1739	1818	1898	2056	2135	2214	2293	2372	2451	2443
4	1601	1680	1759	1838	1917	1996	2075	2154	2234	2313	2392	2471
Total	6286	6602	6919	7235	7552	7868	8184	8500	88172	9133	9449	9766

In other to arrive at a concise forecast of demand, the seasonal adjustment factor for each quarter was evaluated (see Appendix). This factor was used to multiply trend of demand to give the forecast of demand. The table below shows the forecast of demand.

Table3.4: Forecast of Demand for the Mattress Producing Company.

Quarter	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	1403	1475	1547	1691	1763	1835	1835	1906	1979	2050	2122	2194
2	1546	1624	1702	1781	1859	1937	2015	2094	2172	2250	2330	2407
3	1486	1560	1635	1709	1784	1856	1932	2007	2081	2155	2230	2304
4	1841	1932	2023	2114	2205	2296	2387	2478	2569	2656	2750	2841
Total	6277	6593	6908	7224	7539	7855	8170	8486	8801	7113	8433	9748

The difference between the Expected output that was derived from the model and the forecasted demand gives what is termed Error, E(t). A positive value for E(t) indicates that demand has not been satisfied. What this portends is that more of the products will have to be imported to supplement output. On the other hand, a negative value indicates that there is excess of output. In this case, the organization will have to maintain inventory. This will eventually lead to inventory cost. Table 3.5 shows the difference termed errors.

Table 3.5: Evaluation of Error, $E(t) = Q(t) - P(t)$ for the Mattress Producing Company.

P(F)-P (T) / n	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1	3969	3785	3625	3418	3166	2868	2524	2133	1698	1698
2	4262	4121	3877	3515	3018	2359	1509	132	-713	-257
3	4555	4338	3948	2438	1147	-207	-1200	-6685	-6823	-11425
4	4848	4551	3996	3081	1634	-113	-2072	-9361	-17389	-29473
5	5140	4760	4021	2733	50	-322	9297	-19667	-27018	-658867
6	5432	4965	4020	2278	-283	-6648	-17237	-36771	-37018	-65866
7	5724	5165	3990	1342	700	-275	-1155	-29223	-65024	-137833
8	6016	5760	3929	79	-174	-18350	-47236	-11156	-255792	-578850
9	6307	5551	3834	91	-277	-277009	-74231	-187486	469554	-1165884
10	6599	5737	370	-98	-122	-4053	-114609	-313787	-856718	-234027
11	6890	5917	352	-22	-172	-58093	-174927	-520140	-1557741	-4689358
12	7180	6092	331	-38	-236	-82093	-264956	-848761	-2826851	-9387851

A close look at the table shows that a negative value precedes a particular positive value. The optimality point is the point where the quantity of goods demanded is equal to the quantity of goods produced. That is $Q(t) = P(t)$ At this point $E(t) = Q(t) - P(t)$ tends to zero.

The information and technology development at this point can be obtained by the method of interpolation. The interpolation is carried out between the positive value of $E(t)$ and the preceding negative value (see Appendix B). The result is shown in Table 3.6.

Table 3.6: The Optimality Point for the Mattress Producing Company.

n (years)	1	2	3	4	5	6	7	8	9	10	11	12
P(F)=P(T)	0.82	0.82	0.68	0.594	0.513	0.489	0.47	0.43	0.425	0.379	0.394	0.39

The same process use for the analysis of data from the mattress producing company was also use in analyzing data from the building materials manufacturing company. The outcomes are shown in Table 3.7

Table 3.7: Expected Output for the Building Materials Manufacturing Company

n \ P(F)=P(T)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1	317.63	327.06	342.78	364.80	393.10	427.69	468.58	515.75	569.21	628.96
2	320.80	340.14	373.63	423.16	491.38	581.66	698.17	845.83	1030.27	1257.92
3	324.01	353.75	407.26	490.87	614.22	791.06	1040.28	1387.15	1864.78	2515.84
4	327.25	367.90	443.91	569.41	767.77	1075.84	1550.02	2274.93	3375.26	5031.68
5	330.52	382.61	483.87	660.52	959.72	1463.15	2309.53	3730.89	6109.22	10063.36
6	333.83	397.92	527.41	766.19	1199.65	1989.88	3441.21	6118.66	6109.22	10063.36
7	337.17	413.83	574.88	888.8	1499.55	2706.2	5127.4	10034.6	20014.4	40253.44
8	840.54	430.39	626.62	1031.0	1874.45	3680.5	7639.8	16456.7	36226.10	80506.88
9	343.9	447.60	683.3	1196.96	2343.06	5005.45	11383.33	26989	65569.2	161013.76
10	347.38	465.51	744.48	1387.31	2928.8	6807.4	16961.17	44262	118680.3	322027.52
11	350.86	484.12	811.49	1609.3	3661.03	9258.08	25272.14	12589.8	214811.41	644055.04
12	354.36	503.49	884.5	1866.76	4576.29	12590.99	37655.5	119047.2	388808.66	1288110.08

Table 3.8: Quarterly Demand for Goods at the Building Materials Manufacturing Company (in tons).

YEAR / QUARTER	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	150	186	195	180	200	212	220	228	250	370
2	95	85	90	105	95	115	116	120	180	310
3	65	105	155	120	105	169	170	177	200	332
4	215	180	200	245	233	253	304	345	320	433
TOTAL	525	556	600	650	635	749	810	870	950	1150

Table 3.8 was used to determine the trend equation for demand for the building materials manufacturing company. The process involved is shown in Appendix B2 (Aderoba, 1995).

Table 3.9: The Trend for Demand Determined using the Trend Equation: 134.2 + 1.831t

RTER	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	136.03	143.32	150.67	157.99	165.31	172.63	180	187.27	194.59	201.91	209	216.6
	137.86	145.18	152.5	159.8	167.14	174.46	181.38	189.1	196.42	203.74	211	218.4
	139.69	147.01	154.33	161.65	168.97	176.3	183.61	190.93	198.25	205.6	212.9	220.2
	141.52	148.8	156.16	163.48	170.8	178.12	185.44	192.76	200.1	207.4	214.7	222

Table 3.10 gives the difference between the forecasted demand and the expected output, E(t).

Table 3.10: **Evaluation of the Errors, E(t) for the Building Materials Producing Company**

P(F)=P(T) / n(years)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1	235	226	210	188	160	125	84.4	37	-16	-76
2	260	241	207	159	90	-0.66	-117	-265	-449	-677
3	288	258	205	121	2	-179	-428	-775	-1253	-1904
4	318	277	201	76	-123	-431	-905	-1630	-2730	-4387
5	339	287	143	9	-290	-793	-1640	-3061	-5439	-9393
6	364	300	171	-68	-501.65	-1292	-2743	-5421	-10359	19429
7	390	313	152	-162	-773	-1979	-4400.4	-9307	-19287	-39526
8	418	328	131	-273	-1116	-2923	-6882	-15699	-35468	-79749
9	442	338.4	103	-411	-2143	-4219	-10597	-26203	-64783	-160228
10	438.6	321	42	-601	-2143	-6021	-16175	-43476	-117894	-321242
11	493	360	33	-765	-2817	-8414	-24428	-71746	-213967	-643206
12	519	370	11.5	-994	-3703	-11718	-36783	-118174	-387936	-1287237

As with the first case, an interpolation was carried out to determine the optimality point. The result from interpolation is shown below. The process is shown in Appendix A2

Table 3.11: Optimality Points for the Building Materials Manufacturing Company.

n (years)	1	2	3	4	5	6	7	8	9	10	11	12
P(F)=P(T)	0.869	0.599	0.501	0.438	0.403	0.372	0.348	0.322	0.32	0.307	0.304	0.301

The optimality points for both companies (Tables 3.6 and 3.11) were analyzed using SPSS 15.0 (see appendix). The result shows that the model developed gives an output value that has high correlation with actual output. Further analysis gave two mathematical models. These models will help in forecasting the actual output with a given technology level that will satisfy demand for the companies. At this output level there will be no left over and also there will be no importation to supplement demand.

The models are:

For the mattress producing company, we have;

$$P(t) = 5961.161 + 1.361P(F)P(T) + 315.508n \qquad 3.33$$

and for the building materials manufacturing company, we have;

$$P(t) = 526.551 + 3.188P(F)P(T) + 28.995n \qquad 3.34.$$

3.3 COMPUTER PROGRAMME DEVELOPMENT

The computer program written for this study is done using visual basic 6.0. Visual basic programming language was chosen because of its user friendliness. It is also very easy to understand and operate. It allows for Graphical User Interface and enhances simple coding. Lastly it can be use to develop robust programme.

3.3.1 The Algorithm

The algorithm for the computer progrmme is shown as follows:

10 Start

20 Enter Value for P(F), P(T) for the Companies

30 Enter Value of year, n under review

40 If n <= 0 GO TO 20

50 And If P (T) =P (F) GO TO 20 Else GO TO 60

60 Evaluate Outputs, Then GO TO 70

70 Display Outputs Then GO TO 80

80 If there is any other Company GO TO 20 Else GO TO 90

90 Stop.

3.3.2 Flow Chart

The flow chart developed for the computer programme is shown in Fig 3.3:

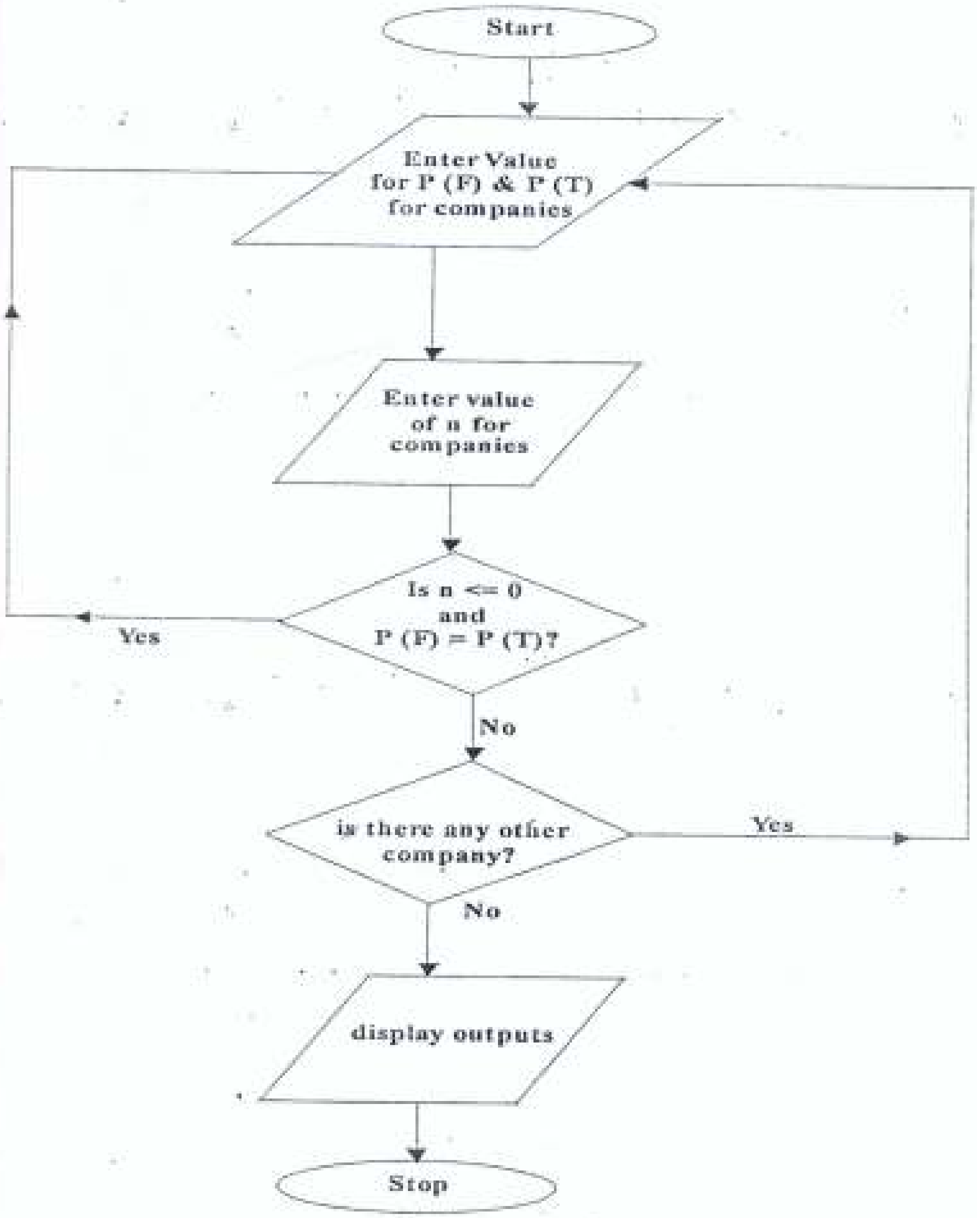


Fig 3.3 Flow Chart for the Optimal Models

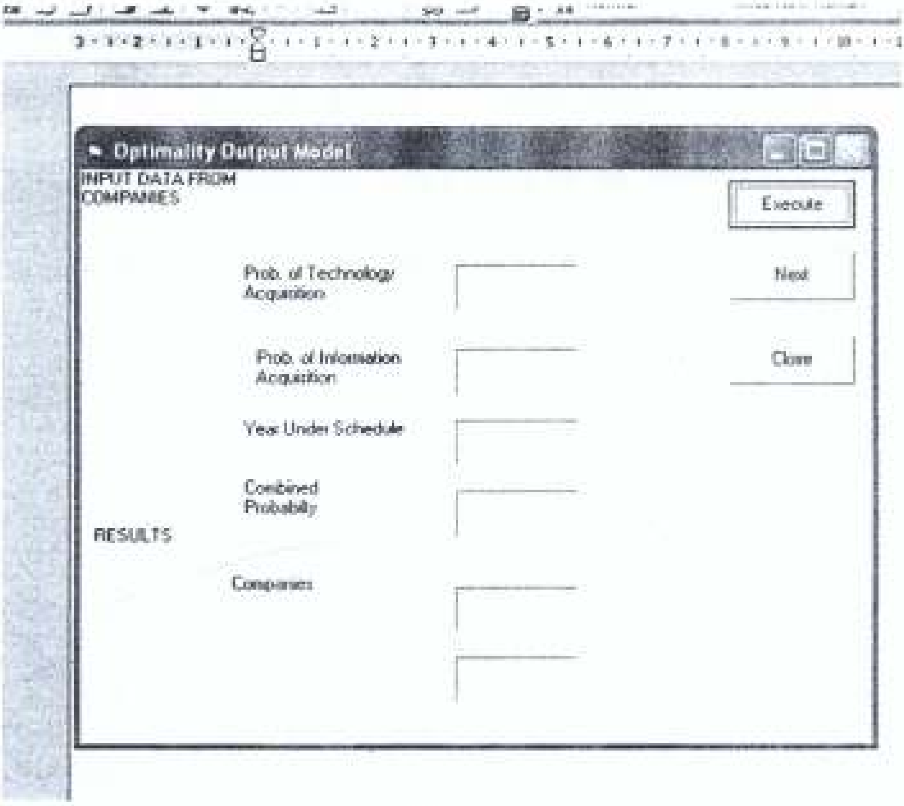


Fig 3.4 Computer Programme Interface

3.3.3 Computer Programme Execution

In other to successfully run the computer programme developed, the various steps should be followed sequentially. Errors like assigning a negative value to n (number of years) will make the programme to give an error report as there cannot be a negative year. The first thing to do is to click the Visual Basic 6.0 start-up icon and then select the Optimality Output Model. The next stage is to input all the Input Data from the companies into the input boxes provided for them accurately. These input data include the probability of technology acquisition, probability of information acquisition and the year under schedule.

After inputting these data click 'Execute'. The results will be displayed in the result section. If there are data from other companies to be worked on click 'Next'. This will clear the data in the input boxes and the results in the result section and set the stage for other data to be inputted. To end or quit the programme click 'Close'. This will successfully end the programme.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

The model developed was validated with data from two organizations for the first company, a mattress producing company; it shows that the expected output for a given year increases as the level of information/awareness of modern techniques and the technology level increases. Values for P(T) = P(F) ranging from 0.1 to 1.0 was evaluated with values of n (years) ranging from 1 to 12. When the technology level is at the lowest (0.1) the expected output is low. And the output increases as the technological level increases. Also when the number of years increases the output also increases.

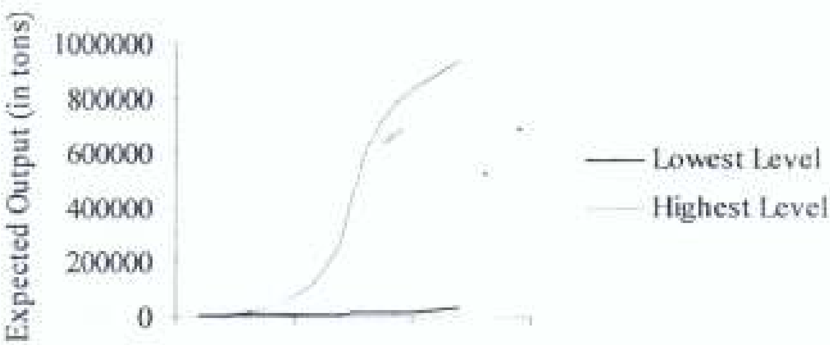


Fig 4.1 Expected Outputs for the Mattress Producing Company at the Highest and Lowest Technology/Information Levels.

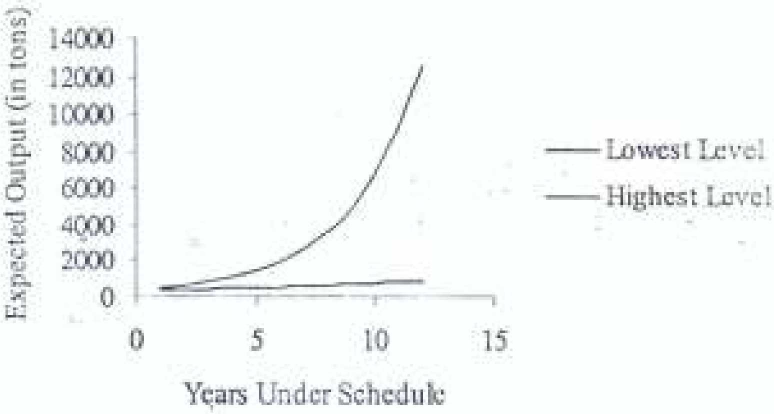


Fig 4.2 Expected Outputs for the **building** Materials **Manufacturing Company at Highest and Lowest Technology**/Information Levels

The quarterly demand of goods from the mattress producing company was used to derive a trend equation. This trend equation was use to determine the trend of demand. With the aid of the seasonal adjustment factor evaluated a forecast was made for demand for the next 12 years. The seasonal adjustment factor was used in other to arrive at a concise forecast.

The difference between the Expected output and the forecasted trend for demand for a given year and technology and information level was obtained and tabulated. It is observed that at lower technological levels the value of $E(t) = Q(t) - P(t)$ is positive. This positive value indicates that demand is more than the Expected output. This positive value reduces until $E(t)$ becomes negative. The negative value indicates that the demand of goods has been fully satisfied and there are leftover. These leftovers will introduce inventory cost to the organization. In other for the organization to meet the demand of their goods they will have to subscribe for importation. And this will have a negative effect on the Nigerian economy as this will lead to loss of foreign exchange.

As the probability of advancing in information and technology increases towards one, the value of E(t) changes from positive to negative. As the probability gets to one, a greater negative value for E(t) results (Tables 3.5 and 3.10). What this indicates is that the organization has been able to satisfy demand and has some leftover. The leftover is much at higher technological levels. And since this high leftover will lead to inventory cost, that cost will take its toll on the net profit of the organization. A close look at the tabulated values for E(t) for a particular year shows that after a particular positive value a negative value follows it. Using the interpolation technique, the value of the level of technology for which E(t) tends towards zero was reached. This point is called the optimality point. At this point, the goods demanded were equal to the quantity of goods produced. At this particular point there will be no cost for keeping inventory and there will be no importation of goods to supplement demand. The optimality point was tabulated (Tables 3.6 and 3.11).

For the second company, the building materials manufacturing company, the same process was employed. Data collected were evaluated with the developed model. The result was then use to obtain the expected output. This was tabulated. The quarterly demands placed on goods were collected and a trend equation was developed. With the aid of the seasonal adjustment factor a concise forecast was made for demand. The difference between the quantity demanded and the expected output was obtained. It is observed that both data behaved in the same way to changes in technology and information level (see Tables 3.1 and 3.7). This proves that the model is highly reliable.

Fig 4.3 Comparison of Expected Output from both Companies

The optimality points for both organizations were collated and analyzed using SPSS 15.0 results from this analysis are attached at the appendix. It also shows that the results obtained from the model are of high correlation with the real data from the companies. From the analysis a simplified model was obtained that can be use obtain the optimal output. Fig 4.4 shows a comparison between the generated optimal outputs for both organizations.

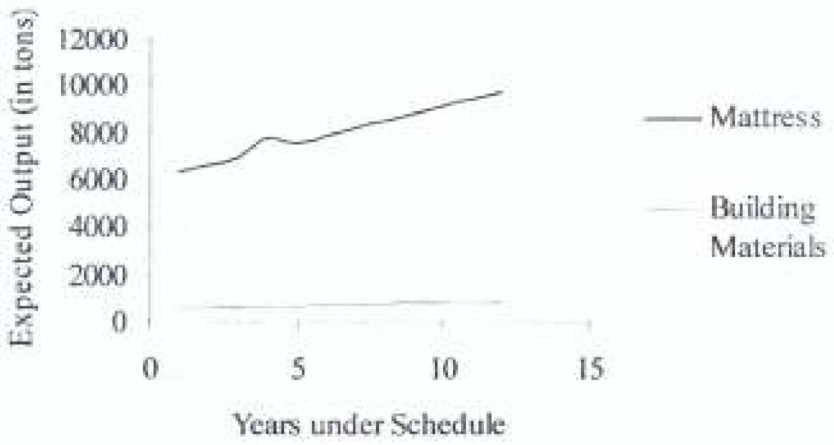


Fig 4.4 Comparing Optimal Outputs for both Organizations

This output also corresponds to the expected demand. This is because at this point E(t) tends to zero that is demand is made equal to output. The total goods produced for this organization will be completely procured by customers. There will be little or no cost of keeping inventory. In addition, there will be little or no cost of importation. The model is of great importance for organization that aims to produce optimally.

The simplified model was used to develop a computer programme that can be use by organizations who can lay hands on them. Visual basic 6.0 was used. This programming language is very easy to use. The program written with it is highly dynamic and very interactive. The program was use to evaluate series of optimal output at different technology levels. The results show that the model developed with the software is highly reliable.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

From this research, it can be seen that for an organization to break even easily and also meet its consumer's needs it has to adopt the best technological level that suits its organization. The factors considered in developing the model which included manpower, machine, infrastructures and raw materials have to be study strongly by the organization. The manpower must be trained to meet the chosen technology level, adequate infrastructure must also be put in place and the raw materials must also be optimally utilized. In this way, the best output can be gotten out of the companies resources.

In addition, the organisation must be able to operate at an optimal level in other to maximize profit. It can be seen that the output increases as the technology and information acquisition levels increases. The problem of importing to substitute demand can be solved if the organisation adopts the strategy that suits the quantity being demanded from it. Also, the organisation should avoid adopting a strategy that is too high compared to its present demand. If they do, then the problem of inventory cost will set in; the cost of keeping inventory will also affect whatever profit the organisation may have.

The organisation must know the quantity of goods being demanded from it by consumers and then having in mind the strength of its manpower, the quantity of raw materials available for its production process and finally, have the necessary infrastructure facilities to support the process of production. With these in mind, the best information and technology level can then be adopted to optimize production.

5.2 RECOMMENDATION

In the course of the research work it was discovered that there is inefficiency in the utilization of manpower, raw materials and the infrastructures available to most organization. It is therefore recommended that these factors should be optimally utilized in other to get the best production output from available resources. As stated earlier, the organisation must not operate below or above its optimal strategy in other to get the best results from its available resources.

Manpower should be developed through special orientation seminars, on the job training, coaching and in-service training. Obsolete machine should be recycled if possible or discarded and modern ones procured. This will lead to proper raw materials utilization. The available infrastructures should not be allowed to ruin. All organizations should develop a good maintenance culture. This will help to improve the life span of this structure.

The government also has a role to play in this lofty agenda. Policies that will help in protecting infant industries and small and medium enterprise should not only be put in place but also enforced to the letter. Furthermore, the indigenous manufacturing sector and production engineering practice should be given incentives. Adequate monitoring should also go into the importation sector to ensure that importations of goods that can be produced in the country are banned. The Nigeria market should not be flooded with goods that can be produced locally.

Government should also look into areas of raw material development in order to ensure that adequate raw materials are available for companies investing in the country. Lastly, organization should not sit on their present technology but should also look out for advancement in these technologies. This can be done through regular survey and sourcing of information.

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APPENDIX A

Table A1: Deriving the Trend Equation for Demand the Mattress Producing Company

Year	Quarter(x)	Demand(y)	xy	x^2
97	1	600	600	1
	2	520	1040	4
	3	398	1194	9
	4	780	3120	16
98	5	550	2750	25
	6	479	2874	36
	7	650	4550	49
	8	800	6400	64
99	9	700	6300	81
	10	700	7000	100
	11	600	6600	121
	12	800	9600	144
00	13	650	8450	169
	14	850	11900	196
	15	810	12150	225
	16	900	14400	256
01	17	800	13600	289
	18	1100	19800	324
	19	900	17100	361
	20	1200	24000	400
02	21	1000	21000	441
	22	1200	28600	484
	23	1100	25650	529
	24	1400	33600	576

03	25	850	21250	625
	26	1100	28600	676
	27	950	25650	729
	28	1300	36400	784
04	29	1000	29000	841
	30	1230	36900	900
	31	900	27900	961
	32	1450	46400	1024
05	33	1200	39600	1089
	34	1400	47600	1156
	35	900	31500	1225
	36	1500	54000	1296
06	37	1100	40700	1369
	38	1400	53200	1444
	39	1100	42900	1521
	40	1600	64000	1600
07	41	1250	51250	1681
	42	1450	60900	1764
	43	1150	49450	1849
	44	1650	72600	1936
08	45	1400	63000	2925
	46	1600	73600	2116
	47	1250	58750	2209
	48	1850	88800	2304
Total	1176	50767	1425878	38024

$\sum y = na + b\sum x$

$\sum xy = a\sum x + b\sum x^2$ (Chattjee, 1999).

The following values were obtained from the analysis carried out.

$\sum y = 50767$ $\sum x = 1176$ $\sum xy = 1425878$ $\sum x^2 = 38024$

Substituting into the above equation and solving gives the values

$a = 573.28$ and $b = 19.77$

Substituting into the linear regression equation

$y = a + bx$ gives

$y = 573.28 + 19.77x$ finally we have that

$Q(t) = 573.28 + 19.77t$

The correlation of the trend equation with real data was also obtained and evaluated using the correlation equation. The degree of agreement of the formula with real data is determined by the coefficient of correlation r which is given by

$$r = 1 - \frac{\sum(y_a - y_c)^2)^{0.5}}{\sum(y_a - y)^2}$$

Where y_a = a particular actual value.

y_c = the corresponding calculated value.

y = mean of the actual values (Rohaltyi, 1985).

The correlation coefficient, r is obtained thus:

Correlation coeffecient, $r = 1 - \frac{\sum(y_a - y_c)^2\}^{0.5}}{\sum(y_a - y)^2}$

$= 0.81$ this gives a high correlation.

Table A2: Evaluation of the Seasonal Adjustment Factor, c

Quarter	1997	1998	1999	2000	2001	2002	Average	c (%)
1	101	82	93	78	88	101	91	0.91
2	85	69	91	100	118	129	99	0.99
3	63	89	114	93	95	107	94	0.94
4	120	109	99	101	124	134	115	1.15

Table A3: Deriving the Correlation Equation

x	y_a	y_c	$(y_a-y_c)^2$	$(y_a-y)^2$
1	600	593.1	47.61	32418
2	520	612.8	51.56	676.26
3	398	632.6	55032.3	145962.2
4	780	652.36	16291.97	0.003
5	550	672.17	14915.74	52932
6	479	691.9	45326.4	90631.10
7	650	711.21	3803.19	16913
8	800	731.44	4700.5	398
9	700	751.21	2622.46	6408

10	700	770.98	5038.16	6408
11	600	790.75	36385.56	32418
12	800	810.52	110.67	398
13	650	830.29	32504.48	16913
14	850	850.06	0.004	4893
15	810	869.83	3579.6	897
16	900	889.83	108.16	14388
17	800	909.37	11961.8	398
18	1100	929.14	29193.14	102368
19	900	948.91	2392.19	14388
20	1200	968.68	53508.9	176358
21	1000	988.45	133.4	48378
22	1300	1008.22	85135.44	270348
23	1100	1027.99	5185.44	102368
24	1400	1047.76	124073.0	384339
Total			535101.8	1588538.7

Table A4: Evaluation of Actual Demand as a Percentage of Calculated Demand.

Quarter	Actual demand (y_a)	Calculated demand (y_c)	$\{y_a/y_c\}$%
1	600	593	101
2	520	612	85
3	398	632	63
4	780	652	120
5	550	672	82
6	479	691	69
7	650	711	89
8	800	731	109
9	700	750	93
10	700	770	91
11	600	790	114
12	800	810	99
13	650	830	78
14	850	850	100
15	810	869	93
16	900	889	101
17	800	909	88
18	1100	929	118
19	900	948	95
20	1200	968	124
21	1000	988	101
22	1300	1008	129
23	1100	1027	107
24	1400	1047	134

In other to arrive at the optimality points, the interpolation technique was used between a positive value and the preceding negative value. The steps are shown below:

For n = 2

132-0/(132+713) =0.8-x(0.8-0.9)

132(-0.1) = (0.8-x) 845

-689.2 = -845x

x = 0.82 That is for E(t) = 0 then P(F) = P(T) = 0.82.

for n = 3

1148 – 0/(1148+270) = 0.6-x/(0.6 -0.7)

-1418x = -965.6

x = 0.68

n = 4

1634.22-0/(1634.22+113) = 0.5-x/(0.5-0.6)

-1037.03 = -1747.22x

x = 0.594

n = 5

$50 - 0/(50 + 322.7) = 0.5 - x/(0.5 - 0.6)$

$-191.35 = -372.7x$

$X = 0.513.$

$n = 6$

$2278.4 - 0 / (2278.4 + 283.9) = 0.4 - x(0.4 - 0.5)$

$-1252.72 = -2562.3x$

$x = 0.489$

$n = 7$

$700 - 0/(700 + 275.6) = 0.4 - x(0.4 - 0.5)$

$-460.24 = -975.6x$

$x = 0.47$

$n = 8$

$79.1 - 0/(79.1 + 277) = 0.4 - x/(0.4 - 0.5)$

$-253.1x = -109.15$

$x = 0.43$

$n = 9$

$91.9 - 0/(91.9 + 272) = 0.4 - x/(0.4 - 0.5)$

-156.75 = -368.9x

x = 0.425

n = 10

370 – 0/(370 +98.78) = 0.3 – x/(0.3 – 0.4)

-177.63 = -468.78x

x = 0.379

n = 11

352.9-0/(352.9+22.9) = 0.3 – x/(0.3 -0.4)

-35.29 = -375.8xx + 112.74

x = 0.394

n = 12

331.29 – 0/(331.29 + 38.53) = 0.3 – x/(0.3 -0.4)

-33.13 = -369.82x + 110.95

x = 0.39

APPENDIX B

Table B1: Evaluation of the Trend Equation for Demand for the Building Materials Manufacturing Company.

Quarter(x)	Demand (y)	xy	x^2
1	150	150	1
2	95	190	4
3	65	195	9
4	215	860	16
5	186	930	25
6	85	510	36
7	105	735	49
8	180	1440	64
9	195	1755	81
10	105	1050	100
11	120	1320	121
12	235	2820	144
13	180	2340	169
14	105	1470	196
15	120	1800	225
16	245	3920	256
17	200	2400	289
18	95	1710	324
19	105	1995	361

20	235	4700	400
21	212	4452	441
22	115	2530	484
23	169	3887	529
24	253	6072	576
$\sum$ 300	3770	49231	4900

From the equation:

$$\sum y = na + b\sum x$$

$$\sum xy = a\sum x + b\sum x^2$$

The coefficients a and b were obtained by substituting for the data evaluated in Table B1

3770 =24a + 3006

49231 = 300 + 4900b

Solving simultaneously gives:

a = 134.2 and b = 1.831

Substituting in the equation

y = a + bx

$y = 134.2 + 1.831x$

$Q(t) = 134.2 + 1.831t$

Table B2: Determination of the Seasonal Adjustment Factor, c.

Quarter(x)	Actual Demand (y_a)	Calculated Demand (y_c)	$(y_a/y_c)\%$
1	150	136.03	110.27
2	95	137.86	68.91
3	65	139.69	46.53
4	215	141.52	151.92
5	186	143.32	129.78
6	85	145.18	58.55
7	105	147.01	71.42
8	180	148.84	120.92
9	195	150.67	129.42
10	105	152.5	68.85
11	120	154.33	77.76
12	235	156.16	150.49
13	180	157.99	113.93
14	105	159.82	65.70
15	120	161.61	74.23
16	245	163.48	149.86
17	200	165.31	120.98
18	95	167.14	56.84
19	105	168.97	62.14
20	235	170.8	137.56
21	212	172.63	122.81
22	115	174.46	65.92

23	169	176.29	95.86
24	253	178.12	142.04

Table B3 below shows the actual demand as a percentage of the calculated demand. The values obtained were used to obtain a concise forecast of demand which is shown in Table B4.

Table B3: Actual Demand as a Percentage of Calculated Demand

Quarter	1	2	3	4	5	6	Average %	C
1	110.27	130	129	114	121	123	121	1.21
2	68.91	59	69	66	57	57	66	0.64
3	46.53	71	78	74	62	96	71	0.71
4	151.92	121	150	150	138	142	142	1.42

Table B4: Forecast of Demand for the Building Materials Manufacturing Company

Quarter	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	165	173	182	191	200	208.9	218	227	235	244	253	262
2	88	93	98	107	107	111	116	121	126	130	135	140
3	99	104	110	115	120	125	130	136	141	146	151	156
4	201	211	222	232	243	253	263	274	284	295	305	315
Total	553	581	612	645	670	698	727	758	786	815	844	873

The optimality point can also be obtained for the second case by following the same method used for the first case that is by interpolation. Recall that the optimality point is the point at which E(t) equals zero

For n=1

(37-0) / (37-(-16)) = (0.8-x) / (0.8-0.9)
37/53 = (0.8-x) / -0.1
-0.07 = 0.8- x
x = 0.869

n=2

90-0 /90-(-0.66) = 0.5-x/ 0.5-0.6

90(-0.1) = 90.66(0.5-x)
-9 = 45.33 - 90.66x
-54.33 = -90.66
x = 0.599

n=3

2-0/2-(-179) = 0.5-x/0.5-0.6

2(-0.1) = 90.5-181x
-90.7 = -181x
x = 0.501

n=4

76-0/7(6+123) = 0.4-x/(0.4-0.5)

76(-0.1) = -199x + 79.6
-87.2 = 199x
x = 0.438

n=5

9-0/9-(-290) = 0.4-x/0.4-0.5

-0.9 = -299x + 119.6
x = 0.403

n=6

171-0/(171 + 68) = 0.3-x /(0.3- 0.4)

-17.1 = 239x + 71.7
-88.8 = 239x
x = 0.572

n=7

$152 - 0/(152+162) \quad = \quad 0.3-x/(0.3-0.4)$

$-15.2 \quad = 314x + 94.2$
$-109.4 \quad = -314x$
$x \quad = 0.348$

n=8

$131-0/(131+273) \quad = \quad 0.3-x/(0.3-0.4)$

$-13.1 \quad = 404x + 121.2$
$-134.3 \quad = -404x$
$x \quad = 0.332$

n=9

$103-0/(103+411) \quad = 0.3-x/(0.3-0.4)$

$-10.3 \quad = 541 + 154.2$
$-164.5 \quad = 514x$
$x \quad = 0.32$

n=10

$42-0/(42+601) \quad = 0.3-x/(0.3-0.4)$

$-4.2 \quad = 643x + 192.9$
$-197.1 \quad = -643x$
$x \quad = 0.307$

n=11

$33-0/(33+765) \quad = 0.3-x/(0.3-0.4)$

$-3.3 \quad = 798x + 239.4$
$-242.7 \quad = 798x$
$x \quad = 0.304$

n=12

$11.5-0/(11.5+994) \quad = 0.3-x/(0.3-0.4)$

$1.15 \quad = 1005.5x + 301.65$
$-302.8 \quad = 1005.5x$
$x \quad = 0.301$

The optimality point for the building materials producing company can be represented on a table thus:

n	1	2	3	4	5	6	7	8	9	10	11	12
P(I)=P(T)	0.869	0.599	0.501	0.438	0.403	0.372	0.348	0.332	0.32	0.307	0.304	0.301

```
VE OUTFILE='C:\Program Files\SPSS Evaluation\odion analysis.sav'
COMPRESSED.
VE OUTFILE='C:\Program Files\SPSS Evaluation\odion analysis.sav'
COMPRESSED.
GRESSION
 /MISSING LISTWISE
 /STATISTICS COEFF OUTS R ANOVA CHANGE
 /CRITERIA=PIN(.05) POUT(.10)
 /NOORIGIN
 /DEPENDENT Ptm
 /METHOD=ENTER Pitm n .
```

Regression

```
ataSet0] C:\Program Files\SPSS Evaluation\odion analysis.sav
```

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	n, Pitm[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Ptm

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	1.000[a]	1.000	1.000	1.284250

Model Summary

Model	Change Statistics				
	R Square Change	F Change	df1	df2	Sig. F Change
1	1.000	4313919.4	2	9	.000

a. Predictors: (Constant), n, Pitm

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14229874	2	7114936.933	4313919.4	.000[a]
	Residual	14.844	9	1.649		
	Total	14229889	11			

a. Predictors: (Constant), n, Pitm

b. Dependent Variable: Ptm

Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	5961.169	5.248		1135.876	.000
Pitm	1.361	6.473	.000	.210	.838
n	315.508	.288	1.000	1097.318	.000

pendent Variable: Ptm

```
ZZ.
T NAME DataSet1 WINDOW=FRONT.
UTFILE='C:\Program Files\SPSS Evaluation\odion analysis.2sav.sav'
RESSED.
UTFILE='C:\Program Files\SPSS Evaluation\odion analysis.2sav.sav'
RESSED.
: Variable Properties.

LE LABELS Ptz  'Production output forecast for zonal nigeria limited'.

LE LABELS Pitz  'Probability of  information and technological develo'+
t.'.

LE LABELS n  'forecast period in years'.
S n (F8.3).
E.
UTFILE='C:\Program Files\SPSS Evaluation\odion analysis.2sav.sav'
RESSED.
SION
SING LISTWISE
TISTICS COEFF OUTS R ANOVA
TERIA=PIN(.05) POUT(.10)
RIGIN
ENDENT Ptz
THOD=ENTER Pitz n  .
```

ession

```
et1] C:\Program Files\SPSS Evaluation\odion analysis.2sav.sav
```

Variables Entered/Removed[b]

del	Variables Entered	Variables Removed	Method
	forecast period in years, Probability of information and technological development.		Enter

All requested variables entered.

Dependent Variable: Production output forecast for zonal nigeria limited

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	1.000[a]	1.000	1.000	1.657247

a. Predictors: (Constant), forecast period in years, Probability of information and technological development.

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	121251.95	2	60625.974	22074.160	.000[a]
	Residual	24.718	9	2.746		
	Total	121276.67	11			

a. Predictors: (Constant), forecast period in years, Probability of information and technological development.

b. Dependent Variable: Production output forecast for zonal nigeria limited

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	526.551	3.849		136.805	.000
	Probability of information and technological development.	-3.188	5.486	-.005	-.581	.575
	forecast period in years	28.995	.254	.996	114.219	.000

a. Dependent Variable: Production output forecast for zonal nigeria limited

```
NEW FILE.
DATASET NAME DataSet2 WINDOW=FRONT.
REGRESSION
  /MISSING LISTWISE
  /STATISTICS COEFF OUTS R ANOVA
  /CRITERIA=PIN(.05) POUT(.10)
  /NOORIGIN
  /DEPENDENT Ptz
  /METHOD=ENTER Pitz n .
```

Regression

[DataSet2]

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	n, Pitz[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Ptz

Model Summary

[illegible]	R	R Square	Adjusted R Square	Std. Error of the Estimate
	1.000[a]	1.000	1.000	1.657247

[illegible]redictors: (Constant), n, Pitz

ANOVA[b]

[illegible]		Sum of Squares	df	Mean Square	F	Sig.
	Regression	121251.95	2	60625.974	22074.160	.000[a]
	Residual	24.718	9	2.746		
	Total	121276.67	11			

[illegible]Predictors: (Constant), n, Pitz

[illegible]Dependent Variable: Ptz

Coefficients[a]

[illegible]		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	526.551	3.849		136.805	.000
	Pitz	-3.188	5.486	-.005	-.581	.575
	n	28.995	.254	.996	114.219	.000

[illegible]Dependent Variable: Ptz

```
OUTFILE='C:\Documents and Settings\user\My Documents\odion3.sav'
PRESSED.
SET ACTIVATE DataSet0.
ine Variable Properties.

ABLE LABELS Ptm  'Production output forecast for mouka Nigeria limited '+
Z'.
E.
ABLE LABELS Pitm  'Probability of information and technologcal developm'+
t in mouka ltd Pitm'.

ABLE LABELS n  'Forecast period n'.
ATS n (F8.3).
UTE.
ESSION
ISSING LISTWISE
TATISTICS COEFF OUTS R ANOVA CHANGE
RITERIA=PIN(.05) POUT(.10)
ORIGIN
EPENDENT Ptm
ETHOD=ENTER Pitm n  .
```

ression

```
aSet0] C:\Program Files\SPSS Evaluation\odion analysis.sav
```

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Forecast period n, Probability of information and technologocal development in mouka ltd Pitm	.	Enter

a. All requested variables entered.

b. Dependent Variable: Production output forecast for mouka Nigeria limited Ptm

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	1.000[a]	1.000	1.000	1.284250

Model Summary

Model	Change Statistics				
	R Square Change	F Change	df1	df2	Sig. F Change
1	1.000	4313919.4	2	9	.000

a. Predictors: (Constant), Forecast period n, Probability of information and technologcal development in mouka ltd Pi

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14229874	2	7114936.933	4313919.4	.000[a]
	Residual	14.844	9	1.649		
	Total	14229889	11			

a. Predictors: (Constant), Forecast period n, Probability of information and technologcal development in mouka ltd Pi

b. Dependent Variable: Production output forecast for mouka Nigeria limited Ptm

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	5961.169	5.248		1135.876	.000
Probability of information and technologcal development in mouka ltd Pitm	1.361	6.473	.000	.210	.838
Forecast period n	315.508	.288	1.000	1097.318	.000

a. Dependent Variable: Production output forecast for mouka Nigeria limited Ptm

```
Public Class Odion


    Private Sub ExecuteButton_Click(ByVal sender As System.Object, ByVal e As System.
    EventArgs) Handles ExecuteButton.Click
        '
        Dim n As Integer
        Dim Pi As Double
        Dim Pt As Double
        '
        Pi = Val(Pi_TextBox.Text)
        Pt = Val(Pt_TextBox.Text)
        n = Val(n_TextBox.Text)
        '
        'for Company 1
        Dim OutPut1 = 5961 + 1.36 * Pi * Pt + 315.5 * n
        '
        'for Company 2
        Dim OutPut2 = 526.6 + 3.188 * Pi * Pt + 28.995 * n
        '
        'show output in Label boxes
        '
        Label4.Text = "Company 1 Output = " & OutPut1.ToString
        '
        Label5.Text = "Company 2 Output = " & OutPut2.ToString
        '
        FileOpen(1, My.Computer.FileSystem.SpecialDirectories.MyDocuments & "\Odion
    Edmund.txt", OpenMode.Output)
        '
        FileOpen(2, My.Computer.FileSystem.SpecialDirectories.MyDocuments & "\Odion
    Edmund2.txt", OpenMode.Output)
        '
        Write(1, "Programme for Odion Osanye Edmund" & vbTab)
        Write(2, "Programme for Odion Osanye Edmund" & vbTab)
        '
        WriteLine(1)
        WriteLine(2)
        '
        Write(1, "P(I)")
        Write(2, "P(I)")
        '
        Write(1, TAB(15), "P(T)")
        Write(2, TAB(15), "P(T)")
        '
        Write(1, TAB(30), "P(I)*P(T)")
        Write(2, TAB(30), "P(I)*P(T)")
        '
        For n = 1 To 12
            Write(1, TAB((n + 2) * 15), n)
            Write(2, TAB((n + 2) * 15), n)
        Next
        '
        WriteLine(1)
        WriteLine(2)
        '
        For i As Double = 0.1 To 1 Step 0.1
            '
            Write(1, i)
            Write(2, i)
            '
            For j As Double = 0.1 To 1 Step 0.1
                '
                Write(1, TAB(15), Math.Round(j, 3))
                Write(2, TAB(15), Math.Round(j, 3))
                '
                Write(1, TAB(30), Math.Round(i * j, 3))
                Write(2, TAB(30), Math.Round(i * j, 3))
                '
                For n = 1 To 12
                    '
                    Pi = i : Pt = j
                    OutPut1 = 5961 + 1.36 * Pi * Pt + 315.5 * n
                    '
                    'for Company 2
```

```
                    OutPut2 = 526.6 + 3.188 * Pi * Pt + 28.995 * n
                    '
                    Write(1, TAB((n + 2) * 15), Math.Round(OutPut1, 3))
                    '
                    Write(2, TAB((n + 2) * 15), Math.Round(OutPut2, 3))
                    '
                Next
                '
                WriteLine(1)
                WriteLine(2)
            Next
            '
            WriteLine(1)
            WriteLine(2)
            '
        Next
        '
        FileClose(1)
        '
        FileClose(2)
        ''
    End Sub
End Class
```

```
: Class Odion

:ivate Sub ExecuteButton_Click(ByVal sender As System.Object, ByVal e As System.
ventArgs) Handles ExecuteButton.Click
    '
    Dim n As Integer
    Dim Pi As Double
    Dim Pt As Double
    '
    Pi = Val(Pi_TextBox.Text)
    Pt = Val(Pt_TextBox.Text)
    n = Val(n_TextBox.Text)
    '
    'for Company 1
    Dim OutPut1 = 5961 + 1.36 * Pi * Pt + 315.5 * n
    '
    'for Company 2
    Dim OutPut2 = 526.6 + 3.188 * Pi * Pt + 28.995 * n
    '
    'show output in Label boxes
    '
    Label4.Text = "Company 1 Output = " & OutPut1.ToString
    '
    Label5.Text = "Company 2 Output = " & OutPut2.ToString
    '
    FileOpen(1, My.Computer.FileSystem.SpecialDirectories.MyDocuments & "\Odion Edmund
txt", OpenMode.Output)
    '
    FileOpen(2, My.Computer.FileSystem.SpecialDirectories.MyDocuments & "\Odion
dmund2.txt", OpenMode.Output)
    '
    Write(1, "Programme for Odion Osanye Edmund" & vbTab)
    Write(2, "Programme for Odion Osanye Edmund" & vbTab)
    '
    WriteLine(1)
    WriteLine(2)
    '
    Write(1, "P / n")
    Write(2, "P / n")

    For n = 1 To 12
        Write(1, TAB(n * 15), n)
        Write(2, TAB(n * 15), n)
    Next
    '
    WriteLine(1)
    WriteLine(2)
    '
    For i As Double = 0.1 To 1 Step 0.1
        '
        Write(1, i)
        '
        Write(2, i)
        '
        For n = 1 To 12

            Pi = i : Pt = i
            OutPut1 = 5961 + 1.36 * Pi * Pt + 315.5 * n
            '
            'for Company 2
            OutPut2 = 526.6 + 3.188 * Pi * Pt + 28.995 * n
            '
            Write(1, TAB(n * 15), Math.Round(OutPut1, 3))
            '
            Write(2, TAB(n * 15), Math.Round(OutPut2, 3))
            '
        Next
        '
        WriteLine(1)
        WriteLine(2)
        '
    Next
    '
```

```
    FileClose(1)
    '
    FileClose(2)
    '
End Sub
Class
```

APPENDIX E1 – GENERATED OPTIMAL OUTPUTS FOR THE BUILDING MATERIALS MANUFACTURIN COMPANY USING THE DEVELOPED MODEL AT VARIOUS TECHNOLOGY/INFORMATION LEVELS

Programme for Odion Osanye Edmund

P(I)	P(T)	P(I)*P(T)	1	2	3	4	5	6	7	8	9	10	11	12
0.1	0.1	0.01	555.627	584.522	613.617	642.612	671.607	700.602	729.597	758.592	787.587	816.582	845.577	874.572
	0.2	0.02	555.659	584.654	613.649	642.644	671.639	700.634	729.629	758.624	787.619	816.614	845.609	874.604
	0.3	0.03	555.691	584.686	613.681	642.676	671.671	700.666	729.661	758.656	787.651	816.646	845.641	874.636
	0.4	0.04	555.723	584.718	613.713	642.708	671.703	700.698	729.693	758.688	787.683	815.678	845.673	874.668
	0.5	0.05	555.754	584.749	613.744	642.739	671.734	700.729	729.724	758.719	787.714	816.709	845.704	874.699
	0.6	0.06	555.786	584.781	613.776	642.771	671.766	700.761	729.756	758.751	787.746	816.741	845.736	874.731
	0.7	0.07	555.818	584.813	613.808	642.803	671.798	700.793	729.788	758.783	787.778	816.773	845.768	874.763
	0.8	0.08	555.85	584.845	613.84	642.835	671.83	700.825	729.82	758.815	787.81	816.805	845.8	874.795
	0.9	0.09	555.882	584.877	613.872	642.867	671.862	700.857	729.852	758.847	787.842	816.837	845.832	874.827
	1	0.1	555.914	584.909	613.904	642.899	671.894	700.889	729.884	758.879	787.874	816.869	845.864	874.859
0.2	0.1	0.02	555.659	584.654	613.649	642.644	671.639	700.634	729.629	758.624	787.619	816.614	845.609	874.604
	0.2	0.04	555.723	584.718	613.713	642.708	671.703	700.698	729.693	758.688	787.683	816.678	845.673	874.668
	0.3	0.06	555.786	584.781	613.776	642.771	671.766	700.761	729.756	758.751	787.746	816.741	845.736	874.731
	0.4	0.08	555.85	584.845	613.34	642.835	671.83	700.825	729.82	758.815	787.81	816.805	845.8	874.795
	0.5	0.1	555.914	584.909	613.904	642.899	671.894	700.389	729.884	758.879	787.874	816.869	845.864	874.859
	0.6	0.12	555.978	584.973	613.968	642.963	671.958	700.953	729.948	758.943	787.938	816.933	845.928	874.923
	0.7	0.14	556.041	585.036	614.031	643.026	672.021	701.016	730.011	759.006	788.001	816.996	845.991	874.986

	0.8	0.16	556.105	585.1	614.095	643.09	672.085	701.08	730.075	759.07	788.065	817.06	846.055	875.05
	0.9	0.18	556.169	585.164	614.159	643.154	672.149	701.144	730.139	759.134	788.129	817.124	846.119	875.114
	1	0.2	556.233	585.228	614.223	643.218	672.213	701.208	730.203	759.198	788.193	817.188	846.183	875.178
0.3	0.1	0.03	555.691	584.686	613.681	642.676	671.671	700.666	729.661	758.656	787.651	816.646	845.641	874.636
	0.2	0.06	555.786	584.781	613.776	642.771	671.766	700.761	729.756	758.751	787.746	816.741	845.736	874.731
	0.3	0.09	555.882	584.877	613.872	642.867	671.862	700.857	729.852	758.847	787.842	816.837	845.832	874.827
	0.4	0.12	555.978	584.973	613.968	642.963	671.958	700.953	729.948	758.943	787.938	816.933	845.928	874.923
	0.5	0.15	556.073	585.068	614.063	643.058	672.053	701.048	730.043	759.038	788.033	817.028	846.023	875.018
	0.6	0.18	556.169	585.164	614.159	643.154	672.149	701.144	730.139	759.134	788.129	817.124	846.119	875.114
	0.7	0.21	556.264	585.259	614.254	643.249	672.244	701.239	730.234	759.229	788.224	817.219	846.214	875.209
	0.8	0.24	556.36	585.355	614.35	643.345	672.34	701.335	730.33	759.325	788.32	817.315	846.31	875.305
	0.9	0.27	556.456	585.451	614.446	643.441	672.436	701.431	730.426	759.421	788.416	817.411	846.406	875.401
	1	0.3	556.551	585.546	614.541	643.536	672.531	701.526	730.521	759.516	788.511	817.506	846.501	875.496
0.4	0.1	0.04	555.723	584.718	613.713	642.708	671.703	700.698	729.693	758.688	787.683	816.678	845.673	874.668
	0.2	0.08	555.85	584.845	613.84	642.835	671.83	700.825	729.82	758.815	787.81	816.805	845.8	874.795
	0.3	0.12	555.978	584.973	613.968	642.963	671.958	700.953	729.948	758.943	787.938	816.933	845.928	874.923
	0.4	0.16	556.105	585.1	614.095	643.09	672.085	701.08	730.075	759.07	788.065	817.06	846.055	875.05
	0.5	0.2	556.233	585.228	614.223	643.218	672.213	701.208	730.203	759.198	788.193	817.188	846.183	875.178
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	672.34	701.335	730.33	759.325	788.32	817.315	846.31	875.305

	0.7	0.28	556.488	585.483	614.478	643.473	672.468	701.463	730.458	759.453	788.448	817.443	846.438	875.433
	0.8	0.32	556.615	585.61	614.605	643.6	672.595	701.59	730.585	759.58	788.575	817.57	846.565	875.56
	0.9	0.36	556.743	585.738	614.733	643.728	672.723	701.718	730.713	759.708	788.703	817.698	846.693	875.688
	1	0.4	556.87	585.865	614.86	643.855	672.85	701.845	730.84	759.835	788.83	817.825	846.82	875.815
0.5	0.1	0.05	555.754	584.749	613.744	642.739	671.734	700.729	729.724	758.719	787.714	816.709	845.704	874.699
	0.2	0.1	555.914	584.909	613.904	642.899	671.894	700.889	729.884	758.879	787.874	816.869	845.864	874.859
	0.3	0.15	556.073	585.068	614.063	643.058	672.053	701.048	730.043	759.038	788.033	817.028	846.023	875.018
	0.4	0.2	556.233	585.228	614.223	643.218	672.213	701.208	730.203	759.198	788.193	817.188	846.183	875.178
	0.5	0.25	556.392	585.387	614.382	643.377	672.372	701.367	730.362	759.357	788.352	817.347	846.342	875.337
	0.6	0.3	556.551	585.546	614.541	643.536	672.531	701.526	730.521	759.516	788.511	817.506	846.501	875.496
	0.7	0.35	556.711	585.706	614.701	643.696	672.691	701.686	730.681	759.676	788.671	817.666	846.661	875.656
	0.8	0.4	556.87	585.865	614.86	643.855	672.85	701.845	730.84	759.835	788.83	817.825	846.82	875.815
	0.9	0.45	557.03	586.025	615.02	644.015	673.01	702.005	731	759.995	788.99	817.985	846.98	875.975
	1	0.5	557.189	586.184	615.179	644.174	673.169	702.164	731.159	760.154	789.149	818.144	847.139	876.134
0.6	0.1	0.06	555.786	584.781	613.776	642.771	671.766	700.761	729.756	758.751	787.746	816.741	845.736	874.731
	0.2	0.12	555.978	584.973	613.968	642.963	671.958	700.953	729.948	758.943	787.938	816.933	845.928	874.923
	0.3	0.18	556.169	585.164	614.159	643.154	672.149	701.144	730.139	759.134	788.129	817.124	846.119	875.114
	0.4	0.24	556.36	585.355	614.35	643.345	672.34	701.335	730.33	759.325	788.32	817.315	846.31	875.305
	0.5	0.3	556.551	585.546	614.541	643.536	672.531	701.526	730.521	759.516	788.511	817.506	846.501	875.496

	0.6	0.36	556.743	585.738	614.733	643.728	672.723	701.718	730.713	759.708	788.703	817.698	846.693	875.688
	0.7	0.42	556.934	585.929	614.924	643.919	672.914	701.909	730.904	759.899	788.894	817.889	846.884	875.879
	0.8	0.48	557.125	586.12	615.115	644.11	673.105	702.1	731.095	760.09	789.085	818.08	847.075	876.07
	0.9	0.54	557.317	586.312	615.307	644.302	673.297	702.292	731.287	760.282	789.277	818.272	847.267	876.262
	1	0.6	557.508	586.503	615.498	644.493	673.488	702.483	731.478	760.473	789.468	818.463	847.458	876.453
0.7	0.1	0.07	555.818	584.813	613.808	642.803	671.798	700.793	729.788	758.783	787.778	816.773	845.768	874.763
	0.2	0.14	556.041	585.036	614.031	643.026	672.021	701.016	730.011	759.006	788.001	816.996	845.991	874.986
	0.3	0.21	556.264	585.259	614.254	643.249	672.244	701.239	730.234	759.229	788.224	817.219	846.214	875.209
	0.4	0.28	556.488	585.483	614.478	643.473	672.468	701.463	730.458	759.453	788.448	817.443	846.438	875.433
	0.5	0.35	556.711	585.706	614.701	643.696	672.691	701.686	730.681	759.676	788.671	817.666	846.661	875.656
	0.6	0.42	556.934	585.929	614.924	643.919	672.914	701.909	730.904	759.899	788.894	817.889	846.884	875.879
	0.7	0.49	557.157	586.152	615.147	644.142	673.137	702.132	731.127	760.122	789.117	818.112	847.107	876.102
	0.8	0.56	557.38	586.375	615.37	644.365	673.36	702.355	731.35	760.345	789.34	818.335	847.33	876.325
	0.9	0.63	557.603	586.598	615.593	644.588	673.583	702.578	731.573	760.568	789.563	818.558	847.553	876.548
	1	0.7	557.827	586.822	615.817	644.812	673.807	702.802	731.797	760.792	789.787	818.782	847.777	876.772
0.8	0.1	0.08	555.85	584.845	613.84	642.835	671.83	700.825	729.82	758.815	787.81	816.805	845.8	874.795
	0.2	0.16	556.105	585.1	614.095	643.09	672.085	701.08	730.075	759.07	788.065	817.06	846.055	875.05
	0.3	0.24	556.36	585.355	614.35	643.345	672.34	701.335	730.33	759.325	788.32	817.315	846.31	875.305
	0.4	0.32	556.615	585.61	614.605	643.6	672.595	701.59	730.585	759.58	788.575	817.57	846.565	875.56

	0.5	0.4	556.87	585.865	614.86	643.855	672.85	701.845	730.84	759.835	788.83	817.825	846.82	875.815
	0.6	0.48	557.125	586.12	615.115	644.11	673.105	702.1	731.095	760.09	789.085	818.08	847.075	876.07
	0.7	0.56	557.38	586.375	615.37	644.365	673.36	702.355	731.35	760.345	789.34	818.335	847.33	876.325
	0.8	0.64	557.635	586.63	615.625	644.62	673.615	702.61	731.605	760.6	789.595	818.59	847.585	876.58
	0.9	0.72	557.89	586.885	615.88	644.875	673.87	702.865	731.86	760.855	789.85	818.845	847.84	876.835
	1	0.8	558.145	587.14	616.135	645.13	674.125	703.12	732.115	761.11	790.105	819.1	848.095	877.09
0.9	0.1	0.09	555.882	584.877	613.872	642.867	671.862	700.857	729.852	758.847	787.842	816.837	845.832	874.827
	0.2	0.18	556.169	585.164	614.159	643.154	672.149	701.144	730.139	759.134	788.129	817.124	846.119	875.114
	0.3	0.27	556.456	585.451	614.446	643.441	672.436	701.431	730.426	759.421	788.416	817.411	846.406	875.401
	0.4	0.36	556.743	585.738	614.733	643.728	672.723	701.718	730.713	759.708	788.703	817.698	846.693	875.688
	0.5	0.45	557.03	586.025	615.02	644.015	673.01	702.005	731	759.995	788.99	817.985	846.98	875.975
	0.6	0.54	557.317	586.312	615.307	644.302	673.297	702.292	731.287	760.282	789.277	818.272	847.267	876.262
	0.7	0.63	557.603	586.598	615.593	644.588	673.583	702.578	731.573	760.568	789.563	818.558	847.553	876.548
	0.8	0.72	557.89	586.885	615.88	644.875	673.87	702.865	731.86	760.855	789.85	818.845	847.84	876.835
	0.9	0.81	558.177	587.172	616.167	645.162	674.157	703.152	732.147	761.142	790.137	819.132	848.127	877.122
	1	0.9	558.464	587.459	616.454	645.449	674.444	703.439	732.434	761.429	790.424	819.419	848.414	877.409
1	0.1	0.1	555.914	584.909	613.904	642.899	671.894	700.889	729.884	758.879	787.874	816.869	845.864	874.859
	0.2	0.2	556.233	585.228	614.223	643.218	672.213	701.208	730.203	759.198	788.193	817.188	846.183	875.178
	0.3	0.3	556.551	585.546	614.541	643.536	672.531	701.526	730.521	759.516	788.511	817.506	846.501	875.496

0.4	0.4	556.87	585.865	614.86	643.855	672.85	701.845	730.84	759.835	788.83	817.825	846.82	875.815
0.5	0.5	557.189	586.184	615.179	644.174	673.169	702.164	731.159	760.154	789.149	818.144	847.139	876.134
0.6	0.6	557.508	586.503	615.498	644.493	673.488	702.483	731.478	760.473	789.468	818.463	847.458	876.453
0.7	0.7	557.827	586.822	615.817	644.812	673.807	702.802	731.797	760.792	789.787	818.782	847.777	876.772
0.8	0.8	558.145	587.14	616.135	645.13	674.125	703.12	732.115	761.11	790.105	819.1	848.095	877.09
0.9	0.9	558.464	587.459	616.454	645.449	674.444	703.439	732.434	761.429	790.424	819.419	848.414	877.409
1	1	558.783	587.778	616.773	645.768	674.763	703.758	732.753	761.748	790.743	819.738	848.733	877.728

Programme for Odion Osanye Edmund

P(I)	P(T)	P(I)*P(T)	1	2	3	4	5	6	7	8	9	10	11	12
0.1	0.1	0.01	6276.514	6592.014	6907.514	7223.014	7538.514	7854.014	8169.514	8485.014	8800.514	9116.014	9431.514	9747.014
	0.2	0.02	6276.527	6592.027	6907.527	7223.027	7538.527	7854.027	8169.527	8485.027	8800.527	9116.027	9431.527	9747.027
	0.3	0.03	6276.541	6592.041	6907.541	7223.041	7538.541	7854.041	8169.541	8485.041	8800.541	9116.041	9431.541	9747.041
	0.4	0.04	6276.554	6592.054	6907.554	7223.054	7538.554	7854.054	8169.554	8485.054	8800.554	9116.054	9431.554	9747.054
	0.5	0.05	6276.568	6592.068	6907.568	7223.068	7538.568	7854.068	8169.568	8485.068	8800.568	9116.068	9431.568	9747.068
	0.6	0.06	6276.582	6592.082	6907.582	7223.082	7538.582	7854.082	8169.582	8485.082	8800.582	9116.082	9431.582	9747.082
	0.7	0.07	6276.595	6592.095	6907.595	7223.095	7538.595	7854.095	8169.595	8485.095	8800.595	9116.095	9431.595	9747.095
	0.8	0.08	6276.609	6592.109	6907.609	7223.109	7538.609	7854.109	8169.609	8485.109	8800.609	9116.109	9431.609	9747.109
	0.9	0.09	6276.622	6592.122	6907.622	7223.122	7538.622	7854.122	8169.622	8485.122	8800.622	9116.122	9431.622	9747.122
	1	0.1	6276.636	6592.136	6907.636	7223.136	7538.636	7854.136	8169.636	8485.136	8800.636	9116.136	9431.636	9747.136
0.2	0.1	0.02	6276.527	6592.027	6907.527	7223.027	7538.527	7854.027	8169.527	8485.027	8800.527	9116.027	9431.527	9747.027
	0.2	0.04	6276.554	6592.054	6907.554	7223.054	7538.554	7854.054	8169.554	8485.054	8800.554	9116.054	9431.554	9747.054
	0.3	0.06	6276.582	6592.082	6907.582	7223.082	7538.582	7854.082	8169.582	8485.082	8800.582	9116.082	9431.582	9747.082
	0.4	0.08	6276.609	6592.109	6907.609	7223.109	7538.609	7854.109	8169.609	8485.109	8800.609	9116.109	9431.609	9747.109
	0.5	0.1	6276.636	6592.136	6907.636	7223.136	7538.636	7854.136	8169.636	8485.136	8800.636	9116.136	9431.636	9747.136
	0.6	0.12	6276.663	6592.163	6907.663	7223.163	7538.663	7854.163	8169.663	8485.163	8800.663	9116.163	9431.663	9747.163
	0.7	0.14	6276.69	6592.19	6907.69	7223.19	7538.69	7854.19	8169.69	8485.19	8800.69	9116.19	9431.69	9747.19

	0.9	0.18	6276.745	6592.245	6907.745	7223.245	7538.745	7854.245	8169.745	8485.245	8800.745	9116.245	9431.745	9747.245
	1	0.2	6276.772	6592.272	6907.772	7223.272	7538.772	7854.272	8169.772	8485.272	8800.772	9116.272	9431.772	9747.272
0.3	0.1	0.03	6276.541	6592.041	6907.541	7223.041	7538.541	7854.041	8169.541	8485.041	8800.541	9116.041	9431.541	9747.041
	0.2	0.06	6276.582	6592.082	6907.582	7223.082	7538.582	7854.082	8169.582	8485.082	8800.582	9116.082	9431.582	9747.082
	0.3	0.09	6276.622	6592.122	6907.622	7223.122	7538.622	7854.122	8169.622	8485.122	8800.622	9116.122	9431.622	9747.122
	0.4	0.12	6276.663	6592.163	6907.663	7223.163	7538.663	7854.163	8169.663	8485.163	8800.663	9116.163	9431.663	9747.163
	0.5	0.15	6276.704	6592.204	6907.704	7223.204	7538.704	7854.204	8169.704	8485.204	8800.704	9116.204	9431.704	9747.204
	0.6	0.18	6276.745	6592.245	6907.745	7223.245	7538.745	7854.245	8169.745	8485.245	8800.745	9116.245	9431.745	9747.245
	0.7	0.21	6276.786	6592.286	6907.786	7223.286	7538.786	7854.286	8169.786	8485.286	8800.786	9116.286	9431.786	9747.286
	0.8	0.24	6276.826	6592.326	6907.826	7223.326	7538.826	7854.326	8169.826	8485.326	8800.826	9116.326	9431.826	9747.326
	0.9	0.27	6276.867	6592.367	6907.867	7223.367	7538.867	7854.367	8169.867	8485.367	8800.867	9116.367	9431.867	9747.367
	1	0.3	6276.908	6592.408	6907.908	7223.408	7538.908	7854.408	8169.908	8485.408	8800.908	9116.408	9431.908	9747.408
0.4	0.1	0.04	6276.554	6592.054	6907.554	7223.054	7538.554	7854.054	8169.554	8485.054	8800.554	9116.054	9431.554	9747.054
	0.2	0.08	6276.609	6592.109	6907.609	7223.109	7538.609	7854.109	8169.609	8485.109	8800.609	9116.109	9431.609	9747.109
	0.3	0.12	6276.663	6592.163	6907.663	7223.163	7538.663	7854.163	8169.663	8485.163	8800.663	9116.163	9431.663	9747.163
	0.4	0.16	6276.718	6592.218	6907.718	7223.218	7538.718	7854.218	8169.718	8485.218	8800.718	9116.218	9431.718	9747.218
	0.5	0.2	6276.772	6592.272	6907.772	7223.272	7538.772	7854.272	8169.772	8485.272	8800.772	9116.272	9431.772	9747.272
	0.6	0.24	6276.826	6592.326	6907.826	7223.326	7538.826	7854.326	8169.826	8485.326	8800.826	9116.326	9431.826	9747.326
	0.7	0.28	6276.881	6592.381	6907.881	7223.381	7538.881	7854.381	8169.881	8485.381	8800.881	9116.381	9431.881	9747.381

	0.8	0.32	6276.935	6592.435	6907.935	7223.435	7538.935	7854.435	8169.935	8485.435	8800.935	9116.435	9431.935	9747.435
	0.9	0.36	6276.99	6592.49	6907.99	7223.49	7538.99	7854.49	8169.99	8485.49	8800.99	9116.49	9431.99	9747.49
	1	0.4	6277.044	6592.544	6908.044	7223.544	7539.044	7854.544	8170.044	8485.544	8801.044	9116.544	9432.044	9747.544
0.5	0.1	0.05	6276.568	6592.068	6907.568	7223.068	7538.568	7854.068	8169.568	8485.068	8800.568	9116.068	9431.568	9747.068
	0.2	0.1	6276.636	6592.136	6907.636	7223.136	7538.636	7854.136	8169.636	8485.136	8800.636	9116.136	9431.636	9747.136
	0.3	0.15	6276.704	6592.204	6907.704	7223.204	7538.704	7854.204	8169.704	8485.204	8800.704	9116.204	9431.704	9747.204
	0.4	0.2	6276.772	6592.272	6907.772	7223.272	7538.772	7854.272	8169.772	8485.272	8800.772	9116.272	9431.772	9747.272
	0.5	0.25	6276.84	6592.34	6907.84	7223.34	7538.84	7854.34	8169.84	8485.34	8800.84	9116.34	9431.84	9747.34
	0.6	0.3	6276.908	6592.408	6907.908	7223.408	7538.908	7854.408	8169.908	8485.408	8800.908	9116.408	9431.908	9747.408
	0.7	0.35	6276.976	6592.476	6907.976	7223.476	7538.976	7854.476	8169.976	8485.476	8800.976	9116.476	9431.976	9747.476
	0.8	0.4	6277.044	6592.544	6908.044	7223.544	7539.044	7854.544	8170.044	8485.544	8801.044	9116.544	9432.044	9747.544
	0.9	0.45	6277.112	6592.612	6908.112	7223.612	7539.112	7854.612	8170.112	8485.612	8801.112	9116.612	9432.112	9747.612
	1	0.5	6277.18	6592.68	6908.18	7223.68	7539.18	7854.68	8170.18	8485.68	8801.18	9116.68	9432.18	9747.68
0.6	0.1	0.06	6276.582	6592.082	6907.582	7223.082	7538.582	7854.082	8169.582	8485.082	8800.582	9116.082	9431.582	9747.082
	0.2	0.12	6276.663	6592.163	6907.663	7223.163	7538.663	7854.163	8169.663	8485.163	8800.663	9116.163	9431.663	9747.163
	0.3	0.18	6276.745	6592.245	6907.745	7223.245	7538.745	7854.245	8169.745	8485.245	8800.745	9116.245	9431.745	9747.245
	0.4	0.24	6276.826	6592.326	6907.826	7223.326	7538.826	7854.326	8169.826	8485.326	8800.826	9116.326	9431.826	9747.326
	0.5	0.3	6276.908	6592.408	6907.908	7223.408	7538.908	7854.408	8169.908	8485.408	8800.908	9116.408	9431.908	9747.408
	0.6	0.36	6276.99	6592.49	6907.99	7223.49	7538.99	7854.49	8169.99	8485.49	8800.99	9116.49	9431.99	9747.49

	0.7	0.42	6277.071	6592.571	6908.071	7223.571	7539.071	7854.571	8170.071	8485.571	8801.071	9116.571	9432.071	9747.571
	0.8	0.48	6277.153	6592.653	6908.153	7223.653	7539.153	7854.653	8170.153	8485.653	8801.153	9116.653	9432.153	9747.653
	0.9	0.54	6277.234	6592.734	6908.234	7223.734	7539.234	7854.734	8170.234	8485.734	8801.234	9116.734	9432.234	9747.734
	1	0.6	6277.316	6592.816	6908.316	7223.816	7539.316	7854.816	8170.316	8485.816	8801.316	9116.816	9432.316	9747.816
0.7	0.1	0.07	6276.595	6592.095	6907.595	7223.095	7538.595	7854.095	8169.595	8485.095	8800.595	9116.095	9431.595	9747.095
	0.2	0.14	6276.69	6592.19	6907.69	7223.19	7538.69	7854.19	8169.69	8485.19	8800.69	9116.19	9431.69	9747.19
	0.3	0.21	6276.786	6592.286	6907.786	7223.286	7538.786	7854.286	8169.786	8485.286	8800.786	9116.286	9431.786	9747.286
	0.4	0.28	6276.881	6592.381	6907.881	7223.381	7538.881	7854.381	8169.881	8485.381	8800.881	9116.381	9431.881	9747.381
	0.5	0.35	6276.976	6592.476	6907.976	7223.476	7538.976	7854.476	8169.976	8485.476	8800.976	9116.476	9431.976	9747.476
	0.6	0.42	6277.071	6592.571	6908.071	7223.571	7539.071	7854.571	8170.071	8485.571	8801.071	9116.571	9432.071	9747.571
	0.7	0.49	6277.166	6592.666	6908.166	7223.666	7539.166	7854.666	8170.166	8485.666	8801.166	9116.666	9432.166	9747.666
	0.8	0.56	6277.262	6592.762	6908.262	7223.762	7539.262	7854.762	8170.262	8485.762	8801.262	9116.762	9432.262	9747.762
	0.9	0.63	6277.357	6592.857	6908.357	7223.857	7539.357	7854.857	8170.357	8485.857	8801.357	9116.857	9432.357	9747.857
	1	0.7	6277.452	6592.952	6908.452	7223.952	7539.452	7854.952	8170.452	8485.952	8801.452	9116.952	9432.452	9747.952
0.8	0.1	0.08	6276.609	6592.109	6907.609	7223.109	7538.609	7854.109	8169.609	8485.109	8800.609	9116.109	9431.609	9747.109
	0.2	0.16	6276.718	6592.218	6907.718	7223.218	7538.718	7854.218	8169.718	8485.218	8800.718	9116.218	9431.718	9747.218
	0.3	0.24	6276.826	6592.326	6907.826	7223.326	7538.826	7854.326	8169.826	8485.326	8800.826	9116.326	9431.826	9747.326
	0.4	0.32	6276.935	6592.435	6907.935	7223.435	7538.935	7854.435	8169.935	8485.435	8800.935	9116.435	9431.935	9747.435
	0.5	0.4	6277.044	6592.544	6908.044	7223.544	7539.044	7854.544	8170.044	8485.544	8801.044	9116.544	9432.044	9747.544

	0.6	0.48	6277.153	6592.653	6908.153	7223.653	7539.153	7854.653	8170.153	8485.653	8801.153	9116.653	9432.153	9747.653
	0.7	0.56	6277.262	6592.762	6908.262	7223.762	7539.262	7854.762	8170.262	8485.762	8801.262	9116.762	9432.262	9747.762
	0.8	0.64	6277.37	6592.87	6908.37	7223.87	7539.37	7854.87	8170.37	8485.87	8801.37	9116.87	9432.37	9747.87
	0.9	0.72	6277.479	6592.979	6908.479	7223.979	7539.479	7854.979	8170.479	8485.979	8801.479	9116.979	9432.479	9747.979
	1	0.8	6277.588	6593.088	6908.588	7224.088	7539.588	7855.088	8170.588	8486.088	8801.588	9117.088	9432.588	9748.088
0.9	0.1	0.09	6276.622	6592.122	6907.622	7223.122	7538.622	7854.122	8169.622	8485.122	8800.622	9116.122	9431.622	9747.122
	0.2	0.18	6276.745	6592.245	6907.745	7223.245	7538.745	7854.245	8169.745	8485.245	8800.745	9116.245	9431.745	9747.245
	0.3	0.27	6276.867	6592.367	6907.867	7223.367	7538.867	7854.367	8169.867	8485.367	8800.867	9116.367	9431.867	9747.367
	0.4	0.36	6276.99	6592.49	6907.99	7223.49	7538.99	7854.49	8169.99	8485.49	8800.99	9116.49	9431.99	9747.49
	0.5	0.45	6277.112	6592.612	6908.112	7223.612	7539.112	7854.612	8170.112	8485.612	8801.112	9116.612	9432.112	9747.612
	0.6	0.54	6277.234	6592.734	6908.234	7223.734	7539.234	7854.734	8170.234	8485.734	8801.234	9116.734	9432.234	9747.734
	0.7	0.63	6277.357	6592.857	6908.357	7223.857	7539.357	7854.857	8170.357	8485.857	8801.357	9116.857	9432.357	9747.857
	0.8	0.72	6277.479	6592.979	6908.479	7223.979	7539.479	7854.979	8170.479	8485.979	8801.479	9116.979	9432.479	9747.979
	0.9	0.81	6277.602	6593.102	6908.602	7224.102	7539.602	7855.102	8170.602	8486.102	8801.602	9117.102	9432.602	9748.102
	1	0.9	6277.724	6593.224	6908.724	7224.224	7539.724	7855.224	8170.724	8486.224	8801.724	9117.224	9432.724	9748.224
1	0.1	0.1	6276.636	6592.136	6907.636	7223.136	7538.636	7854.136	8169.636	8485.136	8800.636	9116.136	9431.636	9747.136
	0.2	0.2	6276.772	6592.272	6907.772	7223.272	7538.772	7854.272	8169.772	8485.272	8800.772	9116.272	9431.772	9747.272
	0.3	0.3	6276.908	6592.408	6907.908	7223.408	7538.908	7854.408	8169.908	8485.408	8800.908	9116.408	9431.908	9747.408
	0.4	0.4	6277.044	6592.544	6908.044	7223.544	7539.044	7854.544	8170.044	8485.544	8801.044	9116.544	9432.044	9747.544

0.5	0.5	6277.18	6592.68	6908.18	7223.68	7539.18	7854.68	8170.18	8485.68	8801.18	9116.68	9432.18	9747.68
0.6	0.6	6277.316	6592.816	6908.316	7223.816	7539.316	7854.816	8170.316	8485.816	8801.316	9116.816	9432.316	9747.816
0.7	0.7	6277.452	6592.952	6908.452	7223.952	7539.452	7854.952	8170.452	8485.952	8801.452	9116.952	9432.452	9747.952
0.8	0.8	6277.588	6593.088	6908.588	7224.088	7539.588	7855.088	8170.588	8486.088	8801.588	9117.088	9432.588	9748.088
0.9	0.9	6277.724	6593.224	6908.724	7224.224	7539.724	7855.224	8170.724	8486.224	8801.724	9117.224	9432.724	9748.224
1	1	6277.86	6593.36	6908.86	7224.36	7539.86	7855.36	8170.86	8486.36	8801.86	9117.36	9432.86	9748.36