

# Quantitative Techniques as Tools for Aiding Effective Management Decision

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## Abstract

*The existing literature has provided narrative and evidence to the assertion that wrong decisions have occasioned the untimely demise of many business organisation. This paper which discusses “Quantitative Techniques as Tools for Aiding Effective Management Decisions” has been prepared to highlight the relevance of quantitative techniques in the setting of decision making within business organisations. Exploratory and descriptive desk research design which relies on relevant extant literature was adopted. The study anchors on the theory of constraints (TOC) which insists on iterative approach and removal of noticeable obstacles to decision making by adapting appropriate management practices in the context of decision making. It was clear that decisions precede and give impetus to actions to resolve business organisations’ problems in the bid to achieve nominated goals and/or objectives. The contexts of decision making in business organisations are complex and solutions to unstructured problems only need to be satisficing using the words of the doyen of decision-making Herbert Simon. On the strength of empirical literature, quantitative techniques are critically useful to making major decisions in business organisations. Therefore, the application of quantitative techniques is recommended to business organisations and government establishments to encourage their managers to as often as practically possible to use quantitative techniques to help make their managerial decisions effective.*

**Keywords:** *Quantitative techniques, Effective Management Decisions, Theory of constraint, Deterministic, Probabilistic, Simplex tableaux,*

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## 1.1 Introduction

Decision making constitutes one of the important functions which managers perform at different levels of business organisations. The dynamic and complex operating business environment poses great challenge to managers in the context of decision making. Hence, the need to leverage quantitative techniques as a set of scientific tools to aid the managerial decision making exercise. There are varieties of quantitative techniques which managers can adopt to aid their decision making notably: queuing theory, game theory, forecasting, break-even analysis, linear programming methods, assignment, transportation, project evaluation and review techniques (PERT), critical path methods, simulation, expected value, decision tree, inventory management, information theory, preference and utility theories. The essence of applying quantitative techniques is to enable managers to achieve optimal results and thus, avoid costly mistakes associated with arbitrary decision

making. The application of any of these quantitative tools depends on the kind of decision which the managers intend to make given the context, time frame and available information. The right application of the quantitative techniques leads to high quality decisions which encourage good management aimed at achieving efficiency and effectiveness in all functional areas as the foundation of viable and sustainable business organisations.

The quantitative techniques, which make use of models, rely on evaluation and interpretation of data to generate hard facts and figures which form the kernel or backbone of managerial decisions. The quantitative model which is “a selective abstraction or representation of reality” is of different types and is mostly expressed in the forms of mathematical-alphanumeric symbols (Eppen *et al.*, 1988). A typical quantitative model has data which describe the environmental context, the decision variables and the objective to be achieved. Depending however on how many uncontrollable variables involved in a model are known or unknown to the model builder, models can be distinguished into two broad categories notably: deterministic and probabilistic or stochastic. The deterministic model describes a situation where all uncontrollable inputs to a model are known and cannot vary. The reverse becomes the case where all uncontrollable inputs to a model are unknown and amendable to variation resulting in probabilistic or stochastic model. The quantitative models or techniques help to concretise or orchestrate the real world by means of mathematical symbols, equations and formulae.

The managers making use of quantitative techniques to better the quality of their decisions occupy key or strategic positions in the structure of the business organisations. The ability of managers to make effective decisions is very crucial to the success of most business organisations just as wrong decisions are capable of accelerating the pace of failure and possible decline of corporate entities. Extant literature has indicated that wrong decisions do put people and business organisations out of operational existence. There are many kinds of situations in business, government, industry and what-have you that require decision making. Incidentally, most managers or those in positions of making critical decisions lack the requisite quantitative skills to grapple with the problems. The managers become circumspect to exercise due diligence to achieve high quality decisions by relying on quantitative techniques as operational working tools in their day-to-day operations and in line with systematic procedures. The procedure of using quantitative techniques warrants that the need to define the objectives which the system is designed to achieve, spells out the mission conditions to attain the

objectives, generate alternatives to accomplish the system and concomitant evaluative criteria for assessing the alternative systems. Therefore, the working knowledge of the quantitative techniques and associated systems by managers and strategic leaders becomes crucial as delegation of the role to specialists in pure statistics and mathematics fields may not quite serve the purpose as they may not appreciate the full import and relevance of the tools in the business context. This research paper attempts to x-ray and explore how quantitative techniques could be applied to help make sound and viable decisions for corporate survival.

## **2.1 Review of Related Literature**

The application of quantitative techniques sharpens and enables managers to appreciate business organisational problems in better light and thus, informs the kind and quality the managers take in different aspects of the business organisations problems. The conceptual review would therefore proceed as follows:

### **2.1.1 Conceptual Framework/Definitions**

The concepts that characterise this content analysis research work revolve around quantitative techniques and effective management with focus on decision making which are discussed in relative more details below:

#### **The concept of Decision Making with Quantitative Tools**

The quantitative technique models are not applied in a vacuum. Rather, they are model-based tools available for solving most of the practical problems with which managers are faced daily. Since most managerial decisions are taken in the atmosphere of risks and uncertainties, modern and seasoned managers resort to quantitative techniques to facilitate their managerial decision-making. According to Lucey (1996) quantitative techniques represent a “modern science attack on complex problems arising in the direction and management of large systems of men, machines, materials and money (4Ms) in industry, business and government.” In other words, quantitative techniques are “tools used to help management determine its policy and action scientifically.”

Under conditions of uncertainty, trade-offs and cost-benefit analysis need to be made using principles of decision matrix such as: the laplace principle, the minima or maxima principle, the Hurwitz principle, the savage principle, the minimum likelihood principle, the Bayesian decision rule and the expectation principle (Devi & Dekavi, 2019). Other quantitative tools include: operations research, models, project management, linear programming, project evaluation and review technique

(PERT), critical path method (CPM), probability theory analysis etcetera (Devi & Devaki, 2019). There are many of these model-based tools as there are model builders and the respective managerial problems of which the models are designed to solve. The managerial problems are intricately linked to the set goals and/or objectives to be achieved. There is no gains-saying the fact that the achievement of organisational goal which can be expressed in terms of profitability, growth, market share, shareholder's wealth etcetera is always subject to constraints (problems) inherent in the environment within which the organisation (public or private) operates. The constraints vary in terms of complexity, currency, resources involved etcetera and given the desire of a manager to make wise decisions, hind-sight and professionalism demand that quantitative skills must be brought to bear on such situations. According to Ayandele (2005), the situations that warrant quantitative approach to managerial decision making include:

The problem is complex, and the manager cannot develop a good solution without the aid of quantitative analysis. The problem is very important (for example, a great deal of money is involved) and the manager desires a thorough analysis before attempting to make a decision. When the problem is new and the manager has no previous experience to draw on, use of quantitative technique becomes expedient. The problem is repetitive and the manager can save time and effort by relying on procedures to make routine decision, a quantitative approach will be of great relevance. Admittedly, many of these kinds of situations abound in business, government, industry and what-have you. Incidentally, most managers or those in positions of making critical decisions lack the requisite quantitative skills to grapple with the problems. Rabab'h, Omar, Ali & Alzyoud (2019) buttress that weak application of quantitative techniques in decision making is commonplace. For instance, planning as the most important function of a manager around which other managerial functions revolve, constantly projects into the future. To plan successfully therefore needs forecasting skills which are involved in the manipulation of quantitative models such as time series analysis, moving average, exponential smoothing, personnel ratios, productivity ratios and regression analysis (Byars & Rue, 2000; Hill, 2000). For instance, this may apply to human resource planning and sales forecast in marketing. The manager must observe the trend of last events and use the same to forecast or predict the future developments. The manager, in this instance, should be able to manipulate the exponential smoothing forecasting model illustrated in section 4.1 of this work.

### **The concept of Effective Management**

Effective management is more or less a sine-qua-non for viable and sustainable business organisations. In line with the functional perspective, management is considered to be a process of getting things done through and with people by leveraging on the managerial functions of planning, organising, leading and controlling (Wehrich, Cannice & Koontz, 2013). The needs to build business organisations that last entail not only having to do things in the right manner but also doing the right things to achieve the desired results which underscore efficiency and effectiveness respectively (Benis & Nanus, 1985; Pearce & Robinson, 1991; Butschi & Steyn, 2006; Northouse, 2010; Wehrich *et al.*, 2013). The accomplished results are a function of clear vision and defined mission reflected in goals in the long term and objectives in the short term respectively (Kazmi, 2002; Wheelen & Hunger, 2010). The pursuit of the goals and/or objectives necessitates the creation of a well-designed organisational structure through which ports or nodes of decision making along the channels of communication are clearly designated and spot-lighted.

Organisational structure though defined in different ways in the management literature, is defined here as how job-tasks are divided, grouped and coordinated (Robbins, 2005). Both classical and neo-classical theorists are of the consensus that business organisations should have structures but differ on the approach to come about the structure. The difference of opinions puts the one-best way approach of the classical school led by the pioneer of scientific management Engineer Frederick Winslows Taylor (1856 – 1915) against the no one-best way stance of the contemporary theorists involving the systems theory by the Biologist, Luwig von Bertalanffy in 1951 and contingency theory by Austrian clinical psychologist, Fred Edward Fiedler in 1964 (Virkus, 2009; Amah & Nkuda, 2014; Sapru, 2013; Nkuda, 2017). Given however the sea and complexity of the environmental factors coupled with the increasingly changing business environment, this author is of the strong opinion that both organisational structure and managerial leadership style should vary with context in tandem with the logical prescription of the systems and contingency theorists. The organisational structure whether intended for formal or informal setting needs to be designed.

The notion of organisational design relates to the creation of new organisational structure where none exists or modification of an existing organisational structure to suit the dynamics of the operating business environment. Both activities of creating and modifying organisational structure as the case may be warrant and

entail decision making to tailor the organisational structure to take mechanistic or organic format. In addition to managerial functions, managers and strategic leaders also assume and play informational, interpersonal and decisional roles to drive and give vitality to effective management of the operations of the business organisations (Griffen, 2005; Schermerhorn, 2010; Robbins, DeCenzo & Coulter, 2011; Wehrich *et al.*, 2013). Admittedly, the decision making exercise falls squarely and appropriately within the domain or purview of decisional role of managers (Griffen, 2005; Schermerhorn, 2010; Robbins *et al.*, 2011; Wehrich *et al.*, 2013). The decision making activity spans the functional areas of management notably: production, finance, management, accounting, marketing, hospitality management and tourism as well as other areas of business activities (Griffen, 2005; Wehrich *et al.*, 2013; Verma & Sharma, 2017; Devi & Devaki, 2019).

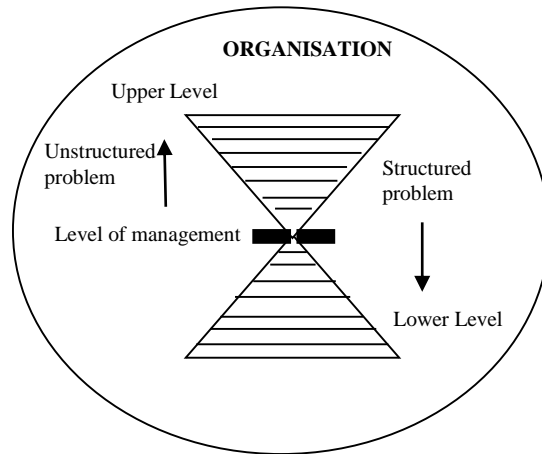
Decision making is both material and core to planning which is the primary function of management although growing conversation in extant literature tends to tilt comparatively in favour of experimenting (Griffen, 2005; Wehrich *et al.*, 2013; Nkuda, 2020). Emphatically important is the fact that, decision constitutes the turning point of planning reflected in resource commitment, defining the direction and shaping the reputation of business organisation. Eclectically, decision making can be defined as the choice among alternatives. Griffen (2005) maintains that decision is the act of choosing one alternative from among a set of alternatives. Sapru (2013) holds that decision making has to do with choosing an appropriate action or set of actions to manipulate strategic factors. Unlike complementary factors which facilitate effective decision making, strategic factors tend to limit the effectiveness of decisions and remain factors that decision makers grapple with in different decision making settings. The strategic factors can also be referred to as limiting factor which principle allows quick recognition and removal of the factors so as to ensure that the best possible alternative is selected (Weirich *et al.*, 2013).

Ayandele (2005) defines decision making as a “mental process by which an individual or group of individuals gather data and makes a choice between two or more alternative courses of action.” It has been established over time that wrong decisions could put people out of business and to that extent, there is no substitute for or alternative to sound and good decisions (Derek cited in Adepetan, 2009; Nkuda, 2017; Schermerhorn, 2010). Herbert Simon (1916 - 2001) prominently associated with the province of decision making in extant scholarly literature stresses that decisions are often not made with full rationality and logic (Griffen, 2005; Sapru, 2013). The decision making has its procedure The typology of

decision making comprises routine (programmed), non-routine (non-programmed) and hybrid decisions as they are explained later in course of the discourse (Gomez-Mejia & Balkin, 2002; Schermerhorn, 2010; Wehrich *et al.*, 2013; Robbins *et al.*, 2011).

### **Decision making Typology in Relation to Quantitative Techniques**

Programmed decision refers to the choice made based on precedent, repetitive and structured work which is wholly routine in nature. In the pharmaceutical company, specifications of chemicals needed to produce a particular drug must be made known, strictly followed by pharmacologists to compound drugs, chemical assays by quality controllers who ascertain acceptable quality of drugs, determine what should be discarded or reworked as the need arises. The programmed decisions are common among the first-level managers at operational levels of business organisations (Wehrich *et al.*, 2013). The nonprogrammed decision, on the other hand, has to do with novel, poorly defined, unstructured and non-recurrent in nature. Most strategic decisions are nonprogrammed in colouration given the magnitude of environmental factors that need to be taken into decision context and analysed to yield the ultimate decision in record time and such decisions are keenly identified with top-level managers (Robbins *et al.*, 2011; Wehrich *et al.*, 2013). Nonprogrammed decisions have no pre-determined specifications which therefore call for subjective judgements in most cases and application of quantitative techniques such as linear programming is not inappropriate. Hands-on experience has demonstrated that in most cases decisions take a dual nature of routine and non-routine which underscores the hybrid type or variant. The space-craft mission involves typical nonprogrammed and strategic decisions. The schema shown below further elucidates the typologies of decision making:



**Fig.2.1:** Typologies of decision making in organisation

### 2.2.2 Decision making Approaches and Quantitative Techniques

Decision making has both approaches and process. The decision making approaches vary from rational, 10-10-10, administrative to bounded or limited rationality (Griffen, 2005; Schermerhorn, 2010; Robbins *et al.*, 2011; Wehrich *et al.*, 2013). Decisions are often taken preparatory to the pursuit of certain goals. The rational decision approach emphasises the selection of the best possible alternative upon full knowledge of all the alternatives, careful analysis and evaluation of those alternatives (Wehrich *et al.*, 2013). Characteristically, decisions are made to guide future actions fraught with uncertainties as against the past, novel situations where all alternatives are not known and also lack of available technique to analyse all options given both latest technique and computer devices available. These problems constitute more or less the drawbacks of rational approach to decision making. Decisions carry definite consequences which could be short, medium or long term.

The adoption of the 10-10-10 approach means taking decisions in ten minutes, ten months or ten years with attendant consequences of immediate regrets, making relevant assumptions depending on the goals in sight and long term effects respectively (Wehrich *et al.*, 2013). Several ten month decisions can add value to strategic decision making especially in the area of resource allocation. The administrative model postulated by Herbert Simon specially describes the way and manner decisions are mostly and actually made in terms of context characterisation viz: certainty, risk and uncertainty (Griffen, 2005). The bottom line approach

becomes bounded or limited rationality which insists on the choice of a course of action that is barely good enough or satisfactory which in the words of Herbert Simon is known as satisficing (Sapru, 2013; Weihrich *et al.*, 2013). The idea of satisficing connotes the managerial bias and aversion to risk in decision making setting. This sufficiently explains why quantitative techniques to help managers to achieve optimal results and solutions to business organisational problems.

### **Decision making Context Characterisation and Quantitative Techniques**

Decisions precede and activate actions to resolve identified problems in business organisations and decision making settings are never ever free of limiting factors which vary from certainty, uncertainty to risk. In the context of certainty, the decision maker is well-equipped with complete information on all possible alternative courses of action from which choice can be made and their respective outcomes known beforehand (Griffen, 2005; Schermerhorn, 2010). Decision making in business organisations within the context of certainty is commonly associated with structured or routine problems resolvable at the operational level of management. Whereas in the context of uncertainty, the decision maker is more or less ignorant of all possible alternatives and the outcomes which defy probability estimations but are rather based on speculative evaluations (Schermerhorn, 2010). Yet, risk has to do with a decision making context where both the alternatives and their respective consequences can at least be assessed on the basis of probabilities (Griffen, 2005; Schermerhorn, 2010). Decision making in business organisations within the contexts of uncertainty and risk relates to unstructured problems handled at the top or strategic level of management. Therefore, to deduce viable decisions when dealing with unstructured problems particularly in the context of risk, it becomes germane and relevant to model the problems using appropriate quantitative tools.

#### **2.1.2 Review of Related Empirical Studies**

Decision making is very crucial to the functioning of any business organisation. Due care needs therefore to be exercised when strategic decisions are to be taken given paucity of real-time information and shortness time available for such decisions. The leveraging of quantitative techniques becomes needful. Therefore, empirical studies reviewed in the course of this study relates to the following quantitative models and problem-solving process which in practical terms can be deterministic or probabilistic:

### **Queuing Theory**

The queuing theory can be defined as the mathematical method used to analyse waiting lines (Stevenson, 1999). The theory was propounded by a Danish Telephone Engineer, A. K. Erlang in the 1920 in the telephone industry. This theory became popular and dominant in the 1950s and 1960s. The queuing technique is basically associated with the needs of managers to better and improve their customer service to remain competitive in their respective industries. Virtually every business organisation or government institution produces one product and/or provides services. The business organizations cut across transportation, aviation, railway, food restaurants, supermarkets, banking, judiciary, schools, hospitals, theatres etc. The phenomenon of waitology which has to do with the time spent waiting to be given a service or have order filled. This time can be intermediary (temporary or short term) or advanced (long term). Irrespective of the duration spent to get a service, cost is involved and the reputation of the business organisation is at stake. The primary goal of queuing technique is to minimise the costs of time of service and the capacity to deliver the service in question (Stevenson, 1999). Factors that account for waiting line include the random arrivals of customers and variety of their service needs. The analysis of queuing technique shows unevenness in the arrival times of customers and their needs vary to some extents. As a result, sometimes the service system witnesses overload and at other times, the system becomes idle. In addition, the service system can be overloaded at micro standpoint where few customers to be served arrive at the same time and under-loaded at macro standpoint where many customers to be served arrive at well spaced intervals allowing the service hands to meet their needs efficiently and effectively. This anomaly of waiting line can be corrected once the arrivals of customers and service time are constant and properly synchronised such that variability is minimal or non-existent resulting in optimal solution. The manipulation of queuing technique is complex and leverages formulae and tables (Stevenson, 1999).

### **Linear Programming**

The concept of linear programming has two terms notably: linear and programming linked together. Linear programming is a quantitative or mathematical technique used by business organisations to allocate available scarce resources to achieve optimal results given objective function, decision variables, constraints and parameters (Lucey, 1996; Stevenson, 1999). The linear component helps to create linear relationships and the programming part involves iterations to achieve optimal solutions which could be maximise the profits and minimise the costs of operations

as the objective functions. The constraints are the limitations to the linear programming model. The decision variables relate to the combination of resource inputs to minimise costs or a combination of outputs to maximise profits (Stevenson, 1999). The practical demonstration of the how the linear programming works from the graphical standpoint is shown in the next section of the research work. The simplex method involves iterative approach which has to do with generating tableaus to achieve a feasible solution space (Lucey, 1996; Stevenson, 1999).

### **Probability Decision Theory**

This theory has to do with the quantification of uncertainty. The managers of business organizations take decisions under conditions of uncertainty, certainty and risks. The probability decision theory tries to help managers the possible outcomes to which favourable outcomes can be related. In other words, the ratio of the number of favourable outcomes to total number of possible outcomes. The occurrence of events or outcomes can be either mutually exclusive or independents. When the occurrence of a particular event depends on the occurrence of another event, the scenario is described as mutually exclusive events. But if the occurrence of an event does not affect the occurrence of another event, the scenario pictures independent events (Lucey, 1996).

### **Payback Analysis**

Quantitative techniques have ubiquitous application. The payback analysis finds practical utility mostly in the area of project evaluation with a view to determining the duration or time-period a particular project will be able to pay back the cost of investment in the project based on its projected cash inflows profile. Lucey (1996) corroborates that payback can be defined as “the period in, usually expressed in years which it takes for the project’s net cash inflows to recoup the original investment.” It is considered to be the break-even period for a project (Akpan, 2004). The determination of the payback period involves the division of the initial cost of investment by the annual income inflows. The result of the calculation gives the number of years the project will be able to pay the investment cost and begins to make profit. The managers must decide to either accept the project or rejects investment in it. Lucey (1996) and Akpan (2004) advocate that the project with the shortest payback period should, ideally, be accepted for investment.

### **Simulations**

The managers of business organisations are constantly on the edge to adopt a technique that can produce high quality results. Simulation model is one of such

techniques. Simulation is an approach that provides opportunity for real-life business problem to be experimented upon with a view to achieving optimal solution (Nkuda, 2019). Stevenson (1999) states that simulation involves a descriptive technique which comes up with a process which allows experiments to be carried out in order to evaluate the behaviour of the system under certain conditions. It has different controllable inputs and with corresponding controllable outputs to allow judgement or decision on optimal solution to be made. Simulation is used where there no other quantitative technique is feasible. Simulation makes use of what-if slogan to continually experiment on alternatives until an optimal solution is attained. It is very useful in examining business problems such as new product development, airline overbooking, inventory management, risks management, waiting lines or queues, ordering food at restaurants etcetera (Nkuda, 2019).

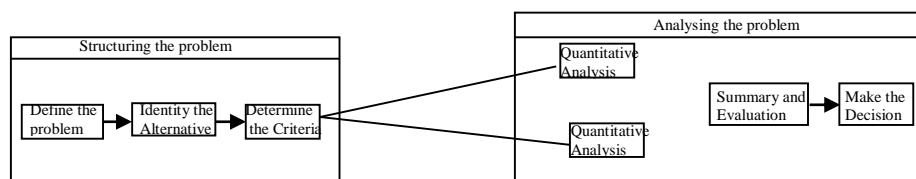
### **Decision Trees**

The decision trees are part and parcel of the decision theory which describes the overall approach to decision making. However, the decision tree represents a schematic picture of the available alternatives and their possible consequences. The picture resembles a tree from which it derives its name. The decision tree comprises sequential decisions represented in the forms of nodes and branches from them. It shows the different decision alternatives that suggest greatest returns or lowest cost and expected monetary value or lowest expected cost. The managers desire to make viable and cost-effective decisions at all times. The decision tree becomes more or less a sign-post to guide such decisions. Effectively, managers are on the safe side to take alternative that carries greatest return and lower cost provided the state of nature is not a factor. However, where the state of nature becomes a factor, managers do well by taking alternative that carries the highest expected monetary value with corresponding lowest expected cost (Stevenson, 1999).

### **Problem-solving Process**

The quantitative approach to decision making, unlike qualitative approach, like planning has a process which involves: creating awareness, developing premises or assumptions, identifying set alternatives, evaluation of the alternatives based on prescribed criteria and selecting the best alternative as the final decision (Anderson, Sweeney & Williams, 2000; Weihrich *et al.*, 2013; Amah & Nkuda, 2014). The creation of awareness takes into consideration the crucial need to properly define the problem to be solved and disseminating information to critical stakeholders to this effect. It is apt to also specify, where possible, the assumptions relative to the

problem to be solved. The different alternatives need to be identified including the option of “do nothing.” The concomitant criteria to evaluate each one of the alternatives to ascertain their respective comparative pay off or values carried out. The choice of the best alternative should be made and followed by careful implementation and periodic reviews of results achieved by way of feedback to improve and better the process overall with the passage of time (Stevenson, 1999; Anderson *et al.*, 2005). The schematic shown below illustrates both qualitative and quantitative decision making processes:



**Fig: 2.2:** The role qualitative and quantities analysis in decision making  
**Source:** Anderson *et al.*, (2000:5.5)

### 2.1.3 Theoretical Framework

Considering the nature of decision making in business organisations and in the face of many management theories, the author opts to anchor and ground this work in the theory of constraints. The theory of constraints (TOC) was pioneered and developed by an Israeli Physicist; Eliyahu M. Goldratt of Goldratt Institute based in New Haven, Connecticut, United States of America in the 1984 novel entitled “The Goal” (DuRivage, 2000). The theory stresses the need to apply iterative approach to do away with all noticeable obstacles (problems or constraints) on the way to achieve set goal by adapting appropriate management and business practices. The common areas of constraints on which attention should be focused include: product quality, product engineering effectiveness, marketing, product cost, materials procurement and production planning and control. It is purely goal-oriented as its application insists on having a clear goal of business organisation set which, according to the theorist, Goldratt, should be profit making. It is often compared to the conventional cost accounting method which lacks what it takes to optimise profits and use of available resources as cost accounting is unit or department-focused unlike theory of constraint which is system cum process-focused.

Buttressing this point, James Cox of Georgia University (cited in DuRivage, 2000) maintains that “traditional cost accounting system used in business for over 70

years doesn't lend itself to tracking the impact of decisions on revenues and profits." The theory places premium more on doing the right things rather than merely doing things right which constitutes the hallmarks of effectiveness and efficiency respectively (Benis & Nanus, 1985; DuRivage, 2000; Nkuda, 2020). The pursuit of theory of constraints eliminates the 'cost world' and installs 'throughput world' in its place. The throughput world operates on three key pillars notably: throughput, inventory and operating expense. Application of the TOC enables management to strategically focus on the foundational issues aimed at tackling root causes of problems instead of the symptoms of the problems. The theory of constraints bears some similarities and differences to the known management philosophies. Specifically, TOC compares favourably to just-in-time manufacturing, total quality management (TQM), statistical process control (SPC) and employee involvement (EI). The TOC emphasises the tackling of constraints or problems as the critical approach to problem-solving in business organisations. This problem-solving orientation differs and opposes the conventional management practice of attempting to address the problems of business organisations in one go or at once which is herculean and physically impossible task. This approach rooted in cost accounting practice is considered to be flawed as it creates and focuses on artificial targets and conceal the root causes of organisational problems (DuRivage, 2000).

### **3.1 Methodology**

Exploratory and descriptive desk research design was employed in this study and relevant secondary data based on extant literature constituted the raw materials or resources for the study.

#### **4.1. Data Presentation and Analysis**

The data obtained in respect of forecasting and graphical method of linear programming are presented and analysed as follows:

Annual sale of a plasma television is forecast by exponential smoothing using a smoothing constant of  $\alpha = 0.5$ . The previous forecast for the latest period was 35,000 units and the actual sales were 45,000 units. The forecast sale figures for the next period.

Solution:  $C_p = P_{t-1} + \alpha (R_{t-1} + P_{t-1})$

$C_p = P_{f.1} + \alpha (R_{t-1} + P_{f.1})$

Where:

$C_p$  = Current period

$P_{f.1}$  = Previous forecast

$\alpha$  = Smoothing constant

$R_{t-1}$  = Previous (actual) value of the time series.

Annual sale of a plasma television is forecast by exponential smoothing using a smoothing constant of  $\alpha = 0.5$ . The previous forecast for the latest period was 40,000 units and the actual sales were 50,000 units. The forecast sale figures for the next period.

Solution:  $C_p = P_{t-1} + \alpha (R_{t-1} + P_{t-1})$

Substitute the right values in the exponential smoothing formula given above as follows:

$$C_p = 40,000 + 0.5(50,000 - 40,000)$$

$$= 40,000 + 0.5(10,000)$$

$$= 40,000 + 5,000$$

$$C_p = 45,000 \text{ units.}$$

This result means that the forecast for the current period ( $C_p$ ) will be 45 units of the television set.

The need to ascertain the point at which the total cost of a firm records or equals total revenue (break-even point) calls for a model with appropriate definition of the symbols used to build the model

e.g.  $\text{Revenue} = \text{Total Cost}$   
 $Px = a + bx$

Where:

$P$  = Unit price of the item

$X$  = Quantity of the item

$a$  = Fixed cost of producing the item

$b$  = Unit variable cost of producing the item

The linear programming (LP) is another quantitative technique that can be used in managerial decision making setting. Depending on the number of variables involved, the linear programming can take the form of graphical method where two or three variables are considered, simplex method where many variables are involved and transportation method where the objective is to minimise transportation cost of moving products from different locations to several other locations where they are demanded. The mathematical representation of linear programming model is as given below:

$$a_1X_1 + a_2X_2 + \dots + a_nX_n .$$

In linear programming parlance, this model is called objective function which could either be to maximise or minimise the given decision variables subject to the constraints expressed further as follows:

$$K_{11}X_1 + K_{12}X_2 + \dots + K_{1n}X_n \leq C_1 \text{ or } \geq$$

$$K_{21}X_1 + K_{22}X_2 + \dots + K_{2n}X_n \leq C_2 \text{ or } \geq$$

$$K_{n1}X_1 + K_{n2}X_2 + \dots + K_{nm}X_n \leq C_n$$

Where:  $X_1 \geq 0, X_2 \geq 0 \dots X_n \geq 0$

$C_1, C_2 \dots C_n$  are constants.

$X_1$  = Variable selected by the process (that is, decision variables).

$m$  = Number of decision variables.

$n$  = Number of constraints.

Assuming Mongramaria Designs seeks advice on the number of shirts and trousers to produce in order to maximise profit. Both designs (trousers and shirts) have to pass through two machines notably: the embroidery and ordinary sewing machines. To make a shirt, six (6) hours are spent in making embroidery and two (2) hours on the sewing machine. For trousers, three (3) hours and four (4) hours are spent on the embroidery and sewing machines respectively. A profit of N120.00 is made on shirt and N100.00 on trousers. A total of number of hours that can be devoted to embroidery and sewing machines are 60 and 32 hours respectively.

The graphical method of linear programming can be leveraged to deduce optimal solution to the problem and thereby be in the vantage position to offer viable and meaningful advice that can effectively enhance the managerial outcomes of the business thus:

**Solution:**

Decision variables are the number of shirts and trousers to be produced.

Let no. of shirts =  $x$

Let no. of trousers =  $y$

Let  $z = 120x + 100y$  be the objective function to be maximised subject to time constraints.

Type of Material	Embroidery Machine and total hours used	Sewing Machine and total hours used
Shirt	6	2
Trousers	3	4
Total hours available to each machine	60	32

The above can be translated into the linear programming model as follows:

$$6x + 3y \leq 60 \dots\dots (i)$$

$$2x + 4y \leq 32 \dots\dots (ii)$$

$$x \geq 0, y \geq 0$$

In equation (i), let  $x = 0$ ;  $6(0) + 3y \geq 60$

$$\underline{3y \geq 60}$$

$$\frac{3}{3} \quad \frac{60}{3}$$

$$y = 20$$

Coordinates of x and y = (0, 20)

In the same equation (i), let  $y = 0$ :  $6x + 3(0) \geq 60$

$$\underline{6x \geq 60}$$

$$\frac{6}{6} \quad \frac{60}{6}$$

$$x = 10$$

Coordinates at point C (10, 0)

In equation (ii), let  $x = 0$ :  $2x + 4y = 32$

$$2(0) + 4y = 32$$

$$\underline{4y = 32}$$

$$\frac{4}{4} \quad \frac{32}{4}$$

$$y = 8$$

Coordinates at point A (0, 8)

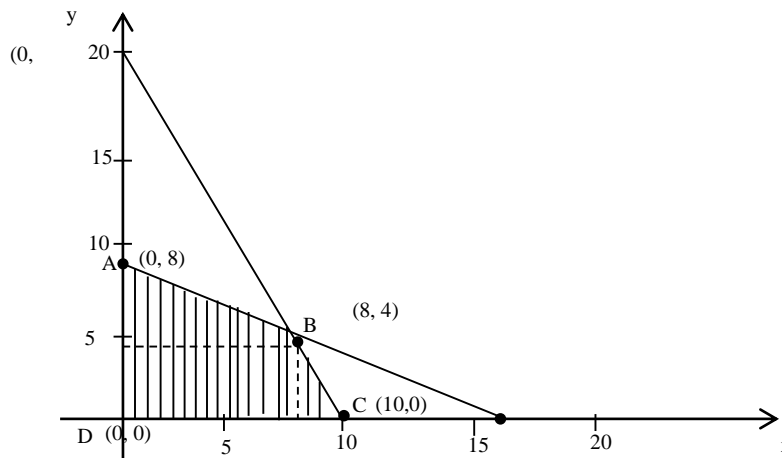
In the same equation (ii), let  $y = 0$ :  $2x + 4(0) = 32$

$$\underline{2x = 32}$$

$$\frac{2}{2} \quad \frac{32}{2}$$

$$x = 16$$

Coordinates (16, 0)



Recall the constraint equations and solve simultaneously to establish the coordinates at the point of intersection or optimal point. By elimination method, find y by multiplying equation (ii) by the coefficient of y in equation (i) which is 3 thus:

$$6x + 3y \leq 60$$

$$2x + 4y \leq 32 \times 3$$

The above equations become:

$$6x + 3y = 60$$

$$\underline{-6x + 12y = 96}$$

$$\underline{-9y = -36}$$

$$-9 \quad -9$$

$$y = 4$$

To obtain the value for x, the value of y has to be substituted in equation (i) as follows:

$$6x + 3y \geq 60$$

$$6x + 3(4) = 60$$

$$6x + 12 = 60$$

$$6x = 60 - 12$$

$$\underline{6x} = \underline{48}$$

$$6 \quad 6$$

$$x = 8$$

Coordinates at point B = (8, 4)

Recall the objective function and substitute the respective coordinates to determine the optimal solution thus:

$$z = 120x + 100y$$

At the point A with coordinates (0, 8):  $z = 120(0) + 100(8)$

$$z = N800.00$$

At the point B with coordinates (8, 4):  $z = 120(8) + 100(4)$

$$z = 960 + 400$$

$$z = N1, 360.00$$

At the point C with coordinates (10, 0):  $z = 120(10) + 100(0)$

$$z = N1, 200.00$$

**Decision:** The point B with coordinates (8, 4) records the highest profit. Hence, it is the optimal solution. The Mongramaria Designs is therefore advised to produce eight (8) shirts and four (4) trousers in order to maximise its profits. Qualitative advice based on experience, intuition, heuristics would not have given such a solid basis to add value to the advice (Griffen, 2005, Nkuda, 2019). It goes to provide credible evidence to the advice being given from the lens of quantitative techniques.

The quantitative models are many and inexhaustive lists of some of the models that can be applied in solving problems to deduce meaningful and effective managerial decisions are as compiled and shown below:

**Decision Models by Uncertainty Class and Corporate Use (D, deterministic, P, probabilistic; H, high, L, low).**

S/No	Model Type	Uncertainty Classification	Frequency of Corporate Use
1	Linear programming	D	H
2	Network (including PERT/CPM)	D, P	H
3	Inventory, production and scheduling	D, P	H
4	Economic, forecasting and simulation	D, P	H
5	Integer programming	D	L
6	Dynamic programming	D, P	L
7	Stochastic programming	P	L
8	Non-linear programme	D	L
9	Game theory	P	L
10	Optimal control	D, P	L
11	Queuing	P	L
12	Difference equations	D	L

**Source:** Eppen (1988). *Quantitative concepts for management*. 3<sup>rd</sup> ed., Toronto, U.S.A.: Prentice Hall, Inc., and Verma and Sharma (2017). The role of quantitative techniques in business and management.

The above table shows that the different model types have equally different classifications in terms of the uncertainty of some of the data employed to evaluate the model and also different frequencies of corporate use. This means that some models are deterministic (D), probabilistic (P) and yet, others are a hybrid (D, P) of deterministic (D) and probabilistic (P). However, studies upon which the table is based have signified that only four of these models have high frequency of corporate use. Interesting aspects of models in quantitative techniques used in managerial decisions are that they have underlying assumptions since the models do not describe the real world situation precisely. That was why, Herbert A. Simon, a Nobel Prize winner in Economics and an expert in decision making (cited in Anderson *et al.*, 2000) says that “a mathematical model does not have to be exact; it just has to be close enough to provide better results than can be obtained by common sense.”

### **5.1 Conclusion and Recommendations**

On the strength of content analysis carried out quantitative techniques are imperative and relevant to making sound managerial decisions. This explains why the use of quantitative techniques is important to decision making in both public and private organisations (Verma & Sharma, 2017; Devi & Devaki, 2019; Rabab’h *et al.*, 2019). Quantitative techniques enable managers to make decisions with confidence. The use of quantitative techniques improves the quality of decisions. The quantitative techniques make satisficing or optimal results possible. The usefulness of quantitative techniques to decision making notwithstanding, a yawning gap that thus exists in its applications as far as managers in Nigerian context are concerned. Rabab’h *et al.*, (2019) acknowledge that weak application of quantitative techniques in decision making is phenomenal. This position together with empirical studies reviewed provokes the recommendation that practicing managers in business and administrators in government institutions be encouraged to apply quantitative techniques and improve their working knowledge of quantitative techniques to enhance their mastery with the passage of time as against exhibition of phobia for the use of quantitative techniques. Devi and Devaki (2017) confirm that managers do need a working knowledge of quantitative techniques. Over all, the continued practice and use of the quantitative techniques in managerial decision making would help to sharpen and hone the skills of managers even more to achieve effective management decisions for business organisations.

## References

- Adepetan, A. (2009, October 12). African countries need to strategise on promoting. *The Guardian*: 25 – 29.
- Akpan, I. (2004). *Fundamentals of finance*. 2<sup>nd</sup> ed., : Uyo: Nelgrafik Nig. Limited.
- Amah, E., & Nkuda, M. O. (2014). *Foundations of business management*. Port Harcourt: Tema T. Press Ltd.
- Anderson, D. R., Sweeney, D. J., & Williams, T. A. (2000). *An introduction to management science: Quantitative approaches to decision making*. 9<sup>th</sup> ed., London: South-Western College Publishing.
- Ayandele, I. A. (2005). *Quantitative techniques for managerial decisions*. Cle-Print Publishers, Uyo.
- Benis, W., & Nanus, B. (1985). *Leaders: Strategies for Taking Charge*. New York: Harper and Row. <https://www.journals.sagepub.com>. Accessed on 21/09/2020.
- Butschi, G., & Steyn, B. (2006). Debate paper: Theory on strategic communication management is the key to unlocking the boardroom. *Journal of Communication Management*, 10(1): 106 - 109. <https://www.emeraldinsight.com>. Retrieved on 07/07/2019.
- Byars, L. L., & Rue, L. W. (2000). *Human resource management*. 6<sup>th</sup> ed., USA: The McGraw-Hill Companies, Inc.
- Devi, A. M., & Devaki, A. (2019). Applications of quantitative techniques in decision making of business organisation. *International Journal of Trend in Scientific Research and Development*, 3(3): 568 – 571. Accessed on 02/12/2020.
- DuRivage, A. (2000). Theory of constraints. In: Malonis, J. A. (Ed.), *Encyclopedia of business*. Farmington Hills: Gale Group, Inc.
- Eppen, C. D. (1988). *Quantitative concepts for management*. 3<sup>rd</sup> ed., Toronto, U.S.A.: Prentice Hall, Inc.
- Gomez-Mejia, L. R., & Balkin, D. B. (2002). *Management*. New York: The McGraw-Hill
- Griffen, R. W. (2005). *Management*. 8<sup>th</sup> ed., New York: Houghton Mifflin Company.
- Hill, T. (2000). *Operations management: Strategic context and managerial analysis*. New York: Palgrave Macmillan.
- Lucey, T. (1996). *Quantitative techniques*. 5<sup>th</sup> ed., London: DP Publications.

- Nkuda, M. O. (2017). Imperative of controlling a new enterprise. A systems' approach perspective. *IIARD International Journal of Economics and Business Management*, 3(1): 57- 69. <https://www.iiardpub.org>.
- Nkuda, M. O. (2017). *Systems approach to management: A handbook for corporate decisions*. Germany: LAP Lambert Academic Publishing.
- Nkuda, M. O. (2019). Case methodology as a pivot of strategic management. In: Karunakaran, N. (Ed.), *Current Perspective to Economics and Management*, 1<sup>st</sup> ed., India: Book Publisher International, 2: 39 – 59.
- Nkuda, M. O. (2020). Organisational transformation: A paradigm shift from the classical to the post-contemporary orientation. *CEDTECH International Journal of Management Studies and Entrepreneurial Development*, 1(2): 58 – 81. Accessible on: <http://www.cedtechjournals.org>.
- Northouse, P. G. (2010). *Leadership: Theory and practice*. 5<sup>th</sup> ed., California: SAGE Publications, Inc.
- Pearce, J., & Robinson, R. B. (1991). *Strategic management: Formulation, implementation and control*. Boston: McGraw-Hill, Inc.
- Rabab'h, B., Omar, M., Ali, A., & Alzyoud, Y. (2019). Literature review of the impact of the use of quantitative techniques in administrative decision making: Study (Public and private sector institutions). *International Journal of Scientific and Research Publications (IJSRP)*, 9(7): 515 – 521. DOI: 10.29322/IJSRP.9.07.2019.p9166. Accessed on 02/12/2020.
- Robbins, S. P. (2005). *Organisational behaviour*. 11<sup>th</sup> ed., New Delhi: Pearson Education, Inc.
- Robbins, S. P., DeCenzo, D. A., & Coulter, M. (2011). *Fundamentals of management*. New Jersey: Pearson Education, Inc.
- Sapru, R. K. (2013). *Administrative theories and management thought*. 3<sup>rd</sup> ed., New Delhi: PHI Learning Private Limited.
- Schermerhorn, J. R. Jr. (2010). *Exploring management, explore, inspire*. 2<sup>nd</sup> ed., Hoboken: John Wiley & Sons, Inc.
- Stevenson, W. J. (1999). *Production operations management*. 6<sup>th</sup> ed., USA: The McGraw-Hill Companies, Inc.
- Verma, G., & Sharma, K. (2017). The role of quantitative techniques in business and management. *Journal of Humanities Insights*, 1(1): 24 – 26. DOI: 10.22034/JHI.2017.59559. Accessed on 02/12/2020.
- Virkus, S. (2009). *Leadership models: Contingency theory*. Tallinn University. <https://www.tlu.ee>. Accessed on 16/11/2020.

Wehrich, H., Cannice, M. V., & Koontz, H. (2013). *Management: A global and entrepreneurial perspective*. 13<sup>th</sup> ed., New Delhi: The Tata McGraw Hill Education Private Limited.