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Full Length Research Paper

Impact of Linear Programming on Profit Maximization in Production Firms: A Survey of Selected Firms in Delta State of Nigeria

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Abstract

The study examines the Impact of Linear Programming on Profit Maximization in some selected Production Firms in Delta State of Nigeria. The objective is to highlight the importance of using the concept of linear programming for decision making in production firms for an efficient and effective allocation of available resources in order to achieve the goals and objectives of organizations. To embark on the study, two statistical hypotheses were formulated and tested at 0.05 level of significance, a sample of one hundred and eighteen (118) respondents was used for the study by Taro Yamen's formula and this was obtained through the stratified random sampling technique. A validated questionnaire based on a five point Likert scale was constructed to guide the study. The statistical tools employed in testing the two null hypotheses were the simple percentage, the Pearson, Product moment correlation coefficient and the t-test. On the basis of these statistical analyses, it was discovered that there is a significant relationship between the application of linear programming model, profitability and that efficient and effective allocation of available resources in an organization can be achieved through the application of the concept of linear programming. Going by these findings obtained, the study concludes that, linear programming remains the most effective tool for the allocation of organizational resources that can lead to profit maximization. It is therefore recommended, that organizations should adopt the concept of linear programming in production decision making in order to achieve her profit maximization goals.

Keywords: Linear Programming, Profit Maximization, Resources Allocation, and Organizations.

INTRODUCTION

Since the advent of the industrial revolution, the world has seen a remarkable growth in the size and complexity of organizations. An integral part of the revolutionary change has been a tremendous increase in the division of labor and segmentation of managerial responsibilities in these organizations. Therefore, planning of production for maximum profit is the goal of management of the production firms. This involves making the best use of available resources (inputs) to determine the quantity of products (outputs) to be produced to maximize the profit of the organizations. The survival of all profit oriented firms in the long run depends on their ability to make a reasonable profit depending on the business conditions and the level of competition. Once the firms are able to make profit, they try to make it as large as possible, i.e., they tend to maximize it.

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Profit maximization implies that a firm either produces maximum output for a given amount of input, or uses minimum input for producing a given output. It is assumed that profit maximization causes the efficient allocation of resources under the competitive market condition. The most common objective of the firms is profit maximization. Any organization that wants to remain in business knows that effective and efficient use of resources is sine-qua-non to the growth and achievement of profit, Winston (2010) opines that linear programming is a mathematical modelling technique designed to optimize the usage of limited resources. In other words, it is a technique for finding the best use of a firm's limited resource. The efficient method in solving Linear Programming problems is the simplex algorithm method. Therefore, progressive firms will adopt the linear programming model in its production activities in order to arrive at an efficient allocation of resources and enable them know the quantity of each products the organizations should produce in order to maximize profit.

The Problem

Industries all over the world, including Nigeria are continuously faced with shortages of production inputs which result in low capacity utilization and consequently low outputs. Decision making has always been very important in the business and industrial world, particularly with regards to problems concerning the production of commodities. For instance, which commodity should be produced and in what quantity and by which process, which is most effective in attaining the goals of the organization, by combining the limited resources at the disposal of the management are the main questions before production manager. Yet, under these seemingly insurmountable obstacles the business would still want to survive and be profitable.

It is essential to state that decision makers and industry planners are aware of the importance of the LP model on profit maximization. But most production industries like flour Mill Company and Eternit Nig Ltd both in Sapele Delta State are yet to adopt this model in their production decision-making. They rather adopt traditional accounting methods such as cost-volume-profit analysis, as well as budgeting and budgetary control, in trying to provide a lasting solution to the challenge of optimal decision making. Some others simply use intuition or the trial-and-error method. This, no doubt, has resulted to ineffective and inefficient allocation of resources, instability and reduction in the profitability profile of these industries.

It has become essential to draw the attention of the management of these production firms towards careful application of linear programming model in finding the optimal production level that effectively utilizes the available resources that will enable them to achieve profit-maximization objective.

Objectives of the Study

The broad objective for embarking on this study is to assess the effects of linear programming model on profit maximization in production firms. Other objectives are:

a). To ascertain whether the use of linear programming model has a positive impact on profitability.
b). To examine whether the linear programming model is in use in the allocation of the organizations' resources.

Statistical Hypothesis

In order that answers may be provided for the objectives stated above, the following hypotheses have been formulated.

Ho: There is no significant relationship between the use of the concept of linear programming model and profit maximization.
Ho: The use of linear programming model has no significant relationship with effective and efficient allocation of resources

Conceptual Framework

There are diverse opinions on the applicability of the linear programming technique to different management decision-making process. These opinions developed over a long period of time following continuous improvement in the application of the technique in solving practical business problems. Most literature on economic development supports the view that linear programming is a practical tool of analysis in allocating scarce resources to their optimal use and is of vital importance to the economies of underdeveloped countries. Tracing the history of linear programming method, it is a mathematical device developed by the mathematician, George Dantzig, in 1947 for planning the diversified activities of the U.S.A. Air Force connected with the problem of supplies to the Froe. Afterwards, Dantzig suggested this approach for solving business and industrial problems. He also developed a

powerful mathematical tool known as “simplex method” to solve linear programming problems (Dantzig, 1974).

In an allocation problem, when there are a number of activities to be performed, alternative ways of doing them, and limited resources or facilities for performing each activity in the most effective way, the management is faced with the problem of how best to combine these activities and resources in an optimal manner so that the overall efficiency is maximized. According to Charles, Cooper and Henderson (2012), this is known as an optimization problem, and can be approached using mathematical programming. They further refer to linear programming as a uni-objective constrained optimization technique. This is because, according to them, it seeks a single objective of either minimizing or maximizing unknown variables in a model. In line with this, Gupta and Hira (2011) argue that linear programming deal with linear optimization of a function of variables known as an objective function subject to a set of linear equations and/or inequalities known as constraints. The objective function may be profit, cost, production capacity or any other measure of effectiveness which is to be obtained in the best possible or optimal manner. The constraints may be imposed by different resources such as market demand, production process and equipment storage capacity, raw material available, and so on. They further posit that programming implies planning and by linearity is meant a mathematical expression in which the expressions among the variables are linear.

Dowing (2012) advocates that the Lagrangian method should be used for any optimization subject to a single inequality constraint, the Graphic approach for optimization subject to only two inequality constraints, and the linear programming model for optimization subject to many inequality constraints. Supporting this view, Dwivedi (2008) posits that linear programming is of great use in making a business decision because it helps in measuring complex economic relations and thereby, provides an optimum solution to the problem of resource allocation. According to him, linear programming technique thus, bridges the gap between abstract economic theories and managerial decision-making.

Furthermore, he stressed that any linear programming equation should have three specifications, namely: objective function specification, constraint equation specifications, and non-negativity requirement. Corroborating this view, several authors (Dowing, 2012, Dwivedi, 2008, Koutsoyiannis, 2007, Henderson and Quandi, 2013, etc) have given the general specification of the linear programming model.

Turban and Meredith (2011) agreeing with Dwivedi (2008), states that linear programming is one of the best known tools of management science. Management science methods are composed of three components; the decision (uncontrolled variables, the environment (uncontrolled) parameters and results (dependent) variables. The linear programming model, according to them, is composed of the same components, but they assume different names; the decision variables which we seek to determine, the objective function which we aim to optimize and the constraints we need to satisfy. But Koutsoyiannis (2007) insists that linear programming can be considered as providing an operational method for dealing with economic relationship which involves discontinuities. She however, maintains that neither economic theory nor linear programming says anything about the implementation of the optimal plan or solution. They simply derive the optimal solution in any particular problem.

Emory and Niland (2011) listed the most difficult problems using linear programming technique as: the recognition of the necessary restrictions (constraints or row equations) and the possible alternatives (the column vectors) and the expression of these in linear equations. The difficulty is to construct, in mathematical form, an accurate definition of the problem. Knowledge of the problem, the details of company operations, the mathematics of linear programming technique and ordinary ingenuity all come into play in the application of linear programming model. For Turban (2012), there is the problem of risks and uncertainties regarding the behavior of customers, resources and commodity prices such that the management finds it difficult to choose the best decision among the alternative decision possibilities. He therefore recommends that managers must become more sophisticated, they must learn how to use new tools and techniques that are being developed in their field. These newly developed tools employ a quantitative approach.

Adam *et al.,* (2011) observed that optimization model aims at finding the best solution from a large or an infinite number of alternatives using a step-by-step improvement approach, Management seek to find the best solution and an optimization algorithm identifies the steps for doing so. In Agbadudu (1999), optimization is the branch of computational science that seeks to answer the question, ‘what is best’ for problems in which the quality of any answer can be expressed as a numerical value. Such problems arise in all areas of business, physical, chemical and biological sciences, engineering, architecture,

economics and management. The range of techniques available to solve them is nearly as wide.

METHODOLOGY

The target population for the study included all personnel involved in the manufacturing and selling of the organisation's products. The organizations are Flour Mill (Nig) Ltd and Eternit Nig Ltd Sapele, Delta State. The study adopted the stratified random sampling technique and Taro Yamen's formula was used to determine the sample size of 125. A five point Likert scale was used to measure the variables, namely the concept linear programming and profitability relationships. The objectives as relate to the hypotheses were tested using the descriptive statistical methods such as a simple percentage, the Pearson product moment correlation coefficient and student's t-test so as to determine whether to accept or reject the null hypotheses

Data Analysis and Interpretation

Out of the one hundred and twenty-five (125) questionnaires distributed, one hundred and eighteen (118) were returned and accepted for analysis. The following table shows the y – response for the hypotheses testing.

Table 1. Item for hypothesis one **X point**

	SA (5)	A (4)	U (3)	D (2)	SD (1)
1	53	56	2	4	3
2	49	27	13	20	9
3	56	41	5	9	8
4	50	37	4	8	8
5	47	31	6	17	17
Total	255	192	30	68	45

	255	92	30	68	45
	5	5	5	5	5
Y- response	51	38	6	14	9

Table 2. Opinion of Respondents According to Hypothesis One

S/N	There is no significant relationship between the application of the concept linear programming model and profitability.	Agree	Undecided	Disagree
1	The use of linear programming concept could lead to increase in profitability.	109	2	7
		92%	2%	6%
2	Organization using the concept of linear programming has advantage over those that does not apply the concept.	76	13	29
		64%	11%	25%
3	The use of the concept linear programming leads to reduction in the cost of production.	97	5	16
		82%	4%	14%
4	The use of linear programming model is foreign to your organization production process.	87	15	16
		74%	13%	14%
5	The uses of the concept of linear programming reduce the production time of the organization.	78	6	34
		66%	5%	29%

Source: Field Survey 2015

Table 3. Ranking of the application of the concept of linear programming model and profitability

Option on research question 1	X Point	Y Response	XY	X^2	Y^2
SA	5	51	255	25	2601
A	4	38	152	26	1444
U	3	6	18	9	36
D	2	14	28	4	196
SD	1	9	9	1	81
Total	$\sum X=15$	$\sum Y=118$	$\sum XY=462$	$\sum^2=55$	$\sum Y^2=4358$

Source: Field Survey 2015

Where X represent value assigned to Likert scale i.e. strongly agree (5), agree (4), undecided (3), disagree (2), and strongly disagree (1). Y is the average of the sum of all research questions for each hypothesis under the various x points as shown in table 1.1. The mean score for research question is also computed in order to know whether it exceeds 3.0 and if otherwise the question is rejected.

$$\text{Correlation coefficient } (r) = \frac{n\sum xy - \sum x \sum y}{\sqrt{[n\sum x^2 (\sum x)^2 - (n\sum y^2 - (\sum y^2)]}}$$

$$r = \frac{5(462) - 15(118)}{\sqrt{5(55) - 225 \;\; 5(435) - (118)^2}}$$

$$r = \frac{540}{621}$$

$$r = 0.87$$

The value above shows that there is strong relationship between the two variables involved. The t-test statistic was employed and the formula is thus:

$$t - \text{cal.} = r\sqrt{\frac{n-2}{1 - r^2}}$$

With n-2 degree of freedom
Where r = correlation coefficient

n = number of paired observation

$$t = 0.87\sqrt{\frac{3}{1 - (0.872)}}$$

$$t = \frac{1.50}{0.49}$$

$$t - \text{cal.} = 3.06$$

Therefore the calculated t value is 3.06. From the t table the critical value of t with (5-2) degree of freedom at 0.05 level of significance is 2.35.

Reject H0: if t-cal. > t-tab

Since t - cal. (3.06) is greater than t - tab. (2.35), it means rejecting the null hypothesis which says that 'there is no significant relationship between the application of the concept of linear programming model and profitability. Hence the alternative hypothesis was accepted. These findings confirm that of Gupta and Hira (2011) that the efficient application of the concept linear programming in organization's production decision making will enable them achieve their profit maximization objective.

Table 4: Item for hypothesis two **X points**

	5	4	3	2	1
1	56	35	4	9	14
2	47	27	12	18	14
3	61	27	4	11	15
4	55	39	5	9	10
5	52	31	7	17	11
Total	271	159	32	64	64

	271	159	32	64	64
	5	5	5	5	5
Y- response	54	32	6	13	13

Testing of Hypothesis two

Table 5. Opinion of Respondent According to Hypothesis Two (2)

S/N	The use of linear programming has no significant relationship with effective and efficient allocation of resources.	Agree	Undecided	Disagree
1	There are so many cases of resource wastage in your organization.	91	4	23
		77%	3%	20%
2	Non-adherence the efficient and effective allocation of resources will seriously affect your organization's overall performance.	74	12	32
		63%	10%	27%
3	Appropriate allocation of resources can lead to profit optimization.	88	4	26
		75%	3%	22%
4	Wastage of resources may be attributed to inappropriate allocation.	94	5	19
		80%	4%	16%
5	Inefficient and ineffective utilization of available resources is as a result of most production managers' failure to direct and coordinate factory hands.	83	7	28
		70%	6%	24%

Source: Field Survey 2015

Table 6. Calculating r for the use of linear programming and efficient and effective allocation of resources

Option on research question 2	X Point	Y Response	XY	X^2	Y^2
SA	5	54	270	25	2916
A	4	32	128	16	1024
U	3	6	18	9	36
D	2	13	28	4	169
SD	1	13	9	1	169
Total	$\sum X=15$	$\sum Y=118$	$\sum XY=455$	$\sum^2=55$	$\sum Y^2=4314$

Source: Field Survey 2015

$$r = \frac{n\sum xy - \sum x\sum y}{\sqrt{[n\sum x^2(\sum x)^2 - (n\sum y^2 - (\sum y^2)]}}$$

$$r = \frac{5(455) - 15(118)}{\sqrt{5(55) - 15^2}\sqrt{5(4314) - (118)^2}}$$

$$r = \frac{505}{618}$$

$$r = 0.82$$

The coefficient of 0.82 indicates that there is a strong positive relationship between the dependent variables and the independent variables. The student's t-test statistics will be used and it is given by;

$$t\text{ - cal.} = r\sqrt{\frac{n-2}{1-r^2}}$$

$$= 0.82\sqrt{\frac{5-2}{1-(0.82)^2}}$$

$$= 0.82\sqrt{\frac{3}{1-0.67}}$$

$$t\text{ - cal.} = 2.62$$

Reject H_0: if t-cal. > t – tab

From the t-tab with 0.05 level of significance, the critical value is 2.35.

However since the computed t-value of 2.62 is greater than the critical value of 2.35, the null hypothesis (H_0) is rejected and the alternative hypothesis is accepted. Therefore, the study concluded that there is a significant and positive relationship between the use of linear programming and efficient and effective allocation of resources. This agrees with Dwivedi (2008) that asserts that linear programming is of great use in making business decision and provides an optimum solution to the problem of resource allocation.

DISCUSSION OF RESULTS

The first major finding of the study, therefore, was that there is a positive significant relationship between the application of the concept of linear programming model and profitability. This finding is evidenced by the responses of respondents of which over 92% indicated that the use of Linear Programming can lead to increase in profitability. Thus, individual companies within the production industry should try as much as possible to adopt the concept of linear programming model in their production decision making in order to avoid decrease in profit. The finding is consistent with those of Wagner (2007) and Turban (2012) that effective application of linear programming enhances profitability. The second finding of the study was that there is a significant relationship between linear programming and effective and efficient allocation of resources. This supports the views of Dowing (2012) that organizations experiencing wastages and inappropriate allocation of limited resources are those that do not apply the concept of linear programming in the allocation of their limited resources.

CONCLUSION

The study has examined the effects of Linear programming model on profit maximization in production industries in Nigeria. The findings revealed among others that the application of linear programming has a positive impact on the level of profitability made by the production industry. It also revealed that there are many cases of resource wastage in these production industries. This may be as a result of the non-utilization of the concept of Linear programming model in the production decision making. Optimization technique such as linear programming remains the most effective tool for the allocation of organizational resources that lead to profit maximization.

We therefore concluded that profit maximization in an organization depends on the application of the concept of linear programming model.

RECOMMENDATIONS

Based on the findings, the study made the following recommendations;

1). The organization should adopt the concept of linear programming in their production decision making to enable them achieved their objectives. The linear programming model yields a better solution, a higher profit and quicken the attainment of the organizational goal more than the rule of thumb.

2). That application of linear programming model shows the worth of the organization resources not only to the outsiders but also to the organization itself. Therefore,

manufacturing organizations should ensure that production managers are properly trained in the field of operations research in order to effectively utilize the concept of linear programming in the systematic approach to allocate scarce resources in the most effective way.

3). That linear programming model helps the management to take proven and objective decision rather than to rely on subjective decisions which are usually full of defects and errors.

4). That manufacturing industry should employ trained and competent operations research personnel, organise workshop to create awareness of the concept LP and adopt the concept linear programming in their production decision making.

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