

Application of Linear Programming Model on the Profit Maximization of Savannah Sugar Company Limited, Numan, Adamawa State

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Abstract

Manpower can either account for unwanted expenses or production shortfalls. Profit maximization could be realised by the staffing the organization with the right number of manpower with required skills. In this research, the inadequate and inappropriate manpower in carrying out operations of sugar production in Savannah Sugar Company Limited (SSCL)–Dangote Groups has been considered to be attributable for present state of the Company. Over the years, the Company has been battling with underproduction which has been translating into lost. The objective was the maximization of profit contribution of the entire personnel in each production day and the constraints included the basic salary and the allowances of each staff in each unit. The manpower requirement problem was modelled into a linear programming problem. TORA software for window version 2.00 was used to solve the problem to optimality. This optimized the profit generation from N29,040,450 to N48,493,450 daily with optimal manpower requirements 480 employee for steam generation, 5,750 for cane preparation, 123 for milling, 68 for centrifuging, 72 for packaging and drying. This study has successfully determined the manpower required which is very critical to meeting the set goals of any business in each production unit of sugar production that will maximize profit in SSCL. This will address the problems of unwanted expenses through over staffing or production shortfalls through under staffing. The study was recommended for implementation in order to adopt scientific approach which provides an analytical methodology as a basis for decision making in profit maximization.

Keywords: Linear Programming, Profit Maximization, Model, Sensitivity Analysis, Personnel.

Introduction

One of the most significant developments in the field of organizations in recent times is the increasing importance given to manpower (human resource). People are vital to organizations as they offer perspectives, values and attributes to organizational life; and when managed effectively, these human traits can be of considerable benefits to the organization (Akinyele, 2007). This scenario lends credence to the increasing attention being paid to the people aspect of organizational wealth. This is so because the development of people, their competencies, and the process development of the total organization are the fulcrum of human resource management. The development of

indigenous manpower to serve as the propelling force for natural growth and development is no doubt a key to Nigeria's socio-economic and political development (Djabatey, 2012). Manpower is a cardinal factor that determines the level at which production facilities are being used to achieve desired set of organizational objectives. The speed at which these facilities are being transformed to goods and services varies depending on capacity, relationship and achievement in terms of experience of the engaged manpower. Resource availability also influences the categories (low performance and high performance) of manpower necessary at a given time. Sometimes combination of these categories may be required. In this sense, low performance manpower means a competent manpower that can operate at low speed as a result of some factors such as old age, ability, capacity, health condition, etc; while high performance manpower can operate with high speed (Rao, 2014). However, one is expected to pay more when high performance staff is engaged than low performance staff and at the same time, more is expected in terms of transformation of resources into useful products from high performance staff than low performance staff (Akinyele, 2010). In developing countries, as a result of low capital outlay, there is a need to keep the cost of production of goods and services at a minimum possible level so that production can continue. This can be possible by employing appropriate quantity of competent manpower when needed based on the available production capacity and time of operation. Competent manpower can be achieved through vocational training and re-training in house and abroad (Arthur, 2016).

Human resource or manpower has been identified as wealth of nation as well as a cardinal element of all aspect of management. As a wealth of a nation, it is argued that the economic development of a country depends largely on the quantity and quality of its manpower resource, the state of technology and the efficient deployment of resources in both the production consumption processes Agbo (2015). In other words, manpower is important to both national development and organizational management. It is the manpower that must develop and manage the national resources into finished products and services (Fapohunda, 2014). In the same vein, Harbison (2016) opined that manpower constitutes the ultimate basic for the wealth of nations, human beings are the active agents who accumulate, exploit natural resources, build social, economic and political organizations and carry forward national development. Clearly, a country, which is unable to develop the skill and knowledge of its people and utilize them effectively in its national economy, will be unable to develop anything else.

Linear programming remains one of the used mathematical techniques in today's modern societies. Today it is a standard tool that has saved many thousands or millions of dollars for most companies or businesses of even moderate size in the various industrialized countries of the world. From report of various surveys, it has been shown that many production companies, particularly the ones operating in Nigeria are not conversant or yet to know fully the application of linear optimizations. Sometimes many production companies are faced with problems of how to utilize the available resources in order to

maximize profit; this is because the use of linear programming which brings a suitable quantitative approach of decision-making has not been fully applied (Kourosh, *et al.*, 2013). Snezana and Milorad (2012) recognize linear programming as an important tool in energy management despite the non-linearity property of many energy system, they argue that the non-linearity property can be converted to a linear form by applying Taylor series expansion so that the optimization method can be applied to determine the best means of generating energy at a minimum cost. Balogun, *et al.* (2012) also reported that, the problem in production sectors is the problem of management, that many companies are faced with decision relating to the use of limited resources such as raw materials.

In this study we shall explore the role linear programming plays in aggregate production planning which addresses the problem of deciding how many employees the firm should retain and for manufacturing company in order to yield maximum profit.

Statement of the Problem

It is generally believed that the success or failure and the effectiveness and ineffectiveness of any organization depend largely on the manpower that manages the daily routine of the organization. Therefore, inadequate number and inappropriate manpower in carrying out the operation and activities of organization is attributable to lack of achieving its set objectives. Thus, the need to determine optimal manpower requirement to carry out organizational activities is important. It has been observed in Savannah Sugar Company Limited, Numan, that inadequate number of manpower accounts for the loss of the company both in measures of time and money.

Objectives of the Study

The objective of the Study is to determine the optimum manpower requirement for the production of sugar product by the company.

Methodology

Research design relates to the general approach adopted in executing the study. As a matter of fact, this study is a descriptive survey designed to examine the manpower requirement in the Nigerian Industrial (production) sector which sugar production processes of Savannah Sugar Company Limited Numan, was considered as a case study. The descriptive survey was based on staff requirement in the factory of the savannah Sugar Company and information obtained from interview with regards to the subject matter under investigation.

Data Collection

In the process of carrying out this study, the data to be used was collected from two major sources. These sources included the primary and secondary sources. The data collected for this research included the following; the information regarding the number of personnel in

the factory, the cost implication of engaging the personnel and the productivity of each personnel. These data were presented in the form of Tables.

The Model

The model used in this study is:

$$\text{Maximize } Z = r_1x_1 + r_2x_2 + r_3x_3 + r_4x_4$$

Subject To:

$$b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 \leq b$$

$$h_1x_1 + h_2x_2 + h_3x_3 + h_4x_4 \leq h$$

$$t_1x_1 + t_2x_2 + t_3x_3 + t_4x_4 \leq t$$

$$k_1x_1 + k_2x_2 + k_3x_3 + k_4x_4 \leq k$$

$$X_i \geq 0 \text{ (where } i = 1, 2, \dots, 4)$$

Where;

Z = total daily profit contribution of the various employee in the factory of Savannah Sugar Company in one production cycle

$r_{1,\dots,4}$ = profit contribution coefficients i.e. the numerical values that express the unit contribution by one employee to the profit equation.

$x_{1,\dots,4}$ = the set of unknown we are seeking to determine i.e. the manpower requirement in each production units of factory of Savannah Sugar Company.

$b_{1,\dots,4}$ = the basic salary required for one employee in each units of the factory of Savannah Sugar Company within the production cycle.

$h_{1,\dots,4}$ = the hazard allowance required for one employee in each units of the factory of Savannah Sugar Company within the production cycle.

$t_{1,\dots,4}$ = the transport allowance required for one employee in each units of the factory of Savannah Sugar Company within the production cycle.

$k_{1,\dots,4}$ = the hospital allowance required for one employee in each units of the factory of Savannah Sugar Company within the production cycle.

b = the available basic salary within the production cycle.

h = the available hazard allowance within the production cycle.

t = the available transport allowance within the production cycle.

k = the available hospital allowance for within the production cycle.

Estimates of the variables are presented in tables. The optimum values of the different personnel in the factory of savannah sugar company shows the combination obtained through the application of linear programming model. The tables also show these resources that are abundant and those that are in short-fall.

Results and Discussion

Table 1: Unit Profit Generated by Each employee from Each Production Unit of the Company

S/N	Units	Unit Profit (N)
1	Steam Generation	4340
2	Cane Preparation	7840
3	Milling	5560
4	Centrifuging	5005
5	Drying and Packaging	4250

Source: Field Survey 2020.

Table 2: Constraints Information

Resources	Resource per unit Products (N)					Available Res. (N)
Allowances	Steam Generation	Cane Preparation	Milling	Centrifuging	Drying & Packaging	
B/Salary	1660	1730	1560	1480	1700	500000
H/A	23	32	27	28	22	41000
T/A	19	21	24	22	23	37000
H*/A	31	34	28	27	30	42500

H/A, =Harzard, T/A, Transport, H*/A hospital allowance: Field survey, 2020.

Decision Variables

x_1 = the man-power requirement in steam generation unit.

x_2 = the man-power requirement in cane preparation unit.

x_3 = the man-power requirement in milling unit.

x_4 = the man-power requirement in centrifuging unit.

x_5 = the man-power requirement in drying and packaging unit.

Profit Contribution Coefficients (Given Constants)

Profit contribution coefficients represent the numerical values that express the per unit contribution to the profit equation (Z).

r_1 = Average net contribution by one employee in steam generation unit in production cycle.

r_2 = Average net contribution by employee in cane preparation unit within production cycle.

r_3 = The average net contribution by one employee in milling unit within production cycle.

r_4 = Average net contribution by one employee in centrifuging unit within production cycle.

r_5 = Average net contribution by 1 employee in drying and packaging unit in production cycle.

1. Constraints formulation: (CF)

Basic salary here represents the salary requirement for one employee in various units of Savannah Sugar Company within the production cycle;

b_1 = the basic salary required for one employee in steam generation unit.

b_2 = the basic salary required for one employee in cane preparation unit.

b_3 = the basic salary required for one employee in milling unit.

b_4 = the basic salary required for one employee in centrifuging unit.

b_5 = the basic salary required for one employee in packaging and delivery unit.

B = the available basic salary within the production cycle.

2. Hazard Allowance Expenses: (HA)

Hazard allowance here represents the hazard allowance required for one employee in various units of Savannah Sugar Company within one year period;

h_1 = the hazard allowance required for one employee in steam generation unit.

h_2 = the hazard allowance required for one employee in cane preparation unit.

h_3 = the hazard allowance required for one employee in milling unit.

h_4 = the hazard allowance required for one employee in centrifuging unit.

h_5 = hazard allowance required for one employee in drying and packaging unit.

H = the available hazard allowance within the production cycle.

3. Transport Allowance Expenses: (TA)

Transport allowance here represents the transport allowance required for one employee in various units of the production line of Savannah Sugar Company within one year period;

t_1 = the transport allowance required for one employee in steam generation unit.

t_2 = the transport allowance required for one employee in cane preparation unit.

t_3 = the transport allowance required for one employee in milling unit.

t_4 = the transport allowance required for one employee in centrifuging unit.

t_5 = the transport allowance required for one employee in drying and packaging unit.

T = the available transport allowance within the production cycle.

4. Hospital Allowance Expenses: (HA)

Hospital allowance here represents the hospital allowance required for one employee in various units of the production line of Savannah Sugar Company within one year period;

k_1 = the hospital allowance required for one employee in steam generation unit.

k_2 = the hospital allowance required for one employee in cane preparation unit.

k_3 = the hospital allowance required for one employee in milling unit.

k_4 = the hospital allowance required for one employee in centrifuging unit.

k_5 = the hospital allowance required for one employee in drying and packaging unit.

K = the available hospital allowance within the production cycle.

Based on all the information provided, Savannah Sugar Company manpower requirement can be translated into the model above, thus:

$$\text{Maximise } Z = 4340x_1 + 7840x_2 + 5560x_3 + 5005x_4 + 4250x_5$$

Subject To:

$$1660x_1 + 1730x_2 + 1560x_3 + 1480x_4 + 1700x_5 \leq 5000000$$

$$23x_1 + 32x_2 + 27x_3 + 28x_4 + 22x_5 \leq 41000$$

$$19x_1 + 21x_2 + 24x_3 + 22x_4 + 23x_5 \leq 37000$$

$$31x_1 + 34x_2 + 28x_3 + 27x_4 + 30x_5 \leq 42500$$

$$x_1, x_2, x_3, x_4, x_5 \geq 0$$

Table 3: The Optimal Tableau

Decision variable	Optimum Values	
Steam Generation	x_1	480
Cane Preparation	x_2	5750
Milling	x_3	123
Centrifuging	x_4	68
Drying and Packaging	x_5	72

Table 4: Sensitivity Analysis

Variables	Current obj. Coef.	Min obj. Coef.	Max obj. Coef.	Reduced Cost
x_1	4240.00	-infinity	Infinity	276684.00
x_2	7840.00	-infinity	Infinity	2500000.00
x_3	5560.00	-infinity	Infinity	523000.00
x_4	5005.00	-infinity	Infinity	294000.00
x_5	4250.00	-infinity	Infinity	297000.00

Discussion

Profit maximization theory is based on profits and profits are a must for the survival of any business organization. Therefore, this research work focused on profit maximization through optimal manpower requirement. Table 3 depicts the optimal tableau which shows that profit has been maximized to N48,493,450 daily. The manpower requirement to facilitate the profit as discussed by Akinyele (2010) maximization for steam generation is 480, for cane preparation is 5750, for milling is 123, for centrifuging is 68, and for packaging and drying is 72. This is against the present N29,040,000, with the manpower strength of 12, 4000, 11, 28, and 13 for steam generation, cane preparation, milling, centrifuging, and drying and packaging respectively.

While Table 4 depicts the Sensitivity Analysis. Since the study will have a major impact on the company, Agbo Melletus (2015), such as maximizing profit, sensitivity analysis became

necessary. It is very clear that there is no change that will affect the optimality solution since the objective coefficient has reached positive and negative infinity related to the report of Akinyele (2007).

Summary

The unit profit generated by each employee from each production unit which was obtained from oral interview with the factory manager formed the objective function which was to maximize profit from sugar production. The resources available for payment of salaries and allowances (included hazard, transport, hospital) to each employee from each of the production unit which formed constraint equations was also obtained from an oral interview with the same factory manager. The unknown x_i , ($i=1, \dots, 5$) is the manpower requirement to maximize profit, The information provided was then modelled as a linear programming problem. The objective was profit maximization from sugar production because the company's principal production activities are processing of sugar cane to refined sugar. Other by-product(s) such as; molasses are not included in this work.

The problem was solved with TORA software for Windows version 2.00. The analysis of the results showed that the objective function yielded a daily profit of N48,493,450 with manpower requirement of 480 for steam generation, 5750 for cane preparation, 123 for milling, 68 for centrifuging, and 72 for packaging and delivery. This is against the current daily profit of N29,040,000 with manpower strength of 12 for steam generation, 4000 for cane preparation, 11 for mailing 28 for centrifuging and 13 for packaging and delivery.

Conclusion

Over the years, it has been observed that inadequate number of personnel is attributable to the shortfalls recorded in production of sugar in SSCL this in turn affected profit generation. This is because the Capacity utilisation of the SSCL has not been fully exploited by the manpower required. This study has successfully determined the manpower required in each production unit of sugar production that will maximize profit in SSCL. The determined manpower required will address the problems of unwanted expenses through over staffing or production shortfalls through under staffing thus maximize profit. The study also shows how adequate manpower resource is very critical to meeting the set goals of any business, which is profit maximization. Thus, the advantage of going beyond mere knowledge of existing decision making tools to actual practical proof of its workability. Profit maximization as function of manpower requirement task was a complex one. It was complex because it involved having the right number of people doing the right at a given time. It was conditioned by several legal work and other organizational rules. It coped with conflicting objectives, such as the minimization of the labour costs or the workforce size and the satisfaction of the employees' preferences.

Recommendation

- Instead of the management to continue to really on their background knowledge of practical experiences, this study is recommended for implementation in order to adopt scientific approach which provides an analytical methodology as a basis for decision making in profit maximization.
- The study can be extended to maximizing profit that can be derived from production of other products or by-products of sugar.

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