APPLICATION OF LINEAR PROGRAMMING IN PROFIT MAXIMIZATION (A CASE STUDY OF CRUNCHES FRIED CHICKEN AT MIAMI TOURS AND TRAVEL HOTEL IN KABALE DISTRICT)

BY

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DECLARATION

I hereby declare that this research report titled "the application of linear programming in profit maximization (a case study of crunches fried chicken at Miami Tours and Travel **Hotel** in **Kabale District)"** is entirely my own work and does not contain any unacknowledged work **from other** sources.

Sign __ ~----------   DATE:23/82/2021

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APPROVAL

This research report titled "the application of linear programming in profit maximization (a case study of crunches fried chicken at **Miami** Tours and Travel Hotel in Ka bale District)" has been submitted for examination with my approval as supervisor.

Signature~

Date: 23/02/2021 ....

MR. KATENDE RONALD

DEDICATION

I dedicate this work to my mum, Mrs. Kyarisiima Juliet my dad Mr. Byaruhanga Evan my beloved brothers and sisters.

ACKNOWLEDGEMENT

I would like to express my appreciation to all those who provided me with possibilities for successful completion of my research work. I feel greatly humbled to a number of individuals as without their assistance this work would be incomplete.

Firstly, I appreciate the almighty **God** for enabling me to successfully accomplish my studies at kabale University.

My gratitude goes to my supervisor **Mr. Katende Ronald** who was generous with his time in providing with invaluable guidance, comments and suggestions which helped me in producing this report.

Finally, I would like to extend my sincere appreciation to my parents Mr. Byaruhanga Evan and **Mrs.** Kyarisiima Juliet, my brothers and sisters for their assistance in many ways. This inspired me and I will always cherish this gesture of immense love.

I remain solely responsible for short comings and views expressed in this research report.

ABSTRACT

This project utilized the concept of simplex method algorithm; an aspect of linear programming to allocate raw materials to complete variables. The decision variables in the project work are the three different sizes of fried chicken on (tomatoes, onions and cooking oil) used in the production of fried chicken and amount of raw materials required for each variable. It was observed that big fried chicken should be produced because it contributed objectively to the profit of the hotel.

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

1.0 Introduction

This study investigated on the application of linear programming in profit maximization (a case study of crunches fried chicken at Miami Tours and Travel Hotel in Kabale District). This chapter presents the background of the study, the statement of problem, objectives of the study, research questions, significance of the study, and definition of operational terms.

1.1 Background of the study

Linear programming (LP) can be defined as a mathematical technique for determining the best allocation of a firs limited resources to achieve optimum goal. It is also a mathematical technique used in Operation Research (OR) or Management Sciences to solve specific types of problems such as allocation, transportation and assignment problems that permits a choice OT choice between alternative courses of action (Yahya, 2004). Linear programming is a term that covers a whole range of mathematical techniques that is aimed at optimizing performance in

terms of combinations of resources (Lucey, 1996).

The aim of every organization, company or firm is to make profit as that is what guarantees its continuous existence and productivity.

Samira (2013), Businesses can only grow and expand when profit is made as profit is the major reason people go into business. In the labor market, a lot have been done to ensure profit maximization in Uganda, ranging from retrenchment of workers which is an anti-people approach to ensuring strict compliance to the mathematical or economic principles of profit maximization. One of the mathematically proven ways to ensure profit maximization is the linear

programming method. Joly (2012),

Linear Programming being the most prominent OR technique, it is designed for models with linear objective and constraint functions. A LP model can be designed and solved to determine the best course of action as in a product mix subject to the available constraints. The objective function may be of maximization of profit or minimization of costs or labor hours. Moreover, the model also consists of certain structural constraints which are set of conditions that the optimal solution should justify. Examples of the structural constraints include the raw material constraints, Production time constraint, and skilled labor constraints to mention a few.

The term "linear, as stated by Akingbade (2006), implies proportionality, which means that the elements in a situation are so connected that they appear as a straight line when graphed. While the "programming" indicates the solution method which can be carried out by an iterative process in which a researcher advances from one solution to better solution until a final solution is reached which cannot be improved upon. This final solution is termed the optimal solution of the **LP problem.**

1.2 Statement of the problem

The current alarming level of organizational liquidation which has led to the increase in unemployment or under employment has been a clog in the wheel of the economic advancement of the nation, the current high level of unemployment amongst our youths has led to the increase in social vices with youths resorting to other illegal means of livelihood, all these is actually as a result of the liquidation of companies and organizations who would have gainfully employed these youths an help in the contribution to the nation's gross domestic products (GDP)

1.3. Objective of the study

1.3.1 General objective

The model develops and analyzes linear programming model for application in profit maximization.

1.3.2 Specific objectives of the study

i) To analyze an LP model using simplex method in the application of linear programming technique in ensuring maximization of profit.

ii) To assess the effect of changing the objective function and decision variables in the use of raw materials.

1.4 scope of the study.

Time scope

The research was designed to cover four months December 2020 to march 2021

1.5 Significance of the study

The findings from this study would be of immense importance to government establishments, captains of industries and employers of labor as it would help in them in profit maximization and organizational growth and expansion.

This study would equally benefit students, scholars and researchers who are interested in the linear programming research.

I: helps to understand the best way of making decisions using quantitative models in order to determine its optimal product-mixes that can maximize its profits subject to the scarce resources it has.

The study provides a deep understanding and insight of the applications of linear programming models in industries and how to apply such models in practical and real world experience.

To other researchers of similar interest who are wiIJing to undertake further investigation on the topic, this research document can be used as a secondary information source.

1.6. Definition of terms

Linear programming: a mathematical method of solving practical problems (as the allocation of resources) by means of linear functions where the variables involved are subject to constraints

Development: the act or process of growing or causing something to grow or become larger or more advanced

Profit Maximization: A process that companies undergo to determine the best output and price levels in order to maximize its return. The company usua11y adjusts influential factors such as production costs, sale prices, and output levels as a way of reaching its profit goal. Profit maximization is a good thing for a company, but can be a bad thing for consumers if the company starts to use cheaper products or decides to raise prices.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter is focused on related literature and it would be obtained from various sources such as books, journals, internet, policy papers and newspapers among others. The researcher reviews literature basing on objectives of the study as identified in chapter one.

2.2 Peculiarities of using linear programming technique at the crunches fried chicken. According to Majeke (2013) commercial farmers are always confronted with the problem of finding the combination of enterprises that will provide them with the highest amount of income through the best use of fann limited resources (constraints), he recognized the over growing **application of linear programming in agricultural sector, particularly in optimization of available** farm resources inorder to attain an optimal income (profit).

Lenka (2013) argue that global economic crisis makes the business environment unfavorable for industries to survive or manage their resources optimally. He formulated two linear programming models where one of them maximizes the revenue of a company and the other minimizes the cost of operation respectively.

According to Miller (2007), linear programming is a generalization of linear algebra use in modeling so many real life problems ranging from scheduling airline routes to shipping oil from refineries to cities for the purpose of finding inexpensive diet capable of meeting daily requirements. Miller argued that the reason for the great versatility of linear programming is due to the ease at which constraints can be incorporated into the linear programming model.

Snezanz.a and Milorad (2009) recognize linear programming as an important tool in energy management despite the non-linearity property of many energy system, they argue that the nonlinearity property can be converted into 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 minimum cost.

Fagoyinbo and Ajibode (2010) reported that the success and failure that an individual or organization experience towards business planning depends to a large extent on the ability of making appropriate decisions. They argue that amanager cannot make a decision based on his persona) experience, guesswork or intuition because the consequences of wrong decision is very costly, hence an understanding of the applicability of quantitative method to decision making is of fundamental importance to the decision maker. They described linear programming as one of the major quantitative approach to decision making and hence applied it in effective use of resources, for staff training, the decision variables for the model, are the junior staff and senior staff and the constraints, was the time available for training as the program is in service training.

According to Mula et a1 (2005) production planning problem is one of the most important application of **optimization** tools using mathematical programming (linear programming).

They argue that the idea of incorporating uncertainty in mathematical models is very important in order not to generate inferior planning decisions.

Stephanos and Dimitros (2010), see linear programming as a great revolutionary development which has given mankind the ability to state general goals and lay out path of detailed decision to take in order to achieve its best goals when faced with practical problem of great complexity.

VeliUlucan (2010) reported that a mixed integer linear programming plays an important role in aggregate production planning which addresses the problem of deciding how many employees the firm should retain and for manufacturing company, the quantity and mix of products to be produced

Ezema and Amaken (2012) argue that the problem of industries all over the world is as a result of shortage of production inputs which result in low capacity utilization and consequently low output.

Balogun et al (2012) 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 manpower, raw materials, capital etc. In their work titled "use of linear programming for optimal production"

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

Crunches fried chicken WA chosen for this study for two main reasons. First, it uses the trialand-error method in arriving at major management decisions even when the research department feels that a linear programming approach would have given a better result

Secondly, Crunches fried chicken produces 8 different products which make the determination of the quantity combinations of the products produced an important and major management decision.

The researcher investigated the overall quantity combination of the 8 products produced by Crunches fried chicken, at Miami Tours and Travel hotel during the research period and the allocation of resources to the various products. This made possible by the records kept by the Production Line Manager and the Sales Department relating to the different brands of products produced by the firm, the technical coefficients, the raw materials available and their relative prices.

The researcher used personal interview with a representative of the management. The researcher then applied linear programming to determine a new quantity combination. The total contribution to profit of each of the products for the months using the new quantity compared with the total profit contribution made by the product mix determined by the trial and error method.

3.1 Model development

The general linear programming model with n decision variables and m constraints can be **stated in the following form**

Optimize **(Max or Min) Z=C,X,+CX;+… +CX**

Such **that**

anX++anX;+... +ax (,=,>)bi

12X1+a222+.... +a2nx (≤,=,>) 12

$a_{m1}x_1+a_{m2}x_2+\dots+a_{mn}xn\ (\leq,=,\geq)\ b_m$

The above model can be expressed in a compact form as follows
Optimize (Max or Min) Z='f,j=1 $cjxi$. (Objective function)

Subject to the linear constraints

Ij=1 $aijxi$ (≤, =,~)bi, I=I, 2 ... m and Xi~ $0,j$ = 1,2... n where C11 C21 .... Cn represent the per unit profit (or cost) of decision variables X, X..., Xn to the values of objective function. And an.au.au .... ,a1n represent the amount of resources consumed per unit of the decision variables. The bi represents the total availability of the i"" resource. Z represents the measure of performance which can be either profits or cost or reverence.

Standard form of linear programming model

The use of the simplex method *is* to solve the linear programming problem requires that the problem to be converted into its standard form. The standard fo.rm of a linear programming problem has the following properties

i) All the constraints should be expressed as acquisitions by adding slack or surplus variables

a. Constraints of type (<): for each constraint i of this type, we add slunk variables e; such that e, is non negative.

Example

3x + 2x2 translates into 3x+ 2x+er=2, en>0

b. Constraints of type k): for each constraint I of this type, we add a surplus variable e; such that e; is non negative.

Example

3x1+ 2x2 2 2 translates into 3x1+ 2x2 - e2 = 2, e,≥ 0

The right hand side of constraint should be made of non-negative (if not). This is done by multiplying both sides of the resulting constraints by negative 1

ii) The objective function should be of the maximization type for any decision variables and M constraints, a standard form of a linear programing model can be formulated as follows

Optimize (Max) Z= CiXn+C;X+... +CX+0Si +0S;+... +0S,
Subject to the linear constraints
V
anXr+anX+...+anX, +0Si=bl
a12Xi+a2x2+... +a2,X
+OS;=b

a1a2x2...+ax+OS=b x,, X:...,
X, Si, S2, ... Sn≥o

This can be stated in a more compact form as

Optimize (Ma) Z= 2}_,cjxi+" OSi Subject

to the linear constraints

2}_, ***aijXjsi*** =bi, i=1, 2.., m and XjSi≥0 (for all i and j)

Basic and non-basic variables

Consider a system of equations with n variables and m equations where nm. A basic solution for this system is obtained in the following way:

a. Set n- m variables= 0. These variables are called non basic variables (N.B.V)
b. Solve the system for the m remaining variables. These are called basic variables (B.V).
c. The vector of variables obtained is called the basic solution (it contains both basic and basic variables).

It is crucial to have the same number of variables as equation.

3.2 Method of data analysis

Collected data was presented in a narrative form and analyzed using linear programming model. Since the purpose of this study was to develop linear programming model for the collected data from the company, the authors tried to transform the data into a linear programming model and solved the model (problem) using simplex algorithm using by applying *MS-Excel solver* in order to determine the optimal combination of the products of the company that can maximize its profit within the available scarce resources. Simplex algorithm was preferred over graphical approach because of this method can help to solve linear programming problems of any number of decision variables.

CHAPTER FOUR

RESULTS

4.0. Application

For analysis proper, the Simplex method proposed by George, (1947) as published in Dantzig (1963) was adopted to solve the above LP problem. The Simplex method has been found to be more efficient and convenient for computer software implementation in many instances (Y ahya, **2004**). **The data consists of total amount of raw materials (cooking oil, tomatoes and onions)** available for the production of their different types of fried chicken (small, medium and big). The content of each raw material per each unit size of fried chicken is as blow.

Cooking oil.

Total amount of cooking oil available 30L

Each size of small fried chicken requires 0.031itres Each

size of medium fried chicken requires 0.03 liters Each size

of big fried chicken requires 0.02 liters **Tomatoes**

Total amount of tomatoes available 100 kgs

Each size of small fried chicken requires 0.5 kgs Each

size of medium fried chicken requires 0.5 kgs Each size

of big fried chicken requires 0.5 kgs Onions

Total amount of onions available 50 kgs

Each unit of small fried chicken requires 0.01kgs Each

unit of medium fried chicken requires 0.02kgs Each unit

of big fried chicken requires 0.02kgs

4.1. Profit contribution per each unit size of fried chicken produced.

Each unit size of small fried chicken shs 1000

Each unit size of medium fried chicken shs 2000

Each unit size of big fried chicken shs 3000

The above values are tabulated as below

Raw materials	Product			Total available raw materials
	Small	Medium	Big	
Cooking oil(l)	0.03	0.03	0.02	30
Tomatoes (kgs)	0.5	0.5	0.5	100
Onions (kgs)	0.01	0.02	0.02	*50*
Profit(shs)	1000	2000	3000	

4.2. **Model** formulation

Let the quantity size of small fried chicken be xi

Let the quantity size of medium fried chicken be x; Let

the quantity size of big fried chicken be x3

Let z denote the profit to be maximized.

The linear programming moda1 for the above production data can be given by;

Max. Z= 1000X7+ 2000X3 + 3000X3

s.t0.03X1+0.03 X3 + 0.02X3< 30

0.5X, +0.5X3 +0.5Xx3< 100

0.01X +0.02X + 0.02x3< *50*

$X_1, X_2, X_3 \geq 0$

In order to represent the above LP model in canonical form, four slack variables e; (*i* =1,2,3,4) were introduced into the model. This changed the inequalities signs in the constraint aspect of the model to equality signs. A slack variable will account for the unused quantity of raw material (if any) it represents at end of the production.

As a result, the above LP model becomes that of
Max.Z=lO00X1+2000X2 + 3000X3 + 0Xi + *OXs* + 0X6

Subject to

0.03 + 0.03X3 + 0.02X3 + X,= 30

0.5X, + 0.5X+ 0.5X + Xs= 100

$0.01X_1+0.02X_2+0.02X_3+X_6=50$; $X_1, X_2, X_3, X_4, X_5, X_6 \geq 0$.

Solving the model using simplex method

	1000	2000	3000	0	0	0			
Cb, XX,	X	X	X,	X	Xs	X,	X		
O X	0.03	0.03	0.02	1	0	0	30		
0 Xs	0.5	0.5	05PIVOT	0	1	0	100		
0 Xo	0.01	0.02	0.02	0	0	1	50		
Zr-c,	-1000	-2000	-3000	0	0	0	0		
0 Xx,	0.02	0.01	0	l	0	-1	-20	R,=R-R3	
3000 X3	1	1	1	0	2	0	200	R.=2R	
0 X,	-0.02	-0.01	0	-1	0	1	20	R3=Ra	
Z-C ,	2000	1000	0	0	6000	0	600,000		

The optimal solutions are ~1=0, X*2=0, X:1*=200, X4*=-20, Xs*=O,)4*=20 and the optimal value is 600,000.

4.3. Changing the objective function.

The standard linear programming model then becomes;

Max. Z=100x+ 200X3+300X+0X+0XS +0Xe

	100	200	300	0	0	0		
CB, *X*	X	X	X	Xi	*Xs*	X,	X	
0 X,	0.03	0.03	0.02	1	0	0	30	
0 *Xx,*	0.5	0.5	), 5Pivot	0	1	0	100	
0 X;	0.01	0.02	0.02	0	0	]	50	
Z-C,	-100	-200	-300	0	0	0	0	
0 X,	0.02	0.01	0	1	0	-1	-20	RH=RI-R
300 X,	I	1	1	0	2	0	200	R.=2R
0 X	-0.02	-0.01	0	-1	0	1	20	R,=RA-R,
Z+-Cl	200	100	0	0	600	0	60,000	

The optimal solutions are Xi*=O, X2*=0, X3*=200, X4*=-20, *Xs*=0,* X6*=20 and the optimal value is 60,000.

4.4Changing the decision variables. The

new standardized LP model become;

Max *Z* = 1000 X1 + 2000X2 + 3000X1 + OX.+ *OXs* +0X,

Subject to;

0.02X7+ 0.02X + 0.01X+ X,= 30

0.4X1+ 0.4Xi+o.4XJ + Xs = 100

0.02X1 + O.OlX2 + O.OlX1 +X, =50

By using the simplex method, you can solve the model

	1000	2000	3000	0	0	0		
CB, XJ	X	X	X	X,	Xs	X	X	
0 X,	0.02	0.02	0.01	I	0	0	30	
0 *X*,	**0.4**	**0.4**	9_4Pivot	**0**	**1**	0	**100**	
0 X	0.02	0.01	0.01	0	0	l	50	
Zr-C,	-1000	-2000	-3000	0	0	0	0	
0 X	0	0.01	0	I	0	-1	-20	RH=RI-Ra
3000 X,	]	]	]	**0**	2.5	0	250	R.=2.5R.
0 X	0	-0.01	0	-1	0	1	20	Ra=Ra-R,
Zr-C	2000	1000	0	0	7500	0	750,000	

Therefore, changing the objective function has no effect on the optimal solutions but affects the optimal value while changing the decision valuable affects both the optimal solution and the optimal value.

CHAPTER FIVE

DISCUSSIONS, CONCLUSION AND RECOMMENDATION

The appropriateness of the linear programming methods for optimal resource allocation in industry has been demonstrated in this work. This is evident from the results obtained from the profit maximization type of the LP model fitted to the data collected on application of Linear Programming in Profit Maximization at Miami Tours and Travel Hotel in Kabale DistrictUganda From the results of the LP model in chapter 3 as reported in chapter 4, Unit size of big fried chicken **products and** its production quantity should be 6000. This will produce a maximum profit of 600,000.

Based on the research carried out, Miami Tours and Travel hotel should produce three unit sizes of fried chicken (small, medium, big) in order to satisfy her customers. Also the big fried chicken should be produced in order to attain the maximum profit because it contributes mostly to the profit earned.

RECOMMENDATION

Based on the findings and the conclusions of the study, the researcher suggests the following recommendations:

Company has annual production and sales records but the company was not employing any mathematical or statistical models for its production or sales forecast rather it depends on a simple trial and error. The company should employ linear regression, linear trend and/or nonlinear regression and trend models to forecast its production capacity and sales.

Therefore, company should work on improving the qualities of its products to meet customer expectations and to search for other customer groups who can use the products beyond the current target markets.

It is clear that model based decision is important for its accuracy and objectivity. But such decision making approach was not widely used in practice. Qualitative decisions like subjective estimation, intuition and trial and error were commonly used by company. It is eye opening concern to the policy makers of company to shift the model based decision making styles in general.

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