OPTIMAL CASH FLOW MANAGEMENT OF INTERNALLY GENERATED FUNDS.

CASE: KOMFO ANOKYE TEACHING HOSPITAL

BY

HANNAH BOAKYEWAA

THESIS SUBMITTED TO THE DEPARTMENT OF MATHEMATICS KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE IN INDUSTRIAL MATHEMATICS

DEPARTMENT OF MATHEMATICS

FACULTY OF PHYSICAL SCIENCE

COLLEGE OF SCIENCE

NOVEMBER 2012

DECLARATION

This thesis is a true account of the candidate's own research work expect for references to other people's work which have been fully acknowledged.

HANNAH BOAKYEWAA 20/12/12

PG4064210........ Signature Date

Certified by

Dr. F.T Oduro 20/12/12

Supervisor Signature Date

Prof. I .K Dotwi ....

Dean of IDL Signature Date

Certified by

Mr. Darkwah ....

Head of Department Signature Date

DEDICATION

I dedicate this thesis with all my love to my dear one, Daniel kyei and my father Mr George Adarkwa for their tremendous support. God bless you all.

ACKNOWLEGEMENT

I thank God for his divine protection, direction and help throughout the course of my education. Also, I wish to express my profound thanks to Dr F.T Oduro, my supervisor,for the excellent guidance, for making valuable suggestions for the improvement of the work, for his constant interest, constructive criticism and support he provided during the planning and carrying out of this project.

My sincere thanks also go the entire staff of the mathematics department, K.N.U.S.T, for their kind advice and encouragement.

I am also grateful to MrAgyemangPrempeh (KATH IGF) office for kindly available to me all the necessary data needed for my project.

I am also greatful to Mr Parker Lamptey who help me to run the model with Microsoft Excel.

ABSTRACT

This paper investigates optimal cash flow management of internally generated funds. In this study, I demonstrate that efficient management of internally generated funds will lead to optimization of cash flow. To test this prediction, I use the financial data collected from the Internally Generated Funds Office of the KomfoAnokye Teaching Hospital in Kumasi, Ghana, and run the data on Microsoft Excel, using a Linear Programming model. My findings indicate that sound fiscal policy and implementation result in financial success and self-sufficiency.

TABLE OF CONTENT

Content **Page**

LIST OF FIGURES OF TABLES

CHAPTER ONE

INTRODUCTION

1.1 Background

The strength of every nation depends on the good health of its citizens. Thus, over the years countries with diverse economic and political ideologies have all sought to provide quality and affordable health care to their respective people. Ghana as a country is no exception. Since the birth of the nation, various past governments from different political divide have never ceased striving to offer health care to its people to protect them against preventable diseases, such as malaria, cholera and waterborne diseases that take the lives of many Ghanaians prematurely. However, it has not been an easy task for any government in its efforts at meeting the health needs of the Ghanaian people.

Vast majority of Ghanaians who are rural dwellers still have little or no access to health care. Thus, in times of sickness, they resort to self-medication with its attendant health implications. The story is no different for Ghanaians living in urban centres and cities across the country. The few medical centres situated in our big city centres and towns are not just choked and over-burdened but are also saddled with financial difficulties which inhibit them from responding to the health needs of people residing in their catchment areas. Recently the financial constraint has become so alarming that it sometimes threatens the shut-down of some health facilities and thus raising the question whether the health facilities cannot be self-sustaining.

It is in the light of this that the KomfoAnokye Teaching Hospital (KATH), a major and strategically located health facility in the country situated in Kumasi in the Ashanti region has been taken as a case study to determine the optimal management of funds.

1.1.1 *Profile of KATH*

The KomfoAnokye Teaching Hospital (KATH) is situated in the city of Kumasi, a vibrant and a culturally rich city and the central capital of the Ashanti region of Ghana. In the 1940s a hospital was located on the hill over-looking Bantama Township known as the African and European Hospitals. Africans received medical services in the African hospital whiles the European Hospital served the medical needs of the officials. However, by 1952 the increasing population in Kumasi, and for that matter the Ashanti region, had necessitated the building of a new hospital. To pave the way for the construction of a new hospital, the European Hospital was moved to Kwadaso Military Quarters. The construction of a new hospital complex was, therefore, commenced and completed in 1954/55 and named Kumasi Central Hospital.

The hospital was subsequently renamed KomfoAnokye Teaching Hospital, after a powerful and legendary fetish priest of the Ashanti called KomfoAnokye, to honour and commemorate him. KATH is the only tertiary health institution in the Ashanti region. The commercial nature of Kumasi and the road network of the country make the hospital accessible to all areas that share boundaries with the Ashanti region and others that are further away. In 1975 KATH was converted into a teaching hospital and affiliated to the School of Medical Sciences of the University of Science and Technology, now Kwame Nkrumah University of Science and Technology to train medical students.

Under the mandate of the Health Services and Teaching Hospitals Act 525, 1996, that established autonomous Teaching Hospital Boards, KATH assumed its autonomy. The hospital is governed by a Board that consists of four Non-Executive members, who are government appointees, six Executive members and the Dean of the School of Medical Sciences. Though autonomous, KATH operates within the policy framework of the Ministry of Health Board. The Chief Executive Officer is responsible for the hospital's day-to-day management. KATH has an accreditation for post graduate training in survey, obstetrics and gynecology, otorhinolaryngology, ophthalmology and radiology from West African College of Surgeons.

From its 500 beds when it was first constructed, KATH currently has 1500 beds and is reputed as the second largest hospital in Ghana. The hospital serves as the referral hospital for the Ashanti, BrongAhafo, Northern, Upper East and Upper West regions. It offers primary care at the Polyclinic and a host of Specialist Medical and Surgical Services.

1.1.2 *Financial Difficulties of KATH*

Notwithstanding the strategic importance of KATH to the country, over the years, it has being grappling with serious financial difficulty. This is owing to the fact that the hospital depends on internally-generated funds for its day-to-day operations. The introduction of the National Health Insurance Scheme (NHIS) in 2007 seems to have worsened the financial situation of the hospital.

AgyemangPrempeh of the KATH's Internally Generated Funds (IGF) Office (personal communication, August 17, 2012) said the hospital generates its income from fees charged from patients that include accommodation, feeding and theatre fees. It also receives funds from pharmaceutical companies to test new drugs and product. According to him, although the hospital also generates funds from non-medical services, such as cafeteria sales, parking garage fees, research grants, and space or equipment rentals, such contributions are insignificant to the overall financial status of the hospital. Therefore, KATH's major source of revenue remains fees charged from patients, which the National Health Insurance Authority (NHIA) pays, except patients who have not registered for the NHIS.

He further stated that under the NHIS, insured patients attended the hospital without making direct payment to the hospital. It was the NHIA which paid the bills on behalf of the patients. The situation was compounded by delays in the release of subsidies from the government and re-imbursements by the NHIA and the rejection of claims from the hospital by the NHIA.

KATH's financial crisis has become so alarming that recently it has gained prominence in public discourse in the country, especially in Kumasi and the Ashanti region, and has attracted the attention of the media. The *Chronicle* in an article ("Cash and Carry" resurfaces in Ashanti", April 23, 2012), carried a story about the NHIA's inadequate Capitation. In the story the Chief Executive of Officer of County Hospital at Abrepo was reported to have said that the Ashanti region was suffering under the Capitation Programme. He noted that the Ghana-Diagnostic Related Groupings (G-DRG) offered GHC 8.56 under the Capitation Grant which was low, as compared to GH C 11.66given to their colleagues in other regions.

Furthermore, the NHIA's tariffs had been adjusted only once since the inception of the Capitation Programme. KATH's financial situation is corroborated by Kofi AkoheneMensah, Administrative Officer of the Aninwa Medical Centre at Emena, near Kumasi, in a statement in which he decried the G-DRG of the Ashanti region. According to him the initial GHC 85.56 G-DRG and the revised per capital rate of GH C 1.43 were insufficient for any medical institution to indulge in the capitation pilot project.

Meanwhile the hospital has to deal with the daily high cost replacing and maintaining ageing equipment and consumables. For instance, last year the management of KATH purchased three stand-by generators, two dryers-machines for oxygen supply and two dialysis machines at the cost of 656 thousand Ghana Cedi. They also spent an unspecified amount of money on general repair of equipment. Accordingly, the hospital was compelled to resort to the abolished "Cash and Carry" system due to the ineffective implementation of the Capitation Programme. The situation at the hospital was so disturbing, in that many patients who were unable to afford the "Cash and Carry" system resorted to self-medication.

According to the *Chronicle*, hospital attendance to KATH had plummeted since the inception of the Capitation Programme. Investigations conducted by the Ashanti Development Union (ADU) demonstrated that the public has lost confidence in the NHIS and capitation. According to ADU hospital attendance in the Ashanti region has greatly plummeted to 50% and resulted in a significant fall in registration for the NHIS by 40%.

Records at KATH showed an attendance of 117,990 and 238,884 at the Out Patients Department at the Polyclinic and specialised clinics respectively in 2011, as compared to 145, 437 and 298, 298in the same period in 2010. Admissions also plummeted slightly from 43,282 in 2011, against 45,000 in 2010, with surgeries declining from 28,000 in 2010, to about 24,000 in 2011.

In another article published by the *Ghana News Agency (GNA)* ("KomfoAnokye Hospital demands upward review of insurance tariffs", August 14, 2012) the CEO of the health institution, Professor OheneAdjei, throws more light on the hospital's difficult financial situation. According to the article the Management of KATH had demanded that an upward adjustment be made to the tariffs the NHIA paid to the hospital. The CEO said an upward adjustment was necessary to salvage the hospital from its current operational challenges and increasing debts. According to him the low tariffs the hospital was paid for providing services to its insured patients had become a major problem that was affecting its functioning.

He revealed that about 85% of the hospital's attendees were insured patients and that the hospital's inability to get back the cost incurred in their treatment was a cause for worry. He said in spite of the huge rise increase in the cost of medical consumables and the medicines, the health insurance tariffs remained static. For instance, while it currently costs the hospital GH C 492.33 to treat "bone marrow hypoplasia" in children younger than 12 years, the hospital receives reimbursement of GH C 237.60 from the NHIA.

Again, the hospital received GH C 269.30 for gynecological laparotomy, though it cost GH C 423.24 to provide the service. In the case of laparotomy for gastric surgery the facility was paid GH C 343.70 instead of GH C 1, 372.75, while they received GH C 242.00 instead of GH C 1, 014.96 for treating neonatal respiratory disorders with ventilation treatment. In effect, the first half of the year had been challenging, in that most of the services targets were not met. The only exception was the radiotherapy that saw significant increase from 3,050 to 3, 785.

The tariffs were fixed in 2008 and slightly adjusted by 20 percent last year. However, the huge disparity between the current cost of medical consumables and equipment as opposed to the rate of re-imbursements from health insurance was worrisome. He also highlighted concerns in the sharp jump in the hospital's maintenance cost. In 2009 KATH's maintenance cost stood at GH C

476, 158.00. However, in 2010 it shot up to GH C 1, 103, 091.00 and even got worse last year as it jumped up to GH C 2,212, 162.16.

The maintenance cost is anticipated to rise this year and yet the hospital would have to finance such huge expenditures with funds derived from the internally generated funds. The CEO therefore encouraged all the directorates and units at the facility to identify new services that the NHIS did not cover and provide those services and charge patients who would need such services. In his opinion, the move would aid generate additional income to fund some of the hospital's pressing needs.

KATH therefore asked patients to pay GH C 10 for a single visit whiles out-patients were asked to pay GH C 2. As evident in an article of the *Daily Graphic* ("KomfoAnokye Hospital Withdraws development", Jul 9, 2012), the new levy which was implemented at the start of July, 2012, elicited reprehension from the public and some hospital staff that the new charges would cause an extra financial burden on patients, though Kwame Frimpong, KATH's Public Relations Officer, claimed that patients would be the ultimate beneficiaries of the services in the hospital, in that monies accruing from the levy were supposed to be used to undertake minor repairs and motivate the hospital's staff.

Although the Management of KATH has been compelled to withdraw the payment of the special levy dubbed "development levy", the financial crisis, which is threatening to shut down the hospital, still persists and is still a cause for worry for the management, who have to confront daily the fiscal crisis that invariably affects working conditions in the hospital.

The deplorable state compelled junior doctors and surgeons to embark on strike until they had seen the condition of the hospital improved. The doctors were complaining of the current condition of the hospital, particularly the accident emergency unit, power shortages, and lack of medicines. In echoing the seriousness of KATH's deplorable condition, Dr. Osei Tutu, the president of the Junior Doctors Association, said that there was no other hospital in Kumasi besides KATH, and thus its collapse would mean the collapse of the health system in the Ashanti region and the entire northern sector which the hospital serves. He stated that the doctors could not watch on helplessly while patients in the hospital died.

Obviously the condition can be fairly attributed to its financial insufficiency. In a *Spyghana* article ("KomfoAnokye Hospital on innovative drive", February 24, 2012), Professor OheneAdjei is on record to have said that the hospital derived about 85% of its funds from the NHIS and had suffered a drastic reduction in its revenue. In effect, the hospital was unable to settle its debts to suppliers of consumables to enable it render uninterrupted services to the public. Clearly, this was the circumstances that influenced the management's decision to reintroduce the Cash and Carry System, which was abolished in 2007, and replaced by the NHIS.

It was against this background that the management of KATH solicited for government intervention to prevent the hospital from a shut-down. In an article published by the *Spyghana*("KomfoAnokye request for immediate bail-out", March 1, 2012) it was reported that the financial situation of KATH was so precarious that the hospital's board had appealed to the Ministry of Health to come to its aid. The government was therefore to make available about GH C 1 million to savage KATH from total collapse and to enable it procure essential drugs and consumables for it to continue functioning.

The hospital's income and expenditure of the 2010/2011 fiscal year, which will be shown in this presentation is an ample demonstration that, if not well managed, can lead to serious financial crises which will affect its smooth running and eventual shut-down, the results of which will be disastrous, not only for the residents of the region but for the entire country.

Given KATH's indispensable role as a major public health provider and the only referral hospital serving the Northern sector of the country, it is crucial that a pragmatic solution is found to the hospital's problem of insufficient funds. Even if the government has agreed to bailout the hospital to ensure that enough infrastructure and equipment are provided for the delivery of health care in the region, the health institution needs a long term solution to its financial problem. Though the Management of KATH has attempted some solutions, such as the attempt to reintroduction the "Cash and Carry" system, the hospital is yet to overcome its fiscal challenges.

1.2 Problem Statement

Lack of adequate funds in KATH is creating a serious financial crisis and deplorable working condition which result in loss of lives in the country, particularly in Ashanti region.

Since KATH derives 85% of its revenue from its internally generated funds, which comes from the NHIA, it is quite understandable that KATH has a difficult task in funding its operations. Nonetheless, the hospital must live up to its mandate as a public health provider. How KATH is going to manage its internally generated funds and still to operate efficiently is as cause of concern for all.

KATH's problem is compounded as claims from the NHIA are low and there are delays in the release of funds. Moreover, the NHIA re-imbursement has only once been reviewed since the inception of the Capitation in 2008. The management of the hospital therefore proposed the hospital charged patients for services not covered under the HNIS. The levy which management said would help improve services for the overall benefit of the patient generated sharp public criticism and management was compelled to withdraw it.

Questions exist with respect to how the health institution is going to survive and effectively function, given their serious financial situation. Today we have some people who prefer to self-medicate to going to a hospital which from their perspective does not really provide them the needed medication. KATH is in a deplorable state. If we ignore the problem the hospital will totally collapse and the situation will lead to loss of jobs and lives, which will impact the country's human resource capacity and affects the livelihood of many people and their families and/or dependents.

If we do not solve the hospitals problem now, we as a country will eventually have to increase resources to handle the escalated problem. Consequently, we will lose scarce resources which could have been channeled into other sectors of the economy or the provision of other social amenities. In this project, I will use Linear Program in managing internally generated funds to optimize cash flow. In my study I try to analyse the fiscal situation of the hospital by employing a mathematical model known as Linear Programming in trying to find out whether they can effectively manage their limited income and still function effectively as public health care providers serving the people of Kumasi and the Ashanti region, and the entire Northern sector of the country.

1.3 Objectives of the Study

The specific objectives of the study are as follows:

1. To formulate an optimal cash flow model as an LP production scheduling problem.
2. To solve the model using data from KATH as parameter values.
3. To interpret the model in view of cash flow management issues in the hospital.

1.3 Methodology

To solve the cash flow management problem, an LP model based on the production scheduling type problem is employed. Furthermore, the model is implemented using Excel Solver to run simplex algorithm. The data has been collected from KATH's Internally Generated Funds (IGF) Office. Other sources of information for the study are obtained from the internet.

1.5 Purpose of the Study

The purpose of the study is to examine whether funds generated at KATH can be sufficient for running of the hospital, if managed efficiently.

1.6 Significance of the Study

The results of the study will benefit hospital funds administration, especially in a situation where NHIS tariff form a very large component. Also, it will be applicable to hospitals and other public sectors. The results will serve as a source of reference for future researchers into optimal cash flow management of internally generated funds of the other major hospitals in the country and other health facilities.

1.7 Organization of the Thesis

This thesis consists of five chapters. The first chapter deals with the background of cash inflow at the hospital, the problem statement, methodology, objective, purposes and importance of the study and the profile of KATH. The second chapter focuses on literature review of the study. The third chapter gives a detailed presentation of the methodology used in the study. In the fourth chapter, the model formulation, solutions and findings are presented. The fifth chapter gives a discussion of the first four chapters and offer recommendations. This is followed by a conclusion.

CHAPTER TWO

LITERATURE REVIEW

1.0 Introduction

This chapter will focus on studies carried out by researchers on cash management problems in firms, industry, construction and market places. Cash is the most important current asset for a business operation. It is the energy that drives business activities and also the ultimate output expected by the owners. The firm should keep sufficient cash at all times. Cash management aims at managing cash flow into and out of the firm. Cash management helps to accomplish at a minimum cost the various tasks of cash collection, payment of out standings and arranging for the deficit funding or surplus investment.

Davidson (1992) defines cash management as a term which refers to the collection concentration and disbursement of cash. It encompasses a company's level of liquidity, management of cash balance and short term strategies. Pindado, (2004) also defines cash management as part of working capital that makes up the optimal level needed by a company.

Several researchers have proposed solutions to the cash management problems.

Barbosa and Pimentel (2011) adopted linear programming model to develop optimal cash flow management to solve specific cash flow issues associated with the construction industry. They included typical financial transactions, possible delays on payments, use of available credit lines, impacts of changing interest rate and budget constraints which often happened in the construction industry.

They proposed alternative formulations to deal with uncertainties, longer planning horizons, and multiplied subcontractors and suppliers. The simple structure of the model, as a network flow and corresponding equations, offered profound visual insight with respect to the relationship between the external inputs and the problem's variables.

Suzuki and Sato (2011) studied the impacts of a sharp cash level fluctuation that results from inflow and outflow of a large amount of cash and the way the cash balance is managed. They described the cash level evolution as a stochastic jump-diffusion process that had a double exponential distributed jump size. They then developed a cash management model for decreasing the sum of transactions and holding-penalty costs. Their model could be constructed as an impulse control model and they derived the cost function assuming that a band-type policy existed.

The following is the band policy: when the cash level falls to d (rise to u), then it is adjusted up to level D (down to U), d < D < u. To clarify the impacts of the exogenous risk on optimal policy, they presented some numerical examples in limited policy with only two threshold d and D. The conclusions of their investigation indicated that the size of the demand for exogenous risk has strong implications for optimal policy.

Kaplan and Zingales(1997) researched into the relationship between investment cash flow sensitivities and financing constraints by undertaking an in-depth analysis of a sample of firms showing an unusual high sensitivity of investment to cash flow. Kaplan and Zingales' investigation interpreted greater investment-cash flow sensitivity forms that were regarded more probably to encounter huge wedge between the internal and external cost of funds as evidence that the firms were in need constrained. Their results demonstrated that firms that seemed less financially constrained showed substantial greater sensitivities than the firms that seemed more financially constrained.

Pacheco, Vellasco, Norontta and Lopes (1998) in an article describe the intelligent systems for financial and cash flow optimization called intelligent cash flow (ICF). ICF is a computational tool thatfordecision support that offers short-term and long term financial strategies with regard to the financial product of the market. The ICF system uses Generic Algorithms to elaborate cash projections that fosters the profit of the company for a specific period. The ICF assists in dealing with the complex parts of cash flow planning by mix of investments that provide a higher profit rates over a period. Their findings indicate that the availability of operational balance and planning strategies strongly affects profitability.

Bea Min and Jin Shin (1998) researched into the relationship between internally generated cash flow and firm investment in the restaurant industry. They concentrated on the difference on investment cash flow sensitivity between franchise and non-franchise restaurant companies. The Tobin Q investment theory forecasts that a firm's optimal investment amount is the function of only its Q value. Their empirical findings demonstrate that in the U.S restaurant companies, a company's investment decision is affected by internal cash flow beyond and more than by Tobin's Q. Moreover, the investment cash flow sensitivity is greater for non-franchise restaurant than for franchise ones.

Povel and Raith (2002) analysed the influence of financial constraints on the investment of a firm. They demonstrated the necessity to differentiate between dimensions of being constrained: the extent of capital market imperfections (such as asymmetrical information) and lack of internal funds. It is important to differentiate between these two dimensions in that they influence the marginal cost of investment and investment itself in diverse ways. Povel and Raith identified that the relationship between the internal and external cost was U-shaped. Their model's major assumption was that internal funds could be negative and that a firm might not be able to contribute to the investment of its own funds. The results of their investigation revealed that sample selection might strongly influence their empirical findings, on the assumption that there was a sufficient relationship between cash flow and the level of internal funds.

Connor and Leland (1995) made analysis of the cash management as a stochastic control problem. They did not consider the future. Although the use of futures in hedging had demerits of possible huge tracking error and extra trading cost because of rollovers, it had merits. For example, low trading cost. Yasuo Yamashita, grounded on Connor and Leland's work (1995), designed two models, namely Spot model (without futures), and Sport and future models (with future) respectively as discrete Markov chain. He made a calculation of the expected tracking error under varied cash management policies of threshold type.

From the comparison of the calculation it was evident that there was no substantial difference between the expected tracking errors. However, spot and future model performed well for all threshold values whiles spot model performance could significantly degrade depending on the levels of the threshold.

Ford (1991) described a method of choosing a suitable mix of the initial assets of a fund so that at specified future dates there would be a high probability that there would be enough cash at hand to meet the outgo at those dates. Ford's method generated net accumulated cash flows in a huge number of stochastic scenarios. He utilized those cash flows to choose optimum distributions of the initial assets to make sure that there was solvency at every test point in all but a small percentage of the scenarios.

According to **Scharfstein and Stein** (1993) the firm invest I in the production technology with gross (output) F (I) which is increasing and concave i.e $F_I > 0$ $F_{II} < 0$.The firm had internally generated cash W. If W was inadequate to in all available positive NPV project, the firm had to raise external financing E = I – W. Because of capital market imperfection, external funding E had an additional cost C(E,K) over the cost of internal funds (assume to be zero), where k measured the degree of financing constraints that the firm encountered. C was increasing and convex in E, and increasing in k, i.e., $C_E > 0$, $C_{EE} > 0$ and $C_k > 0$.

Ferstl and Weissensteiner (2007) investigated cash management problem whereby a company with given financial endowment and future cash flows lowers the Conditional Value at Risk of final wealth using a lower bound for the anticipated terminal wealth. They designed the optimization problem as a multi-stage stochastic linear program (SLP). The goal was to find an optimal asset allocation decision which explained future uncertainty within a planning horizon and reduced the coherent risk measure, i.e. the Conditional Value at Risk (CVaR) associated with final wealth. Consequently, they got optimal first and second stage decisions for the asset allocation and a trade-off between risk and levels of target wealth.

San Jose, Hurralde, and Maseda(2008) did an analysis of the treasury management responsibilities that financial departments assumed and developed to confirm those responsibilities. They used factor analysis to formulate a model which explained cash management. They used exploratory factor analysis to define construct, using inductive approach, and to deduce theoretical models. Next, they used confirmatory factor analysis to demonstrate the validity of the construct that resulted from those deductions.

They randomly sub-divided the sample into two to validate the model and to make it more robust. They then applied exploratory factor analysis to one of the subsamples and confirmatory analysis to the other. Furthermore, they used structural equation in their investigation. The result of the investigation revealed that cash management was part of companies' strategies, and by and large depended on managers themselves rather than the characteristics of companies.

Almeida, Campella, and Weisbach (2002) proposed a theory on corporate liquidity management. According to the theory, though firms had access to valuable investment opportunities, they however could potentially not be funded with external funds. They could rather obtain internally generated funds to finance those investments. Firms with no financial constraints could embark on all positive NPV projects without any consideration to their cash positions. Thus, their financial status was irrelevant.

However, financially constrained firms had an optimal cash position that was determined by today's investment which was relative to expected future value of future investment. Taking into account hedging, dividend and borrowing policies, the model predicted that constrained firms would save in the form of liquid assets a positive fraction of incremental cash flow. However, unconstrained firm would not.

Barbosa and Pimentel (2011) adopted linear programming model to develop optimal cash flow management to solve specific cash flow issues associated with the construction industry. They included typical financial transactions, possible delays on payments, use of available credit lines, impacts of changing interest rate and budget constraints which often happened in the construction industry. They proposed alternative formulations to deal with uncertainties, longer planning horizons, and multiple subcontractors and suppliers. The simple structure of the model, as a network flow and corresponding equations, offered profound visual insight with respect to the relationship between the external inputs and the variables of the problem.

According to Ogden and Sundaram (1998), cash management today efficiently speeds up collections and eventually sweep excess balances into money market account. They formulated a model for optimal utilization of a firm's line of credit. Ogden and Sundaram applied Beranek model, Baumol model and Miller-Orr model to find an optimal cash-short term investment mix.

From Beranek's perspective companies have short-term assets just because they encounter uncertainties that are associated with their operations. For instance, a firm could incur substantial cost if, the labour of a vendor supplying critical part suddenly go on strike. The Baumol model assumes that cash manager investments excess funds in interest bearing securities and liquidate them to satisfy the firm's demand for cash. The Miller-Orr model assumes that a firm's net cash flows are normally distributed with a mean of zero and a constant standard deviation. Homonoff learned that these models performed fairly well and could minimize the amount of time managers devote for monitoring cash balances.

Bayer (2011) made an analysis of a model of investment which incorporated an imperfect capital market and fixed investment cost. The main results were to find the difference between a short-run impact of liquidity on frequency of investment and long-run impact on the optimal stock of capital. Bayer identified no substantial impact of finance on a firm's capital decision. Nonetheless, when the short-run investment function was estimated, finance had substantial effect, which was the strongest for fundamental investment incentives.

Povel and Raith (2002) analysed the influence of financial constraints on the investment of a firm. They demonstrated the necessity to differentiate between dimensions of being constrained: the extent of capital market imperfections (such as asymmetrical information) and lack of internal funds. It is important to differentiate between these two dimensions in that they influence the marginal cost of investment and investment itself in diverse ways. Povel and Raith identified that the relationship between the internal and external cost was U-shaped. Their model's major assumption was that internal funds could be negative and that a firm might not be able to contribute to the investment of its own funds. The results of their investigation revealed that sample selection might strongly influence their empirical findings, on the assumption that there was a sufficient relationship between cash flow and the level of internal funds.

Caglayanet, Baum, Ozkan, and Talavera (2004) researched the impacts macroeconomic volatility has on the cash holding behavior of non-financial firms. They used an augmented cash buffer-stock model to show that any increase in microeconomic volatility would cause the cross sectional distribution of the cash-to-assets ratios of the firm to narrow. To test this prediction of their model, they used the annual COMPUSTAT database drawn from a panel of U.S non-financial firms over the period 1970-2000.

The result of their findings was that firms behaved more homogeneously when microeconomic uncertainty heightened. Their results were shown to be robust to the inclusion of levels of microeconomic factors, namely the index of leading indicators, the rate of inflation and short-term Treasury and LIBOR interest rate. Ultimately, the findings verified and supported the hypothesis that microeconomic uncertainty significantly determined a cash holding behavior of a firm, with size of its effects differing substantially across classifications.

Denis and Silbilkov (2007) offered robust evidence that cash holdings were more valuable for financially constrained firms than unconstrained and studies why this was so. To test this hypothesis, they first estimated cross-sectional regression of Tobin's Q on cash holdings and series of control variables. The conclusions of their study are that cash holding are more valuable to constrained firms in that they allow them to increase investment in value increase projects, many constrained firm have amazingly low cash reserves. Again, their results demonstrate that greater cash holdings are related to higher levels of investment for constrained firms as well as unconstrained firms. However, the marginal value of investment is larger for constrained firms.

Mesquita (2010) investigated the pattern of funding and liquidity management of internationally active banks. The risks and the complexities related to funding and liquidity management of international banks became clearer during the financial meltdown. As liquidity in major banks funding and the FX swap markets disappeared, the sizeable mismatches across currencies added to the balance sheet pressure on internally active banks. As part of the outcome, international banking activities fell sharply in the late 2008.

The risk management at internationally active banks is more complex than the one at the local bank. There are several interrelated risks which are essential. Direct and indirect currency mismatches are generated, because several currencies dominate assets and liabilities. These are most of the time covered by short-duration hedges that must frequently be rolled over. Mesquita advised that any supervisory effort should have the objective of making sure that banks kept robust liquidity management practices, even as the memory of global financial crises began to disappear.

Diaz and Ramirez (2011), using a correlated random effects estimated model, formulated a new measure of firms-level 'cash flow sensitivity of cash'. Their measure, besides traditional observable, firm characteristics, was able to integrate unobservable, time invariant firm characteristics in the analysis of firm's cash flow. Therefore, we could use their measure to improve significantly the assessment of the impact of a firm's individual characteristics and cash stock piling activities on firm value and the investment policies of a firm. The findings corroborated existing findings that concluded that financially constrained firms showed a higher level of cash flow sensitivity than unconstrained firms.

Zhang (2011) studied the relationship between working capital management and corporate cash holding in firms exploring, if the working class capital management affected the level of corporate cash holding and vice-versa. He discussed three theoretical models that could be employed in explaining the decision of corporate cash holding that included trade-off model, pecking order and cash flow model. Trade-off model showed that firms decided their optimal level of cash holding by comparing the marginal cost and the benefits of the holding cash.

The pecking order model that Myers and Majluf (1984) developed proposed that cash acted as buffer between retained earnings and investment requirements, and that firm did not have to set any target cash levels. Jensen's free cash flow theory (1986) asserted that management had the incentive to pile up cash under control and take decision that might not be in their shareholders' interest. For example, it would be more probable that the low benefit or low return mergers and would destroy than to create value to the firms and shareholders. The expected relationship between cash flow variability and cash holding was positive and in accordance with the regression result and the coefficient was statistically significant at the 1% level. What that meant was that firms with high cash flow variability held more cash level.

Mizen and Vermeulen (2005) investigated corporate investment and cash flow sensitivity. They identified the differences in the degree of sensitivity across the country that ascribed the nature of lender-borrower relationship in those countries' financial systems. Grounded on the investigation of these two recent cross-country investment, Mairesse et al (1999) and Bond et al

(2003), they modeled investment in a flexible error correction. For a neoclassical profit-maximizing firm with CES production function and no adjustments costs the capital stock was proportional to output.

Mizen and Vermeulen utilized variables which were comparable across countries such as capital stock investment, sales and cash flow. These were taken from manufacturing firm's balance sheet. They chose firms that had consolidated data. It meant that data were on group level (capital stock assets, turnover, etc.). This made their investigation more comparable with the U.S. study that was based on compustat that further consolidated data.

Their findings demonstrated that cash flow had positive and significant impacts on investment in UK, whiles in Germany cash flow was insignificant. Interestingly, in a comparative study by the European system of central banks, with more than 5,000 observations for Germany, Chatelain et al., (2003) found that, using an autoregressive for investment, none of the four cash flow terms was substantial.

Gugler and Peev(2007) suggested an estimate accelerator cash flow models for 25,000 firms in 15 transition economies from 1993-2003. They found that investment–cash flow sensitive's decline over transition years which was attributed to a decline of asymmetric information and managerial discretion as capital markets and corporate standards developed. Cash flow sensitivity dwindled after ownership changed the investment. This indicated the new owners cash constraints or managerial discretion or both.

Baccarin (2009) investigated the optimal control of the multidimensional cash management system in which the cash balance fluctuates as a homogeneous diffusion process in R^n. He constructed the problem as an impulse control on an unbounded domain with an unbounded cost function. He characterized the value function as weak solution of quasi-variational inequality in a weighted sobolev space which indicated that an optimal policy existed. Baccarin proved the local uniform convergence of a finite element scheme to compute numerically the value function as well as the optimal cost.

He computed the solution's model in two-dimensions with linear cost and function, and indicated what the shapes of the optimal policies were in those two simple cases. The solution was that the transaction costs and the holding penalty cost were nonlinear functions. Moreover, the dynamics of the cash stock might have some correlations and might have drift and diffusion coefficients on the state of the system.

Fatemi and Luft (2002) formulated a framework within which the cost and benefit of corporate risk management decision analysed. Their findings confirmed the assumption that corporate risk management pursed strategies with the in intent to reduce the cost of financial distress and to do away with the problem of underinvestment. The major conclusion was that risk management strategies should be employed to facilitate shareholder value. In spite of the fact that systematic hedging of all variation in the net cash flow might be in management's best interest, it was not consistent with maximizing firm and shareholder value.

Constantinides (2002) suggested a continuous time model for time management that developed with stochastic demand and permitting positive and negative cash balance. In his model the state of cash management systems at time t is defined by the cash level x (t). The cost of maintaining a positive and negative cash balance is: $C(x) = Max[hx, px]$, where h and p are holding cost rate and penalty cost rate, h and p are positive constraints.

The holding cost of cash is basically the opportunity cost of holding cash rather than investing the wealth in interest-b earing bonds. The form of the optimal policy is assumed to be simple form (d, D, U, u). Miller-Orr took into account a case in which a particular interest rate forbids cash balance. According to their approach, we add the constraint d = 0 for making the holding and penalty cost rates function of the cash level.

Richard and Constantinides(1977) developed a continuous-time, infinite-horizon, discounted cost cash management models with fixed and proportional transaction cost with linear holding and penalty costs. They modeled the cumulative demand for cash by the Wiener process with drift and the use of the optimal control of 'impulse control' to find sufficient under which optimal policy exist. They indicate that these conditions are met all the time. Thus, they are a proof of the fact that there is always optimal policy for cash management problems. When the proportional transactions cost of minimizing the cash balance is sufficiently high, it is never optimal to decrease the cash balance.

Bastina et al (2007) presented an approach to cash management for automatic teller machine (ATM) network. The basis of their approach was an artificial network to project a daily cash demand for every ATM in the network as well as optimization procedure to estimate optimal cash load for every ATM. The most important factors for the ATM maintenance were taken into account during the optimization procedure. They were namely cost of cash, cost of uploading and cost of daily services. Stimulation research demonstrates that in case of a higher cost of cash (interest rate) and low cost for moneys uploading, the optimization procedure allows the minimization of ATM maintenance cost around 15-20%.

Yieuet al (2009) perceived cash management problem as any moment during the period when there was either increased or decreased inventory by purchasing or selling on a spot market where prices fluctuated randomly over a period. The firm's objective was to reduce the expected discounted profit over time where profit constituted the revenue from the sales of goods to meet demand on the spot market or salvage minus the cost of purchasing goods and transaction penalty of holding costs.

To begin with, they demonstrated that this optimization problem was equivalent to two-dimensional singular control problem. They used a recently constructed control-theoretical to demonstrate that optimal policy was totally characterized by a simple price dependent two-threshold policy. Using a series of computational experiments, they explored the value of actively managing inventory until the same limit was reached. They observed through their experiments that as price vitality went up, the value of actively managing inventory also increased until some limit was reached.

Waweru (2011) investigated into cash balance management approaches in Savings and Credit Corporative Society (SACCos) in Nakura county Kenya. Waweru's investigation explored cash management approaches in SACCos grounded on the assumption that cash management was regarded a major ingredient for the survival of any business. Nakuru County had a population of 143 SACCos. With the use of stratified sampling, a sample of 38 SACCos was selected. His findings revealed that, notwithstanding the fact that majority of SACCOs were aware of the need to manage their cash balance, the vast majority of them had no cash management policies. On the account of the findings, Baumol (1952), Beranek (1963) and Miller-Orr (1968) modeled were employed on cash balance management for the SACCos in the Nakuru county.

The Baumol (1952) model is applied to the Economic Order Quantity (EOQ) to cash. The limitations of Baumol model are as follows: The model assumes that the disbursement rate of the firm is constant. The model also assumes that no cash receipts exist during the forecasted periods. The Baumol model is the simplest and the most striped down sensible model for determining the optimal cash position. Miller-Orr (1966) assumes that the daily net cash flow distribution is normal. The model works in terms of upper (H) and lower (L) control limits and a target cash balance (Z). The target cash balance is permitted to randomly wander between H and L. The firm makes cash transaction only when the cash balance reaches H, when the firm purchases H-Z marketable securities or when the cash balance reaches L, when the firm sells L-Z marketable securities.

Beranke (1963) hinged on the optimal allocation of funds between cash balance and marketable securities. He argued that as far as cash flows were controllable and recurred in a cyclical manner, the financial manager could forecast cash needs over the planning period and invest the amount they regarded surplus.

None of the models named above was found to have been used by the SACCos, which suggests that the SACCos deemed it useful to apply a multiple of strategies to effectively manage their cash balances. The findings confirmed an existing one of Ouma (2001) study of the NSE quoted companies. The findings of the study demonstrate that although majority of SACCos were conscious of the importance of managing their cash balance just a few of them had polices on their cash management and very few SACCos had set optimum cash balance model.

Distnik, Duchin and Schmidt (2010) investigated the interaction between corporate hedging and liquidity policies. They presented a theoretical model which indicated how corporate hedging promoted greater reliance on cost-effective, externally-provided liquidity in lieu of external sources. To test the predictions of their model they used a new empirical approach that distinguished cash flow hedging from non-cash flow hedging. They employed detailed hand-collected data and constructed hedging instruments to address endogeneity. They found that cash flow hedging minimized the firm's precautionary demand for cash and allowed it to rely more on bank lines of credit. They also employed this theoretical model and found a significant positive influence on cash flow hedging on firm value.

Sawaki and Sato (2009) found that many firms encountered problem of managing their cash balance to increase the amount of funds available for investment and to avoid the risk of insolvency. They looked at a cash management model in which there were two funds when the manager adjusted cash level. Their assumption was that the rate at which two funds could be used for the amount of adjustment was constant. They had the goal to minimizing the expected discount cost over an infinite horizon. They developed this cash balance management problem as an impulse control problem and derived an optimal cash management policy. To demonstrate that there was an optimal policy, they utilized a QVI approach under some conditions.

Bensoussan, Chutani and Sethi(2009) optimized cash management under uncertainty. They identified the problem of optimal investment in two kinds of assets over a period and developed it as a stochastic optimal control problem. Bank account and stock were two assets they considered. The earnings generated from stock were made up of dividends and capital gains. Let us consider a firm that invested its cash in stock or bank account. The amount invested in the bank account at time t isx (t) and the amount invested in the stock is y (t); t E (0, T) defines the length of the planning horizon.

The interest rate earned on the bank account is $r_1(t)$ and the returns derived from stock at time takes two forms: capital gains rate of $r_2(t)$ and cash dividend rate $r_3(t)$. The firm has a demand rate d (t) for cash at any time. The demand d (t) can be positive or negative. By the use of standard Brownian motion the randomness in the return of stock is modeled. An explicit decision rule of the bang-bang is derived for optimal management of cash, using a stochastic maximum principle.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter focuses on linear Programming and its application to production scheduling. Production Scheduling is the management and allocation of resources, events and process to create goods and services. The goal of Production Scheduling is to balance client needs with available resources whiles operating in the most efficient cost-efficient manner

3.1 Linear Programming (LP)

Linear Programming is a subset of Mathematical Programming that is concerned with efficient allocation of limited resources to known activities with the objective of meeting a desired goal of maximization of profit or minimization of cost. It was developed by George B. Denting in 1947. Linear Programming (LP) is a technique for optimization of linear objective function, subject to linear equality and linear in equality constraint.

In general, linear programming models are stated as:

$$Maximize(or..Minimize)\sum_{j=1}^{n} c_j x_j$$

Subject to

$$\sum_{i=1}^{m}\sum_{j=1}^{n} a_{ij}x_j \{\le,=\ge\} b_i$$

$x_j \ge 0$ for $i = 1,2....m$

$j = 1,2....n$

where

The ith row may be an equation '=' or an inequality $\le, or.. \ge$

c_j are known as cost coefficient

x_j are decision variables

a_{ij} are called structural coefficients

b_i resource value (or stipulations because they define the constraint requirement)

3.1.1 *Components of Linear Programming*

Decision Variation: Decision variables describe the quantities that the decision makers would like to determine. They are the unknowns of a mathematical programming model. Typically, we will determine their optimum values with an optimization method. In a general model, decision variables are given algebraic designations such as: $x_1, x_2, x_3.....x_n$. The number of decision variables is *n*, and x_j is the name of the *j*th variable. In a specific situation, it is often convenient to use other names such as x_{ij} or y_k or $z(i,j)$.

Objective Function: The objective function evaluates some quantitative criterion of immediate importance such as cost, profit, utility, or yield. The general linear objective function can be written as

$$z = c_1x_1 + c_2x_2 + ... + c_nx_n = \sum_{j=1}^{n} c_j x_j$$

Here c_j is the coefficient of the *j*th decision variable. The criterion selected can be either maximized or minimized.

Constraints: A constraint is an inequality or equality defining limitations on decisions. Constraints arise from a variety of sources such as limited resources, contractual obligations, or physical laws. In general, an LP is said to have *m* linear constraints that can be stated as

$$\sum_{j=1}^{n} a_{ij} x_j \{\le, =, \ge\} b_i \text{ fori} = 1 \text{ ......m}$$

One of the three relations shown in the large brackets must be chosen for each constraint. The number a_{ij} is called a "technological coefficient," and the number b_i is called the "right-side" value of the *i*th constraint. Strict inequalities (<, >, and) are not permitted. When formulating a model, it is a good practice to give a name to each constraint that reflects its purpose.

Parameter: The collection of coefficients (c_j, a_{ij}, b_i, u_j) for all values of the indices *i* and *j* are called the parameters of the model. For the model to be completely determined all parameter values must be known.

3.1.2 *Standard form of Linear Programming*

The standard form of the LP is given as follows:

1. n decision variables

$x_1, x_2, .. x_n$

2. One objective function to be minimized or maximized

$$Z = c_1x_1 + ... + c_nx_n$$

3. m constraints :

$$a_{11}x_1 + a_{12}x_2 + ... + a_{1n}x_n = b_1$$

$$a_{21}x_1 + a_{22}x_2 + ... + a_{2n}x_n = b_2$$

$$a_{m1}x_1 + a_{m2}x_2 + ... + a_{mn}x_n = b_m$$

4. non-negativity requirements:

$$x_1 \geq 0, x_2 \geq 0, ..., x_n \geq 0$$

3.1.3 *Matrix form of LP*

In matrix notation the LP problem may be written as follows

Min $c^T x$

s.t: $Ax = b$

$x \geq 0$

where

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{pmatrix} \quad X = \begin{bmatrix} x_1 \\ x_2 \\ \cdot \\ \cdot \\ \cdot \\ x_n \end{bmatrix} \quad b = \begin{bmatrix} b_1 \\ b_2 \\ \cdot \\ \cdot \\ \cdot \\ b_m \end{bmatrix} \quad c = \begin{bmatrix} c_1 \\ c_2 \\ \cdot \\ \cdot \\ \cdot \\ c_n \end{bmatrix}$$

3.1.4 *Assumptions of Linear Programming*

The assumptions of the Linear Programming model are as follows:

Certainty: In all LP models, it is assumed that, all the model parameters such as availability of resources, profit (or cost) contribution of a unit of decision variable and consumption of resources by a unit of decision variable must be known and constant.

Divisibility: The solution values of decision variables and resources are assumed to have either whole numbers (integers) or mixed numbers (integer or fractional). However, if only integer variables are desired, then Integer programming method may be employed.

Additivity: The value of the objective function for the given value of decision variables and the total earned from each decision variable and sum of the resources used by each decision variable respectively. The objective function is the direct sum of the individual contributions of the different variables.

Proportionality: A problem can be phrased as a linear program only if the contribution to the objective function and the left-hand side of each constraint by each decision variable (x_1............x_n) is proportional to the value of the decision variable.

3.1.5 *Applications of Linear Programming (LP)*

Linear Programming has been applied to a wide variety of constraint optimization problems. Some of these are:

1. Optimal **Product** Mix: In the real world, most firms produce a variety of products rather than a single one and must determine how to best use their plants, labor, and other inputs to produce the combination or mix of products that maximizes their total profits subject to the constraints they face. For example, the production of a particular commodity may lead to the highest profit per unit but may not use all their firm's resources.

2. **Satisfying Minimum Product Requirements:** Production often requires that certain minimum product requirements be met at a minimum cost. For example, the manager of a college dining hall may be required to prepare meals that satisfy the minimum daily requirements of protein, minerals, and vitamins at a minimum cost.

3. **Optimal Process Selection:** Most products can be manufactured by using a number of processes, each requiring a different technology and combination of inputs. Given input prices and the quantity of the commodity that the firm wants to produce, linear programming can be used to determine the optimal combination of processes needed to produce the desired level and output at the lowest possible cost, subject to the labor, capital, and other constraints that the firm may face.

- **Other Specific Applications of Linear Programming:** Linear programming has also been applied to determine:

(a) The least-cost route for shipping commodities from plants in different locations to warehouses in other locations, and from there to different markets (the so-called transportation problem).

(b) The best combination of operating schedules, payload, cruising altitude, speed, and seating configurations for airline.

(c) The best portfolio of securities to hold to maximize returns subject to constraints based on liquidity, risk, and available funds (cash flow matching).

3.1.6 *Procedure used in formulating and solving Linear Programming Problem*

- Identify the decision variables
- Formulate the objective function
- Identify and formulate the constraints
- Write the non-negativity constraints.

3.1.7 *Solving the Linear Programming (LP) Problem*

When an LP is solved one of the following four cases will occur:

1. The LP has a unique optimal solution
2. The LP has alternate (multiple) optimal solution. It has more than one optimal solution.
3. The LP is infeasible. It has no feasible solution (The feasible region has no point)
4. The LP is unbounded. In the feasible region there are points with arbitrary large objective function values.

3.2 The Simplex Algorithm for Solving Linear Programs (LP's)

The simplex algorithm or the simplex method is an iterative procedure that provides a structured method for moving one basic feasible solution to another, always maintaining or improving the objective function until an optimal solution is obtained.

The simplex algorithm for solving linear programs was developed by Dantzig in the late 1940's. For any LP the optimal solution occurs at the vertex of the feasible solution.

Steps

1. Convert the LP to standard form
2. Obtain a basic feasible solution (bfs) from the standard form
3. Determine whether the current bfs is optimal. If optimal, stop.

4. If the current bfs is not optimal, determine which nonbasic variable should become basic variable and which basic variable should become a nonbasic variable to find a new bfs with better objective function
5. Go back to step 3.

3.2.1 Setting Up The Initial Simplex Tableau

The terms that are used in the initial simplex tableau are defined as follows

c_j = objective function coefficients for variable j

b_i = right hand-side coefficients for constraint i

a_{ij} = coefficients of variable j in constraint i

c_B = objective function coefficients of the basic variables

General form- Initial Simplex Tableau

		Decision variables				**Slack Variables**						**Objective Function Coefficients**
C_j		C_1	C_2	...	C_n	0	0	...	0	**Solution**		
C_B	Basic variables	x_1	x_2	...	x_n	1		...	s_m			Heading
0	s_1	a_{11}	a_{12}	...	a_{1n}	1	0	...	0			Constraints

...	s_2	a_{21}	a_{22}	...	a_{2n}	0	1		0			coefficients
0	...	...	...	...	...	...	...	...	...			
	s_m	a_{m1}	a_{m2}	...	a_{mn}	0	0	...	1			
		Z_1	Z_2	...	Z_{mn}	Z_{11}	Z_{12}	...	Z_{1m}	Current value of objective function		
	C_j-Z_j											Net contribution

3.2.2 Simplex method Techniques

The following are some of the techniques use when solving linear programming problem using the simplex

- **Tie for entering basic variable:** whenever there is a tie between two or more variables for entering the basis having the same $C_j - Z_j$ values, the tie can be broken as a choice between two or more variables tying or entry can be made arbitrarily. It does not matter which variable is chosen for entry into the basis, an optimal solution will be reached regardless of the initial choice among the tied variables.
- **Tie for leaving basic variable- degeneracy:** In applying the simplex method, we can encounter a situation in which a tie occurs between two or more variables, in terms of selecting the minimum non negative ratio for the variable to leave the basis. This situation will be indicated by these variables having exactly the same (minimum non

negative) ratio formed as the values in the 'solution' column are divided by the corresponding values in the pivot column. When this occurs, the variable selected for the removal from the basis will be driven to zero, but will remain in the basis. TAhis will result in the degenerate basic feasible solution, having one or more of the basic variableds equal to zero.

- **Unconstrained Variables:** In many practical situation we may want to allow one or two of the decision variables, the x_j to be unconstrained in sign, that is either positive or negative. The use of the simplex method requires that all the decision variables must be non-negative at each iteration. A linear programming problem involving variables that are unconstrained in sign can be converted to an equivalent problem having only non-negative variables
- **Non positive right-hand side values**: In a situation where one or more of the right-hand side values, the b_i, i= 1,2,…,m may be negative. For example, if we consider this constraints $2x_1 + 8x_2 \leq -6$

If we add a slack variable, S_1 and select this slack variable as an initial basic variable, we would set $S_1 = -6$. However, this is not permissible in the application of the simplex method, that is , we must maintain feasibility with all $x_j \geq 0$. This can only be solved by converting the right-hand side to a positive value, and then add either a slack variable or a surplus and artificial variables as required.

3.2.3 Definitions

Slack Variable: A slack variable is associated with the (≤) constraint and represents the amount by which the right-hand side of the constraint exceeds its left hand side. Slack variables are given coefficient of zero in the objective function because they make no contribution to profit.

Surplus Variable: A surplus variable is identified with a (≥) constraint and represent the excess to the left-hand side over the right-hand side. It is subtracted from the left-hand side of the inequality to convert the constraint to equality. It measures the amount of a product (or output) in excess of the required amount.

Infeasible Solution: If one or more variables are less than zero, the basic solution is said to be infeasible.

Feasible Solution: When all variables are greater than or equal to zero. Each point within or on the boundary of the solution space satisfies all the constraints and hence represents a **feasible point.**

Example:

Maximize $z = 6x_1 + 8x_2$

Subject to

$5x_1 + 8x_2 \leq 60$

$4x_1 + 4x_2 \leq 40$

$x_1 \geq 0, x_2 \geq 0$

Solution

In standard form,

$$Maximize.z = 6x_1 + 8x_2 + 0s_1 + 0s_2$$

Subject to $5x_1 + 10x_2 + s_1 = 60$

$$4x_1 + 4x_2 + s_2 = 40$$

$$x_1 \geq 0, x_2 \geq 0, s_1 \geq 0, s_2 \geq 0$$

Using the simplex tableau to solve

FIRST TABLEAU

C_j		6 8 0 0					
		X_1	X_2	S_1	S_2	RHS	
0	S_1	5	10	1	0	60	60/10
0	S_2	4	4	0	1	40	40/4
Z_j		0	0	0	0		
C_j-Z_j		6	8	0	0		

SECOND TABLEAU

C_j		6	8	0	0		
		X_1	X_2	S_1	S_2	RHS	
0	X_2	1/2	1	1/10	0	6	6/0.5
0	S_2	2	0	-2/5	1	16	16/2
Z_j		4	8	4/5	0	48	
C_j-Z_j		2	0	-4/5	0		

THIRD TABLEAU

C_j		6	8	0	0	
		X_1	X_2	S_1	S_2	RHS
8	X_2	0	1	1/2	0	2
6	X_1	1	0	-4/5	½	8
Z_j		6	8	2/5	1	64
C_j-Z_j		0	0	-2/5	-1	

Hence the $Z_j = 64$, which the optimal solution

$X_1 = 2 \quad X_2 = 8$

3.3 Duality of Linear Programming

Definition of Dual Problem

Consider the primal problem stated in canonical form:

$Max c^T x$

Subject to $Ax \leq b$

where $x = (x_1, x_2, ..., x_n)^T$ is any n-vector

$c = (c_1, c_2, ..., c_n)^T$ is any n-vector

$A = (a_{ij})$ is n mxn matrix and

$b = (b_1, b_2, ..., b_n)^T$ is an n-vector

The associated dual problem

Minimize $b^T w$

Subject to $A^T w \geq c$

$w \geq 0$

is called the dual of the given problem. The variables in the primal problem are primal variables and the variables in the dual problem are called dual variables.

4.3 Production Scheduling Problem a General Linear Programming Approach

The production Problem can be formulated as a general linear programming problem as shown in the example below:

Example 1

A production manager is in a process of preparing in four-month production schedule. What is the schedule that minimizes the total production cost, if the company wants to have 300 units in inventory at the end of April?

Decision variables:

X_i = Quantity produced in month i on regular time basis for i = 1,2,3,4

Y_i = Quantity produced in month i on overtime for i = 1,2,3,4

I_i = Quantity in inventory at the end of month i for i = 1,2,3,4

The objective function and the constraints for this problem can be stated as follows

Minimize $Z = 500(x_1 + x_2 + x_3 + x_4) + 650(y_1 + y_2 + y_3 + y_4) + 40(I_1 + I_2 + I_3 + I_4)$

Subject:

$X_1 \leq 3000$

$X_2 \leq 2000$ (Regular time production constraint for each month)

$X_3 \leq 3000$

$X_4 \leq 3500$

$Y_1 \leq 500$

$Y_2 \leq 400$ (Overtime production constraint for each month)

$Y_3 \leq 600$

$Y_4 \leq 800$

The total production (regular + Overtime) minus what we carry in inventory must equal the demand for a particular month. These constraints results in the following transition equalities:

$X_1 + Y_1 - I_1 = 2800$

$X_2 + Y_2 - I_2 = 3000$

$X_3 + Y_3 - I_3 = 3500$

$X_4 + Y_4 - I_4 = 3000$

The inventory constraints can be formulated as follows:

$I_1 \geq 100$

$I_2 \geq 100$

$I_3 \geq 100$

$I_4 = 300$

Solution

$X_1 = 2900$ (Quantity produce in January on regular time basis)

$X_2 = 2000$ (Quantity produce in February on regular time basis)

$X_3 = 3000$ (Quantity produce in March on regular time basis)

$X_4 = 3300$ (Quantity produce in April on regular time basis)

$Y_2 = 400$ (Quantity produce in February on overtime)

$Y_3 = 600$ (Quantity produce in March on overtime)

$I_1 = 100$ (Quantity in inventory at the end of January)

$I_2 = 100$ (Quantity in inventory at the end of February)

$I_3 = 100$ (Quantity in inventory at the end of March)

$I_4 = 300$ (Quantity in inventory at the end of April)

Z = GH C 6274000

Example 2: A Production Scheduling Example

The demand estimates for ABC Company Limited Product for all months of 1999, d_i : i = 1,...,12 and they are very uneven ranging from 440 to 920. They currently have 30 employees, each of whom produce 20 units of the product each month at a salary of 2,000: They have no stock of the product. How can they handle such fluctions in demand? Assumming they are three ways

- Overtime: but this is expensive since it costs 80% more than regular Production and has limitations, as workers can only work 30% overtime.
- Hire and fire workers: but hiring costs 320 and firing costs 400
- Store the surplus Production: but this cost 8 per item per month

Solution

This rather involved Problem can be formulated and solved as a Linear Program. As in all such reductions, a crucial first step in defining the variables

- Let w_i be the number of workers. We have i^{th} month ----- we have w_o = 30
- Let x_i be the Production for month i.
- O_i is the number of workers hired/ fired in the beginning of month i
- S_i is the amount of product stored at the end of month i

The Constraints:

- $X_i = 20w_i + O_i$----the amount Produced = regular Production + Overtime Production
- $W_i = W_{i-1} + h_i - f_i$, $w_i \geq 0$----new workers = old workers + hired- fired
- $S_i = S_{i-1} + X_i - d_i \geq 0$-----the amount stored at the end of this month, is what we started with, plus the Production, mins the demand.
- $O_i \leq 0 \leq 0\ 6w_i$----- only 30% of the items Produced in overtime

The Objective Function:

Min 2000 $\sum w_i$ + 400 $\sum f_i$ + 320 $\sum h_i$ + 8 $\sum s_i$ + 180 $\sum o_i$

CHAPTER FOUR

MODEL FORMULATION AND ANALYSIS

4.0 Introduction

In this chapter, a linear programming model is formulated to solve the optimal cash flow management problem. Data collected from KomfoAnokye Teaching Hospital (KATH) IGF office from 2010-2011 is used to implement the model and thus maximize cash flow for the Hospital.

4.1 Modelling

4.1.1 The Decision Variables

The main objective of this research is to estimate the exact amount of money to allocate to the various categories on monthly basis. For example, for the first category which is represented by Utilities and Minor Maintenance, the researcher aims at estimating the allocation that should be made to the considered expense from January to December.

The decision variables are therefore the individual categories per month. We introduce the notation for the decision variables here as

$$y_{ij} \quad i = 1, 2, 3, 4, 5; \quad j = 1, 2, \ldots, 12$$

Where $i$is the number label of particular categories and j represents the number label of the months in a year. There are therefore 60 different decision variables to work with.$y_{1,7}$for example is the expense for Utilities and Minor maintenance in the seventh month that is July.

The key objective again is to estimate the amount of allocation that should be made on monthly basis to the different categories so that net cash flow is maximized.

4.1.2 The Linear Programming Model

The linear programming model is given as

$$Maximize\ Z = \sum_{j=1}^{12} c_j(1+r) - \sum_{j=1}^{12}\sum_{i=1}^{5} y_{ij}(1+R)$$

Subject to

$$y_{ij} \leq c_j$$

$$\sum_{j=1}^{12}\sum_{i=1}^{5} y_{ij} \geq E$$

Where y_{ij} – decision variables, c_j – the income generated in the *j*th month, *r* – interest of lending rate with regards to investing the money, *R* – interest or borrowing rate with regards to having to borrow some money.

4.2 Model Implementation

4.2.1 Specification of Model Parameters

Income	Expenditure	Interest rate on savings	Interest rate on overdraft
C_j	E	r	R

4.2.2 Categorization of Expenses

The expenditure list of the health facility consisted of 29 different items including miscellaneous expenses. The total annual expenditure on these items amounted to GHC 23,363,926.17. These items are grouped into 5 exclusive categories each comprising of similar items.

The first category is Utilities and Minor Maintenance. The second category is Major Maintenance. The third, fourth and fifth are the Allowances category, Materials and Support category and Reward category respectively. Table 4.2.2 shows the individual categories and the items that are in each category.

Table 4.2: Categorization of Expenses

Utilities/Minor Maintenance	Maintenance	Allowances	Materials	Rewards
Utilities	Rent	Management	Training	property eq
Cleaning	Transport	Hearing	Consultancy	rehabilitation
Office con	Repairs	Directors	Materials	end of year
Printing	Charges	Cashiers	Non-drug	child health
		Risk	Medicine	legal comp
		Sitting		blood bank
		Fuel		miscellaneous
		Car Maintenance		
		Others		

4.2.3 Income data (KATH IGF)

The total income at the end of each month is represented by C_j. Where j = 1, 2… 12.

Table 4.3: Monthly Income data

Cj	Month
C_1	*GHC 22,230,15.240*
C_2	GHC 20,913,01.600
C_3	GHC 24,962,84.240
C_4	GHC 6,446,79.380
C_5	GHC 22,663,89.970
C_6	GHC 24,796,14,070
C_7	*GHC 24,401,71.700*
C_8	GHC 26,338,11.900
C_9	GHC 24,605,83.960
C_{10}	GHC 14,258,49.500
C_{11}	GHC 22,754,84.630
C_{12}	GHC 23,999,57.970
Total	**GHC 25,837,144.160**

4.2.4 Model Formulation Using the Hospital Data

Using data from the hospital as described above the formulation of the model is as given below:

Maximize $Z = (1.05)(25,837,144.160) - (1+34/12)(Y_{1,1}+ Y_{2,1} + Y_{3,1}+ Y_{4,1}+ Y_{5,1}+ Y_{1,2}+ Y_{2,2}+ Y_{3,2}+ Y_{4,2} + Y_{5,2}+ Y_{1,3} + Y_{2,3} + Y_{3,3}+ Y_{4,3}+Y_{5,3}+ Y_{1,4}+ Y_{2,4}+ Y_{3,4}+ Y_{4,4}+ Y_{5,4}+ Y_{1,5}+ Y_{2,5}+ Y_{3,5}+ Y_{4,5}+ Y_{5,5}+ Y_{1,6}+ Y_{2,6}+ Y_{3,6}+ Y_{4,6}+Y_{5,6}+ Y_{1,7}+Y_{2,7}+ Y_{3,7}+ Y_{4,7}+ Y_{5,7}+ Y_{1,8}+ Y_{2,8}+ Y_{3,8}+ Y_{4,8}+Y_{5,8}+ Y_{1,9}+ Y_{2,9}+ Y_{3,9}+ Y_{4,9}+ Y_{5,9}+ Y_{1,10}+ Y_{2,10}+Y_{3,10} + Y_{4,10}+ Y_{5,10}+ Y_{1,11}+ Y_{2,11}+Y_{3,11}+ Y_{4,11}+ Y_{5,11}+ Y_{1,12}+ Y_{2,12}+ Y_{3,12}+ Y_{4,12}+ Y_{5,12})$.

Subject to

$Y_{1,1} \leq 185,251.27$ $Y_{2,1} \leq 185,251.27$ $Y_{3,1} \leq 185,251.27$ $Y_{4,1} \leq 185,251.27$ $Y_{5,1} \leq 185,251.27$

$Y_{1,2} \leq 174,275.13$ $Y_{2,2} \leq 174,275.13$ $Y_{3,2} \leq 174,275.13$ $Y_{4,2} \leq 174,275.13$ $Y_{5,2} \leq 174,275.13$

$Y_{1,3} \leq 208{,}023.69 \quad Y_{2,3} \leq 208{,}023.69 \quad Y_{3,3} \leq 208{,}023.69 \quad Y_{4,3} \leq 208{,}023.69 \quad Y_{5,3} \leq 208{,}023.69$

$Y_{1,4} \leq 53{,}723.28 \quad Y_{2,4} \leq 53{,}723.28 \quad Y_{3,4} \leq 53{,}723.28 \quad Y_{4,4} \leq 53{,}723.28 \quad Y_{5,4} \leq 53{,}723.28$

$Y_{1,5} \leq 188{,}865.83 \quad Y_{2,5} \leq 188{,}865.83 \quad Y_{3,5} \leq 188{,}865.83 \quad Y_{4,5} \leq 188{,}865.83 \quad Y_{5,5} \leq 188{,}865.83$

$Y_{1,6} \leq 206{,}634.51 \quad Y_{2,6} \leq 206{,}634.51 \quad Y_{3,6} \leq 206{,}634.51 \quad Y_{4,6} \leq 206{,}634.51 \quad Y_{5,6} \leq 206{,}634.51$

$Y_{1,7} \leq 203{,}347.64 \quad Y_{2,7} \leq 203{,}347.64 \quad Y_{3,7} \leq 203{,}347.64 \quad Y_{4,7} \leq 203{,}347.64 \quad Y_{5,7} \leq 203{,}347.64$

$Y_{1,8} \leq 219{,}484.33 \quad Y_{2,8} \leq 219{,}484.33 \quad Y_{3,8} \leq 219{,}484.33 \quad Y_{4,8} \leq 219{,}484.33 \quad Y_{5,8} \leq 219{,}484.33$

$Y_{1,9} \leq 205{,}048.66 \quad Y_{2,9} \leq 205{,}048.66 \quad Y_{3,9} \leq 205{,}048.66 \quad Y_{4,9} \leq 205{,}048.66 \quad Y_{5,9} \leq 205{,}048.66$

$Y_{1,10} \leq 118{,}820.79 \quad Y_{2,10} \leq 118{,}820.79 \quad Y_{3,10} \leq 118{,}820.79 \quad Y_{4,10} \leq 118{,}820. \quad Y_{4,10} \leq 118{,}820.79$

$Y_{1,11} \leq 189{,}623.7 \quad Y_{2,11} \leq 189{,}623.72 \quad Y_{3,11} \leq 189{,}623.72 \quad Y_{4,11} \leq 189{,}623.72 \quad Y_{4,11} \leq 189{,}623.72$

$Y_{1,12} \leq 199{,}996.5 \quad Y_{2,12} \leq 199{,}996.5 \quad Y_{3,12} \leq 199{,}996.5 \quad Y_{4,12} \leq 199{,}996.5 \quad Y_{4,12} \leq 199{,}996.5$

$Y_{1,1}+ Y_{2,1} + Y_{3,1}+ Y_{4,1}+ Y_{5,1}+ Y_{1,2} + Y_{2,2}+ Y_{3,2}+ Y_{4,2} + Y_{5,2} + Y_{1,3} + Y_{2,3} + Y_{3,3}+ Y_{4,3}+Y_{5,3}+ Y_{1,4}+$

$Y_{2,4}+ Y_{3,4}+ Y_{4,4}+ Y_{5,4}+ Y_{1,5}+ Y_{2,5}+ Y_{3,5}+ Y_{4,5}+ Y_{5,5}+ Y_{1,6}+ Y_{2,6}+ Y_{3,6}+ Y_{4,6}+Y_{5,6}+ Y_{1,7} +Y_{2,7}+$

$Y_{3,7}+ Y_{4,7}+ Y_{5,7}+ Y_{1,8}+ Y_{2,8}+ Y_{3,8}+ Y_{4,8}+Y_{5,8}+ Y_{1,9}+ Y_{2,9}+ Y_{3,9}+ Y_{4,9}+ Y_{5,9}+ Y_{1,10}+$

$Y_{2,10}+Y_{3,10} + Y_{4,10}+ Y_{5,10}+ Y_{1,11}+ Y_{2,11}+Y_{3,11}+ Y_{4,11}+ Y_{5,11}+ Y_{1,12}+ Y_{2,12}+ Y_{3,12}+ Y_{4,12}+ Y_{5,12} \geq$

$35{,}196{,}041.37$

4.3 Solution of the Model

Through the Excel Solver, the simplex algorithm was used to solve the model above.

Table 4.3a and 4.3b are summaries of the initial (previous) allocation based on what the health facility was allocating and final (current) allocation based on the optimization of the cash flow using linear programming. Table 4.3a has the previous and current allocations from January to June and Table 4.3b has the previous and current allocation from July to December.

Table 4.3a: Optimal Solution for First Six Months

Period	y1,1	y1,2	y1,3	y1,4	y1,5	y1,6
Current	**185,251.27**	**174,275.13**	**208,023.69**	**53,723.28**	**188,865.83**	**206,634.51**
Previous	63,369.02	148,889.10	63,369.02	63,369.02	63,369.02	63,369.02
Period	y2,1	y2,2	y2,3	y2,4	y2,5	y2,6
Current	**185,251.27**	**174,275.13**	**208,023.69**	**53,723.28**	**188,865.83**	**206,634.51**
Previous	208,721.14	208,721.14	208,721.14	208,721.14	208,721.14	208,721.14
Period	y3,1	y3,2	y3,3	y3,4	y3,5	y3,6
Current	**185,251.27**	**174,275.13**	**208,023.69**	**53,723.28**	**188,865.83**	**206,634.51**
Previous	131,374.46	131,374.46	131,374.46	131,374.46	131,374.46	131,374.46
Period	y4,1	y4,2	y4,3	y4,4	y4,5	y4,6
Current	**185,251.27**	**174,275.13**	**208,023.69**	**53,723.28**	**188,865.83**	**206,634.51**
Previous	884,033.37	1,013,613.39	984,033.37	1,884,033.37	884,033.37	884,033.37
Period	y5,1	y5,2	y5,3	y5,4	y5,5	y5,6
Current	**185,251.27**	**174,275.13**	**208,023.69**	**53,723.28**	**188,865.83**	**206,634.51**
Previous	477,139.92	703,410.04	344,250.00	941,500.00	164,250.00	1,423,250.23

Prior to the linear programming solution, the annual amount spent on all the items considered summed up to GHC 23,363,926.17. The health facility however generates GHC 25,837,144.16. The difference amounts to GHC 2,473,217.99.

With this activity and in the face of interest (i.e. both borrowing and investing the income generated) the cash flow initially amounts to GHC 23,675,007.92.

Table 4.3b: Optimal Solution for Last Six Months

Period	y1,7	y1,8	y1,9	y1,10	y1,11	y1,12
Current	**203,347.64**	**219,484.33**	**205,048.66**	**118,820.79**	**189,623.72**	**199,996.50**
Previous	63,369.02	63,369.02	63,369.02	63,369.02	63,369.02	63,369.02
Period	y2,7	y2,8	y2,9	y2,10	y2,11	y2,12
Current	**203,347.64**	**219,484.33**	**205,048.66**	**118,820.79**	**189,623.72**	**199,996.50**
Previous	208,721.14	208,721.14	208,721.14	208,721.14	208,721.14	208,721.14
Period	y3,7	y3,8	y3,9	y3,10	y3,11	y3,12
Current	**203,347.64**	**219,484.33**	**205,048.66**	**118,820.79**	**189,623.72**	**199,996.50**
Previous	192,474.46	132,174.46	132,174.46	132,174.46	132,174.46	132,174.46
Period	y4,7	y4,8	y4,9	y4,10	y4,11	y4,12
Current	**203,347.64**	**219,484.33**	**205,048.66**	**118,820.79**	**189,623.72**	**199,996.50**
Previous	884,033.37	884,033.37	884,033.37	884,033.37	884,033.37	884,033.37
Period	y5,7	y5,8	y5,9	y5,10	y5,11	y5,12
Current	**203,347.64**	**219,484.33**	**205,048.66**	**118,820.79**	**189,623.72**	**199,996.50**
Previous	439,250.00	344,250.00	495,500.00	389,250.00	344,250.00	467,450.00

The linear programming maximizes cash flow subject to restricting the expenses within the income generated per month and making full use of the budget allocation to the hospital.

The constraints involved therefore are for the amount of allocation to each of the expenditure of any category not to exceed the income generated per month. It therefore rounds up to a set of 60 different inequalities of each the expenditure per month being constrained by income generated in that month.

The second constraint accounts for the balancing of the expenditure with the budget allocation for the year on the various expenses at a total of GHC 35,196,041.37.

After optimization, the total expenditure reduces by GHC 10,765,476.73 for all the items considered and this produces an optimal cash flow of GHC 25,581,034.99.The last constraint on the use of the budget available was not met because of the reduction due to the income generated by the hospital being the upper limit of expense.

4.4 Summary

From table 4.3a and 4.3b the following observation were made under each categories of expenses

Utilities: Comparing their previous expenditure with the current expenditure, the hospital expenditure was very less from January to December. For example for $y_{1,10}$, which is an item under utilities at the end of October, the previous expenditure was GHC 63,363.02 and the current expenditure was GHC 189,623.72. It was only the month of April that their previous expenditure was a little higher than the current one and since their expenditure the whole year was less they can still cater for that expenditure.

Maintenance: Their expenditure fluctuates. For the month of April they over spent, their previous expenditure was GHC 208, 721.14 and the current expenditure from the solution using the model was GHC 53,723.28.

Allowances: For the month of April the hospital over spent, their previous expenditure was GHC 131,374.46 and the current expenditure was GHC 53, 723.28.

Materials: The hospital over spent from January to December. Much expenditure was made in the month of April as compare their previous expenses to that of the current one.

The previous expenditure was GHC 1,884,033.37 and the current expenditure GHC 53,723.28

Rewards: All their expenses throughout that particular year was very high as compare to the current expenditures. That means the hospital will have to solicit for funds before they can cater for this particular expenditure

In conclusion, considering all the five categories under expenses the hospital over spent in the month of April. Hence the hospital cannot get optimal cash flow less and over expenditure made. The hospital should follow the pattern use in allocating for the various expenses to reduce their expenditure by GHC 10,765,476.73.

4.5 Graphical representation for all the five categories of items

A graphical summary of the results are given in the following figures

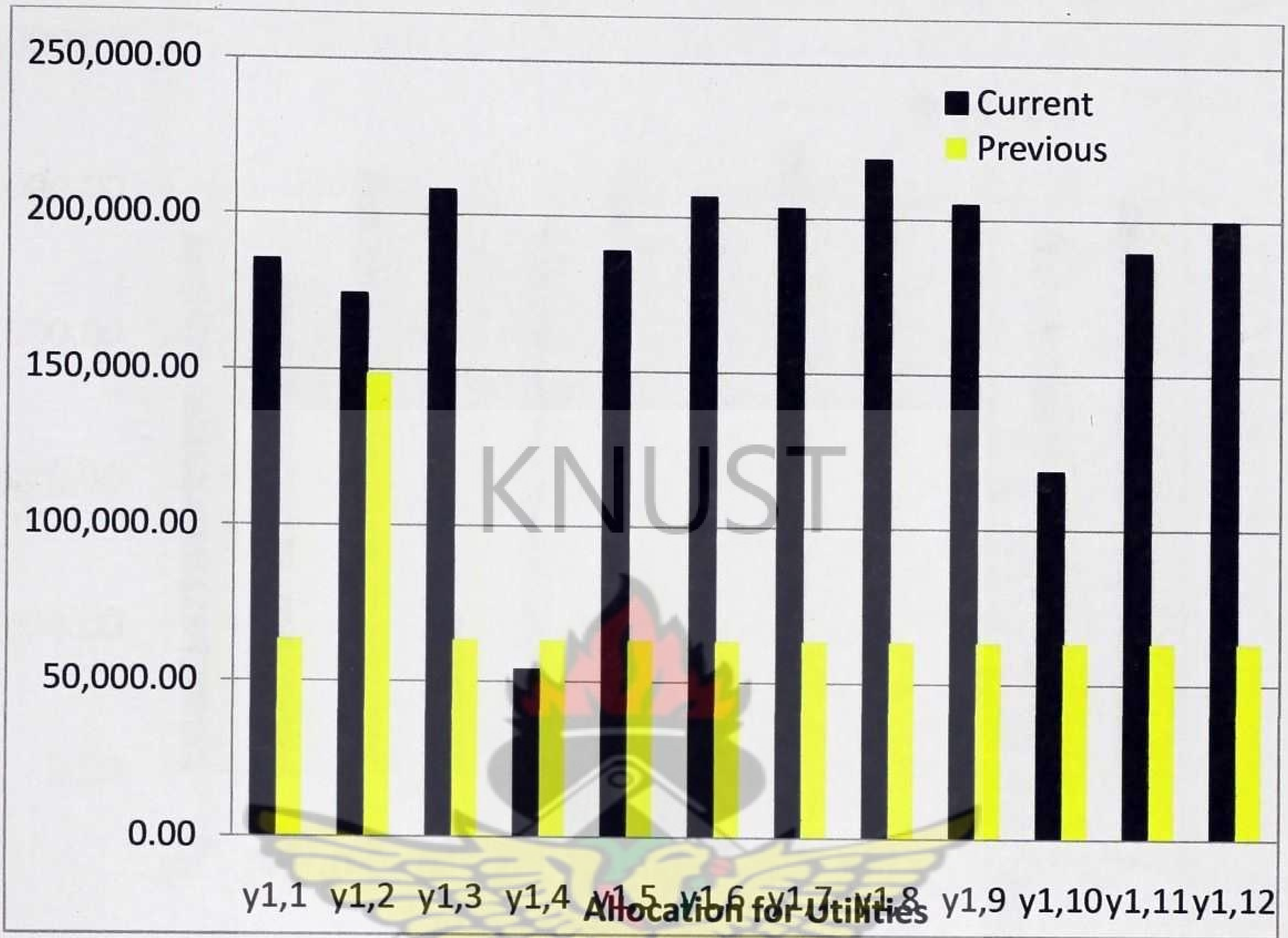

Figure 4.1: Allocation for utilities

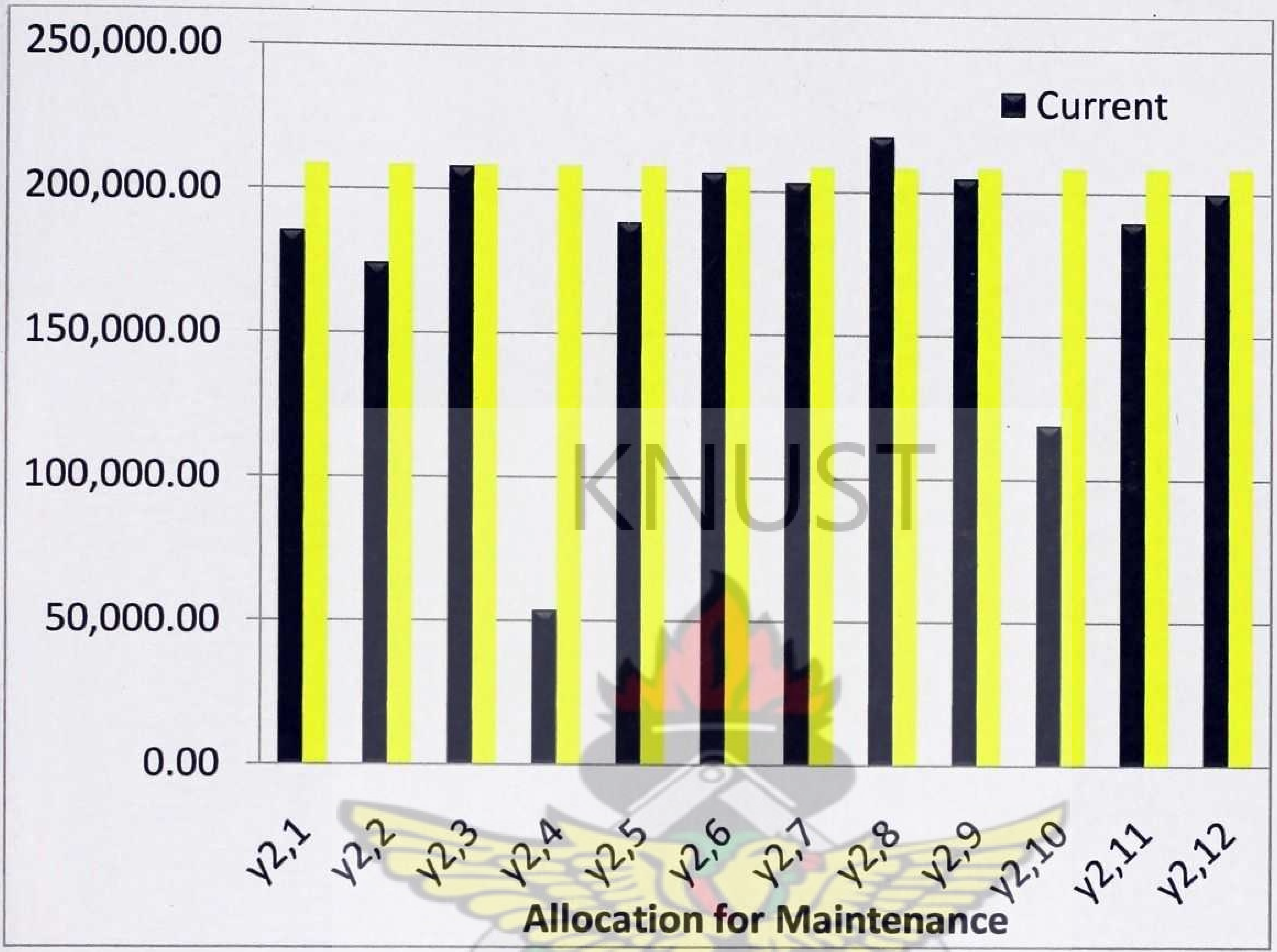

Figure 4.2: Allocation for Maintenance

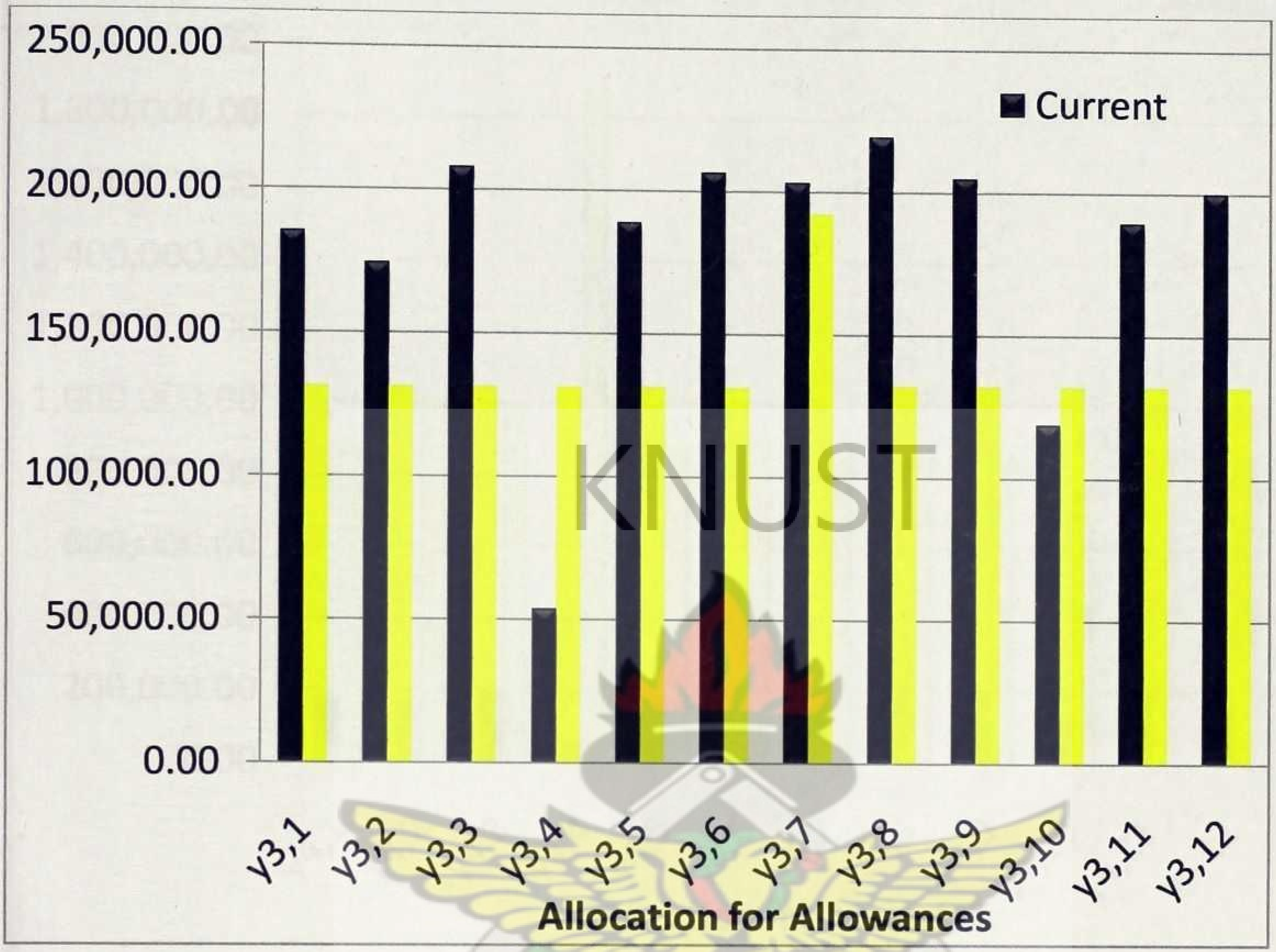

Figure 4.3: Allocation for Allowances

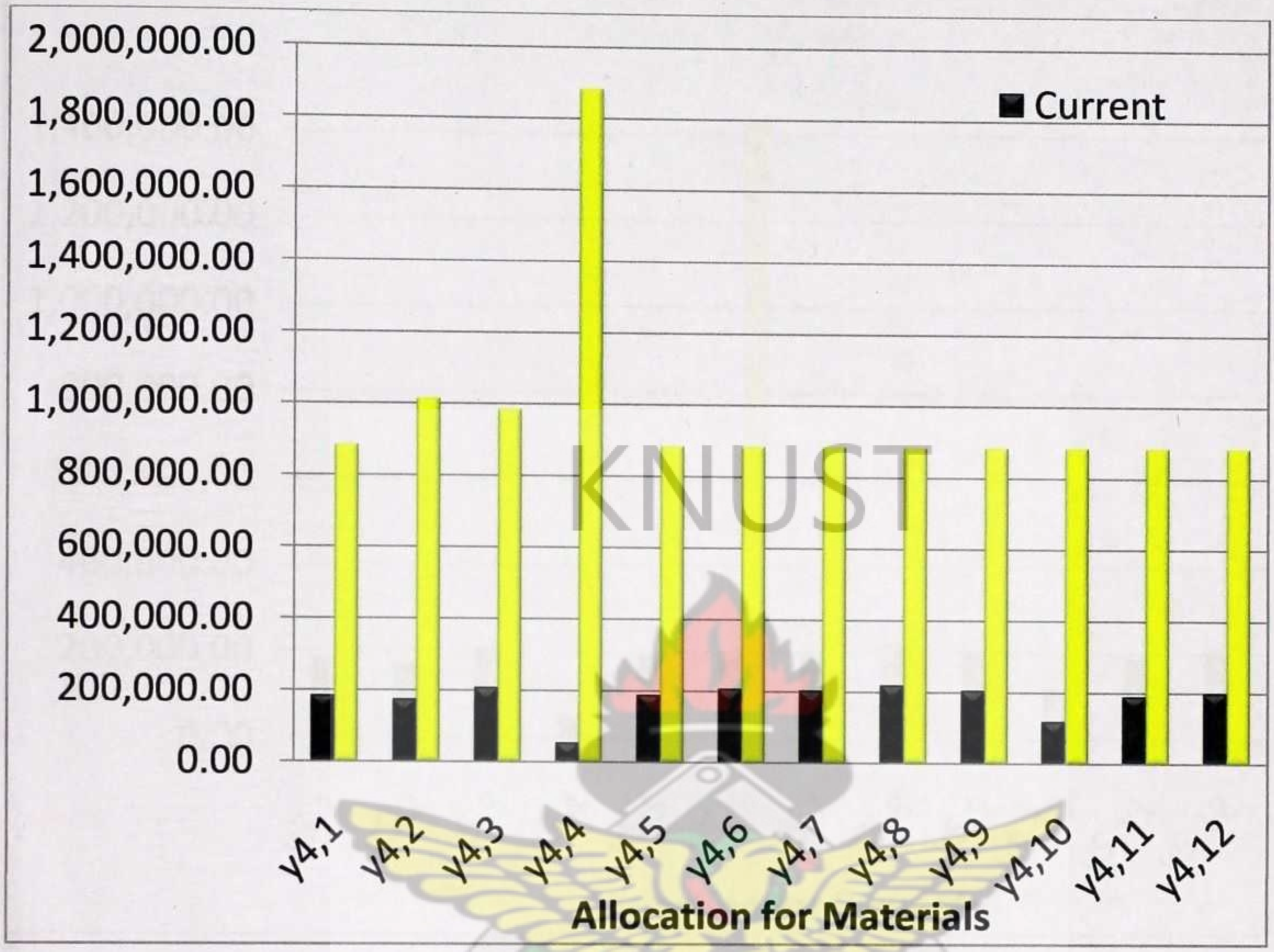

Figure 4.4 : Allocation for Materials

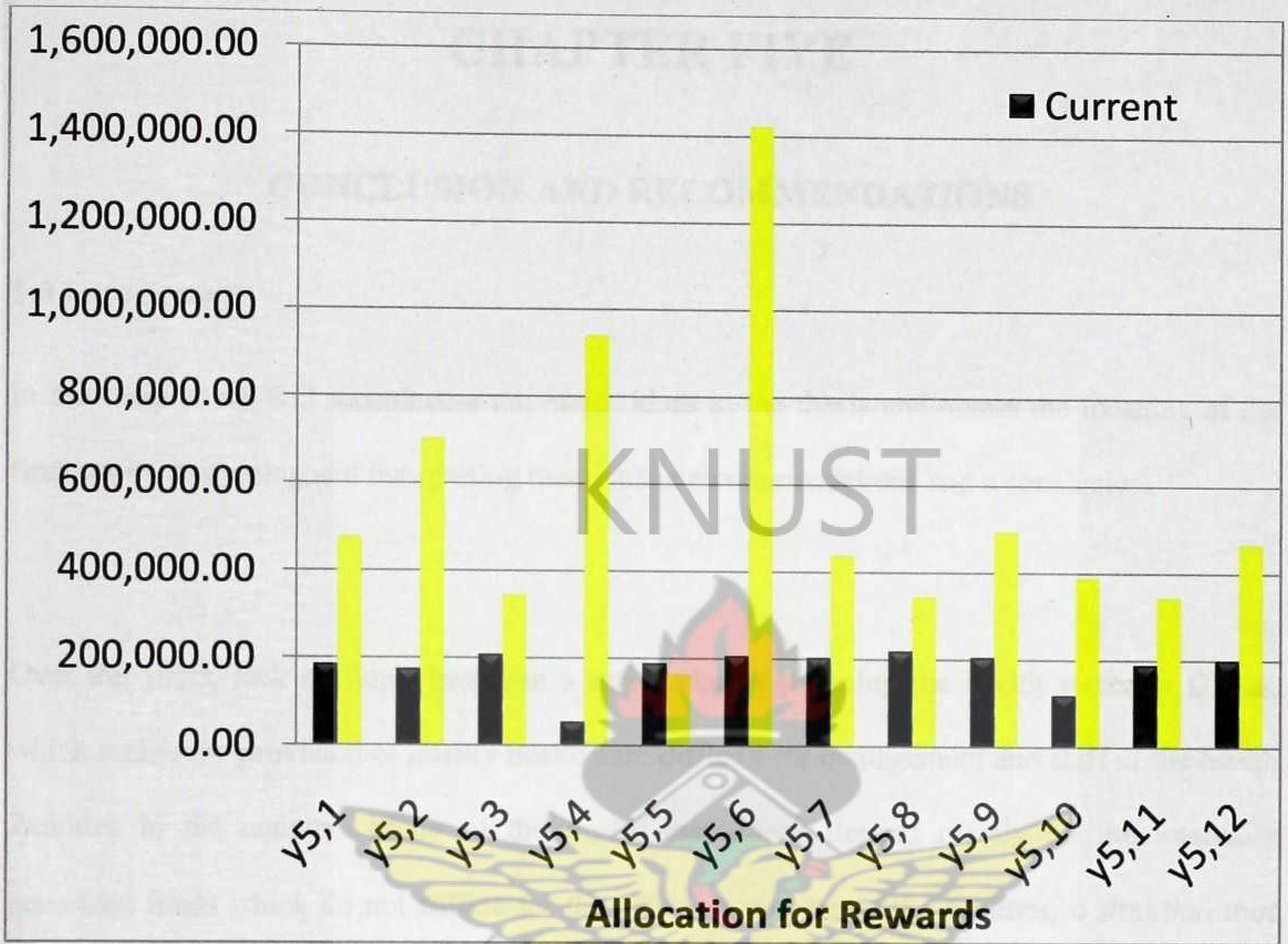

Figure 4.5 : Allocation for Rewards

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.0 **Introduction**

In this chapter we will recapitulate the major ideas in the thesis and assess the meaning of the findings by evaluating and interpreting them, make recommendations and a conclusion.

Over the years, lack of funds has been a major challenge facing the health sector in Ghana, which makes the provision of quality health care difficult for management and staff of the health facilities in the country. Many of the health institutions depend mainly on the internally generated funds which do not suffice for the effective *running of the facilities, a situation that has recently attracted public attention and discourse.*

In this study, the financial situation of KATH has been examined to see if the hospital can depend on its internally generated funds to run its operations by using an LP Optimal Cash Flow model implementation to run its finances. Though the internally generated funds may be inadequate for it to function efficiently, the results of the investigation indicate that underneath KATH's financial difficulty is lack of sound financial management.

From the findings

- KATH budgets disproportionally to its revenue. At the end of the fiscal year 2010/2011 their total budget was GHC 35,196,041.37. Meanwhile their total income for that period stood at GHC 25,837,144.16. Thus, there was budget shortfall of GH C 9,358,897.2. The hospital may assume that prices of items may rise in the course of the year and therefore budget higher, but they may eventually overspend. This model, however, reduces the expenditure of KATH by GHC 10,765,476.73 which means the hospital can actually save GH C 1,406,579.53 while successfully operating within budget.

- Its expenditure far exceeds it income in certain months of the year. For instance, in the month of February their total income was GHC 2,091,301.600 and they spent GHC 2, 206,008.13. Also, in the month of April their income was GHC 644,679.380, but they ended up spending GHC 3,228,997.99. In effect, they may end up going in for loans from a bank. Thus, they have two things to worry about: how to pay for the loan with the interest, as evident in the month of April; and how to manage their finances in the hospital. Consequently, the hospital ends up using a lot of its income to service its loans instead of focusing on how to fund their operations to keep the facility functioning effectively.

- KATH does not invest - a situation which impacts its income generation. For example, in the 2010/2011 fiscal year the health facility generated GH C 25,837,144.16 at the end of the year. They however spent GH C 23, 363, 926.17, leaving them a difference of GHC 2,473,272. However, if KATH had invested its generated income of GH C 25, 837,144.16 in a bank at the rate of 5% per annum it would have yielded an amount of GH C 27, 129, 001.37. Also, if they had borrowed GH C 23, 363, 926.17 at the rate of 34% per annum at the end of the year the hospital would have earned a profit of GHC 12,703,262. Clearly KATH does not invest, which contributes to the financial difficulty in which they find themselves.

- The health institution cannot obtain financial sufficiency unless it applies prudent fiscal management. From the table 4.1 on income in the month of April, for instance, their income amounted to GH C 644, 679.380 and in table 4.2 their expenditure in the same month was GH C 3,228,997.99. Apparently, there was a huge difference the hospital would have to make up for. So, if nothing was left in the preceding month for them to supplement for the month of April there would be a serious financial crisis which may lead them with no alternative either than going for a loan or attempting to pass on the difference to the patients, as in their recent attempt to reintroduce the "Cash and Carry" system.

KATH's problem of financial insufficiency can be solved. It will, however, require that the hospital invests in the bank to attract interest and other businesses such as pharmaceutical companies to gain more revenue; budgets and spend according to its internally generated funds. In a nut-shell, KATH ought to adopt holistic financial approach while implementing an optimal cash flow model such as the one which has been formulated in this study. If these proposals can be implemented, we will surely see a significant improvement in KATH's financial standing and the hospital will be able to provide quality health care to the residents of Kumasi and the Ashanti region, and beyond.

REFERENCES

Almeida, Campello and Weisbash (2002). The demand for corporate liquidity

Bo-Bae Min and Yeo-Jin Shin. Corporate investment and cash flow in the U.S. restaurant industry. College of Hotel and Tourism management Kyung Hee university, Seoul, Rep. of Korea.

Christopher Griffin 2009-2011. Linear Programming: Penn state math 484 lecture notes pp.13.

GH C l million bailout for komfoAnokye Teaching Hospital, March 2, 2012, from the World Wide Web: http://www.spyghana.com

Government secures funds for komfoAnokye Teaching Hospital maternity block, March2, 2012, World Wide Web: http://www.myjoyonline.com

Hospital official website. January 23, 2009, from the World Wide Web: http:// www.kathsp.org.

Kasseeah (2012). Financial constraints and leverage decisions in small and medium-sized firms. Journal of Economics and Behavioural studies vol 4, No 1, pp.55-65.

KATH on the verge of collapse…internally generated funds fail to meet high expenditure…Nation Health Insurance exacerbates situation, Prof. OheneAdjei KATH CEO (The Chronicle. February 23, 2012)

Kocherlakota, E.S. Rosenbloom and Elias S. W Shiu (1990). Cash flow matching and Linear Programming Duality

KomfoAnokye Hospital demands review in insurance tariffs, August 14, 2012. (Ghana News Agency) from the World Wide Web: http://www.ghheadlines.com

KomfoAnokye Hospital withdraws development levy, July 9, 2012 from the World Wide Web: http://www.spyghana.com/health-...

KomfoAnokye Teaching Hospital on innovative drive, February 23, 2012 (The Ghanaian Journal) from the World Wide Web: http://www.theghanaianjournal.com

KomfoAnokye Teaching Hospital request for immediate bail-out, March 1, 2012 from World Wide Web: http://www.spyghana.com; August 1, 2012 from the World Wide Web: htpp://www.joyonline.com

Komfo-Anokye Teaching Hospital Directorates. Retrieved March 12, 2007 from the World Wide World: http:// www.kathksi.org/ directorates.htm

Linear Programming.Managerial Economics in a Global Economy.

Ministry of Health stops KATH development levy, July 8 from the World Wide Web: http://www.myjoyonline.com

Povel and Raith (2002). Optimal investment under financial constraints: the roles of internal funds and asymmetric information.

Reeb and Leavengood.Using the simplex method to solve linear programming maximization problem.Operation Research. October 1998.

San Jose, Iturralde and Maseda (2008).Treasury management versus cash management.International Research Journal of Finance and Economics. @ Euro Journal publishing. Inc. 2008.

Shioda and Bertsima (2002).Restaurant revenue management. Sloan school of management E53-363 Massachusetts Institute of Technology Cambridge, Massachusetts 02139 dbertsim@mit.edu

Talavera, Caglayan, Ozkan and Baum (2004).The impact of macroeconomic uncertainty on cash holdings for non-financial firms.

Weissensteiner and Ferstl (2007).Cash management using multi-stage stochastic programming.

Yamashita. Cash management with futures in passive investment

Zhang and Junli (2011).The relationship between working capital management and corporate cash holdings.University of Eastern Finland.Faculty of Social Science and Business studies.

Definition of Production Scheduling by Laura Acevedo, eHow Contributor

Linear Programming Applications WEB CHAPTER B (pg 10, pg 14)