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Minimizing healthcare cost in selected tertiary institutions in Nigeria

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Abstract

Research Problem: *Healthcare and health insurance are words often used interchangeably but the former is much wider than the later when used in a University system. The proposed review of the health insurance cost by theNational Health Insurance Scheme (NHIS) in the year 2018 call for this study to investigates healthcare cost in tertiary institutions in Nigeria.*

Methodology: *We proposed a linear programming model as an optimization solution to minimize healthcare cost in tertiary institutions in Nigeria. This studyused mathematical assumptions and data sourced through questionnaires and interviewsto determine the decision parameters on the linear programing model to minimize healthcare cost. The main aim of the study was to investigate if linear programming is a satisfactory representation in healthcare cost minimization model. The Cronbach's alpha value was used to test the consistency, validity and reliability of the data and the assumptions adopted in the study. To achieve the objective, research questions and linear programming models were formulated and the appropriate variables were proxies as healthcare cost are distilled from related literatures.*

Findings: *To answer the research questions, the calculated value from the linear programming solver was used to compare the study expected healthcare cost incurred by the selected tertiary institutions at time t. It was revealed that the acceptance of the alternative hypothesis and the linear programming is a satisfactory representation for minimizing healthcare cost.*

Conclusion:*The study therefore conclude that cost reduction should be redistributed to the participating insured, so as to make health insurance business a risk minimizing institution and not a profit maximization centre, as practiced by various Health Management Organisations in Nigeria.*

Keywords*:1 Healthcare cost,2 linear programming,3 minimization, 4tertiary institutions*

1.0 Introduction

As the number of institutions increase in Nigeria, healthcare cost, health insurance and the healthcare delivery system become essential for the growth of tertiary institutions.Healthcare cost accounts for a significant portion of the annual budget of many tertiary institutions in Nigeria. Apart from the high cost incurred by tertiary institutions, healthcare cost modelling for tertiary institutions has not been on the mainstream of operational research in Nigeria.

Due to the high costs involved in healthcare delivery and the forecasted increase in the demand, efficient allocation of healthcare resources has become more crucial. Decision making in healthcare system as regard healthcare cost in tertiary institutions in Nigeria is a complex and critical process that requires absolute screening and rescreening of healthcare cost variables. Healthcare cost variables and modelling have becomean attractive research application area for Operations Researchers in Nigeria's tertiary institutions.

Healthcare cost (in this study) is the cost incurred by tertiary institutions in providing healthcare to staff and students of the institutions. Due to the complexity of healthcare cost determinants, the health insurance variables have become a core issue discussed by professionals and researchers across the globe, especially during the period of the global lockdowndue to the Corona virus pandemic (COVID-19).

Nigeria, as a developing nation, has a healthcare cost that is extremely high. Such healthcare cost is crucial and it affects tertiary institutions' budget as health provision for both academic and non-academic staff as well as the students. Itisalso important for the continuous running of the university system. A high or low healthcare cost affects institutional budget either positively or negatively.

Since the cost of healthcare cannot be overemphasised, there is therefore a need to maximize healthcare service delivery and to minimize the cost across selected institutions in Nigeria.

As the world advances, financial and non-financial institutions use data science techniques in modelling and to minimize costs. As the issue of COVID-19 rises, most Health Management Organisations (HMOs) in developing nations focus on profit maximization rather than risk management or minimization.

In this twenty-first century, most quantitative modelling or algorithms in management sciences are done with Financial Technology (FINTECH) to avoid the possibility of wrong modelling. With appropriate modelling, developed nations like the United States compensate the insured if they do not suffer loss within a specified period of time so as to maintain business relationship and position insurance firms as risk management institutions. However, many health insurance payers in private and public institutions in most developing nations like Nigeria have never enjoyed cost reduction in health insurance premium or fee for service as a result of low service utilization of health insurance services. The initial introduction of health insurance in Nigeria have over time failed to address insurance as a risk management institution, but rather than a profit centre where parties involved are interested in hedging andprofit.

Derivatives and finance literaturespostulate that hedging is put in place to reduce risk and not for profit maximization (John-Hull, 2008). Formulating an appropriate model for cost determinants is therefore an avenue to showcase risk reduction and cost minimization and not profit maximisation.

1.1 The Importance of Healthcare

One of the primary goals of health insurance is to make healthcare available to all. The cost of health insurance usage in Nigeria's high institutions is very highand most health insurance marketers apply marketing strategies to win customers. This has prompted series of debatesamong scholars as to the likelihood of which healthcare insurance cost by Nigerian institutions can be reduced.

In 2018, the National Health Insurance Scheme (NHIS), basedin Nigeria,set to review health insurance premium charged by the HMOs. This indicates that the health insurance premium was not empirically beneficialin terms of cost, thus making Nigerians to believe that health insurance premium in Nigeria does not reflect all available information of the primary variables used in modelling the cost. In this study, we looked at the total cost incurred by selected institutions in Nigeria and how such costs can be minimized if tertiary institutions are taken as a unified set.

1.2 The Underlying Theories

Economics and finance theoriespostulate that risk minimization is the core motive for hedging. The hedgers pay a risk premium to speculate for assuming risk while the conventional theory states that the additional healthcare purchased as a result of becoming insured is an opportunity price. Based on these theories, the study assumes that the coming together of two or more institutions with similar parameters in their healthcare cost determinants can minimize cost.

High variances in health insurance cost and low benefits on healthcare services in Nigeria had made the World Health Organization (2017) to rate Nigeria as the third in the list of countries with the highest infant mortality in the world. In the year 2010, the World Health Organization rank Nigeria as 197out of 200 nations in health service provision. A simple analysis shows that there is a decline of 1% from the

1990s to 2010. The Health Insurance Report (2016) states that Nigeria's costs for health insurance averaged USD 8,053 for 2016, placing it in the 63rd position in the world. This indicates that the cost of health insurance in Nigeria is high compared to her other African counterparts like South Africa.
The foregoing narrative shows that in Nigeria, as health management organisations crave for profit maximization, health insurance payers hardly maximize benefits,neither do they minimize their insurance cost. Therefore, in order to minimize healthcare cost in tertiary institutions in Nigeria, the health insurance professionals need to analyze some factors or variables that are determinants of the cost.

2.1Literature
John (1994) states that insurance firms in Germany compensate individuals holding different insurance policiesafter five years of consistent insurance premium with no loss suffered. Many health insurance policy holders in Nigeria have constantly paid health insurance cost, with low or no healthcare service utilization, but they have never been compensated by health insurance firms in Nigeria. Health insurance policy holders with life insurance policy, personal medical insurance and of age pay more than those with no insurance policy. In Nigeria, no health insurance firms compensate health insurance policy holders for low or no health care service utilization. The cost for health insurance increases often based on government policies and market anomalies.
The Health Insurance Association of America states that health insurance is a coverage that provides for the payments of benefits as a result of sickness or injury. This includes insurance for losses from accident, medical expenses, disability or accidental death and dismemberment. Health insurance is also an insurance that covers the whole or a part of the risk of a person incurring medical expense, or spreading the risk over a large number of persons. By estimating the overall risk of healthcare and health system expenses over the risk pool, an insurer can develop a routine finance structure, such as a monthly premium or payroll tax, to provide the money to pay for the healthcare benefits specified in the insurance agreement. The benefit is administered by a central organization such as a government agency, a private business, or a not-for-profit entity. For any health insurance agreement, there must be a health insurance policy in place.
A health insurance policy is a contract between an insurance provider (an insurance company or a government) and an individual or his/her sponsor (an employer or a community organization). The contract can be renewable (annually, monthly) or lifelong, in the case of private insurance, or mandatory for all citizens, in the case of national plans. The type and amount of healthcare costs that will be covered by the health insurance provider are specified in writing, in a member contract or "Evidence of Coverage" booklet for private insurance, or in a national health policy for public insurance. The health insurance policy contains a capitation payment.
The health insurance cost is an amount paid by an insurer to a health care provider, for which the provider agrees to treat all members of the insurer. Alternatively, members of the insurer (insured) are required to pay a fraction of the health insurance cost for their health maintenance and they are categorized in groups based on age, income, gender, location and position. Since health insurance cost is spread over a risk pooled individual, the service utilisation does not follow a normal distribution.

2.2 Linear Programming
Linear Programming is a mathematical model used for cost minimization or profit maximization based on the circumstances surrounding the problem. When data are insufficient, the use of assumptions to model linear programming problem becomes necessary.

2.3 Healthcare Cost
Studies on healthcare costhave not been well-explored and documented (Long & Marquis, 2002). Scholars like Trujillo (2003), Liu and Chen (2002), and Cameron and McCollum (2015) used marital status to justify the opinion that the cost of health insurance varies for single individual than for a married couples. Their studies found out that married couples buy more health insurance coverage of any kind, and those gainfully employed also take health insurance coverage more than the unemployed. The study of Pauly and Herring (2001) concluded that the cost of health insurance or premium has a significant influence on the demand for health insurance as the income of the insured is important in taking a decision. Adewole, *et al*(2015) concluded in their findings that distance affect healthcare service and cost for insured individuals. Their reason being that the payment for health insurance in the rural area is difficult as most healthcare providers are in the urban area while Kronick and Gilmer (1999) observed that healthcare cost as always been on the increase and thus influence the decision maker to participate in a given healthcare insurance programme where his or her income is constant. Backnighausan and Asunso (2018) used age, marital status and sex to find the impact of people's decision

between professional healthcare and non-professional care. Their study concluded that age, marital status and sex affect people's decision and that the use of awareness campaign might increase the use of medical services among people with different demographic factors. Kiriga (2005) observed the relationship between health insurance consumption and the various social, economic and demographic characteristics of South African women, and the conclusion is that there is a linear relationship while marital status was found to have a significant positive effect on the demand for health insurance. Kiriga(2005) and Liu and Chen(2002)conclude that married couples demand health insurance more than the unmarried because of the need to protect their children and avoid the risk of unaffordable health expenses. Ibok (2016) stated that religious faith of the people have been investigated and found with empirical evidence that this affect health insurance consumption. Juetting (2003) found a significant relationship between Catholicism and health insurance consumption. On the other hand, access to health insurance information through either the print or broadcast media were found to positively and significantly affect health insurance patronage. However, Islam and Banowary (2009) observed that most family planning messages and health-related information was disseminated via the broadcast media. Accordingly, they found the television as the most effective medium in disseminating health-related information than any other medium.

Health insurance consumption should rise with income because a person's consumption and human capital typically increase along with income thereby, creating a demand for insurance in order to safeguard the income potential of the insured. Trujillo(2003) observes that education is undoubtedly an important determinant of the consumption of health insurance. Similarly, occupation, sex, and family size were found to be robust predictors of health insurance consumption (Temple, 2002).

Madura (2010), in his book on financial markets and institutions, stated that health insurance companies do not compensate the beneficiary of a policy upon the policyholder's death. They charge policyholders a premium that should reflect the probability of making a payment to the beneficiary as well as the size and timing of the payment. The idea of health insurance was derived from Life insurance companies. Life insurance also commonly offers employees of a corporation a group life policy. Theoretical models for the demand for life and health insurance have been established by 'Yaari (1965), Fischer (1973), Karni and Zilcha (1985, 1986), Lewis (1989) and Bernheim (1991) where the view of life insurance was the way by which risk in the household's income, linked to the expected premature death of a holder's primary wage earner, was decreased (Prosper, 2016). Browne and Kim (2003) used correlation to find the relationship between payment paid for insurance and the insured level of income and found out that the higher the level of income the higher the chance of demanding for insurance. Ibok (2016) stated that demand for health or life insurance varies inversely with the amount of wealth an individual possesses.

Beck and Webb (2003) used econometrical analysis to promote that insurance companies play important role in the financial sector; they used macroeconomic variables to test the relevance of insurance in a macroeconomic setting. Their study concluded that insurance affect the macroeconomic sector of any economy.

Bekaert and Harvey (2017) conducted a research in China on the effect of a cost on health care delivery by insurance firms covering the period 2000-2004. The result showed a positive impact of a cost on healthcare delivery. It shows that whenever there is an increase in healthcare delivery, there is a reduction in healthcare cost. Freshiaand Pauline (2016) states that the use of linear optimization model to model health insurance cost yield positive results. This was concluded by extracted data from Nairobi Health Insurance Market regarding five important sectors for the period where multiple regressions model for analysis was used. The study also shows that variables that are determinants of health insurance have a quantum of information which healthcare professionals take advantage of.

Ali and Ishtiaq (2018) found out that volume, distance and age are relevant in linear modelling of health insurance cost. The study also concluded that all stakeholders closely watch variables used by health insurance professionals in modelling health insurance cost. Sakine and Mehme (2013) used optimization model to solve the problem of healthcare delivery and designing of healthcare policies. Their study shows the different use of optimization techniques such as discrete convex analysis, stochastic programming and approximate dynamic programming in these areas.Samad and Irfan (2017) used optimization modelling for healthcare delivery and allocation for decision making.

2.4 Gaps in the Study, Identification of Decision Variable Parametersand the Study Hypothesis

There is the need to find out the variables needed to minimize health insurance cost in tertiary institutions in Nigeria. The effects of healthcare cost in tertiary institutions cannot be underestimated as healthcare cost is expenditure, and its impact is quite big. It is therefore important to investigate this paradoxical situation. Many studies have considered variables such as income, marital status, distance, sex, age and income in determining healthcare cost. These variables are good but they have not been used to minimize healthcare cost in tertiary institutions in Nigeria.Madura (2010) opined that health insurance does not compensate for death.This study has gone beyond existing literature by trying to fill the gap of

redistributing the variance obtained from the actual healthcare cost and the expected healthcare cost in tertiary institutions in Nigeria and testing if linear programing is the appropriate modelling tool.

3.1 Methodology

Optimization is one of the widely used Operations Research methodologies in modelling and solving healthcare operations management problems. Linear programming is a minimization model adopted in this study as a result of the cost problem the study attempts to solve and the hypothesis raised from the gap identified in the literature. The study used a population of 90 tertiary institutions in Nigeria. These institutions were coded on a sampling frame with T_1, T_2, T_3...T_{90}. The sample size was determined from the sampling frame using a conveniencenon-probability sampling method to obtain the sampling fraction of 9/90=1/10. The sample size was used to model the constraints equations for each selected tertiary institutions while data was collected with questionnaires and interview methods. The data collected was tested for reliability, consistency and validity with Cronbach's alpha. The methodology applied in this study has been proposed by Sakine and Mehme (2013) and Samad andIrfan (2017) as an optimization model suitable in healthcare delivery and health insurance research.

3.2 Model Formulation

Linear programming can be applied to various fields of study. It is widely used in mathematics and to an extent in business, economics, finance and insurance and for some actuarial problems. It has proven useful in modelling for diverse problems in planning, routing, scheduling, assignment, etc. In order to obtain a minimization solution, theparameters and linear programming model for the study wasformulated as follows:

Decision Parameters:

$\lambda_1 = (volume) population\ of\ tertiary\ institutions\ \ j$

$\lambda_2 = (distance) distance\ in\ kilometers\ between\ tertiary\ institution\ j\ and\ hospital$

$\lambda_3 = (NHIS\ fee) the\ minimum\ account\ paid\ by\ insured\ in\ tertiary\ institution\ j$

$\lambda_4 = (age)\ minimum\ age\ of\ the\ insured\ in\ tertiary\ institution\ j$

$\lambda_5 = (income) minimum\ wage\ of\ insured\ in\ tertiary\ institution\ j$

$\lambda_6 = (sex)\{total\ value\ of\ married\ insured, 0\ otherwise\ for\ tertiary\ institution j\}$

$\beta_{ij} = are\ coefficients\ of\ the\ parameters\ obtained\ based\ on\ certain\ assumptions$

$C_{vd1} = healthcare\ cost\ incurred\ by\ institution\ j$

MIN. C= $\boldsymbol{\beta_1\lambda_1 + \beta_2\lambda_2 + \beta_3\lambda_3 + \beta_4\lambda_4 + \beta_5\lambda_5 + \beta_6\lambda_6}$(Objective Function)

Subject to the constraints:

$\beta_{11}\lambda_1 + \beta_{12}\lambda_2 + \beta_{13}\lambda_3 + \beta_{14}\lambda_4 + \beta_{15}\lambda_5 + \beta_{16}\lambda_6 \geq C_{vd1}$(i)

$\beta_{21}\lambda_1 + \beta_{22}\lambda_2 + \beta_{23}\lambda_3 + \beta_{24}\lambda_4 + \beta_{25}\lambda_5 + \beta_{26}\lambda_6 \geq C_{vd2}$(ii)

$\beta_{31}\lambda_1 + \beta_{32}\lambda_2 + \beta_{33}\lambda_3 + \beta_{34}\lambda_4 + \beta_{35}\lambda_5 + \beta_{36}\lambda_6 \geq C_{vd3}$(iii)

$\beta_{41}\lambda_1 + \beta_{42}\lambda_2 + \beta_{43}\lambda_3 + \beta_{44}\lambda_4 + \beta_{45}\lambda_5 + \beta_{46}\lambda_6 \geq C_{vd4}$(iv)

$\beta_{51}\lambda_1 + \beta_{52}\lambda_2 + \beta_{53}\lambda_3 + \beta_{54}\lambda_4 + \beta_{55}\lambda_5 + \beta_{56}\lambda_6 \geq C_{vd5}$(v)

$\beta_{61}\lambda_1 + \beta_{62}\lambda_2 + \beta_{63}\lambda_3 + \beta_{64}\lambda_4 + \beta_{65}\lambda_5 + \beta_{66}\lambda_6 \geq C_{vd6}$(vi)

$\beta_{71}\lambda_1 + \beta_{72}\lambda_2 + \beta_{73}\lambda_3 + \beta_{74}\lambda_4 + \beta_{75}\lambda_5 + \beta_{76}\lambda_6 \geq C_{vd7}$ (vii)

$\beta_{81}\lambda_1 + \beta_{82}\lambda_2 + \beta_{83}\lambda_3 + \beta_{84}\lambda_4 + \beta_{85}\lambda_5 + \beta_{86}\lambda_6 \geq C_{vd8}$ (viii)

$\beta_{91}\lambda_1 + \beta_{92}\lambda_2 + \beta_{93}\lambda_3 + \beta_{94}\lambda_4 + \beta_{95}\lambda_5 + \beta_{96}\lambda_6 \geq C_{vd9}$ (ix)

$\lambda_{a..z} \geq 0$

Rewriting the linear programing models in matrix form:

$$\begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13}\beta_{14} & \beta_{15} & \beta_{16} \\ \beta_{21} & \beta_{22} & \beta_{23}\beta_{24} & \beta_{25} & \beta_{26} \\ \beta_{31} & \beta_{32} & \beta_{33}\beta_{34} & \beta_{35} & \beta_{36} \\ \beta_{41} & \beta_{42} & \beta_{43}\beta_{44} & \beta_{45} & \beta_{46} \\ \beta_{51} & \beta_{52} & \beta_{53}\beta_{54} & \beta_{55} & \beta_{56} \\ \beta_{61} & \beta_{62} & \beta_{63}\beta_{64} & \beta_{65} & \beta_{66} \\ \beta_{71} & \beta_{72} & \beta_{73}\beta_{74} & \beta_{75} & \beta_{76} \\ \beta_{81} & \beta_{82} & \beta_{83}\beta_{84} & \beta_{85} & \beta_{86} \\ \beta_{91} & \beta_{92} & \beta_{93}\beta_{94} & \beta_{95} & \beta_{96} \end{bmatrix} \begin{matrix} \\ \boldsymbol{\lambda_1} \\ \boldsymbol{\lambda_2} \\ \boldsymbol{\lambda_3} \\ \boldsymbol{\lambda_4} \\ \boldsymbol{\lambda_5} \\ \boldsymbol{\lambda_6} \\ \\ \\ \end{matrix} = \begin{matrix} C_{vd1} \\ C_{vd2} \\ C_{vd3} \\ C_{vd4} \\ C_{vd5} \\ C_{vd6} \\ C_{vd7} \\ C_{vd8} \\ C_{vd9} \end{matrix}$$

Table 1**: Assumptions on the Parameter Estimates of the Linear Programming Model**

Variables	**Description for Mathematical Computations**
Volume or Population	We assume that volume parameters of each institution selected can be calculated by dividing NHIS benchmark by institutional volume.
Distance	We assume that the distance from insured home to the healthcare centre is 5 kilometers. To find the distance parameter, we divide the sum of the distance (45 km) by institutional volume.
NHIS Benchmark	We assume that 1,150 naira is the minimum price paid per insured as the NHIS benchmark
Age	We assume that the least age of person working in the institution is 18years. To find Age parameter, we divide 18 by institutional volume.
Income	We take the minimum wage in Nigeria as the average income. To find the income parameter, we divide the Average income by the institutional healthcare total cost.
Sex proxy with number of married insured.	We assume only married insured. To find the parameter for sex, we divide each institution married insured by each institutional volume.
Objective Function Parameters	We obtained our objective function by dividing each institutional healthcare cost by each decision variables.

Source: Researchers' idea from available information from questionnaires and interview

Table 2**: Test for Reliability, Validity and Consistency of the Data with Cronbach's alpha.**
Since assumptions are used alongside limited data, the study checked for the consistency of the data.

Case Processing Summary			
		N	%
Cases	Valid	9	100.0
	Excluded[a]	0	.0
	Total	9	100.0
a. Listwise deletion based on all variables in the procedure.			

Reliability Statistics		
Cronbach'sAlpha[a]	Cronbach's Alpha Based on Standardized Items	N of Items
.750	.748	6

Source: SPSS Output

Table 3:**Summary of Raw Data and Assumptions to Compute Constraint Values**

INSTITUTIONS	**VOLUME**	**DISTANCE (KM)**	**HNIS BM**	**AGE**	**INCOME**	**SEX**
I	1702	5	1150	18	30000	1428
Ii	851	5	1150	18	30000	556
Iii	289	5	1150	18	30000	258
Iv	301	5	1150	18	30000	278
V	256	5	1150	18	30000	198
Vi	336	5	1150	18	30000	293
Vii	213	5	1150	18	30000	171
Viii	228	5	1150	18	30000	152
Ix	102	5	1150	18	30000	53
SUM	**4278**	**45**	**10350**	**162**	**270000**	**3387**
Constraint Variables	β_1	β_2	β_3	β_4	β_5	β_6
model i	0.675676	0.002938	0.038333	0.010576	0.693642	0.839013
model ii	1.351351	0.005875	0.038333	0.021152	0.693642	0.653349
model iii	3.979239	0.017301	0.038333	0.062284	0.693642	0.892734
model iv	3.820598	0.016611	0.038333	0.059801	0.693642	0.923588
model v	4.492188	0.019531	0.038333	0.070313	0.693642	0.773438
model vi	3.422619	0.014881	0.038333	0.053571	0.693642	0.872024
model vii	5.399061	0.023474	0.038333	0.084507	0.693642	0.802817
model viii	5.043860	0.021930	0.038333	0.078947	0.693642	0.666667
model ix	11.27451	0.049020	0.038333	0.176471	0.693642	0.519608
OBJECTIVE VALUES	1010	9611	4178	2669	1601	1276
FORMULARS:	β_1= NHIS BM/VOLUME					
	β_2=DISTANCE/VOLUME					
	β_3=NHIS BM/INCOME					
	β_4= AGE/VOLUME					
	β_5= INCOME/TOTAL EXPECTED COST					
	β_6= SEX/VOLUME (SEX=MARRIED INSURED)					
	OBJECTIVES VALUES=EXPECTED COST/SUM OF VARIABLE					
	NOTE: NHIS BM IS ASSUME ₦1150					
	EXPECTED COST ₦4325000					

Source: Researchers'computations with Microsoft Excel using available data and mathematical assumptions.

Table 4:**Data Presentation in Linear Programming Format for Optimization Solver**

DECISION VARIABLES	λ_1	λ_2	λ_3	λ_4	λ_5	λ_6			
Z							**objectives**		
cost	1010	9611	4178	2669	1601	1276			
Constraint Variables									
model 1	0.675676	0.002938	0.038333	0.010576	0.693642	0.839013		=>	1500
model 2	1.351351	0.005875	0.038333	0.021152	0.693642	0.653349		=>	1750
model 3	3.979239	0.017301	0.038333	0.062284	0.693642	0.892734		=>	1666
model 4	3.820598	0.016611	0.038333	0.059801	0.693642	0.923588		=>	1550
model 5	4.492188	0.019531	0.038333	0.070313	0.693642	0.773438		=>	1800
model 6	3.422619	0.014881	0.038333	0.053571	0.693642	0.872024		=>	1700
model 7	5.399061	0.023474	0.038333	0.084507	0.693642	0.802817		=>	1950
model 8	5.04386	0.02193	0.038333	0.078947	0.693642	0.666667		=>	1450
model 9	11.27451	0.04902	0.038333	0.176471	0.693642	0.519608		=>	1650
Special constraints									
λ_1	1							>=	1500
λ_4				1				>=	1800
λ_6						1		>=	1650
Non-negative constraints									
λ_1	1							>=	0
λ_2		1						>=	0
λ_3			1					>=	0
λ_4				1				>=	0
λ_5					1			>=	0
λ_6						1		>=	0

Source: Computed with Microsoft Excel

$\lambda_{1..6} \geq 0$

4.1 Results and Discussions

Because of the significance of healthcare cost optimization in tertiary institutions in Nigeria, we proposed a linear programming method. We test the reliability, stability and consistency of the data using Cronbach's Alpha. We found out that the Alpha value is 0.750. This indicates that 75% of the data scales is reliable. From the test of the hypothesis, we can deduce that the estimated cost for the nine institutions used in the study was ₦43, 250,000 while the minimization cost was ₦12, 690,000. This indicates that the linear programming model of optimization gives optimal result. From the foregoing, the findings of this study can be linked with other studies to conclude if the result can be generalized. Bekaert and Harvey

(2017) found out that models can be adjusted to optimize cost. From the findings of this study, it can be seen that the models stated were adjusted based on some assumptions. The application of the theoretical assumption aids the optimization of the model. It is therefore concluded that the finding of this study corroborate the findings of Bekaert and Harvey (2017) that cost can be minimized. Freshiaand Pauline (2016) advanced that the use of linear optimization model to model health insurance cost yield positive results. The issue of positive result infers that the health insurance cost estimated value is greater than the health insurance calculated value. However, the variables used as determinants of health insurance consumption cost are volume, distance, age and sex. Ali and Ishtiaq (2018), found out that volume, distance and age announcements are relevant in linear modelling of health insurance cost. The study also concluded that all stakeholders closely watch variables used by health insurance professionals in modelling health insurance cost. The conclusions of Ali and Ishtiaq (2018), shows that there is a linear relationship between the variables and finding of this study and that of Ali and Ishtiaq (2018). The study objective value of ₦12, 690,000 was matched with the estimated value of ₦43,250,000 for the alternative hypothesis to be accepted, indicating that linear optimization is a satisfactory representation of health insurance consumption cost. In the limit report, the values of the lower limits were the same with the value of the special constraints variables and there were no value for the upper limits in the variables. The sensitivity report shows the cost reduction for three models used in the study. The solver report shows status for three binding variables, indicating that those variables are the decision variables that optimized the models.

5.1 Conclusion

We offer a linear programming model to minimize healthcare cost in tertiary institutions in Nigeria. Our variables and parameters used take precedence from previous studies. The goal of our study was to find out if linear programing model was a satisfactory representation for healthcare cost minimization in tertiary institutions in Nigeria. In this study, we selected nine tertiary institutions using a convenience sampling method. We determined the parameters that are likely to affect the healthcare cost by using available data sourced from questionnaire administration and interview alongside some mathematical assumptions. Based on the findings of this study, weconcluded that healthcare cost in Nigerian tertiary institutions is very high due to wrong modelling. However, previous researches on the health insurance has not taken into explicit consideration the issue of combining firms or institutions with similar characteristics to increase volume and optimize cost. To the best of the researchers' knowledge, little empirical work has been carried out to specifically analyse healthcare cost using linear programing method. This study thus presents a model exploring the joint contribution of these variables in modelling healthcare cost for health insurance consumption in Nigeria. From the analysis carried out in the study, there is a reduction of cost when compared with the estimated total cost paid by the selected institutions. With the passage of time when modelling of healthcare cost reflect information for policy holders, appropriate modelling for cost optimization will become more pronounced. However, the limitations of this study may be the number of tertiary institutions used to generalize the findings, the mathematical assumptions applied, the method of data collection and the variables used. It is therefore suggested that further researches should be carried out by academic scholars in this field.

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