COMPARISON OF GSM PROMOTION SUBSCRIBERS' APPLICATION SERVICES

By

AMUCHE, OCHIGBO BENEDICT,
Reg. No: PG/MSC/11/59582

Being an MSc project report submitted in partial fulfillment of the requirements for the award of a Master of Scienceôs degree in Computer Science of the University of Nigeria, Nsukka.

SUPERVISOR: PROFESSOR BAKPO, F. S.

Department of Computer Science,
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CERTIFICATION PAGE

I, Amuche Ochigbo Benedict, hereby declare that the work presented herein was done by me, and not by a third party. Should I be convicted of having cheated in this work, I shall accept the verdict of the university.

AMUCHE, OCHIGBO BENEDICT

(Reg. No: PG/MSC/11/59582)

APPROVAL PAGE

This project has been approved by the Department of Computer Science, University of Nigeria, Nsukka

By

_____	_____
PROF. BAKPO F.S	**PROF. BAKPO F.S**
Supervisor	Head of Department
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External Examiner	Internal Examiner

_____

Dean, Faculty of Physical Sciences

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DEDICATION

This work is dedicated to Almighty GOD who guides, protects, loves, supports and encourages me during the period of this research. May HIS name be praised.

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ABSTRACT

The degree of confusion/illusion and domestic revenue wastages by GSM subscribers due to GSM promotional products increase annually. The GSM network operators are often ingenious and are typically motivated by money, anonymity or both. Due to the rising competition in the GSM promotion, network operators are becoming more collaborative, and as a result, more ingenious. Because of this, comparison of GSM promotion subscribersô application services is required as an advisor to keep pace with the numerous promotional products churn out by GSM Operators regularly. A system to compare GSM promotion subscribers in changing GSM operations with high impact on time is proposed. The study uses Scheffeôs Method of Pair Wise Multiple Comparison techniques to detect the significant differences between the subscribersô data and rank the alternatives to determine the best promotion and applied the multivariate analysis in evaluating the last releases to help us improve the processes. The system compares the potential and profitable GSM promotion subscriptions drawn from twenty states across the six geo-political zones in Nigeria for effective decision making. The system has been developed using AJAX for UI, JAVA as a development language, Netbeans as a development environment and Microsoft Visio as an UML tool for analysis & design. The analysis of the data shows a reasonably strong correlation between the input variables. The result shows that more than 87% of the outputs were accurate. From the result that has been produced, multivariate analysis and Scheffeôs Method of Multiple Comparison has the potential to be used for comparing GSM promotion subscriptions.

CHAPTER ONE

INTRODUCTION

1.1 Background

GSM promotion subscribers are increasing and changing frequently resulting in higher degree of confusion in comparison and selection of the right GSM operators that provides low tariff promotion products, hence, the loss of billions of domestic revenue worldwide annually by different subscribers. The history of GSM promotion was reviewed by Coyles and Gokey (2005). The promotion subscribersô comparison is the act or process of examining two or more set of promotion subscribers in order to discover similarities and differences between them. The GSM promotion subscribersô comparison is an identified process for examining two or more set of GSM promotion subscribers in order to discover similarities and differences between them. It has identified itself as one of the remedies for domestic revenue wastage by subscribers.

According to the International Journal of Business and Social Sciences; The Determinants of Customer Loyalty in Nigeriaôs GSM Market; Volume 3, No 14, page 210 *(Special Issue – July 2012)* - The explosive growth rate in the market has thrown up intense rivalry among the GSM operators and necessitated the need to engage in marketing activities that would enable them to retain a large chunk of their customers and make them loyal. The resultant competition has led to the reduction in tariff, introduction of new and innovative products, advertising blitz, rising sales promotion, and innovative customer service. The choice of these promotion products and subscription in GSM networks has been a problem that has always beleaguered the base line of subscribers who are interested in different packages according to their requirements/benefits.

According to Deng et al (1998) the ability of a service provider to create high degree of satisfaction is crucial for subscription differentiation and developing strong relationship with the user. The lure of this satisfaction derived from promotion subscription differentiation and development turns many people into an ocean of confusion/illusion facing the stress of which network and/or package to subscribe to.

With the competition becoming tough, service providers realized that retaining oneôs existing customer base is important as much as the acquiring of a new customer (Coyles and Gokey (2005)). The situation, according to Long and Chun (2004) makes mobile telecommunication companies not only to promote their service quality, but also change their marketing core strategy to holding their existing customers by enhancing and optimizing the customer loyalty. In the light of this intense competition, the major challenge confronting all the mobile operators in Nigeria, therefore is the determination, comparison, selection and execution of promotion subscriptions that would not only lead to attraction of new subscribers, but also retention of the existing ones who would then become loyal customers. This generated strong argument on the quest for subscription differentiation and development as identified by Deng et al. Consequently, great number of GSM promotion products is released on the daily basis. Considering this, there is a need for the comparison of GSM promotion subscribers which is basically ignored in our society and cause a lot of damages to mobile network operatorsô financial and customer base, rendering subscribers to change service providers regularly.

Price plays a vital role in telecommunication market especially for the mobile telecommunication service providers (Kollmann (2000)). Customers can suffer from indiscriminate tariff/service charges due to loss of confidence in benefits attached to a particular promotion package and can also experience óovercharged billsô (that is, bills that could be ordinarily lesser if the right promotion package is subscribed to) due to lack of loyalty to a particular GSM promotion provider that serve them best at a given period. It is therefore necessary according to Gustafsson et al. (1998) for a telecommunication service provider to concentrate on the improvement of service quality and charge appropriate fair price in order to satisfy its subscribers which will ultimately help in retaining them. Hence, proper comparison of these essential promotion subscribers has become inevitable so as to estimate and engage those with fair prices.

On the other hand, Ahn et al (2003) noted that users get satisfied to a brand more if they get all the needed services accumulated in that very brand. Consequently, subscribers attach themselves to those brands that usually provide the needed and

accumulated qualities. Therefore, there is a need for both network operators and potential subscribers to have an effective, current, fast and accurate automated system that should be able to compare different set of promotion subscribers (considering all the embedded and accumulated services) with each other within or between networks.

Nigeria has maintained its lead as Africanôs largest telecom market with active subscribers of 92,006,608 by the end of February, 2012 (Nigerian Communications Commission (2012), relegating South Africa to second place with about 60 million subscribers. This represents a tele-density of 68.68% up from a tele-density of 0.73% in 2001. The more we experience high growth of subscribers the more different promotion packages are developed and confusion in the choice of suitable GSM promotion service provider. More so, the high growth of subscribers resulting in impressive financial performance of the GSM providers has necessitated the need to examine the factors that minimize the rate of domestic income expenditure/wastage (on the side of subscribers) and influence customer loyalty in the market (on the side of GSM service providers).

In todayôs market, the mobile technology has been extremely competitive and service providers are moving aggressively to attract versatile subscribers by offering some meaningful attractive promotions and services. The comparison and estimation of these set of promotion subscribers become an integral part of the processes to this attraction as to enable different service providers achieve this major objective.

The image of a service provider is also a consideration to a subscriber and according to Lambert (1999), brand plays an important role in userôs selection of service provider even when the call rate offered by that provider is high. It is therefore, an affirmation that GSM subscribers often attribute quality to branded products on the basis of price, brand reputation, store image, market share, product features and service provider. This serves as a major reason for proper comparison of the set of promotion subscribers to avoid fatal lost of domestic income due to the associated illusion created by the service providers.

The mobile operators are concerned about changes in usersô behavior in response to its service offerings. Hence any development in the telecom sector is of great concern

to the mobile subscribers and the mobile operators and it is physically seen in promotion subscriptions which models directly the needs and benefits of the promotion to different subscribers. The comparison, estimation and engagement of these promotion subscription become an integral part of the reaction to this effect as to enable different service providers achieve their major objective.

The aim of this project is to develop a system to compare the set of GSM promotion subscribers within large quantity and camouflaged GSM promotion services providers. In particular, this study focused on the identification of promotion services providers whose behaviour has made Nigerian mobile subscribers to appreciate more the importance of minimizing the income used on the service. For this problem the objectives was to compare and estimate promotion subscription while minimizing domestic income wastage. This study was conducted with real data obtained from Nigerian Communications Commission in Nigeria.

1.2 Statement of the Problem

The focus is to create a sophisticated system to compare and estimate GSM promotion subscribers of large quantity and camouflaged promotion products release on a daily basis by GSM promotion services providers in Nigeria.

There are a lot of limitations with the current manual systems for comparing and estimating the promotion subscription because of the huge quantity of the promotions in circulation, the increase in different promotion packages, the rise in competition among the service providers, the sophisticated nature of the products, the frequency of introduction of new products and similarities in the features of the products which have allowed each to be seen as the best, thereby confusing subscribers. However, the major problem in the promotion subscription comparison application is to choose the suitable matching technique for comparing the promotion subscription; hence, the motivation for this study by using multivariate Analysis and Scheffeôs Method of Pair Wise Multiple Comparison technique.

An efficient comparison of promotion subscription application services can help subscribers to diminish their sufferings from major revenue losses. To conquer this

problem, the subscribers to GSM Service Providers like Globacom, MTN, Airtel, Etisalat, Visafone etc. need a system that is competent in comparing and estimating a suitable promotion subscription. Therefore, the suggested Comparison of GSM Promotion Subscribers Application Services which would enable the subscribers to respond to the best and suitable GSM promotion service providers can be a tool to help improve the existing circumstances.

1.3 Objectives of the Study

The main objective of this project is to create a system to compare and estimate promotion subscriptions. The system developed should be able to:

I. Compare GSM promotion subscribersô data.
II. Compare selected GSM promotion subscriptions using multivariate analysis and Scheffeôs Method of Pair Wise Multiple Comparison technique.

1.4 Significance of the Study

The proposed research will help in the following ways;

a. The findings will provide an overview of the usage of multivariate analysis and Scheffeôs Method of Pair Wise Multiple Comparison technique for the comparison of GSM promotion subscribersô application services.
b. Quickening the process of investigation for GSM promotion subscription.
c. The domestic revenue wastages due to GSM promotion products will be minimized; hence maximizing domestic income savings for GSM subscribers, once the solution is validated and implemented.
d. The research findings will help GSM service providers to have a constant maintenance culture of their customer loyalty.
e. The research findings will create more awareness to deal with disguised/faked promotion subscriptions initiators in the GSM world.
f. Suggested solutions will add more knowledge on the ways to comparing promotion subscribers in GSM.
g. Suggested solutions can be used by the user as a recommendation in heightening the use of comparison of GSM promotion subscribersô application services model.

1.5 Scope of the Study

The scope of this project is to develop a system for comparing GSM promotion subscribers. This system will focus on comparing as many GSM promotion subscribers as possible. The system will use multivariate analysis and Scheffeôs Method of Pair Wise Multiple Comparison techniques to compare GSM promotion subscribers and also use real data provided by Nigerian Communications Commission in Nigeria.

1.6 Definitions of Relevant Terms used in the Research

1.6.1 GSM Promotion

The commercial activity or package aimed at encouraging or advertising the patronage of GSM promotional products.

1.6.2 GSM Promotion Subscribers

This is the technical words for the consumers of GSM promotional products.

1.6.3 GSM Promotion Subscribers' Data

This is statistical raw facts for the set of consumers of GSM promotional products.

1.6.4 GSM Promotion Subscribers' Comparison

The GSM promotion subscribersô comparison is an identified process for examining two or more set of GSM promotion subscribers in order to discover similarities and differences between them.

1.6.5 GSM Promotion Provider

This simply means the GSM Network Operator that is involved in rendering GSM promotional products for the subscribers.

1.6.6 Best Promotion

This is GSM operator with the largest number of promotion subscribers in a state or geo-political area or Nigeria, and high regard for time.

CHAPTER TWO

THEORITICAL BACKGROUND/LITERATURE REVIEW

2.0 Introduction

When identifying and designing the proposed system, the theoretical background and review of related literatures have been carried out. The first section describes the theoretical background concerning GSM promotion (section 2.1). In section 2.2, overview about statistical model or computer science model used by the researcher in the related area has been reviewed. The application of multivariate analysis and Scheffeôs Method of Pair Wise Multiple Comparison techniques as related to comparing GSM promotion subscriptions have been reviewed. In the same section, complexity of comparison of GSM promotion subscribersô application services methods was also reviewed. The choice of multivariate analysis and Scheffeôs Method of Pair Wise Multiple Comparison techniques was also stated.

2.1 Theoretical Background

Observing that subscribers are facing rising competition and that losses have been on the rise, comparison and selection of promotion subscribers has become a dominant factor on the faces of both subscribers and operators. Comparison of Promotion Subscribers is considered as attractive from the subscriberôs point of view, since no special equipment is needed, and the subscribersô data set in question is easily seen as a driving force for the selection and subscription.

The world of GSM progresses with a long history of competition but the creative methods engaged by operators in designing promotion products call for continuous improvements on the solutions deployed to compare the associated promotion subscribers. In spite of the fact that global GSM Operators have extorted significant amounts of money due to promotion activity in their networks, large numbers of subscribers are still not addressing this critical issue. In many cases, they even feel that such extortion does not exist. Despite the fact that one wishes that such extortion does not exist; it has eaten deep into domestic financial disposition. Domestic income losses due to GSM promotion activity are often swept under the carpet.

2.1.1 GSM Promotion

According to Kotler et al. (2010) promotion is the activities that communicate about the products or services and its potential merits to the target customers and

eventually persuades them to buy. Rowley (1994) considers promotion as one of the media which is used by organizations to communicate with consumers with respect to their product offerings. Kotler and Armstrong (2010) stated that promotion is when companies inform, persuade, or remind customers and the general public of its products. GSM promotion is a tool that can help Mobile Network Operators in the achievement of their objectives as outlined by Kotler et al and Rowley. GSM Promotion is concerned with ensuring that subscribers are aware about the network service providers and its products that are available to them. Promotions impact consumersô purchasing behavior and decisions towards that particular brand, especially during sales promotion period. Only a few have investigated the lag effect of sales promotions on brand preference and the resultant buying behavior once the promotion campaign is rescinded. GSM Promotion goes beyond mere communication of product awareness but involves inducing the subscriber to remain in the business royalty.

The rapid forces of globalization, change and competition have compelled network service providers in Nigeria to formulate marketing strategy and mix that operate beyond the present market challenges by satisfying current subscribers and entice a sizeable proportion of the target market in the long run through a continuous modification of its promotional tools. GSM Promotion is an important mix because the subscribers are informed about the new products and their attributes before they develop positive attitudes toward them. It is a way to persuade and informing the target market about the product existence and hence like the product.

Totten & Block (1994) stated that the term sales promotion refers to many kinds of selling incentives and techniques intended to produce immediate or short-term sales effects. Typical sales promotion includes coupons, samples, in-pack premiums, price-offs, displays, etc.

According to Ndubisi & Chew (2006), In term of coupon promotions, those consumers obtained coupon are entitled to get discount of the products at its original price while Gilbert and Jackaria (2002) concurring to the popularity of coupon reported that coupon is ranked last as the promotional least widely used by consumers and least

influence on product trial. Peter and Olson (1996) view trial ability as the degree to which a product can be tried on a limited basis or divided into small quantities for an inexpensive trial.

According to Schindler (1998), a price promotion that is designed to evoke attributions of responsibility could be expected to appeal to consumers more than one that does not evoke such attributions, and thus have a greater ability to create product trial among consumers.

According to Shimp (2000) ñ*Sales promotions are marketing communications activities used to encourage the trade and/or end customer to purchase or take other relevant action by affecting the perceived value of the product being promoted or to otherwise motivate action to be taken.*ò Shimp (2003) viewed sales promotion as any incentive used by a manufacturer to induce the trade or consumers to buy a brand and to encourage the sales force to aggressively sell it. Sales promotion refers to ñ*short-term incentives to encourage the purchase or sale of a product or service* (Kotler et al. (2005)). Sales promotions could be in form of monetary and non-monetary ones. These types provide both utilitarian and hedonic benefits to the subscribers. Utilitarian benefits refer to such benefits such as quality, convenience in shopping, saving in time efforts and cost (Luk and Yip (2008)). Hedonic benefits on the other hand refer to value expression, exploration, entertainment, intrinsic stimulation and self esteem (Chandon, Wansink and Laurent (2000)). According to Luk and Yip (2008) monetary promotions are incentive-based and transactional in nature and provide immediate rewards and utilitarian benefits to the customers. However, non-monetary promotions provide hedonic benefits but weaker utilitarian benefits (Kwok and Uncles (2005)).

Monetary promotion have been reported to be preferred over non-monetary promotion across all consumer goods in terms of their ability to elicit purchase intentions (Luk and Yip (2008); Kwok and Uncles (2005)). Several other studies had reported different impact of sales promotion on subscriber behavior. For example, Blatterger and Wisniewski (1989) reported that consumer gain more from price cut when buying an established up-market brand than a mass market brand. Pauwels, Hanssens and Siddarth

(2002) argued that price promotion elicits temporary changes in brand and product choices and purchased quantity for established brand in mature market. These changes are because up-market brands are associated with prestigious brand with high level of reliability, low level of risks, greater concerns for customerôs needs and stronger hedonic benefits (Luk and Yip (2008)). It is not settled in literature whether sales promotion can enhance or undermine brand preference beyond the time they are offered (Luk and Yip (2008); DelVecchio, Henard, Freling (2006)). In the light of all these arguments, an intelligent system that is capable of comparing the promotion subscriptions as a measure of the subscribersô behavior towards the promotion products will serve better.

Monetary sales promotions could lead to negative impact on brand preference and trust. This is because monetary promotion can divert attention to financial incentives which may encourage brand switching behavior, increase price sensitivity and make quality criterion less important (Aaker (1996); Manaled et al (2007)). Gedenk and Neslin (1999) argued further that sales promotion can lead to a significant decrease in brand loyalty. From the above discussions sales promotion seem to have double-edge impact on subscribersô behavior depending on the subscribersô level of commitment. A committed subscriber is less receptive of sales promotional efforts. However, a less committed subscriber is highly influenced by sales promotional efforts (Mariole and Elina (2005)). This means the GSM subscriberôs behavior is the direct measure of GSM promotion. Therefore, these findings suggest a need for more research on comparison of GSM promotion subscribersô application services in Nigeria.

2.1.2 Types of GSM Network Promotion

Unique to each case, it is almost impossible to classify GSM network promotion products, often resulting in unconstructive oversimplifications. Instead, classification is based on the types of network providerôs products and services that are released. One can subsequently observe a set of well-defined traits; this can be the defining parameters of

each promotion product with respect to the network providers in Nigeria (Glo, MTN, Etisalat, Airtel, Visafone etc).

2.1.2.1 Type of Glo Promotion

Table 2.1a below has the detail of all the major GLO promotion products.

Table 2.1a: Description of GLO promotion products

Promotion	Description	Benefits	Disadvantages	Price
G-BAM HI 5ive	G-Bam Hi 5ive allows subscribers to call five special numbers at only three kobo per second. It offer...	Very innovative and mind blowing package....	All benefits are available at a daily access fee of N5 only....	
Yan-Me-More	Glo Yan-Me-More offer is a prepaid tariff plan which rewards the customer daily with lower rates for...	Very affordable and no daily access charge....	Tariff is enjoyed only after the 1st 60 seconds of the day at 55K/s ...	
Glo Flexi	Flexi is a revolutionary prepaid dynamic tariff plan that offers unprecedented discounts to ...	Subscribers are free to register or unregister from Glo Flexi at any time...	...	

Infinito	The NEW GLO INFINITO is a ñNo Conditionsò 25k flat rate tariff plan for all prepaid customers. Gl...	-No Conditions -No Monthly, Weekly or Daily Rentals - Huge Savings on calls -Free Calls from Midni...	...	

2.1.2.2 Types of MTN Promotion

Table 2.1b below has the detail of all the major MTN promotion products.

Table 2.1b: Description of MTN promotion products

Promotion	Description	Benefits	Disadvantages	Price
FAMILY & FRIENDS XPANDED	No access fee Migration is via USSD. First migration is free while subsequent ones are charge...	Family and Friends Register up to eight (8) MTN numbers on Family and Friends and call these ...	A N100 deduction from every change after initial registration ...	
Super Saver plan	Do you think the MTN TalkOn plan is great for you? Then get ready to enjoy so much more on the MTN S...	Regressive rates (the more you talk, the less you pay!) MTN2 MTN calls first min...	...	

MTN Virtual Top-Up	Virtual Top-Up (VTU) is a service that allows the sale of airtime to MTN prepaid and postpaid custom...	1. Subscribers are allow to top up as many times as you want.2. There is no need to scratch an...	The vendor has a PIN to protect the airtime, if PIN is known the vendor loses the amount of air...	

2.1.2.3 Types of Etisalat Promotion

Table 2.1c below has the detail of all the major Etisalat promotion products.

Table 2.1c: Description of Etisalat promotion products

Promotion	Description	Benefits	Disadvantages	Price
Etisalat Easy Pass	Easy Pass service enables Etisalat Nigeria subscribers who are roaming in countries within the West ...	Easy Pass is available by default....	Roaming services are usually expensive....	
Gaga Voice Plan	The Gaga Android Smartphone is Etisalat customized 3G-enabled Smartphone for undergraduates, &	You also enjoy special offers including: Free monthly 50MB for 4 months (Free 200MB in total)...	This plan is only available on the Etisalat Gaga Android Smartphone ...	

	n...			
Blackberry Voice Plan		When you subscribe to the Etisalat BlackBerry Voice Plan, you also get the lowest tariffs on the net...	Only available to all Etisalat pre-paid subscribers. In order to get the maximum benefit fro...	
ELITEWORLD	Elite World is fully packed with a lot of services and incentives to suit the lifestyle of all...	The advantages of belonging to Elite World are myriad. From simple benefits such as an easy to...	Inabilty to roam except in SAUDI ARABIA...	
EASY CLIQ	Easy cliq is the special prepaid package from Etisalat to every Nigerian youth! With your l...	Every member of the easy cliq community stands the opportunity to enjoy many more services and...	...	1
E-TOP UP	E-top up (Electronic Top UP) is a service	- Recharge is done without the use of PINs	...	

	that enables direct top up of Etisalat lineswith prepa...	or recharge numbers obtained from scratch recharge cards....		
DOT ME	Etisalat DotMe is a new SMSbased bulletin board service ï for on go information sharingWho i...	- Followers can be on any network, anywhere in the world!- Easy way to share information and sta...	- messages must start with a dot before it can be accepted.- Restriction of 140 characters per m...	
You & Me	This service allows only easy starter customers enjoy N300 ñfree creditò every week to call a l...	- Easy starter customers enjoy N300 ñfree creditò with a minimum of N200 weekly recharg e	The Credit received can only be used to call registered You & Me number; Every subsequent r...	
Home Zone Bonus	...	I minute free credit for receiving ca lls up to 3 minutes on your	...	

		Etisalat Easy Starter home zone pac...		
Easynet Recharged	Etsalat mobile data network using Easynet recharged is designed to give you the best experience ï pe...	-Lowest price for daily data plan -Lowest price for monthly data plan -Package allows you to calcu...	...	NGN0.05 k/kilobyte

2.1.2.4 Type of Airtel Promotion

Table 2.1d below has the detail of all the major Airtel promotion products.

Table 2.1d: Description of Airtel promotion products

Promotion	Description	Benefits	Disadvantages	Price
Airtel Club 10	Build your own club of 10 and get fantastic discounts and freebies on calls, SMS and data within you...	Add 9 Airtel lines to yourself to form a club of 10 Make calls to your members at 10k/ sec...	You can only enjoy this after first minute call of the day is charged at 60k/sec....	1

Big Family Xtra	Talk to the whole Nigeria Airtel community Airtel Big Family gets bigger with additiona...	Free mid-night calls between 12.30am and 4.30am daily to all Airtel nos.40 free On-net SMS (...	Tariffs are enjoyed only after 1st minute call charged at 60k/sec....	
My Airtel My Offer	MAMO is your friendly service with personalized offers for you. It is a service which gives cu...	Airtel helps you make the best choice from our wide array of offers. We would study your uniq...	Customers have to call customer care to get their special offer....	
Airtel 2Sim	This service enables you have one one pack with two matching numbers that have cheap cal...	Some numerous benefits are:- 10k/sec between paired SIMs all day- 1k/sec ...	This service is available to prepaid subscribers only....	
Airtel Big Family	This new package allows existing and new customers to make On-Net calls at 15 Kobo per second a...	Airtel Big Family has the following benefits: 20 bonus SMS monthly after the first recharge of the m...	First minute is NGN0.60K/sec, upon migration to the plan.Free SMS applies to numbers within Air...	
Airtel 2Good	A new postpaid retail plan targeted at Individuals.	2Good comes with 3 major benefits which the customer can enjoy:	First 1 minute is billed at NGN0.60k/sec on a	NGN0.20 k/sec

Postpaid	How to enjoy it: Existing customers can ap...	1. 20k/sec rate to all national/d...	daily bases....	
Airtel 2Good Prepaid	What is 2Good? Our revolutionary new plan with a 20k/sec rate to all networks in Nigeria and USA!...	2Good comes with 3 benefits which the customer can enjoy: 1. 20k/sec rate to all national/domesti...	The 1st minute cost NGN0.60k per sec daily. Although not too bad a bargain!...	NGN0.20 k/sec

2.1.2.5 Type of Visafone Promotion

Table 2.1e below has the detail of all the major Visafone promotion products.

Table 2.1e: Description of Visafone promotion products

Promotion	Description	Benefits	Disadvantages	Price
Visa Entree	It is good for subscribers whose monthly airtime usage is between 0 and 55 minutes. ...	Very Reasonal flat call rates to Calls to India and China ...	You have a limitation of only 2 friends and Family in order to reduce your call rates ...	
Visa Super	Visa SuperCircle is a package	-No daily, weekly or	Visa SuperCircle restricts you to	NGN0.20k/sec

Circle	designed for the mass market especially for those who want to connect ...	monthly rental -No hidden charges -Huge savings on daily calls -Available th...	register up to just Eight (8) Numbers [5 on-net numbers, 1 off ï ne...	
Prepaid Package; Visa Entree	Visa Entree is a prepaid package designed for subscribers whose monthly airtime usage is between 0 a...	-Lowest International Call rates from N12/min to US, -Canada and UK -Calls to India and China at a ...	Your first migration within the first month is free, but subsequent migrations will be charged at N1...	

2.2 Related Work

Although manual observation and selection are the ways of comparing promotion subscribers, operators will usually find ways to circumvent such measures. Methodologies for the comparison of promotion application services are therefore essential if we are to select the proper promotion product that will match our requirement at any particular point in time. Different systems may be needed for different kinds of products with each system having different procedures, different parameters to tune, different database interface, different case management tools, features and most importantly different statistical methods.

Statistical evaluation of experimental results has been considered an essential part of validation of new machine learning methods for quite some time. The tests used have however long been rather naive and unverified. While the procedures for comparison on a single problem have been proposed almost a decade ago, comparative studies with more variables and/or more data sets still employ partial and unsatisfactory solutions.

2.2.1 Related Statistical Work

One of the most cited papers from this area is the one by Dietterich (1998). After describing the taxonomy of statistical questions in machine learning, the focus was on the question of deciding which of the two algorithms under study would produce more accurate classifiers when tested on a given data set. Examination was on five statistical tests and the analysis was concluded by recommending the newly crafted 5×2cv t-test which overcomes the problem of underestimated variance and the consequently elevated Type I error of the more traditional paired t-test over folds of the usual *k*-fold cross validation. For the cases where running the algorithm for multiple times is not appropriate, Dietterich finds McNemarôs test on misclassification matrix as powerful as the 5×2cv t-test. The warning against t-tests after repetitive random sampling and also discouragement of using t-tests after cross-validation was noted. The 5×2cv t-test has been improved by Alpaydēn (1999) who constructed a more robust 5×2cv F test with a lower type I error and higher power.

Bouckaert (2003) argues that theoretical degrees of freedom are incorrect due to dependencies between the experiments and that empirically found values should be used instead, while Nadeau and Bengio (2000) propose the corrected resampled t-test that adjusts the variance based on the overlaps between subsets of examples. Bouckaert and Frank (Bouckaert and Frank (2004); Bouckaert (2004)) also investigated the replicability of machine learning experiments, found the 5×2cv t-test dissatisfactory and opted for the corrected resampled t-test. For a more general work on the problem of estimating the variance of k-fold cross validation, see the work of Bengio and Grandvalet (2004).

None of the above studies deal with evaluating the performance of multiple comparisons and neither studies the applicability of the statistics when comparisons are

tested over multiple data sets. For the former case, Salzberg (1997) mentions ANOVA as one of the possible solutions, but afterwards describes the binomial test with the Bonferroni correction for multiple comparisons. As Salzberg himself notes, binomial testing lacks the power of the better non-parametric tests and the Bonferroni correction is overly radical. V´azquez et al. (2001) and Pizarro et al. (2002), for instance, use ANOVA and Friedmanôs test for comparison of multiple models (in particular, neural networks) on a single data set.

Finally, for multiple comparisons over multiple data sets, Hull (1994) was, to the best of our knowledge, the first who used non-parametric tests for comparing data set in information retrieval and assessment of relevance of documents. Brazdil and Soares (2000) used average ranks to compare classification algorithms. Pursuing a different goal of choosing the optimal algorithm, they do not statistically test the significance of differences between them.

2.2.2 Multivariate Analysis

The general purpose of multivariate analysis of variance (MANOVA) is to determine whether multiple levels of independent variables on their own or in combination with one another have an effect on the dependent variables. MANOVA requires that the dependent variables meet parametric requirements. MANOVA is used under the same circumstances as ANOVA but when there are multiple dependent variables as well as independent variables within the model which the researcher wishes to test. MANOVA is also considered a valid alternative to the repeated measures of ANOVA when sphericity is violated.

If MANOVA is being used to reduce multiple testing, this loss in power needs to be considered as a trade-off for the reduction in the chance of a Type I error occurring.

In complex MANOVA models the likelihood of achieving robust analysis is intrinsically linked to the sample size. There are restrictions associated with the generalizability of the results when the sample size is small and therefore researchers should be encouraged to obtain as large a sample as possible.

The MANOVA gives one overall test of the equality of mean *vectors* for several groups. But it cannot tell which groups differ from which other groups on their mean *vectors*. In addition, MANOVA will not tell you which variables are responsible for the differences in mean vectors. Again, it is possible to overcome this with proper contrast coding for the dependent variables, hence, a need for Scheffeôs method for pair wise multiple comparisons.

2.2.3 Scheffe's Method of Pair Wise Multiple Comparison techniques

In its most general form, Scheffe's method of multiple comparisons is very general, implying that it can be used for the widest variety of different types of comparisons. Here, it shall be use only for pair wise comparison of means as the family of interest is the set of estimates of all possible contrasts among the GSM promotion subscribers. A contrast is a comparison involving two or more set of GSM promotion subscribers and includes the case of a pair wise difference between the sets of GSM promotion subscribers.

2.2.4 Complexity of Comparison of GSM Promotion Subscribers' Application Services Methods

Similar datasets that are constantly evolving in GSM Promotion brings about complexity of comparison method to be deployed and also operators are adaptive in designing products with similar or even the same characteristics aiming at enticing subscribers to keep on subscribing and re-subscribing to enable them remove subscription fees.

Many advisor/comparison systems are based on manual approach. Existing methods of comparison are based primarily on setting predetermined thresholds and then monitoring the traits of the subscribers to detect when a threshold has been achieved. Parameters for such thresholds include total price charged per second of calls in a day, on-net calls charges, off-net calls charges, on-net SMS charges, off-net SMS charges, charges on calls less than one minute in duration, charges on calls more than 1 hour in duration, charges on calls to specific countries, etc. Many parameters can be used to tailor a particular thresholding system for certain customers or services.

These thresholds must be manually programmed, which is labor intensive and time consuming. Moreover, these thresholds are generally subjective and not directly based upon empirical data. In addition, manually programmed thresholds are static and thus do not adjust to changing patterns of promotion subscribers. They are therefore easy for operators to re-package the same product with different names to circumvent the subscribers.

Also, since such thresholds must be set conservatively in order to select most suitable promotion subscribers, they are frequently achieved by comparing the promotion subscribers, contributing to high rates of positivity. When a threshold is achieved, a set of promotion subscribers is triggered and presented to a user/analyst as a reflection of GSM promotion operator to subscribe to. The user/analyst must query many sources of data, to assess the probability of similar set of subscribers. This manual process of analyzing and correlating is time consuming, labor intensive, highly subjective and prone to error.

2.2.5 Motivation for Multivariate Analysis and Scheffe's Method of Pair Wise Multiple Comparison techniques

Multivariate Analysis and Scheffeôs method of GSM Promotion Subscribersô Comparison is a method of inducing a Scheffeôs Method of Pair Wise Multiple Comparison techniques from sample data/examples. It is based on empirical data, which makes it less prone to error. Comparison using Multivariate Analysis and Scheffeôs Method of Pair Wise Multiple Comparison technique has several advantages over other methods as outlined below:

a. Scheffeôs Method of Pair Wise Multiple Comparison technique can be used for the widest variety of different types of comparisons.
b. The purpose of MANOVA is to test whether the *vectors* of means for more than one group are sampled from the same sampling distribution.
c. MANOVA also explores how independent variables influence some patterning of response on the dependent variables.
d. The MANOVA gives one overall test of the equality of mean *vectors* for several groups.

e. The Scheffeôs Method is applicable for MANOVA models when the family of interest is the set of estimates of all possible contrasts among the means.

Typically, MANOVA gives one overall test of the equality of mean *vectors* for several groups. But it cannot tell you which groups differ from which other groups on their mean *vectors*. In addition, MANOVA will not tell which variables are responsible for the differences in mean vectors. All these can be overcome with proper contrast coding for the dependent variables using Scheffeôs Method of Pair Wise Multiple Comparison technique.

This typifies the comparison system proposed in this project. The Scheffeôs Method of Pair Wise Multiple Comparison technique can be used to enforce a multiple comparison on the inputs-thereby ensuring that no particular input always causes poor performance-or even to bound the error rate that are allowed to produce incorrect results on a limited basis.

CHAPTER THREE

SYSTEM ANALYSIS AND DESIGN

3.0 Introduction

Here all activities, tools and deliverables involved in the system analysis and design are discussed.

3.1 Data Gathering

In this study, the list of GSM promotion subscribersô datasets about five major GSM network operators in Nigeria was acquired from twenty states across the six geo-political zones through Nigerian Communications Commission (NCC).

The datasets consists of six attributes. These attributes are state, Glo promotion subscribers, MTN promotion subscribers, Etisalat promotion subscribers, Airtel promotion subscribers, and Visafone promotion subscribers. The dataset has 20 subscribersô dataset for each of the GSM Operator mentioned above. Table 3.1 shows the sample datasets described above.

Table 3.1: Five major GSM Operators Promotion Subscribersô Datasets Collected Quarterly in Nigeria.

State	Glo Promotion Subscribers	MTN Promotion Subscribers	Etisalat Promotion Subscribers	Airtel Promotion Subscribers	Visafone Promotion Subscribers
Adamawa	487,012	727,389	150,838	300,848	00
Katsina	612,913	1,234,471	361,466	598,116	49,732
Nasarawa	600,982	1,263,778	357,093	599,830	48,938
Borno	290,738	674,899	148,937	274,600	16,028
Kwara	630,928	1,364,788	367,928	611,911	49,008
Abuja	1,838,739	3,703,413	1,084,398	1,674,348	149,196
Niger	621,927	1,483,600	363,099	589,048	52,088

Lagos	1,925,379	3,944,778	1,274,890	1,873,439	181,131
Oyo	640,983	1,275,468	370,009	570,094	50,122
Ondo	590,847	1,277,389	359,038	550,091	51,006
Taraba	580,937	1,098,378	300,839	540,947	00
Anambra	650,947	1,472,680	362,908	613,877	49,987
Enugu	613,867	1,264,773	360,998	611,290	48,093
Bayelsa	649,008	1,482,900	362,227	599,049	55,011
Rivers	1,999,826	3,899,575	1,008,379	1,783,900	198,370
Akwa Ibom	639,730	1,476,758	378,097	570,989	50,998
Kaduna	670,937	1,093,780	290,827	501,038	47,998
Kano	2,009,387	3,990,993	1,189,287	1,996,470	190,022
Ekiti	614,732	1,276,400	349,038	600,981	00
Ebonyi	599,836	1,300,937	333,009	560,090	40,758

3.2 Analysis of the Existing System

This section identifies the analysis of existing GSM promotion subscribersô comparison system using probability analysis and randomized algorithms for estimating the selection of right GSM promotion. Suppose, a new GSM promotion is needed to be selected because the previous attempts at selection have been unsuccessful. Using publication agency which publishes each GSM promotion at a time as sources of GSM promotion data, the comparison could be done. The GSM promotion is compared with one another and then the decision either to select one or not is taken. Some advantages/thresholds of the current GSM promotion must be lost during comparison. To actually select a GSM promotion is more costly, however, since the current GSM promotion products must be unsubscribed and some of its advantages forfeited. One is committed to having, at all times, the best possible GSM promotion subscription. Therefore, the decision is that, after comparing each promotion subscribersô dataset, if that GSM promotion dataset is more advantageous or larger than the current GSM

promotion, one will unsubscribe the current GSM promotion and select the new GSM promotion. One is willing to forfeit the resulting advantage(s) of this strategy (of unsubscribing a current), but wish to estimate what that advantage(s) will be.

3.3 Analysis of the Proposed System

In this analytical method, **multivariate analysis of variance** (MANOVA) was used to compare the means of the promotion variables across the promotion data samples (groups). The purpose of MANOVA in GSM promotion subscribersô comparison system is to test whether the *vectors* of means for the five groups are sampled from the same sampling distribution. Here, MANOVA examines the degree of variance within the five major GSM Operators in Nigeria (independent variables) and determines whether it is smaller than the degree of variance between the independent variables. If the within subjects variance is smaller than the between subjects variance it means the independent variable has had a significant effect on the dependent variables (twenty states drawn from six geo- political zones in Nigeria).

3.3.1 Multivariate analysis of variance-GSM Promotion on Twenty Dimensions

In this analytical process, the following assumptions were made:

i. *k* independent random samples (GSM Operators in Nigeria) of size *N we*re obtained from *p*-variate normal populations with equal covariance matrices, as in the following layout for balanced one-way multivariate analysis of variance. (In practice, the sample vectors y_{ij} would ordinarily be listed in row form, and sample 2 would appear below sample 1, and so on as shown in the skeletal table 3.2).

ii. **Dependent Variables:** (twenty states drawn from six geo- political zones in Nigeria were selected as dependent variables as seen in table 3.1).

iii. **Independent Variable:** (five major GSM Operators in Nigeria were selected as independent variables as seen in table 3.1).

iv. **Experimental Units:** Glo, MTN, Etisalat, Airtel and Visafone (containing 100 promotion subscribersô datasets as seen in table 3.1).

Table 3.2: The skeleton of table 3.1.

	Sample 1 From Np(μ_1,Σ)	Sample 2 From Np(μ_2, Σ)	Sample 3 From Np(μ_3, Σ)	é	Sample k From N_p(μ_1, Σ)
	y_{11}	y_{21}	y_{31}	é	y_{k1}
	y_{12}	y_{22}	y_{32}	é	y_{k2}
	.	.	.	é	.
	.	.	.		.
	.	.	.		.
	y_{1n}	y_{2n}	y_{3n}	é	y_{kn}
Total	$y_{1.}$	$y_{2.}$	$y_{3.}$	é	$y_{k.}$
Mean	$\bar{y}_{1.}$	$\bar{y}_{2.}$	$\bar{y}_{3.}$	…	$\bar{y}_{k.}$

Here, the first index represents sample or independence variable (k) and the second represents dataset per sample (n).

Totals and means are defined as follows:

Total of the i^{th} sample: $y_{i.} = \sum_{j=1}^{n} y_{ij}$.

Overall total: $y_{..} = \sum_{i=1}^{k}\sum_{j=1}^{n} y_{ij}$.

Mean of the i^{th} sample: $\bar{y}_{i.} = y_{i.}/n$

Overall mean: $\bar{y}_{..} = y_{..}/kn$

Where, i = 1, é , k = 5; j = 1, é , n = 20.

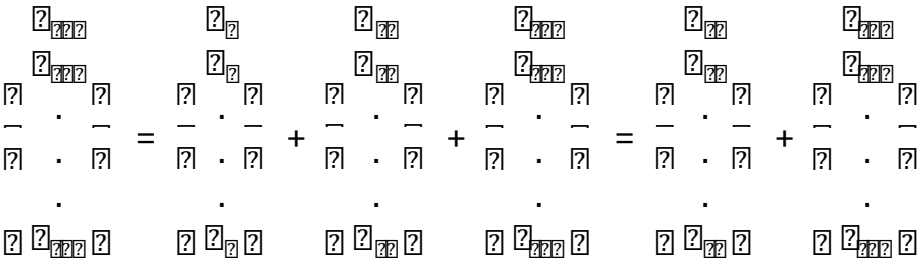
The model for each observation or sample vector is

$$y_{ij} = \mu + \tau_i + \varepsilon_{ij}$$

$= \mu_i + \varepsilon_{ij}$, $i = 1, 2, \ldots, k$; $j = 1, 2, \ldots, n$; é é é (3.1)

Where y is sample vector, μ is mean vector, is variance vector and Σ is covariance vector. See Appendix A for the numerical application of the model on the acquired data sample.

In terms of the p variables in $y_{ij,}$ (3.1) becomes



Where, y represents a Nxp (100x20) matrix, the first index (i) represents sample, the second (j) represents unit id within sample (replicate) and the third index (p) represents the dependent variable.

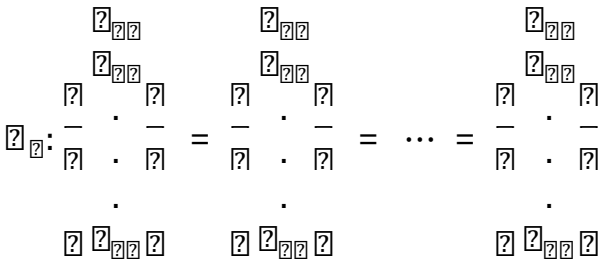
So that the model for the r[th] variable (r = 1, 2, é p) in each vector is

 = + + = + .

Testing whether the mean of the promotion samples vectors (Glo, MTN, Etisalat, Airtel and Visafone) are equal among the twenty states drawn from six geo- political zones, the hypothesis below was therefore, used to compare the mean vectors of the *k* samples for significant differences.

: = = ⋯ = : at least two ôs were unequal.

Note that the equality of the mean vectors implies that the *k* means are equal for each variable; that is, $\mu_{1r} = \mu_{2r} = \cdots = \mu_{kr}$ for $r = 1, 2, \ldots, p$. If two means differ for just one variable, for example, $\mu_{23} \neq \mu_{43}$, then H_0 is false and then rejected. This is seen by examining the elements of the sample mean vectors as shown below:



Thus H_0 implies p sets of equalities:

 = = ⋯ = ,

 = = ⋯ = ,

⋮ ⋮ ⋮

$$\mu_{21} = \mu_{22} = \cdots = \mu_{2k}.$$

All p(k ï 1) equalities must hold for H_0 to be true; failure of only one equality will falsify the hypothesis.

Let ñbetweenò and ñwithinò matrices be **H** and **E** respectively. Where **H** denotes the effect sums of squares and cross products matrix and **E** denotes the error sums of squares and cross products matrix. Hence, **H** and **E** are defined as

$$\mathbf{H} = \sum_{i=1}^{k} (\bar{x}_{i\cdot} - \bar{x}_{\cdot\cdot})(\bar{x}_{i\cdot} - \bar{x}_{\cdot\cdot})' \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

$$= \sum_{i=1}^{k} \frac{1}{n} x_{i\cdot} x_{i\cdot}' - \frac{1}{nk} x_{\cdot\cdot} x_{\cdot\cdot}',$$

$$\mathbf{E} = \sum_{i=1}^{k} \sum_{j=1}^{n} (x_{ij} - \bar{x}_{i\cdot})(x_{ij} - \bar{x}_{i\cdot})' \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.3)$$

$$= \sum_{i=1}^{k} \sum_{j=1}^{n} x_{ij} x_{ij}' - \sum_{i=1}^{k} \frac{1}{n} x_{i\cdot} x_{i\cdot}'.$$

The $p \times p$ effect matrix **H** has a between sum of squares on the diagonal for each of the p variables. Off-diagonal elements are analogous sums of products for each pair of variables. Assuming there are no linear dependencies in the variables, the rank of **H** is the smaller of p and v_H, $\min(p, v_H)$, where v_H represents the degrees of freedom for hypothesis; in the one-way case $v_H = k$ ī 1. Thus **H** can be singular. The $p \times p$ ñerroròmatrix **E** has a within sum of squares for each variable on the diagonal, with analogous sums of products off-diagonal. The rank of **E** is p, unless v_E is less than p.

Thus **H,** the effect matrix, has the form

$$\mathbf{H} = \begin{bmatrix} \sum_{i=1}^{k} (\bar{x}_{i1} - \bar{x}_{\cdot 1})^2 & \sum_{i=1}^{k} (\bar{x}_{i1} - \bar{x}_{\cdot 1})(\bar{x}_{i2} - \bar{x}_{\cdot 2}) & \cdots & \sum_{i=1}^{k} (\bar{x}_{i1} - \bar{x}_{\cdot 1})(\bar{x}_{ip} - \bar{x}_{\cdot p}) \\ \sum_{i=1}^{k} (\bar{x}_{i2} - \bar{x}_{\cdot 2})(\bar{x}_{i1} - \bar{x}_{\cdot 1}) & \sum_{i=1}^{k} (\bar{x}_{i2} - \bar{x}_{\cdot 2})^2 & \cdots & \sum_{i=1}^{k} (\bar{x}_{i2} - \bar{x}_{\cdot 2})(\bar{x}_{ip} - \bar{x}_{\cdot p}) \\ \vdots & \vdots & & \vdots \\ \sum_{i=1}^{k} (\bar{x}_{ip} - \bar{x}_{\cdot p})(\bar{x}_{i1} - \bar{x}_{\cdot 1}) & \sum_{i=1}^{k} (\bar{x}_{ip} - \bar{x}_{\cdot p})(\bar{x}_{i2} - \bar{x}_{\cdot 2}) & \cdots & \sum_{i=1}^{k} (\bar{x}_{ip} - \bar{x}_{\cdot p})^2 \end{bmatrix} \ldots\ldots\ldots (3.4)$$

Where,

$$SS_{11} = \sum_{i=1}^{n} (x_{i1} - \bar{x}_{.1})^2 = \sum_{i=1}^{n} \frac{x_{i1}^2}{n} - \frac{x_{..1}^2}{nn},$$

$$SS_{22} = \sum_{i=1}^{n} x_{i2} - \bar{x}_{.2} x_{i2} - \bar{x}_{.2} = \sum_{i=1}^{n} \frac{x_{i2} x_{i2}}{n} - \frac{x_{..2} x_{..2}}{nn}.$$

In these expressions, the subscript 1 or 2 indicated the first or second variable.

The error or residual matrix **E** can be expressed in a form:

$$E = \begin{bmatrix} SS_{11} & SS_{12} & \cdots & SS_{1n} \\ SS_{21} & SS_{22} & \cdots & SS_{2n} \\ \vdots & \vdots & & \vdots \\ SS_{n1} & SS_{n2} & \cdots & SS_{nn} \end{bmatrix} \quad \ldots\ldots\ldots (3.5)$$

$$SS_{11} = \sum_{j=1}^{k} \sum_{i=1}^{n} (x_{ij1} - \bar{x}_{.j1})^2 = \sum_{j=1}^{k} x_{ij1}^2 - \sum_{j=1}^{k} \frac{x_{.j1}^2}{n},$$

$$SS_{12} = \sum_{j=1}^{k} \sum_{i=1}^{n} x_{ij1} - \bar{x}_{.j1} x_{ij2} - \bar{x}_{.j2} = \sum_{j=1}^{k} x_{ij1} x_{ij2} - \sum_{j=1}^{k} \frac{x_{.j1} x_{.j2}}{n}.$$

Note that the elements of **E** are expressed in terms of sums of squares and cross products, not variances and covariance. This is the pure application of mathematical indolence to MANOVA in order not to be bothered with the expression of information in terms of the estimate of variance and to save steps in calculation. Computationally, mean squares (variance matrices) denote the quantity resulting from dividing the sum of squares by its associated degrees of freedom.

The multivariate equivalent of the *A* statistic (the ratio of the sum of squares for an hypothesis and the sum of squares for error) is the matrix **A** which is

$$\mathbf{A} = \mathbf{H}\mathbf{E}^{-1} \quad \text{é é é é é é é é é é é é é} \quad ..(3.6)$$

The MANOVA tests is then performed on matrix **A** by:

a. **Pillai's trace** which is the sum of the eigenvalues of $(\quad + \quad)^{-1}$ (that is, the variance between groups). The formula is

$$\text{Pillai's trace} = \text{tr}[(\quad + \quad)^{-1}] = \sum_{i=1}^{s} \frac{\lambda_i}{1+\lambda_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.7)$$

Where **H** is the effect matrix, **E** is the error or residual matrix, λ_i is the i^{th} eigenvalue of matrix **A** which is equal to $\mathbf{HE}^{-1}$.

b. **Hotelling- Lawley's trace** which is the ratio of the determinants of the between-groups and the within-groups. This is also the sum of the eigenvalues (trace) of the matrix products $\mathbf{HE}^{-1}$. Larger values indicate greater differences between group centroids. The formula is

$$\text{Hotelling-Lawley's trace} = \text{tr}(\quad) = \sum_{i=1}^{s} \lambda_i \quad \ldots\ldots (3.8)$$

c. **Wilki's lamda** ($\wedge$) compares the within sum of squares and products matrix **E** to the total sum of squares and products matrix **E**+**H**. It is a measure of how much the total variances is due to the residual, with smaller values indicating larger group differences. The formula is

$$\text{Wilki's lamda} = \wedge = \frac{|\quad|}{|\quad + \quad|} = \prod_{i=1}^{s} \frac{1}{1+\lambda_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.9)$$

d**. Roy's largest root** which is the largest eigenvalue of $\quad^{-1}$. That is, the eigenvalue of the linear combination that explains most of the variance between groups. The formula is

$$\text{Roy's largest root} = \quad_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.10)$$

Once the above MANOVA tests in (3.7), (3.8), (3.9) and (3.10) are obtained, they are translated into F statistics in order to test the null hypothesis. See Appendix A for the numerical application of the equations on the acquired data sample.

3.3.2 Scheffe's Method of Pair Wise Multiple Comparison

Since the above MANOVA culminating in rejection of the hypothesis of equal treatment effects still has not indicated those effects which may be equal or those which are probably different, Scheffeôs Method of Pair Wise Multiple Comparison using

General Linear Model was used. In this method the following analytical processes were followed:

a. The absolute values of pair wise differences between sample means were obtained. $|\bar{y}_i - \bar{y}_j|$

b. Statistical significant differences were identified by finding those with an absolute value larger than the corresponding comparison value $|\bar{y}_i - \bar{y}_j| \geq \sqrt{(k-1)F(\alpha; k-1, v)}$; Where $F(\alpha; k-1, v)$ is the α-level critical value of an F statistics with $(k-1)$ numerator degrees of freedom and (v) denominator degrees of freedom. See Appendix A for the numerical application of the formula on the acquired data sample.

c. State the significance level chosen and the direction of statistically significant differences between pairs of means.

3.4 Description of the model for GSM promotion subscribers' comparison

From the above analysis, the model employed in this project is made up of two stages:

The first stage involves the analysis of MANOVA model while the second stage involves Scheffe's method.

The first step of the first stage is to state the null and alternative hypotheses, and choose a significance level. This step is completed by performing the hypothesis test as follows:

H_0: $\mu_1 = \mu_2 = \cdots = \mu_k$ H_1: At least two μs were unequal. (α=0.05)

The second step of the first stage is calculating the f test statistic and constructing the MANOVA table. See Appendix C for more detail of MANOVA table of the acquired data sample.

The third step of the first stage is to define the rejection region, decide whether or not to reject the null hypothesis, and obtain the p-value of the test. The rejection region is defined by the f-score above which lies 0.05 of the area under the f density curve with degree of freedom. This marks the end of the first stage.

The first step of Scheffe's method (that is, the second stage) is to obtain the absolute values of pair wise differences between sample means.

The second step of Scheffe's method is to obtain values against which to compare the absolute values of differences between sample means. This shall be called the comparison values. The completion of the second step is by identifying the statistically significant pair wise differences.

The third and last step of Scheffe's method is to state the results, including the significance level and the directions of differences. After checking the direction of the significant differences, the verification can be summarized in the results of Scheffe's method as text, bar chart, pie chart, histogram and box plots that might be used to graphically display the results of the one-way MANOVA and Scheffe's method.

3.5 System Design

From the analysis and study in this research, the GSM promotion subscribersô comparison model based on MANOVA and Scheffe's method has been designed. This part introduces the detail of the objected oriented design methodology used in this study and includes the Unified Modeling Tools (use case diagram, class diagram, and sequential diagram), and database design.

3.5.1 Use Case Diagram

The following is the Use Case diagram of the application (figure 3.4). It contains two actors which are User and Administrator and the functions performed by these actors. The functions that will be performed by User are:

- Login
- Update User Profile
- Upload promotion data
- Compare promotion data
- View the output

The functions that will be performed by Administrator are:

- Login
- Create User

- Manage User
- Configure System
- Manage the GSM promotion data
- Compare promotion data
- View the User

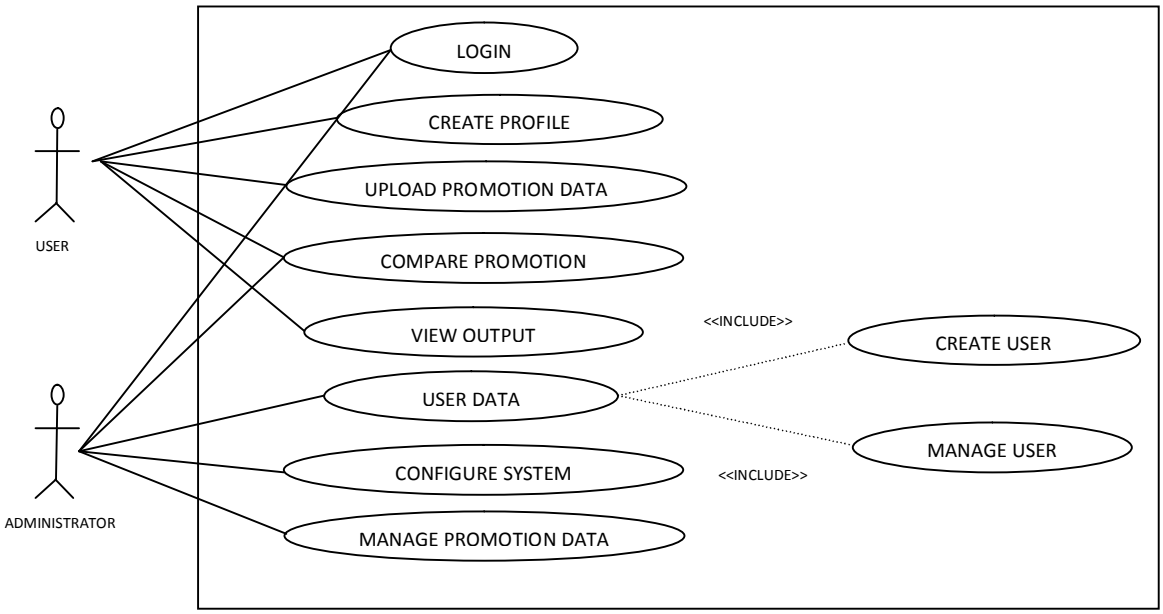


Figure 3.4: Use Case Diagram of GSM Promotion Comparison System

3.5.2 Class Diagram

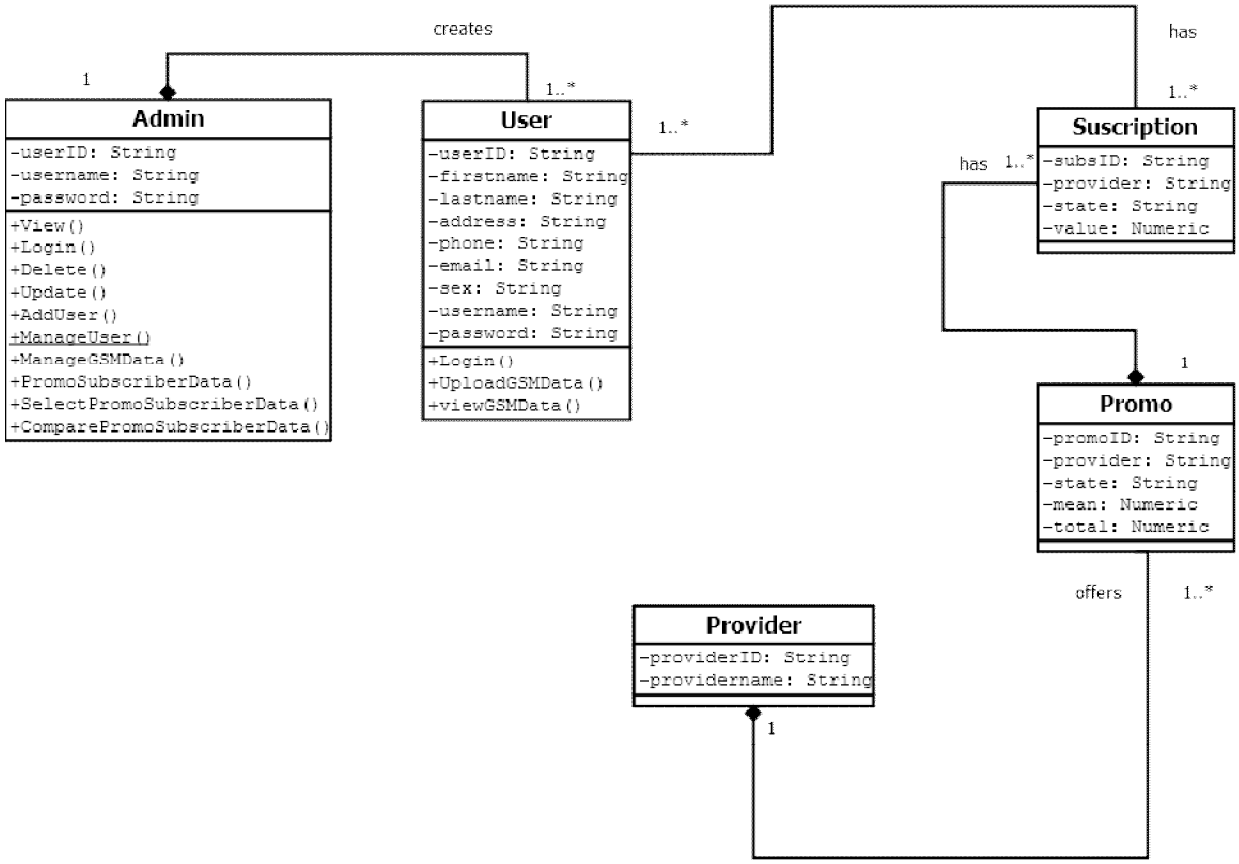


Figure 3.5: Class Diagram of GSM Promotion Comparison System

3.5.3 Activity Diagram

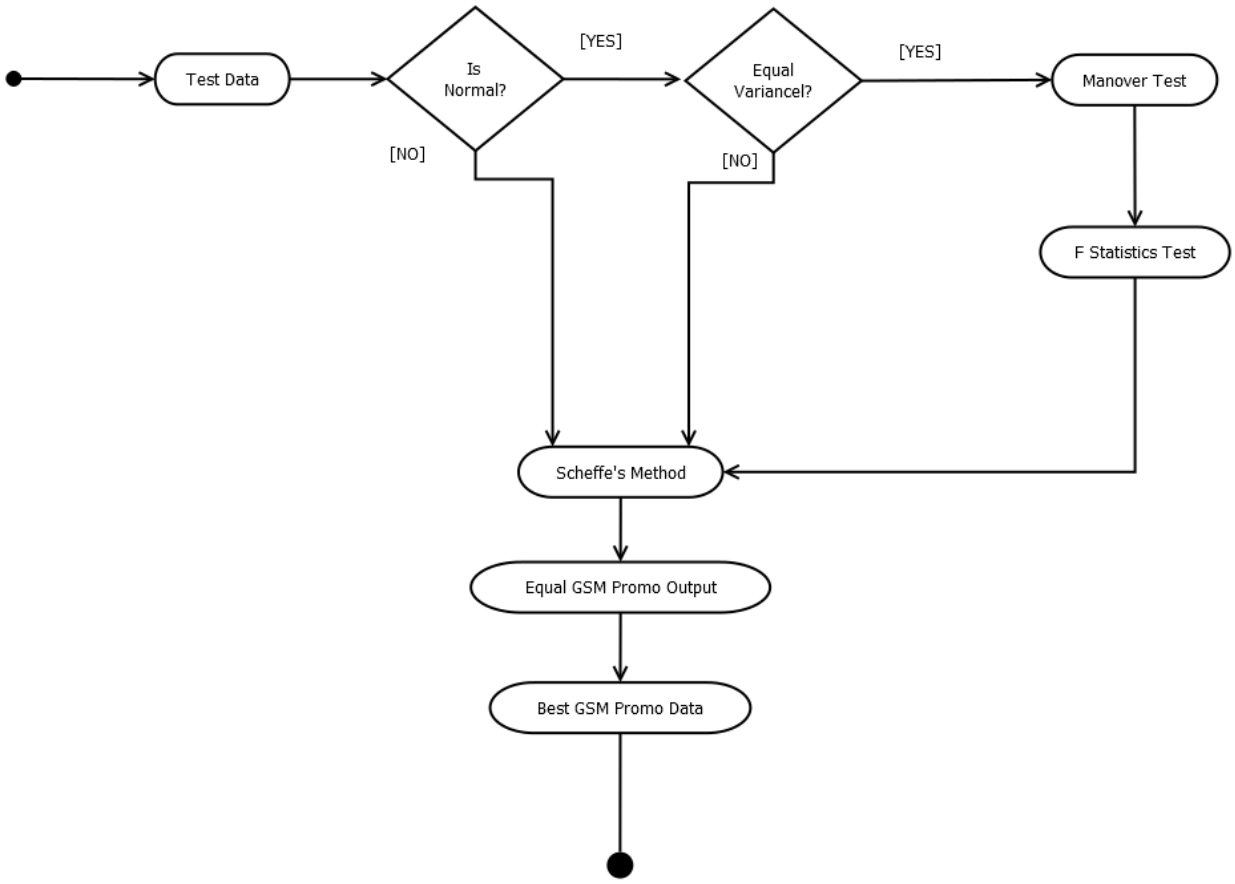


Figure 3.6: Activity Diagram of GSM Promotion Comparison System

3.5.4 Sequential Diagram

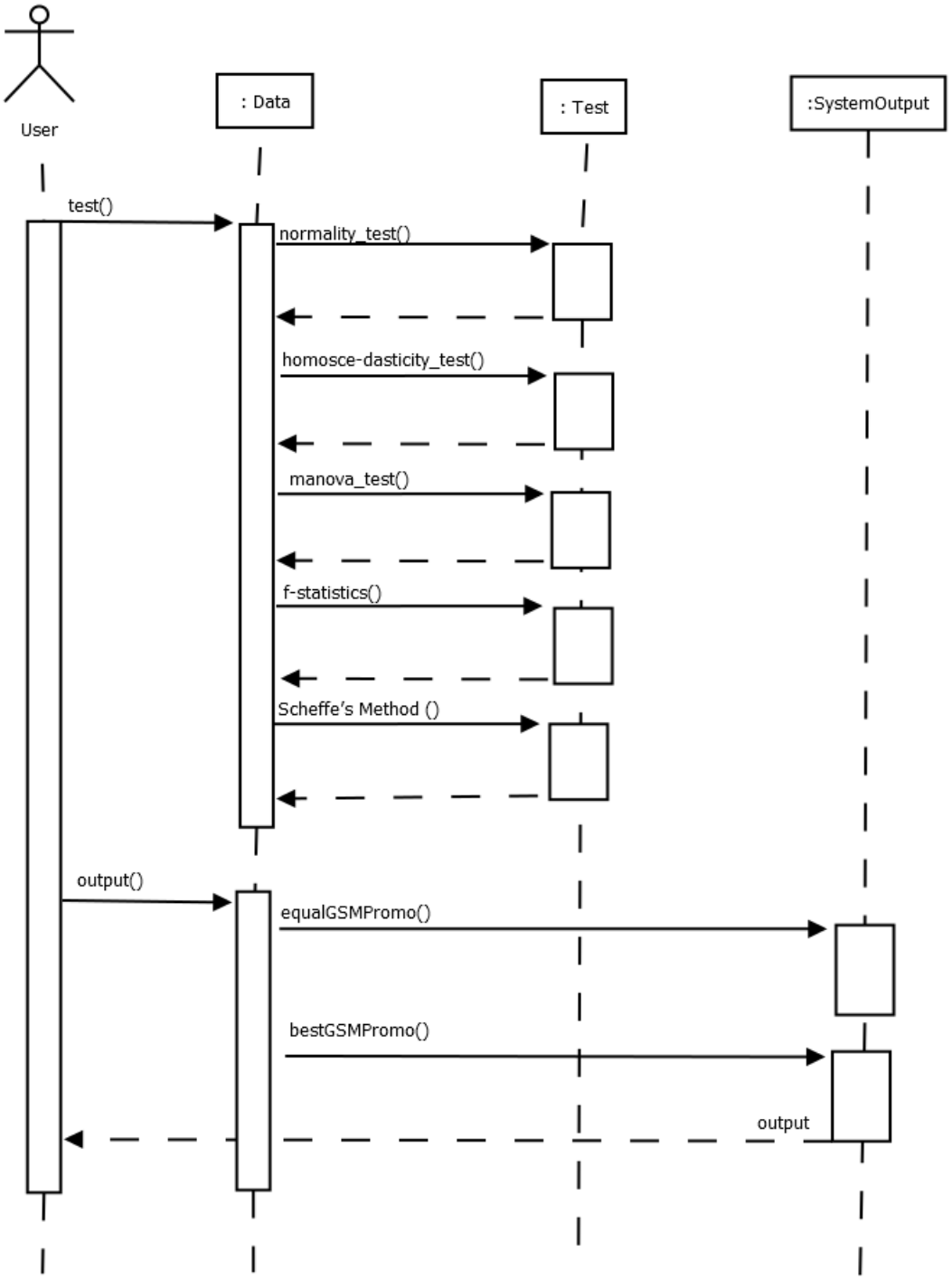


Figure 3.7: Sequential Diagram of GSM Promotion Comparison System

3.5.5 Database Design

The Database includes 5 tables to provide complete information to users and they are stored in MySQL database management system.

Table 3.3: Admin Table Database Structure

FIELD NAME	DATA TYPE	FIELD SIZE
ID	Numeric	20
Username	Text	20
Password	Text	50

Table 3.4: User Table Database Structure

FIELD NAME	DATA TYPE	FIELD SIZE
ID	Numeric	20
Name	Text	20
Sex	Text	5
Address	Text	20
Email	Text	20
Phone	Text	20
State	Text	20

Table 3.5: Provider Table Database Structure

FIELD NAME	DATA TYPE	FIELD SIZE
ID	Numeric	10
Name	Text	20

Table 3.6: Subscription Table Database Structure

FIELD NAME	DATA TYPE	FIELD SIZE
ID	Numeric	10
Provider	Text	20
State	Text	10
Value	Numeric	10

Table 3.7: PromotionData Table Database Structure

FIELD NAME	DATA TYPE	FIELD SIZE
ID	Numeric	10
Provider	Text	20
State	Text	20
Mean	Numeric	10
Total	Numeric	10

3.5.6 The System Architecture

Figure 3.8 is the architecture of the proposed system.

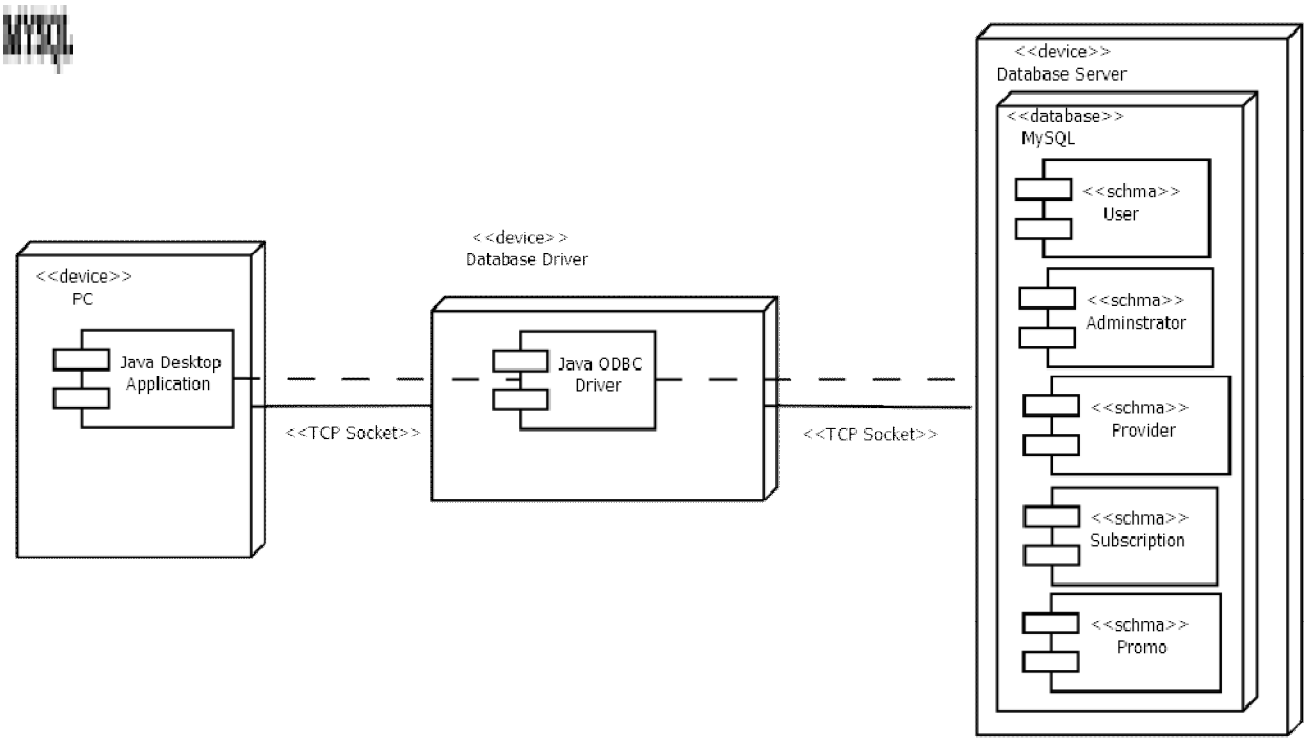


Figure 3.8: The Architecture of the Proposed System.

The users, the GSM promotion subscribers or the GSM network providers will access the system via the PC component of the system architecture. They will be guided by the decision process from the model which will be housed by the Java Desktop Application. An Internet connection is made available through the Internet medium (TCP socket). The system database server will store the system data that will be available for the proposed system users to access. The genuine user can access the system with his/her actual password after creating an account.

CHAPTER FOUR

SYSTEM IMPLEMENTATION

4.0 Introduction

This chapter contains description of the general implementation architecture of the comparison of GSM promotion subscribersô application system in GSM network environment, the system specifications, the development environment, system integration & testing and documentations.

4.1 The Implementation Architecture

Figure 4.1 is the implementation architecture of the proposed system. It described the transformation/implementation process of the state of data from GSM promotion subscribersô data to the output data.

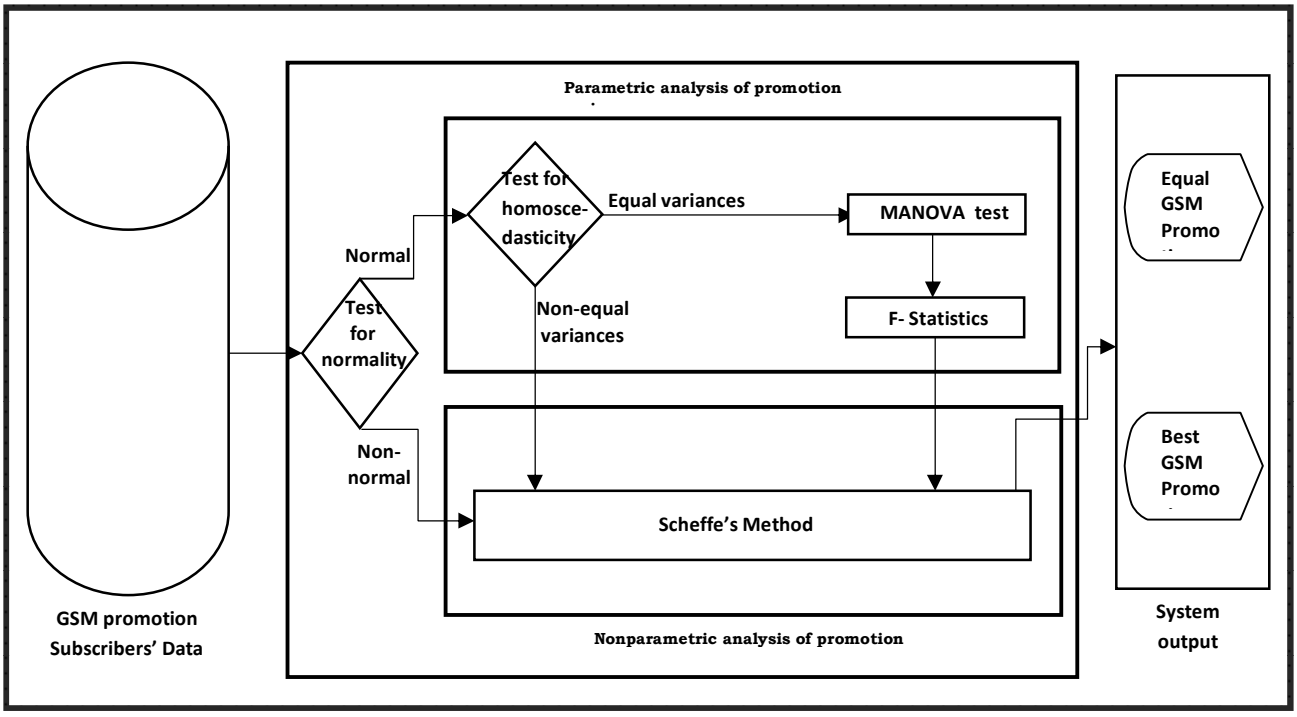


Figure 4.1: Implementation Architecture

4.2 The System Specifications

This section provides the detailed documentation of the proposed system. It is designed to bridge the communication gap between the clients and the developer for effective implementation of the system. It is divided into two parts:

i. Software specification and
ii. Hardware specification

4.2.1 Software Specification

The proposed system requires the following components (and the description of their functions) at minimal level for effective implementation:

- **Web Browser**: Running on client-side, it allows users log.
- **Web Application**: Running in the server-side, it handles requests from users and then decides the route and the protocol that it uses to send the requests. This is the server side component to be built by the project.
- **Database Server**. This is the server-side component deployed using mysql for data storage.
- **Windows operating System**. Any version of windows operating system is compactible.

4.2.2 Hardware Specification

The proposed system is executable via the following minimal hardware specification:

- Pentium IV Processors.
- A 128MB RAM Size.
- A 40GB hard disk capacity.
- A standard keyboard and mouse.

4.3 Development Environment

The application has been developed by using AJAX for UI, JAVA as a development language and Netbeans as a development environment and Microsoft Visio as an UML tool for analysis & design specifications. Every function of the applications

were exported into Web services using JAXWS, which is much easier for AtLink to develop other new functions or change the user interfaces when needed.

4.4 System Integration and Testing

System Integration and Testing is seen as the implementation of software on a particular platform. The deployment environment for the system includes a single installation of windows operating system, a browser and an internet connection.

System Testing is a phase of system development life cycle that starts after the completion of other phases. It is conducted on a complete integrated system to evaluate the system compliance with the specified functional and non functional requirements.

Based on the validation of the application accuracy, completeness in performing the designed functions, the simulations of real promotion subscribersô data in real life testing environment and the alignment of the result, system testing is complete and positive.

4.5 Documentation

The system documentation is presented below.

4.5.1 User's Manual

Comparison of GSM promotion subscribersô application services is divided into the following interfaces:

I. System Login
II. Subscribersô Data Input
III. Registration
IV. Create User
V. Compare Promotion
VI. Graphical Result Interface
VII. View Comparison Result Interface

I. System Login Interface:

Figure 4.2 below shows the System Login Interface. Both the Administrator and the Created Users can login via this interface. This interface is to ensure the security of the system from un-authorized users. The user of this system can manually type in his/her username, password, and select user type then click óLoginô. The user can also click on óExitô, if he/she wishes not to login.

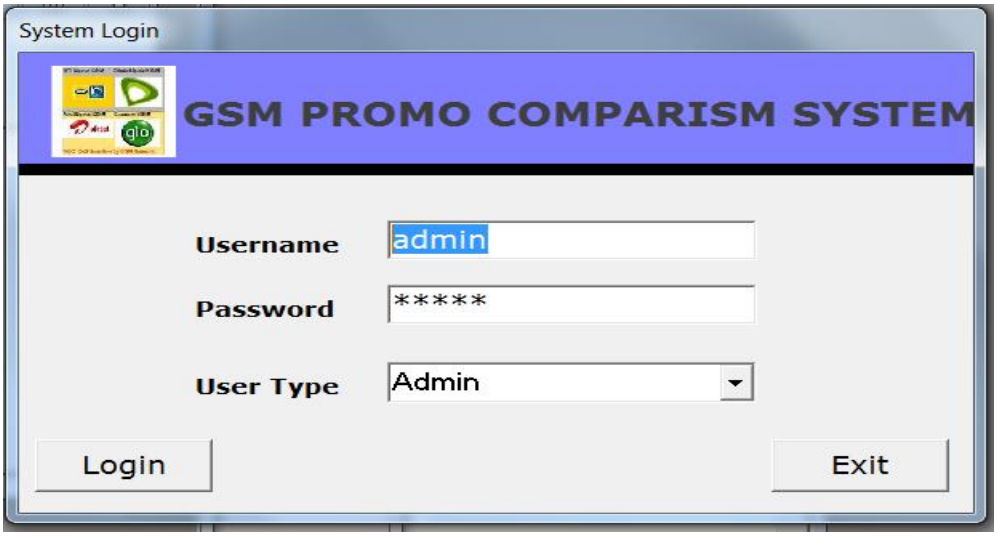


Figure 4.2: System Login Interface.

II. Subscribers' Data Input Interface:

Figure 4.3 below shows the Subscribersô Data Input Interface. Only the Administrator can use this interface. This interface is to ensure the addition of GSM data into the system by the Administrator. The user of this system can manually type in GSM Service Provider Name, state, value, and click óAddô to add data to the database. The user can also click on óExitô, if he/she wishes to cancel the transaction.

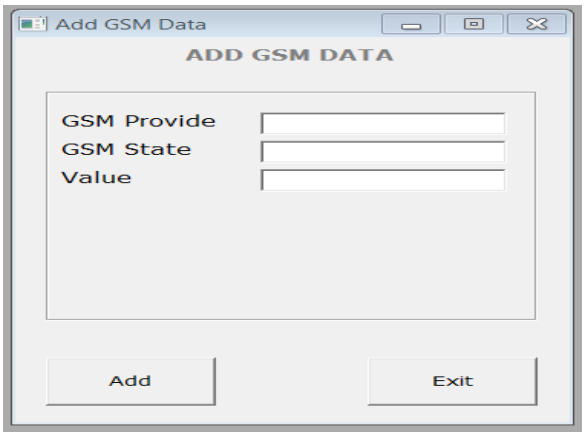


Figure 4.3: Subscribersô Data Input Interface.

III. Registration Interface:

Figure 4.4 below shows the Registration Interface. Only the User can use this interface. This interface is to ensure the addition of user profile data into the system by the user. The user of this system can manually type in his/her name, sex, address, email, phone number, state of residence and click óAddô to add data to the database. The user can also click on óExitô, if he/she wishes to cancel the transaction.

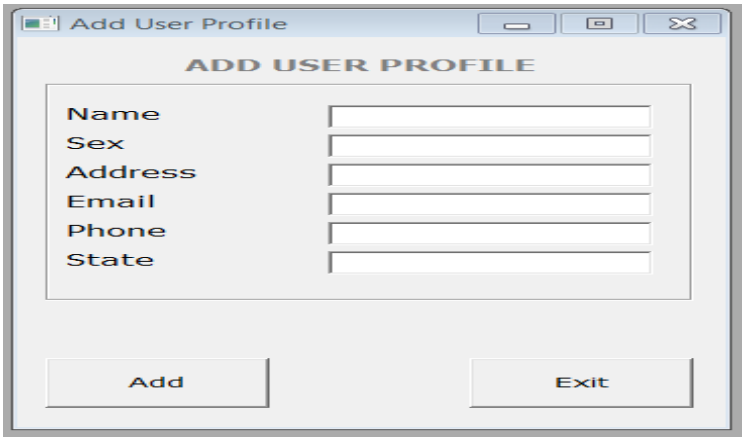


Figure 4.4: Registration Interface.

IV. Create User Interface:

Figure 4.5 below shows the Create User Interface. Only the Administrator can use this interface. This interface is to ensure the security of the system by assigning user name and password to the users. The Administrator of this system can manually type in user

name, password and click óAddô to add data to the database. The user can also click on óExitô, if he/she wishes to cancel the transaction.

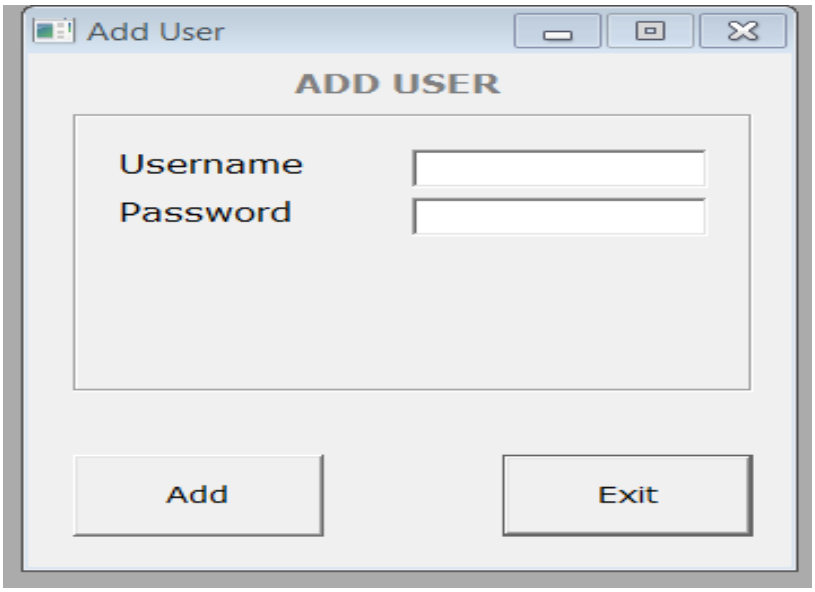


Figure 4.5: Create User Interface.

V. The Compare Promotion Interface:

Figure 4.6 below shows the Compare Promotion Interface. Both the Administrator and the Created Users can carry out comparison transaction via this interface. The user of this system can select states and press óEnterô from the keyboard to view the textual result of the transaction. The user can also click on óExitô, if he/she wishes to cancel the transaction.

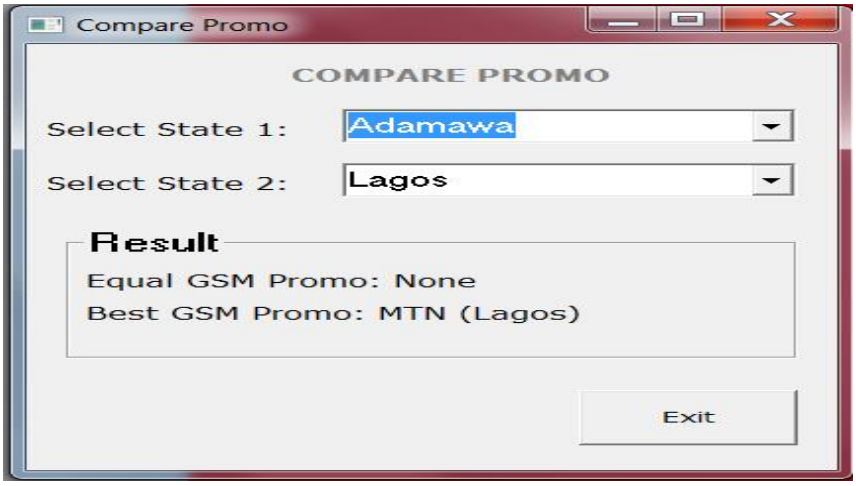


Figure 4.6: The Compare Promotion Interface.

VI. The Graphical Result Interface:

Figure 4.7 and 4.8 below shows Promotion Graph showing Bar and Pie Chart and Promotion Graph showing Line and Pie Chart Interface. Both the Administrator and the Created Users can carry out graphical comparison transaction via this interface. The user of this system can select state and click ôPlot Graphô to perform the transaction.

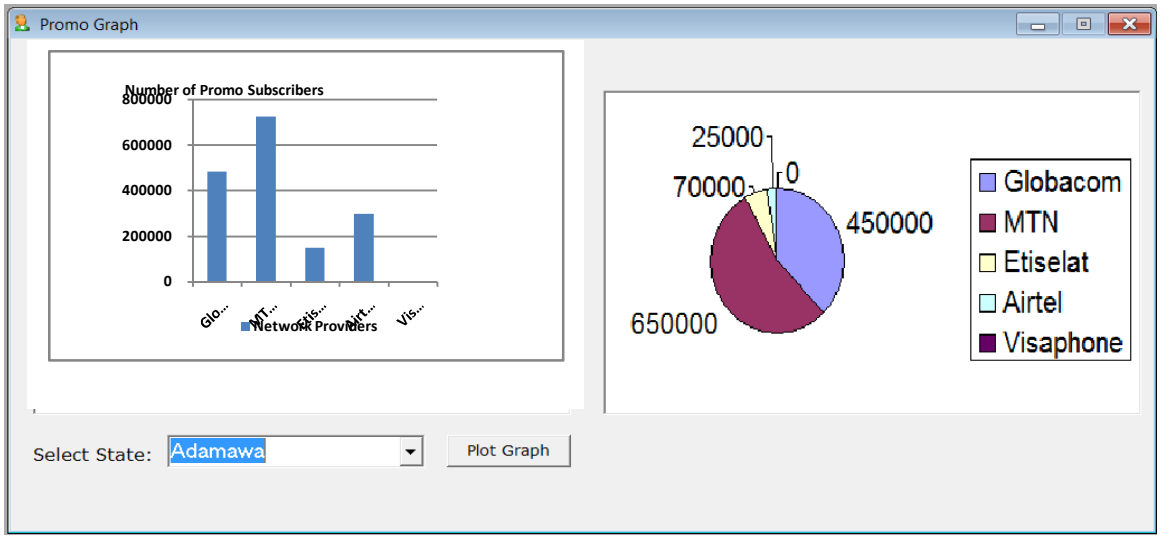


Figure 4.7: Promotion Graph showing Bar and Pie Chart

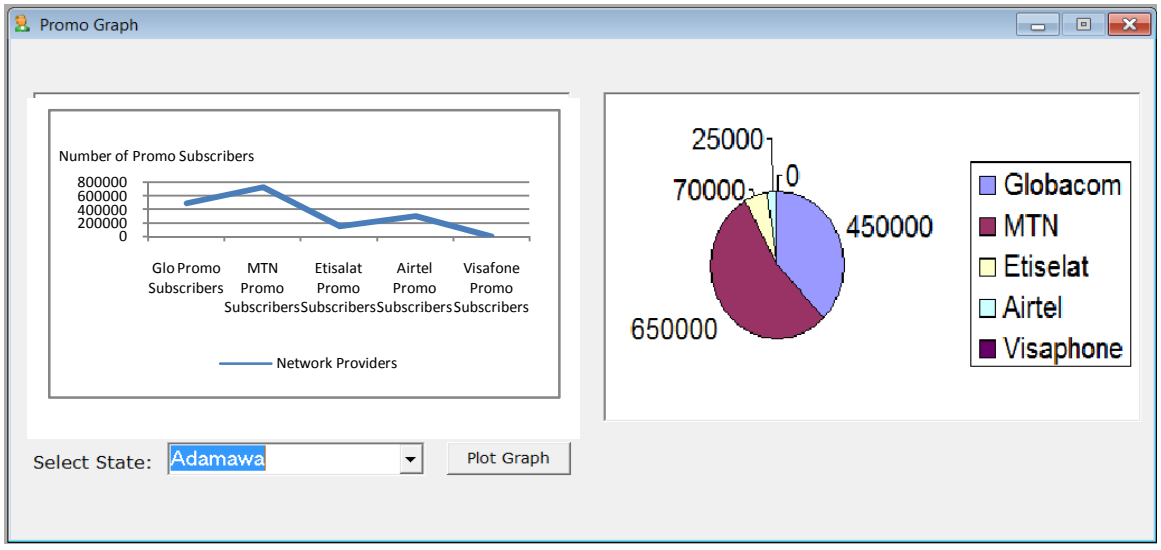


Figure 4.8: Promotion Graph showing Line and Pie Chart Result.

VII. The View Comparison Result Interface:

Figure 4.9 below shows the View Comparison Result Interface. Both the Administrator and the Created Users can view the result of the transaction via this interface. The user of this system can select óviewô from pull down menu to view the result. The user can also click on óExitô, if he/she wishes to cancel the transaction.

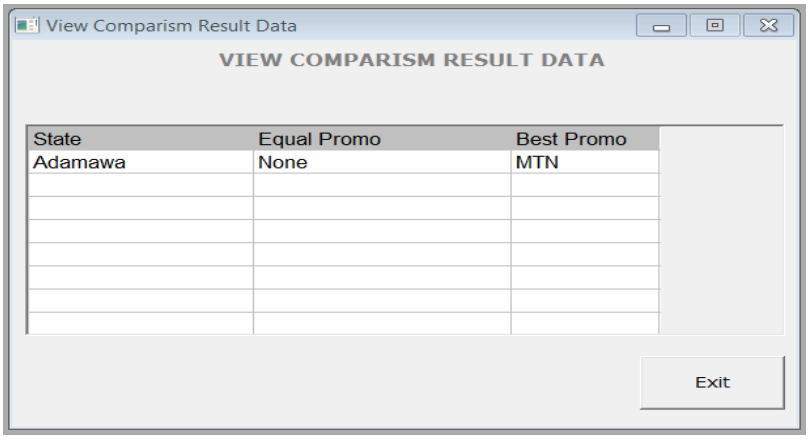


Figure 4.9: View Comparison Result Interface.

See Appendix B for the detailed Sample Output.

4.5.2 Source Code Listing

See Appendix A for the detailed Source Codes Listing.

4.6 Performance Evaluation of the Proposed System

All experimental results are evaluated at this stage. The results were interpreted and analyzed. The process evaluation is the main part in order to determine the most appropriate attributeôs significant differences as weight to be applied on GSM promotion subscribersô dataset. In order to evaluate and measure the performance of the system, the attributeôs significant differences were estimated and as a benchmark were applied via the application of the equation of Scheffeôs Method accuracy.

Statistical significant differences were identified by finding those with an absolute value larger than the corresponding comparison value $|\bar{y}_i - \bar{y}_j| \geq \sqrt{(k-1)F(k; k-1, \alpha)}$; Where $F(k; k-1, \alpha)$ is the α-level critical value of

an F statistics with $(k-1)$ numerator degrees of freedom and (v) denominator degrees of freedom. A total of 100 datasets (see table 3.1) were employed. Performance was assessed by estimating the significant differences between the datasets by using the equation of Scheffeôs Method accuracy and other multiple comparison methods. Accuracy of the Scheffeôs method measurements and reliability of the proposed system are relevant factors in the use of this proposed system by the users. Schefféôs pairwise comparison method is a method that measures the comparison of a pair of two GSM promotion subscriptions out of all GSM promotion subscriptions. All possible combination of pairs should be compared on attribute scales usually anchored with bipolar adjective pairs.

The comparison of GSM promotion subscribersô application services presented in this research provides a complete view of the quantitative approach of analyzing GSM subscribersô data in GSM business environment. The method proposed in this research provides several advantages over the manual/primitive approach. The basic advantage is that MANOVA and Scheffeôs Method provide an established framework for comparison of GSM promotion subscribersô application system. Multivariate statistical methods, or simply **multivariate methods,** are statistical methods for the simultaneous analysis of data on several variables. What distinguishes the analysisô whatever form it may takeô is that it consider subscribersô perceptions of all the GSM products *jointly*. That is, if the GSM promotion subscriptions are related, it is likely that subscribersô perceptions of the GSM promotion subscriptions will be correlated. Incorporating knowledge of such correlations in the analysis makes it more accurate and more meaningful.

4.6.1 Performance Evaluation of the Proposed System

Statistical significant differences were identified by finding those with an absolute value larger than the corresponding comparison value $|\bar{y}_{\cdot} - \bar{y}_{\cdot}| \geq \sqrt{(k-1)F(\alpha; k-1, v)}$

Table 4.1 below presents the complete computation of the significant differences between the datasets using standard Scheffeôs formula shown above and respective

formulae for other methods. See appendix A for detailed estimation of the Significant Differences.

Table 4.1: Complete Computation of the Significant Differences between the Datasets

Independence Variables	Significant Differences due to Scheffe (%)	Significant Differences due to Turkey (%)	Significant Differences due to Bonferroni (%)	Significant Differences due to Sidak (%)	Total Significant Differences due to others (%)	Average Significant Differences due to others (%)
VisafonePromotionSubscribers	10.00	1.50	1.90	1.80	1.50	1.90
GloPromotionSubscribers	14.40	6.50	4.80	5.50	6.50	4.80
MTNPromotionSubscribers	11.00	3.50	3.40	7.30	3.50	3.40
AirtelPromotionSubscribers	9.50	3.30	4.00	8.40	3.30	4.00
VisafonePromotionSubscribers	8.30	2.70	2.70	6.20	2.70	2.70
GloPromotionSubscribers	8.70	2.50	2.90	7.50	2.50	2.90
EtisalatPromotionSubscribers	9.00	3.20	2.10	6.90	3.20	2.10
MTNPromotionSubscribers	7.60	2.00	1.90	5.90	2.00	1.90
AirtelPromotionSubscribers	7.20	2.20	3.30	6.30	2.20	3.30
VisafonePromotionSubscribers	10.40	4.10	5.60	12.20	4.10	5.60
GloPromotionSubscribers	10.60	1.70	1.70	7.80	1.70	1.70
MTNPromotionSubscribers	7.20	1.30	2.00	5.40	1.30	2.00
EtisalatPromotionSubscribers	11.00	3.60	3.20	6.70	3.60	3.20
AirtelPromotionSubscribers	12.80	3.70	4.20	8.90	3.70	4.20

Note: See Appendix C for the detailed derivation of the table 4.1.

Figure 4.10 below presents the Bar Chart showing the Significant Differences between Promotion Subscribersô Datasets due to Scheffeôs method and other methods.

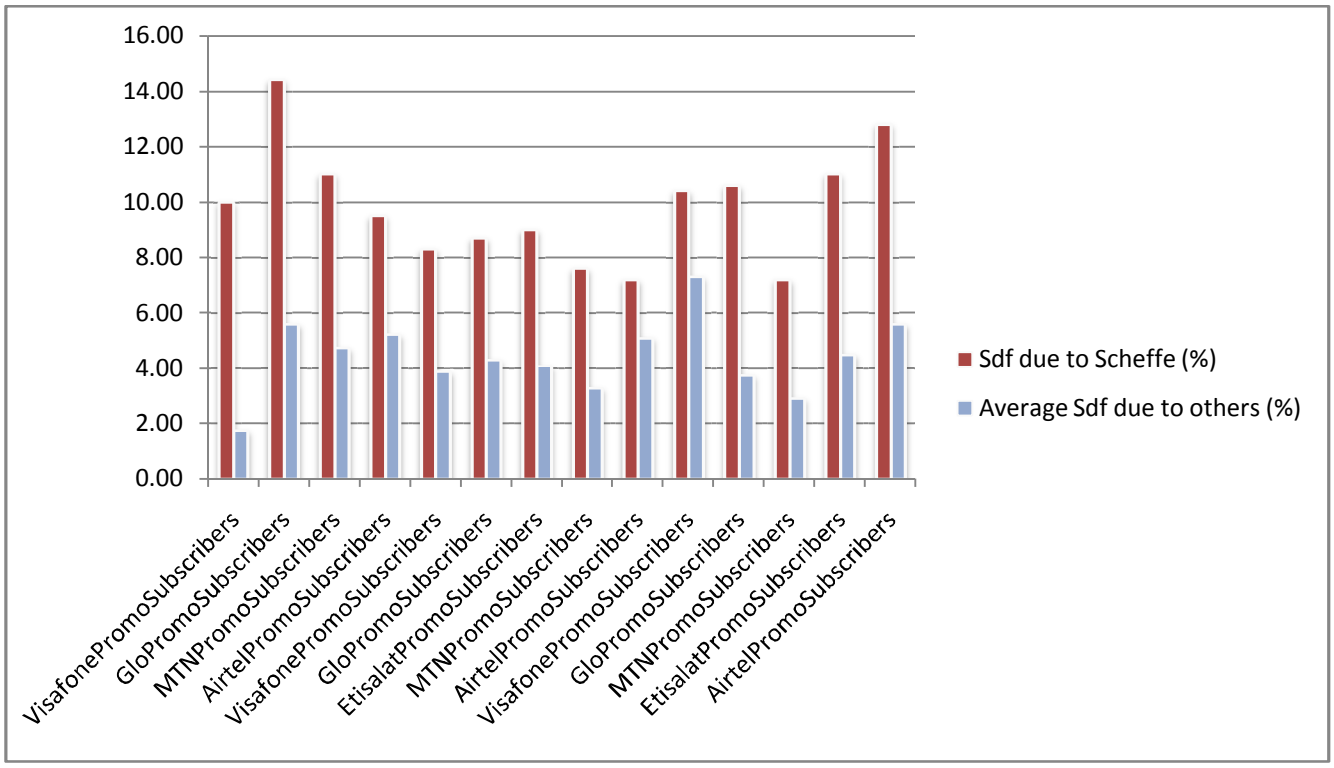


Figure 4.10: Bar Chart showing the Significant Differences between Promotion Subscribersô Datasets due to Scheffeôs method and other methods.

Figure 4.11 below presents the Line Graph showing the Significant Differences between Promotion Subscribersô Datasets due to Scheffeôs method and other methods.

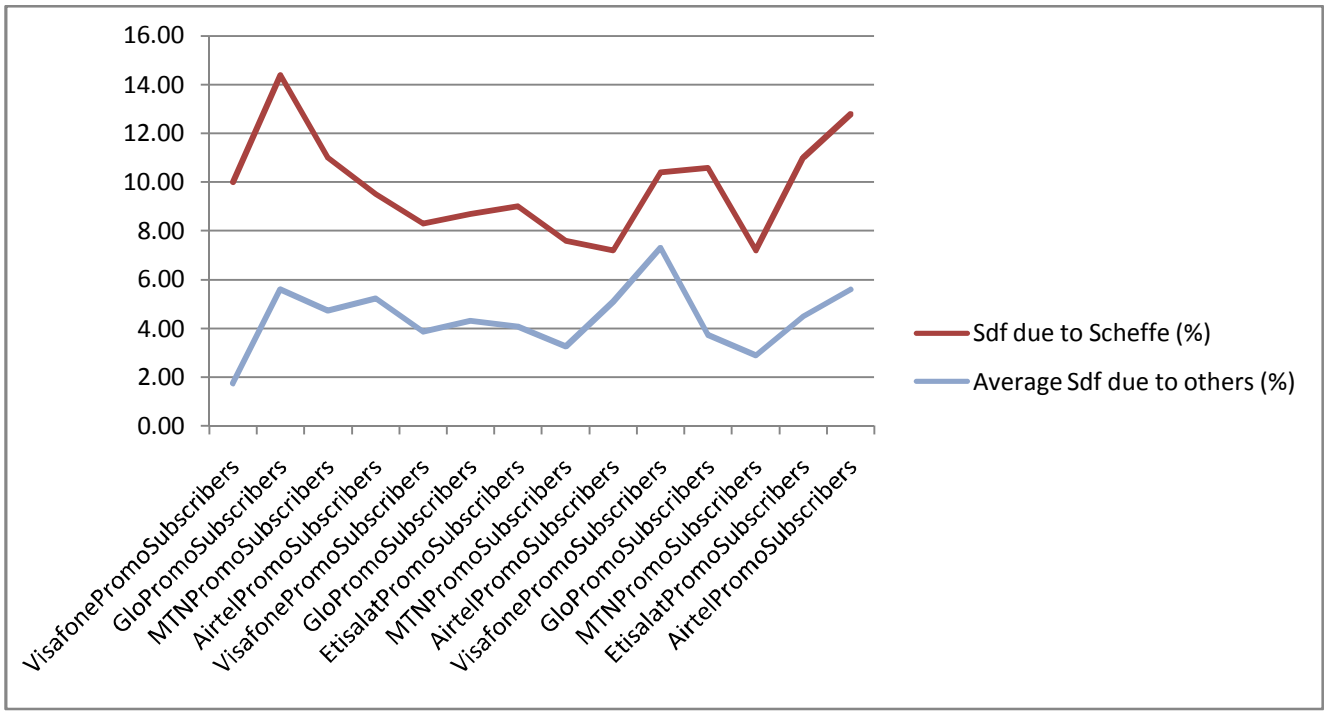


Figure 4.11: Line Graph showing the Significant Differences between Promotion Subscribersô Datasets due to Scheffeôs method and other methods.

Note: Sdf represents óSignificant Differenceô, as show in the figure 4.10 and figure 4.11 above.

Using Significant Differences as a benchmark, the proposed system investigated showed good performance. The overall Scheffeôs results obtained are comparable or better than what is evaluated for other methods as shown in figure 4.10 and figure 4.11. From the graph, the result shows clearly that more than 87% of the outputs were accurate.

The improved performance of this proposed system is more relevant as it enables a more reliable detection, comparison and selection/subscription to reliable network. Based on the improved accuracy and precision in the Significant Differences, it is likely that the number of false positive and false negative result is reduced compared with other systems.

Finally, the appraisal of the proposed system was also evaluated from two broad perspectives:

i. Evaluator (Supervisor) determined that the system was in compliance with regulatory of proposed system, and program requirements. And

ii. Evaluator determined the effects or the results of the appraisal of the proposed system by ensuring the following:

    a) That the stated objectives of the system were met.

    b) That the benefits of the proposed system outweigh the costs.

    c) That there has been an improvement in unit and complete proposed system performance.

CHAPTER FIVE

SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.0 Introduction

In this chapter, a brief summary of achievements on the research project was presented. The recommendations that will serve as guidelines to assist researchers in further studies were made. Finally, conclusion on the research project was presented.

5.1 Summary of Achievements

The purpose of this research was to create a system to compare and estimate promotion subscriptions. The empirical investigation has been triggered by the degree of mystification/fantasy and inventiveness of GSM network providers and domestic income diminution by GSM subscribers due to GSM promotion products. Consequently, the focus was on the description of the problem under investigation, the choice of multivariate analysis and Scheffeôs Method of Pair Wise Multiple Comparison techniques, the system analysis and design, system implementation, the interpretation of results that subsequently led to the findings and the performance evaluation of the system.

5.2 Recommendations

This system application was developed for comparing promotion subscription data in telecommunications using multivariate analysis of variance and Scheffeôs method of pair wise multiple comparisons. This will help comparing promotion subscription data on telecommunicationôs future data. The researcher recommends that this application should be put to its intended use to complement the existing manual promotion comparison system in place or to help human experts in filtering promotion subscription data but not to entirely replace human experts as it will increase effectiveness of comparing and selecting the best promotion in telecommunication world.

5.2.1 Suggested Areas for Further Studies

The following areas are suggested for further research:

- ❖ Further research has to be made on comparison of GSM promotion products nationwide to confirm the significance of each promotion product.
- ❖ More so, further research has to be made on extension and modification to this method of comparing subscription data using Multivariate Analysis of Variance and Scheffeôs Method to achieve better performance and a better degree of automation, like increased speed of comparison with a large amount of data.

5.3 Conclusion

This study has demonstrated that Multivariate Analysis of Variance and Scheffeôs Method can be employed to improve the comparison of GSM promotion subscribersô data and give the best recommendation to the user on suitable and widely used GSM network in a state or region or Nigeria as a whole. The objectives of this research study as outlined in chapter one, have been met. The aims of this research have been identified and related to the need for the creation of a sophisticated system to compare and estimate GSM promotion subscribersô data in Nigeria.

The GSM promotion subscribersô comparison system using Multivariate Analysis of Variance and Scheffeôs Method is developed to minimize the degree of illusion and domestic revenue wastages by GSM subscribers due to GSM promotion products. Besides that, this system can serve as an advisor to GSM network provides in order to conquer the ordeal of the competitive market in GSM world. The development of this system is very important and contributes to the nationôs economic performance.

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Appendices

Appendix A: Code Listing

```
//For some core functionality, I use mathematical class library available from  //Visual Numerics. Therefore Java Develoment Kit, JDK, must be on any //system before the following program must be used.

import visualNumerics.math.*;
import java.text.*;

//manova method
public class manova()
{
        // this class carries out a manova measure with standardization of the
        //inputs data, to standard output results.
        //VisualNumerics.math.* classes, in particular DoubleMatrix and DoubleSVD, are used

        //methods used in this class:
        //RowProj, for determining row projections
        //ColProj, for determining column projections
        //printMatrix, for printing a matrix
        //printVect, for printing a vector
        //DoubleVector.sum, sum of vextors
        //DoubleVector.multiply, multiply vector by scalar
        //DoubleMatrix.multiply, matrix multiplication
        //DoubleMatrix.transpose, matrix transpose
        //system.out.print
        //system.out.println
        //SumsofSquare
        //Scheffe()


        //method for standardising the input data
        public static double [][] Standardize(int nrow, int ncol, double[][] A)
        {
                double[] colmeans = new double[ncol];
                double[] colstdevs = new double[ncol];
                //adat will contain the standardized data and will be retured
                double[][] Adat = new double[nrow][ncol];
                double[] tempcol = new double[nrow];
```

```
		//determine means and standard deviations of variables/columns
		for (int j=0; j<ncol; j++)
			{
				for (int i=0; i<nrow; i++)
					{
						temcol[i] = A[i][j];
					}
				colmeans[j] = Statistics.average(temcol);
		//Sample stddev = sqrt((\sum_i(x_i - \bar{x})^2)/(n-1))
			colstdevs[j] = Statistics.standardDeviation(tempcol);
			}
			System.out.println("Variable means:");
			printVect(colmeans);
			System.out.println("Variable standard deviations:");
			printVect(colstdevs);

	// matrix determinant

for (int j=0; j<ncol; j++)
			{
				for(int i=0; i<nrow; i++)
					{
						Adat[i][j] -colmeans[j]/colstdevs[j];
					}
			}
		return Adat;
		}


	// Method for determine row projections

	public static double[][] RowProj(double[][] evecs, double[][] dat)
	{
	double[][] rproj = DoubleMatrix.multiply(dat, evecs);
	return rproj;
	}

	//Method for determining column projections
	//From SVD decomposition, here we want: Corr U with colwise div by
sqrt(lambda)
	public static double[][] ColProj(int n1, int n2, double[][] evecs, double[][] cdat,
double[] evals)
```

```
{
double[][] cproj = DoubleMatrix.multiply(cdat, evecs);

//Rescale by eigenvalues
for (int j1=0; j1<n2; j1++)
        {
                for (int j2=0; j2<n2; j2++)
                        {
                                cproj[j1][j2] =cproj[j1][j2]/Math.sqrt(evals[j2]);
                        }
}
return cproj;
}
```

//Method for determining wilk lambda

```
public static WilkLambda()
{
double[][] WilkLambda = DoubleMatrix.multiply(cdat, evecs);

//Rescale by eigenvalues
for (int j1=0; j1<n2; j1++)
        {
                for (int j2=0; j2<n2; j2++)
                        {
                        WilkLamda[j1][j2] =cproj[j1][j2]/Math.sqrt(evals[j2]);
                        }
}
return WilkLamda;
}

//Little method for helping in output formating
public static String getSpaces(int n) {

StringBuffer sb = new StringBuffer(n);
for (int i=0; i<n; i++) sb.append(' ');
return sb.toString();
}
```

//Method for determining covariance matrix

```
public static cov(){
```

```
        getMeth(CovRobust(matrix(rnorm(40), ncol = 2)))
        data("variance")
         CovControlOgk(smrob = "s_mad", svrob = "qc")
         CovRobust(variance, ctrl)
         round(getCenter(est), 2)
}
```

//method for determining the sums of squares

```
        public static SumsofSquare()
        {
double[] colmeans = new double[ncol];
                double[] colstdevs = new double[ncol];
                // SumsofSquare will contain the standardized data and will be returned
                double[][]SumsofSquare = new double[nrow][ncol];
                double[] tempcol = new double[nrow];
                //determine means and standard deviations of variables/columns
                for (int ESS jī 1=0; ESS j<ncol; ESS jī 1++)
                        {
                                for (int i=0; i<nrow; i++)
                                        {
                                                temcol[i] = A[i][j];
                                        }
                                colmeans[j] = Statistics.average(temcol);
                for (int j=0; j<ncol; j++)
                        {
                                for (int i=0; i<nrow; i++)
                                        {
                                                temcol[i] = A[i][j];
                                        }
                                colmeans[j] = Statistics.average(temcol);
        }
```

//Method for ploting graph

```
        public static plot(){
data("")
usr (set(mfrow = c(1, 2)))
plot(CovMcd(delivery(),  tolEllipsePlot(), toBarPlot(), toLinePlot(), classic = TRUE)
 plot(CovMcd(data(ñò)), screeplot(), classic = TRUE)
getMeth(CovRobust(matrix(rnorm(40), ncol = 2)))
return(usr)
}
```

```
Scheffe(){
usr (set(mfrow = c(1, 2)))
scheffe(manova(f-statistic()), (h□k.x, k = 5), sub(data set: evk.x, k=5))
bestPromotion(PcaHubert(h□k.x, k = 5), sub(data set: h□k.x, k=5))
return bestGSMPromotion(providerName()) else
return equalGSMPromotion(ñò)
}
        }

        //Utility for printing a matrix
        public static void printMatrix(int n1, int n2, double[][] m)
        {
        //Some definitions for handling output formating
        NumberFormat myFormat = NumberFormat.getNumberInstance();
        FieldPosition fp = new FieldPosition(NumberFormat.INTEGER_FIELD);
        myFormat.setMaximumIntegerDigits(4);
        myFormat.setMaximumFractionDigits(4);
        myFormat.setMinimumFractionDigits(4);
        for (int i=0; i<n1; i++)
        {

        //Print each row, elements separated by spaces
                for (int j=0; j<n2; j++)
        //Leave a gap after the entire matrix
        System.out.println();
        }


//Utility for printing a vector
public static void printVect(double[] m)
{
        //Some definitions for handling output formating
        NumberFormat myFormat = NumberFormat.getNumberInstance();
        FieldPosition fp = new FieldPosition(NumberFormat.INTEGER_FIELD);
        myFormat.setMaximumIntegerDigits(4);
        myFormat.setMaximumFractionDigits(4);
        myFormat.setMinimumFractionDigits(4);
        int len = m.length;
        for (int i=0; i<len; i++)

        //Start a new line at the row end
        System.out.println();
```

```
        //Leave a gap after the entire vector
        System.out.println();
}


//The main method contains the body of the program
public static void main(String[] argv)
{
        //Define dimensions of the matrix I used
        int nrow = 20;
        int ncol = 5;
//Define the matrix that I used
        double[][] A = {487012,    727,389,     150838,     300848,     00    }
                       {612913,    1234471,     361466,     598116,     49732 }
                       {600982,    1263778,     357093,     599830,     48938 }
                       {290738,    674899,      148937,     274600,     16028 }
                       {630928,    1364788,     367928,     611911,     49008 }
                       {1838739,   3703413,     1084398,    1674348,    149196}
                       {621927,    1483600,     363099,     589048,     52088 }
                       {1925379,   3944778,     1274890,    1873439,    181131}
                       {640983,    1275468,     370009,     570094,     50122 }
                       {590847,    1277389,     359038,     550091,     51006 }
                       {580937,    1098378,     300839,     540947,     00    }
                       {650947,    1472680,     362908,     613877,     49987 }
                       {613867,    1264773,     360998,     611290,     48093 }
                       {649008,    1482900,     362227,     599049,     55011 }
                       {1999826,   3899575,     1008379,    1783900,    198370}
                       {639730,    1476758,     378097,     570989,     50998 }
                       {670937,    1093780,     290827,     501038,     47998 }
                       {2009387,   3990993,     1189287,    1996470,    190022}
                       {614732,    1276400,     349038,     600981,     00    }
                       {599836,    1300937,     333009,     560090,     40758 }


//Print it out
System.out.println("A is our input matrix:");
printMatrix(nrow, ncol, A);

//Standardised the input matrix
double[][] Adat = Standardize(nrow, ncol, A);
//prin it out
System.out.println("Standardized matrix for analysis:");
```

```
printMatrix(nrow, ncol, Adat);
//Determine correlations
double[][] Corr = DoubleMatrix.multiply(DoubleMatrix.transpose(Adat), Adat);

//Perform the SVD
DoubleSVD svdres = new DoubleSVD(Corr);

System.out.println("Eigenvalues");
printVect(svdres.S());

//Sum of eigenvalues
//I use methods sum and multiply from class DoubleVector from JNL
double tot = DoubleVector.sum(svdres.S());
tot = 1.0/tot;
double[] percentvar = DoubleVector.multiply(tot, svdres.S());
System.out.println("variances:");
printVect(percentvar);
System.out.println();
System.out.println("Eigenvectors:");
System.out.println("Number of variables (rows) x Dimensionality (cols)");
System.out.println("Columns = definitions of new axes in terms of old variables");
System.out.println("Col 1 = new axis 1, etc.");
printMatrix(ncol, ncol, svdres.U());
//Right singular vectors are the same in this case
//System.out.println("Right eigenvectors, column principal components:");
//printMatrix(ncol, ncol, svdres.U());
        System.out.println("Row projections:");
        System.out.println("Rows: obj1, obj2, ..., objn");
        System.out.println("Columns: proj1, proj2, ..., projm");
        double[][] rproj = RowProj(svdres.U(), Adat);
        printMatrix(nrow, ncol, rproj);
        System.out.println("Column projections:");
        System.out.println("Rowsoutput: (Old)Vbe1, (Old)Vbe2, ..., (Old)Vbem");
        System.out.println("Columns on output: proj1, proj2, ..., projm");
        double[][] cproj = colProj(nrow, ncol, svdres.V(), Corr, svdres.S());
        printMatrix(ncol, ncol, cproj);
        System.out.println(bestGSMPromotion);
        System.out.println(equalGSMPromotion);
        System.out.println(plot());
}
```

//The code below was obtained to submit the data file into the system

```
<?php
```

```
if (isset ($ REQUEST[ôSubmitô])) :
require once (òdb.phpò);
ini set (òmax execution timeò,ò120ò);
ini set (òmax input timeò,ò60ò);
$filename = $ FILES[ôfileô][ôtmp nameô];
$handle = fopen($filename,òrò);
if ($handle)
{
while (!feof($handle))
{
$buffer = fgets($handle,496);
$array = explode(ò,ò,$buffer);
if($n > 0)
{
$q .= òUPDATE promotionData SETò;
$mq = òWHERE mean = ôò.$array[0].òôò;
}else
{
$q.= òINSERT INTO promotionData SETò;
$mq = ò ò;
if($array[3] == ò ò) {
// use current date if date isnôt given
$array[3] = date(date(òd-m-Yò); }
}
if($n > 0)
{
$q .= òUPDATE userData SETò;
$mq = òWHERE id = ôò.$array[0].òôò;
}else
{
$q.= òINSERT INTO userData SETò;
$mq = ò ò;
if($array[3] == ò ò) {
// use current date if date isnôt given
$array[3] = date(date(òd-m-Yò); }
}
if($n > 0)
{
$q .= òUPDATE adminData SETò;
$mq = òWHERE id = ôò.$array[0].òôò;
}else
{
$q.= òINSERT INTO adminData SETò;
```

```
$mq = ò ò;
if($array[3] == ò ò) {
// use current date if date isnôt given
$array[3] = date(date(òd-m-Yò); }
}
if($n > 0)
{
$q .= òUPDATE providerData SETò;
$mq = òWHERE id = ôò.$array[0].òô ò;
}else
{
$q.= òINSERT INTO providerData SETò;
$mq = ò ò;
if($array[3] == ò ò) {
// use current date if date isnôt given
$array[3] = date(date(òd-m-Yò); }
}
if($n > 0)
{
$q .= òUPDATE subscriptionData SETò;
$mq = òWHERE value = ôò.$array[0].òô ò;
}else
{
$q.= òINSERT INTO subscriptionData SETò;
$mq = ò ò;
if($array[3] == ò ò) {
// use current date if date isnôt given
$array[3] = date(date(òd-m-Yò); }
}
// check if number exists
$ql = òSELECT * FROM promotionData WHERE mean = ôò.$array[0].òôò;
$r = mysql query($ql);
$n = mysql num rows($r);
$q = òò;
if($n > 0)
{
$ql = òSELECT * FROM userData WHERE id = ôò.$array[0].òôò;
$r = mysql query($ql);
$n = mysql num rows($r);
$q = òò;
if($n > 0)
{
$ql = òSELECT * FROM adminData WHERE id = ôò.$array[0].òôò;
```

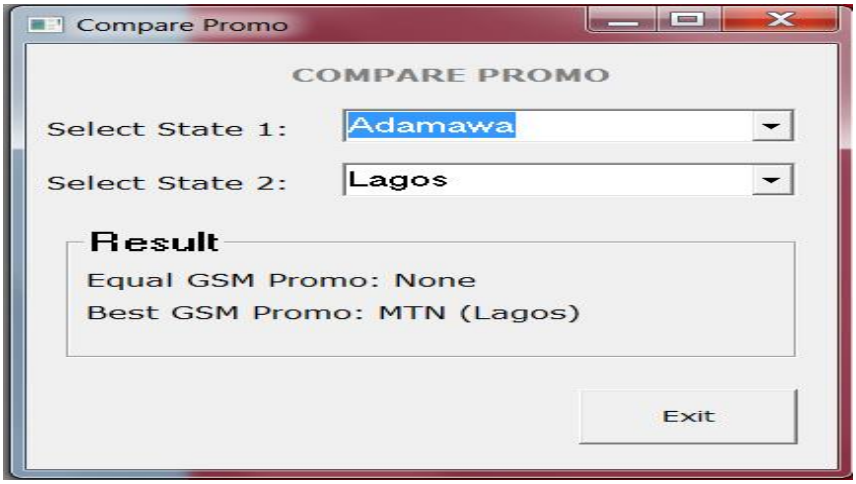
```
$r = mysql query($ql);
$n = mysql num rows($r);
$q = òò;
if($n > 0)
{
$ql = òSELECT * FROM providerData WHERE id = ôò.$array[0].òôò;
$r = mysql query($ql);
$n = mysql num rows($r);
$q = òò;
if($n > 0)
{
$ql = òSELECT * FROM subscriptionData WHERE value = ôò.$array[0].òôò;
$r = mysql query($ql);
$n = mysql num rows($r);
$q = òò;
if($n > 0)
{
/*************************************************/
$sql = ò
SELECT
(state + id) As initialData, ( ( + mean) \ credit limit) AS ratio,
(TO DAYS(CURDATE()) - TO DAYS(last payment date)) AS pay duration,
phone number FROM ò;
$resource = mysql query($sql);
$output = ò<?xml version = ò1.0ò encoding = òiso-8859-1ò? >ô;
$output .= ò<balance ratio>ò;
while($row = mysql fetch array($resource)) {
$output .= ò<number=\òò.$row[ôphone numberô].ò\ò
balance=\òò.$row[ôbalanceô].ò\ò
ratio=\òò.$row[ôratioô].ò\ò
pay duration=\òò.$row[ôpay durationô].ò\ò
>ò;
if ($row[ôpay durationô] < 30)
{
if ($row[ôratioô] > 1)
{
$output .= òFraud (Subscription)ò;
} elseif ($row[ôratioô] < 1)
{
$output .= òNot Fraudò;
}
}elseif ($row[ôpay durationô] > 30)
{
```

```
$output .= òfraud (Bad debt)ò;
}else
{
//revisit
$output .= òNot fraud ò;
}
$output .= ò </number>ò;
}
$output .= ò </balance ratio >ò;
$fh =open(ônumber01.xmlô,òw+ò);
$fh = fwrite($fh,$output);
@fclose(sfh);
endif;
?>
<!DOCTYPE html PUBLIC ò-//W3C//DTD XHTML 1.0 Transitional//ENò
òhttp://www.w3.org/TR/xhtmll/DTD/xhtmll-trasitional.dtdò>
<html xmln=òhttp://www.w3.org/1999/xhtmlò>
<head>
<meta http-equiv=òContent-Typeò content=òtext/html; charset=iso-8859-1ò/>
<title>Comparison of GSM Subscribersô Application Services</title>
<script type=òtext/javascriptò src=òjs.jsò> </script>
</head>
<body topmargin=ò0ò marginheight=ò0ò>
50
<table width=ò100%ò border=ò0ò cell spacing=ò0ò cellpadding=ò1ò
bgcolor=ò#84A8DFò style=òborder-bottom: 1px solid #2736BAò>
<form action=òò enctype=òmultipart/form-dataò method=òpostò>
<tr bgcoloròò>
<td width=ò28%ò>Upload File </td>
<td width=ò29%ò> <input type=òfileò name=òfileò /></td>
<td width%ò43%ò colspan=ò2ò rowspan=ò2ò> <div align=òrightò>
<table width=ò100% border=ò0ò cellspacing=ò0ò cellpadding=ò0ò>
<tr>
<td width=ò21%ò>  </td>
<td width=ò79%ò> <select name=òstatusò id=òstatusò>
<option value=ò0ò>All Numbers</option>
<option value=ò1ò <?php echo ($ REQUEST[ôstatusô] ==1)? ôselectedôòò;?> >Fraud
(Subscription)
</option>
<option value=ò2ò <?php echo ($ REQUEST[ôstatusô] ==2)? ôselectedôòò;?>>Best GSM
Promotion</option>
<option value=ò3ò <?php echo ($ REQUEST[ôstatusô] ==3)? ôselectedôòò;?> >Equal
GSM Promotion </option>
```

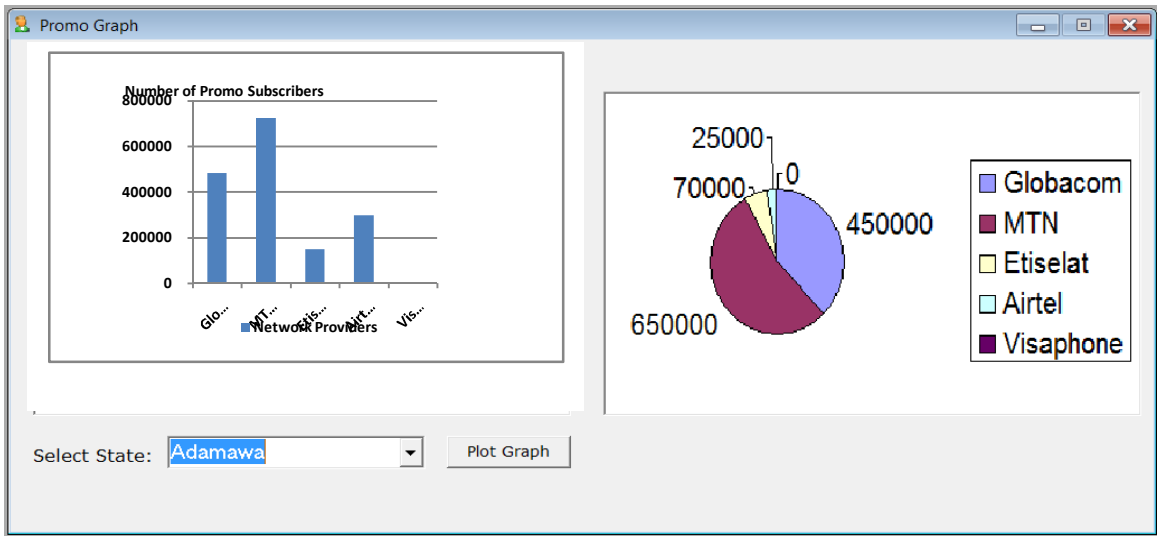
```
</select>
</td>
</tr>
<tr>
<td>   </td>
<td><input name=òSearchò type=òsubmitò id=òSearchò value=òSearchò /></td>
</tr>
</table>
</div></td>
</tr>
<tr>
<td>   </td>
<td><input type=òsubmitò name=òsubmitò value=òsubmitò /></td >
</tr>
</form>
</table>
<br>
<div><a href=òjavascript:;ò
onclick=òopenPrintWindow(ôprint.htmôôPrint Outô);>Print</a> </div>
<div id=òprintò

//*Code below was to print the output
//print òCharacter data found on line $line.
The data was $chardata <BR />ò;
}
xml set character data handler($parser, òcharDataò);
$file = ônumbers01.xmlô;
if (!file exists($file))
{
print òError loading XML file - please check the file exists and that you have access to
it.ò;
exit;
}else
{ //print òXML file loaded successfully! <BR /><BR />ò;
print ò<u>List of numbers</u> <BR /><BR />ò;
}
$data = file get contents($file);
if (!xml parse($parser, $data, true)) {
print ò<H1>Unrecoverable XML error encounted!
</H1>ò;
printf(ò<P> The error report was %s at line %d </P>ò,
xml error string(xml get error code($parser)),
xml get current line number($parser));
```

```
}else
{
//print ò< BR /><BR / > Parsing complete.ò;
}
xml parser free($parser);
echo ò</table>ò;
endif;
?>
</div>
</body>
</html>
```

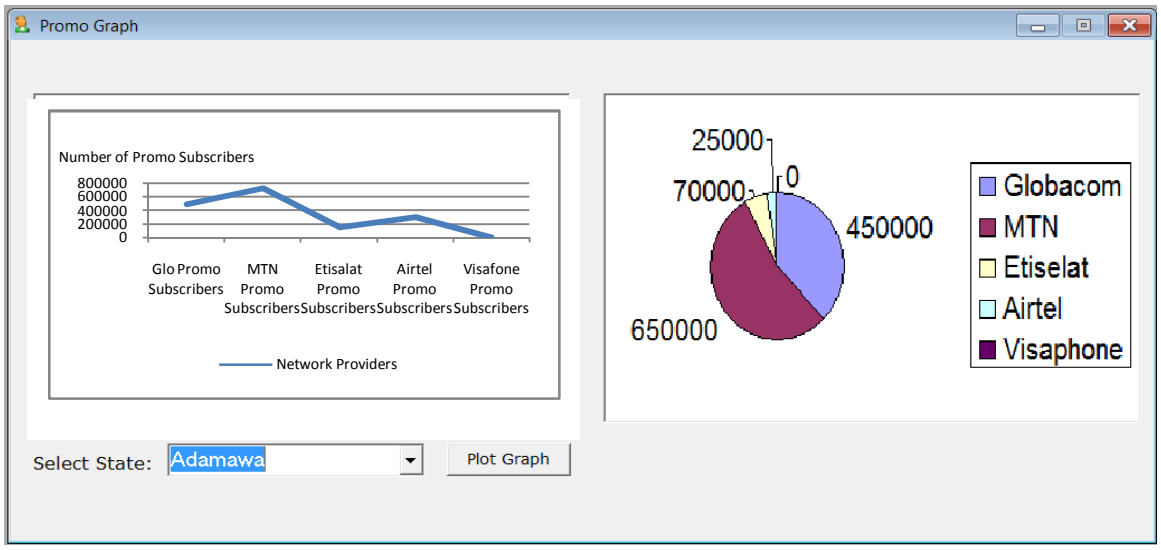
Appendix B: Sample Output



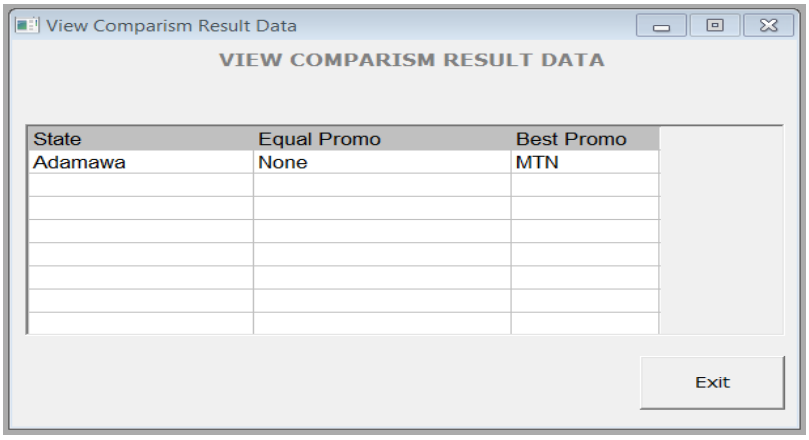
The Compare Promotion Interface.



Promotion Graph showing Bar and Pie Chart



Promotion Graph showing Line and Pie Chart Result.



View Comparison Result Interface.

Appendix C: Multivariate Analysis of Variance and Scheffeôs Method Computations

MANOVA

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	1.000	1751.592[b]	2.000	1.000	.017	1.000
	Wilks' Lambda	.000	1751.592[b]	2.000	1.000	.017	1.000
	Hotelling's Trace	3503.185	1751.592[b]	2.000	1.000	.017	1.000
	Roy's Largest Root	3503.185	1751.592[b]	2.000	1.000	.017	1.000
VisafonePromotionSubscribers	Pillai's Trace	1.975	9.451	34.000	4.000	.020	.988
	Wilks' Lambda	.000	11.407[b]	34.000	2.000	.084	.995
	Hotelling's Trace	932.317	.000	34.000	.000	.	.998
	Roy's Largest Root	890.709	104.789[c]	17.000	2.000	.009	.999

a. Design: Intercept + VisafonePromotionSubscribers

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	GloPromotionSubscribers	5972683521867.751[a]	0.50	314351764308.829	1.90	10.00
	MTNPromotionSubscribers	23382080264228.543[a]	2.50	1230635803380.450	3.80	14.40
	EtisalatPromotionSubscribers	2236749514671.750[a]	1.50	117723658666.934	3.10	11.00
	AirtelPromotionSubscribers	5534278660295.200[a]	0.30	291277824226.063	5.00	9.50
	VisafonePromotionSubscribers	72040683042.200[a]	0.70	3791614896.958	2.70	8.30
Intercept	GloPromotionSubscribers	14912049190951.238	0.50	1491204919095 1.238	2.90	8.70
	MTNPromotionSubscribers	62329731463980.420	1.20	6232973146398 0.420	2.10	9.00
	EtisalatPromotionSubscribers	4775874531151.244	2.00	4775874531151.244	1.90	7.60
	AirtelPromotionSubscribers	12833551557696.785	1.20	1283355155769 6.785	3.30	7.20
	VisafonePromotionSubscribers	882437526099.800	0.10	88243752609.800	5.60	10.40
State	GloPromotionSubscribers	5972683521867.751	2.70	314351764308.829	1.80	10.60
	MTNPromotionSubscribers	23382080264228.550	1.30	1230635803380.450	2.20	7.20
	EtisalatPromotionSubscribers	2236749514671.751	0.60	117723658666.934	3.20	11.00
	AirtelPromotionSubscribers	5534278660295.200	0.70	291277824226.063	4.20	12.80
	VisafonePromotionSubscribers	720406830 42.200	0.50	3791614896.958	1.90	10.00
Error	GloPromotionSubscribers	.000	2.50	.	2.80	14.40
	MTNPromotionSubscribers	.000	1.50	.	3.40	11.00

	EtisalatPromotionSubscribers	.000	0.30	.	1.00	9.50
	AirtelPromotionSubscribers	.000	2.70	.	2.70	8.30
	VisafonePromotionSubscribers	.000	0.50	.	2.90	8.70
	GloPromotionSubscribers	2088473271 2819.000	2.20		2.10	9.00
	MTNPromotionSubscribers	8571181172 8209.000	1.00		1.90	7.60
Total	EtisalatPromotionSubscribers	7012624045 823.000	1.20		3.30	7.20
	AirtelPromotionSubscribers	1836783021 7992.000	0.10		5.60	10.40
	VisafonePromotionSubscribers	1602844356 52.000	1.70		1.70	10.60
	GloPromotionSubscribers	5972683521 867.751	1.30		2.00	7.20
	MTNPromotionSubscribers	2338208026 4228.543	1.60		3.20	11.00
Corrected Total	EtisalatPromotionSubscribers	2236749514 671.750	0.70		4.20	12.80
	AirtelPromotionSubscribers	5534278660 295.200	1.50		1.90	10.00
	VisafonePromotionSubscribers	7204068304 2.200	1.5		2.3	12.7

a. R Squared = 1.000 (Adjusted R Squared = .)

Mean Computation

State		GloPromotionSubscribers	MTNPromotionSubscribers	EtisalatPromotionSubscribers	AirtelPromotionSubscribers	VisafonePromotionSubscribers
Adamawa	Mean	487012.0000	727389.0000	150838.0000	300848.0000	.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	487012.00	727389.00	150838.00	300848.00	.00
	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
Katsina	Mean	612913.0000	1234471.0000	361466.0000	598116.0000	49732.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	612913.00	1234471.00	361466.00	598116.00	49732.00
	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
Nasarawa	Mean	600982.0000	1263778.0000	357093.0000	599830.0000	48938.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	600982.00	1263778.00	357093.00	599830.00	48938.00
	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
Borno	Mean	290738.0000	674899.0000	148937.0000	274600.0000	16028.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	290738.00	674899.00	148937.00	274600.00	16028.00

Kwara	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	630928.0000	1364788.0000	367928.0000	611911.0000	49008.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	630928.00	1364788.00	367928.00	611911.00	49008.00
Abuja	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	1838739.0000	3703413.0000	1084398.0000	1674348.0000	149196.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	1838739.00	3703413.00	1084398.00	1674348.00	149196.00
Niger	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	621927.0000	1483600.0000	363099.0000	589048.0000	52088.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	621927.00	1483600.00	363099.00	589048.00	52088.00
Lagos	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	1925379.0000	3944778.0000	1274890.0000	1873439.0000	181131.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	1925379.00	3944778.00	1274890.00	1873439.00	181131.00

Oyo	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	640983.0000	1275468.0000	370009.0000	570094.0000	50122.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	640983.00	1275468.00	370009.00	570094.00	50122.00
Ondo	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	590847.0000	1277389.0000	359038.0000	550091.0000	51006.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	590847.00	1277389.00	359038.00	550091.00	51006.00
Taraba	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	580937.0000	1098378.0000	300839.0000	540947.0000	.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	580937.00	1098378.00	300839.00	540947.00	.00
Anambra	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	650947.0000	1472680.0000	362908.0000	613877.0000	49987.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	650947.00	1472680.00	362908.00	613877.00	49987.00

Enugu	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	613867.0000	1264773.0000	360998.0000	611290.0000	48093.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	613867.00	1264773.00	360998.00	611290.00	48093.00
Bayelsa	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	649008.0000	1482900.0000	362227.0000	599049.0000	55011.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	649008.00	1482900.00	362227.00	599049.00	55011.00
Rivers	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	1999826.0000	3899575.0000	1008379.0000	1783900.0000	198370.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	1999826.00	3899575.00	1008379.00	1783900.00	198370.00
Akwa Ibom	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	639730.0000	1476758.0000	378097.0000	570989.0000	50998.0000
	N	1	1	1	1	1
	Std. Deviation	.	.	.	.	.
	Sum	639730.00	1476758.00	378097.00	570989.00	50998.00

	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	670937.0000	1093780.0000	290827.0000	501038.0000	47998.0000
	N	1	1	1	1	1
Kaduna	Std. Deviation	.	.	.	.	.
	Sum	670937.00	1093780.00	290827.00	501038.00	47998.00
	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	2009387.0000	3990993.0000	1189287.0000	1996470.0000	190022.0000
	N	1	1	1	1	1
Kano	Std. Deviation	.	.	.	.	.
	Sum	2009387.00	3990993.00	1189287.00	1996470.00	190022.00
	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	614732.0000	1276400.0000	349038.0000	600981.0000	.0000
	N	1	1	1	1	1
Ekiti	Std. Deviation	.	.	.	.	.
	Sum	614732.00	1276400.00	349038.00	600981.00	.00
	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	599836.0000	1300937.0000	333009.0000	560090.0000	40758.0000
	N	1	1	1	1	1
Ebonyi	Std. Deviation	.	.	.	.	.
	Sum	599836.00	1300937.00	333009.00	560090.00	40758.00

	Std. Error of Mean	.	.	.	.	.
	Variance	.	.	.	.	.
	Mean	863482.7500	1765357.3500	488665.2500	801047.8000	66424.3000
	N	20	20	20	20	20
	Std. Deviation	560670.81635	1109340.25591	343108.81462	539701.60666	61576.09030
Total	Sum	17269655.00	35307147.00	9773305.00	16020956.00	1328486.00
	Std. Error of Mean	125369.80584	248056.02224	76721.46332	120680.94800	13768.83237
	Variance	314351764308.829	1230635803380.450	117723658666.934	291277824226.063	3791614896.958

Paired Samples Test

		Paired Differences					t	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
					Lower	Upper		
Pair 1	GloPromotionSubscribers - AirtelPromotionSubscribers	62434.95000	65955.75617	14748.15543	31566.70593	93303.19407	4.233	.000
Pair 2	GloPromotionSubscribers - VisafonePromotionSubscribers	797058.45000	501650.19125	112172.39286	562278.93351	1031837.96649	7.106	.000

Nonparametric Tests: Independent Samples.

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	MTNPromotionSubscribers	23225167681319.880[a]	17	1366186334195.287	17.413	.056	.993
	EtisalatPromotionSubscribers	2215380620137.750[b]	17	130316507066.926	12.197	.078	.990
	GloPromotionSubscribers	5963924719851.084[c]	17	350819101167.711	80.107	.012	.999
	AirtelPromotionSubscribers	5483834850746.533[d]	17	322578520632.149	12.790	.075	.991
Intercept	MTNPromotionSubscribers	63740393772111.710	1	63740393772111.710	812.432	.001	.998
	EtisalatPromotionSubscribers	4925092376251.432	1	4925092376251.432	460.959	.002	.996
	GloPromotionSubscribers	15043478664241.049	1	15043478664241.049	3435.054	.000	.999
	AirtelPromotionSubscribers	13083268467716.996	1	13083268467716.996	518.726	.002	.996
VisafonePromotionSubscribers	MTNPromotionSubscribers	23225167681319.867	17	1366186334195.286	17.413	.056	.993
	EtisalatPromotionSubscribers	2215380620137.749	17	130316507066.926	12.197	.078	.990
	GloPromotionSubscribers	5963924719851.079	17	350819101167.711	80.107	.012	.999
	AirtelPromotionSubscribers	5483834850746.532	17	322578520632.149	12.790	.075	.991
Error	MTNPromotionSubscribers	156912582908.667	2	78456291454.333			
	EtisalatPromotionSubscribers	21368894534.000	2	10684447267.000			
	GloPromotionSubscribers	8758802016.667	2	4379401008.333			
	AirtelPromotionSubscribers	50443809548.667	2	25221904774.333			

Total	MTNPromotionSubscribers	857118117 28209.000	20				
	EtisalatPromotionSubscribers	701262404 5823.000	20				
	GloPromotionSubscribers	208847327 12819.000	20				
	AirtelPromotionSubscribers	183678302 17992.000	20				
Corrected Total	MTNPromotionSubscribers	233820802 64228.547	19				
	EtisalatPromotionSubscribers	223674951 4671.750	19				
	GloPromotionSubscribers	597268352 1867.751	19				
	AirtelPromotionSubscribers	553427866 0295.200	19				

a. R Squared = .993 (Adjusted R Squared = .936)
b. R Squared = .990 (Adjusted R Squared = .909)
c. R Squared = .999 (Adjusted R Squared = .986)
d. R Squared = .991 (Adjusted R Squared = .913)

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of GloPromoSubscribers is the same across categories of State.	Independent-Samples Kruskal-Wallis Test	.457	Retain the null hypothesis.
2	The distribution of MTNPromoSubscribers is the same across categories of State.	Independent-Samples Kruskal-Wallis Test	.457	Retain the null hypothesis.
3	The distribution of EtisalatPromoSubscribers is the same across categories of State.	Independent-Samples Kruskal-Wallis Test	.457	Retain the null hypothesis.
4	The distribution of AirtelPromoSubscribers is the same across categories of State.	Independent-Samples Kruskal-Wallis Test	.457	Retain the null hypothesis.
5	The distribution of VisafonePromoSubscribers is the same across categories of State.	Independent-Samples Kruskal-Wallis Test	.457	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Scheffe's method analysis

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
MTNPromotionSubscribers	.398	17	2	.889
EtisalatPromotionSubscribers	.527	17	2	.820
GloPromotionSubscribers	.491	17	2	.839
AirtelPromotionSubscribers	.600	17	2	.782

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + VisafonePromotionSubscribers

Estimated Marginal Means
VisafonePromotionSubscribers

Estimates

Dependent Variable	VisafonePromotionSubscribers	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
MTNPromotionSubscribers	.00	1034055.667	161716.100	338247.446	1729863.888
	16028.00	674899.000	280100.502	-530276.191	1880074.191
	40758.00	1300937.000	280100.502	95761.809	2506112.191
	47998.00	1093780.000	280100.502	-111395.191	2298955.191
	48093.00	1264773.000	280100.502	59597.809	2469948.191
	48938.00	1263778.000	280100.502	58602.809	2468953.191
	49008.00	1364788.000	280100.502	159612.809	2569963.191
	49732.00	1234471.000	280100.502	29295.809	2439646.191
	49987.00	1472680.000	280100.502	267504.809	2677855.191
	50122.00	1275468.000	280100.502	70292.809	2480643.191
	50998.00	1476758.000	280100.502	271582.809	2681933.191
	51006.00	1277389.000	280100.502	72213.809	2482564.191
	52088.00	1483600.000	280100.502	278424.809	2688775.191
	55011.00	1482900.000	280100.502	277724.809	2688075.191
	149196.00	3703413.000	280100.502	2498237.809	4908588.191
	181131.00	3944778.000	280100.502	2739602.809	5149953.191

	190022.00	3990993.000	280100.502	2785817.809	5196168.191
	198370.00	3899575.000	280100.502	2694399.809	5104750.191
	.00	266905.000	59678.157	10130.615	523679.385
	16028.00	148937.000	103365.600	-295809.281	593683.281
	40758.00	333009.000	103365.600	-111737.281	777755.281
	47998.00	290827.000	103365.600	-153919.281	735573.281
	48093.00	360998.000	103365.600	-83748.281	805744.281
	48938.00	357093.000	103365.600	-87653.281	801839.281
	49008.00	367928.000	103365.600	-76818.281	812674.281
	49732.00	361466.000	103365.600	-83280.281	806212.281
EtisalatPromotionS	49987.00	362908.000	103365.600	-81838.281	807654.281
ubscribers	50122.00	370009.000	103365.600	-74737.281	814755.281
	50998.00	378097.000	103365.600	-66649.281	822843.281
	51006.00	359038.000	103365.600	-85708.281	803784.281
	52088.00	363099.000	103365.600	-81647.281	807845.281
	55011.00	362227.000	103365.600	-82519.281	806973.281
	149196.00	1084398.000	103365.600	639651.719	1529144.281
	181131.00	1274890.000	103365.600	830143.719	1719636.281
	190022.00	1189287.000	103365.600	744540.719	1634033.281
	198370.00	1008379.000	103365.600	563632.719	1453125.281
	.00	560893.667	38207.334	396500.779	725286.555
	16028.00	290738.000	66177.043	6001.166	575474.834
	40758.00	599836.000	66177.043	315099.166	884572.834
	47998.00	670937.000	66177.043	386200.166	955673.834
	48093.00	613867.000	66177.043	329130.166	898603.834
	48938.00	600982.000	66177.043	316245.166	885718.834
	49008.00	630928.000	66177.043	346191.166	915664.834
	49732.00	612913.000	66177.043	328176.166	897649.834
GloPromotionSubs	49987.00	650947.000	66177.043	366210.166	935683.834
cribers	50122.00	640983.000	66177.043	356246.166	925719.834
	50998.00	639730.000	66177.043	354993.166	924466.834
	51006.00	590847.000	66177.043	306110.166	875583.834
	52088.00	621927.000	66177.043	337190.166	906663.834
	55011.00	649008.000	66177.043	364271.166	933744.834
	149196.00	1838739.000	66177.043	1554002.166	2123475.834
	181131.00	1925379.000	66177.043	1640642.166	2210115.834
	190022.00	2009387.000	66177.043	1724650.166	2294123.834
	198370.00	1999826.000	66177.043	1715089.166	2284562.834
AirtelPromotionSu	.00	480925.333	91691.339	86409.345	875441.322
bscribers	16028.00	274600.000	158814.057	-408721.737	957921.737

40758.00	560090.000	158814.057	-123231.737	1243411.737
47998.00	501038.000	158814.057	-182283.737	1184359.737
48093.00	611290.000	158814.057	-72031.737	1294611.737
48938.00	599830.000	158814.057	-83491.737	1283151.737
49008.00	611911.000	158814.057	-71410.737	1295232.737
49732.00	598116.000	158814.057	-85205.737	1281437.737
49987.00	613877.000	158814.057	-69444.737	1297198.737
50122.00	570094.000	158814.057	-113227.737	1253415.737
50998.00	570989.000	158814.057	-112332.737	1254310.737
51006.00	550091.000	158814.057	-133230.737	1233412.737
52088.00	589048.000	158814.057	-94273.737	1272369.737
55011.00	599049.000	158814.057	-84272.737	1282370.737
149196.00	1674348.000	158814.057	991026.263	2357669.737
181131.00	1873439.000	158814.057	1190117.263	2556760.737
190022.00	1996470.000	158814.057	1313148.263	2679791.737
198370.00	1783900.000	158814.057	1100578.263	2467221.737