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Modelling Students' Preferences for Mobile Telecommunication Plans: A Discrete Choice Experiment

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Authors' contributions

This work was carried out in collaboration among all authors. Author OAO conceptualized the study and wrote the first draft of the manuscript. Author CEO collected the data and performed the statistical analysis. Authors OAO and CEO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: We employed a discrete choice experiment (DCE) to investigate students' preferences for mobile telecommunication plans in a South African University.
Study design: Locally optimal DCE were constructed for our choice sets using readily available ideas from blocked fractional factorial designs. This is in contrast to other approaches that may be more complex practically especially when the number of attributes is large.
Place and duration of study: The study was conducted in August 2017 at the University of KwaZulu-Natal, Edgewood Campus, Pinetown, South Africa.
Methodology: Four hypothetical mobile telecommunication companies were considered and the selected attributes were call rate, data speed, customer service, premiums and network coverage. A two-stage sampling technique was used to select 180 respondents from the student population and data were collected via face-to-face interview. A 2^{5-1} blocked fractional factorial design in 2^2 blocks each of size four was used to generate the choice sets used to obtain information from the

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respondents. An extra choice set was included to ascertain the consistency of the choices. Proportion of rational respondents was computed. Multinomial logit model was used to analyze the data and marginal willingness to pay estimates was obtained for the attributes.
Results: The proportion of "rational" respondents was 74%. At 0.1% level of significance, the students valued all the attributes except data speed in the process of choosing a particular mobile network. Furthermore, marginal willingness to pay estimates showed that students preferred to pay 51 cents more per minute to have very good customer service. They also preferred to pay extra 13 and 45 cents per minute for more premiums and better network coverage respectively.
Conclusion: The results provide empirical evidence of what students perceive as the most important factors influencing their choice of mobile network service providers and these may have decision-making implications for South African-based telecommunication companies.

Keywords: Discrete choice experiment; mobile telecommunication plans; students' preferences; blocked fractional factorial design; willingness to pay.

1. INTRODUCTION

Communication plays an important role in all strata of the society; from education, social, industrial and economic sectors to the management of our private lives. It has become intertwined with our daily activities. The mobile communication industry has witnessed significant technological advancements in the past three decades. The mobile communication technology has evolved from 1G and 2G, which basically allowed users to speak and send text messages via their mobile phones to 3G which allowed connection to the internet and reception of multimedia messages. 4G came with a very high speed that made mobile internet easily accessible. The latest technology, 5G with a speed of 10 gigabits per second (Gbps), 10 to x100 faster than the speed of 4G, has been in operation since 2018. It was launched in 2020 by some network service providers in South Africa and services are already been rendered in some parts of the country.

The goal of every industry, including telecommunication, is to maximize profit. The telecommunication industry is highly competitive, requiring that service providers meet consumers' expectations in all ramifications so as to be able to retain their present customers as well as attract new ones. Consumers naturally tend to choose products or service from which they derive satisfaction. They usually consider certain factors in making this choice. Therefore telecommunication companies need to identify their customers' needs and perceptions about price, product, promotion, service quality, customer service and other factors that may be influencing their choice of telecommunication service providers. This would enable the service providers strategize effectively for profit maximization.

Previous research on consumer preferences for mobile telecommunication networks and services abound in literature. [1] conducted a study, using data collected via non-probability convenience sampling technique and a methodology based on structural equation modelling (SEM), to identify significant factors contributing to Bangladeshi consumers' choice of telecommunication service providers. The results showed that Bangladeshi consumers considered price most when selecting a particular telecommunication service provider. [2] investigated factors that influence consumers' choice of mobile telecommunication service provider in Nigeria using the SEM approach. Convenience sampling technique was also used to select respondents used in the study. The result revealed that call rate, service quality, and service availability were the factors mobile phone users considered most in their choice process. [3] utilized a discrete choice experiment (DCE) to study factors consumers considered as most important in terms of improvements in mobile telecommunication services in North Cyprus. An orthogonal main effects plan (OMEP) was used to construct the choice scenarios while a probability sampling technique, exogenous stratified random sampling (ESRS), was used to select the respondents used in the study. From the results, unrestrained roaming, followed by increased internet speed and unlimited use of the internet are the factors the consumers valued most. [4] used a DCE to identify what consumers value most when selecting a mobile telecommunications plan in Portugal. An orthogonal main effects plan (OMEP) was used to construct the choice scenarios used in the study. The authors showed that consumers were willing to pay extra 1.3 euro per month to get a reduced commitment period of 6 months from an initial 1 year. In this study, a probability two-stage sampling technique was used to select our

respondents to overcome the limitation posed by the use of non-probability sampling techniques in [1,2]. Also, we made use of readily available ideas from blocked fractional factorial designs to construct a locally optimal DCE for our choice sets in contrast to other approaches that may be more complex practically especially when the number of attributes is large.

A typical DCE involves the presentation of samples of hypothetical scenarios drawn *a priori* from all possible scenarios according to statistical design techniques to respondents. Each respondent is required to select a single option in each scenario. Each scenario has several options comprising attributes with at least two levels. It is assumed that the respondent chooses the option with the highest utility; the benefit the respondent derives from choosing the particular option. By securing a certain variation in the scenarios, the extent of influence of each attribute on the choice of the decision maker is estimated [5]. Discrete choice experiments have found applications in different research fields including marketing science, health, agriculture and transportation economics [6,7, 8, 9,10,11].

Following the introductory section, the rest of the paper is structured as follows: Section 2 presents the methodology employed in the study. Section 3 presents empirical results, interpretation and discussion of the findings while concluding remarks are presented in Section 4.

2. METHODOLOGY

2.1 Attributes and Levels

Focus group discussions were conducted with randomly selected students of the Edgewood Campus of the University of KwaZulu-Natal, South Africa. Comprehensive search of related literature [3,4,12,13,14,15] helped us to arrive at the attributes and their respective levels. These are presented in Table 1. The attributes are call rate, data speed, customer service, premiums and network coverage. Each attribute has two levels coded 0 and 1 respectively. For instance, 0 is for call rate at 99 cents while 1 is for call rate at 76 cents.

2.2 Experimental Design and Choice Sets

The design of the DCE is critical because it determines how attributes and their levels are combined to form choice sets [19]. Five attributes, namely: call rates, data speed, customer service, premiums and network coverage, each at two levels (that is 2x2x2x2x2), were identified giving a total of 32 treatment combinations. This was obviously not feasible for the study because of its size. Experimental designs are usually applied to reduce the size of designs in DCEs. Numerous applications of experimental designs abound in literature including [20,21,22,23,24,25] among others. In this study, a two-level Blocked Fractional Factorial Design (BFFD) was used to reduce the number of total treatment combinations.

2.2.1 Two-level blocked fractional factorial designs (BFFD)

Two-level full factorial designs are factorial designs with k factors each at two levels (2^k where k is the number of factors). They are rarely used in practice because they require 2^k number of runs which are usually uneconomical to cope with because of their large size. To overcome this limitation, a fraction of the full design, called fractional factorial design (FFD), is used, voluntarily trading-off the estimation of some of the interaction terms [19,26,27]. Detailed discussion on FFDs can be found in [27]. Blocking is introduced to reduce systematic variations leading to increase in precision of parameter estimates [28,29]. In BFFDs, the defining relation has two kinds of *words*, those containing treatment factors only and those involving at least one blocking factor. Definitions, construction techniques and examples of BFFDs can be found in [19,27,28,29]. BFFDs have natural applications in DCEs since the number and the size of the block in the BFFD corresponds to the number of choice sets and the number of options within each choice set respectively in the DCE [19,29].

The 2^{5-1} BFFD in 2^2 blocks each of size four used in this study is presented in Table 2. We utilize this design because:

(i) the design is locally optimal for the estimation of parameters in the multinomial logit model

(ii) the alias structure and the number of effects that are estimable are known in advance

(iii) The design is able to produce a choice design with fewer choice sets than when a full factorial design is used.

(iv) Our sample size is reasonably large enough to take care of any bias that might result from not specifying two-factor interactions in our model [29,30,31].

Table 1. Attributes and levels

Attributes	Definitions	Attribute levels
Call rate/minute	This is the amount paid by a customer to the network service provider for conversing via mobile phones	0. 99c 1. 76c
Data Speed (Mbps)	This is the speed (measured in megabits per second (Mbps)) with which data or content travels from the World Wide Web to computers, tablets, or smartphone [16]	0. 22.22 1. 21.63
Customer Service	This is a series of activities put together to ensure that customers' expectations are met on specific products or services [17]	0. Not very good 1. Very good
Premiums	This is an added reward given to customers to purchase a product or service.	0. Low 1. High
Network Coverage	This is the geographical area through which a mobile phone can be used to successfully execute a call via the mobile telecommunications network [18]	0. Vast 1. Not vast

Table 2. 2^{5-1} BFFD in 2^2 blocks each of size 4

I					II				
	A	**B**	**C**	**D**		**A**	**B**	**C**	**D**
Call rate	0	0	1	1	Call rate	0	0	1	1
Data speed	0	0	1	1	Data speed	0	0	1	1
Customer service	0	0	1	1	Customer service	1	1	0	0
Premiums	0	1	0	1	Premiums	0	1	0	1
Network coverage	0	1	1	0	Network coverage	1	0	0	1
III					IV				
	A	**B**	**C**	**D**		**A**	**B**	**C**	**D**
Call rate	0	0	1	1	Call rate	0	0	1	1
Data speed	1	1	0	0	Data speed	1	1	0	0
Customer service	0	0	1	1	Customer service	1	1	0	0
Premiums	0	1	0	1	Premiums	0	1	0	1
Network coverage	1	0	0	1	Network coverage	0	1	1	0

Note: A, B, C, D are hypothetical network service providers

2.3 Study Area and Data Collection

The study was conducted in 2017 at the University of KwaZulu-Natal, Edgewood Campus, Pinetown, eThekwini Metropolitan Municipality, KwaZulu-Natal, South Africa. This campus is home to the University's School of Education. The eThekwini municipality, with a total land area of 2,558.9 square kilometers has an estimated population of 3,702,231 as at 2016. The median age is 27 while 59% of the total population are in the 18-64 age group [32]. A stated preference questionnaire was constructed. A description of the overall choice scenario was given at the beginning of the choice task to facilitate respondent's quick understanding. Using Table 2, four choice sets were generated for the DCE questionnaire. A sample of a choice scenario is presented in Table 3. Each respondent completed the questionnaire by selecting preferred option from each of the four scenarios. To examine the consistency and rationality of the respondents, an extra choice set was included, the fifth scenario (a repetition of the first scenario). The proportion of "rational" respondents in this study was 74%.

Using Orme's formula [33], a minimum sample size of 125 was obtained. Consequently, a two-stage sampling technique was used to select 180 respondents from the student population residing in various residences on the campus via face-to-face interview. More specifically, ten residences were randomly selected from the twelve residences on the campus. Eighteen respondents were further randomly selected from each of the selected residences to give a total of 180 respondents.

2.4 Econometric Modelling

2.4.1Random utility theory (RUT)

This theory assumes that respondents maximize their utility U. This implies that the individual i is confronted with a choice set having *J* alternatives $(j = 1, \dots, J; with\, J \geq 2)$. Each alternative j has a known level of utility U for the individual i leading to U_{ij}. Practically, an individual i chooses the alternative with the highest utility. For example, if an individual attaches the highest utility U to option 3 out of options 1, 2 and 3, then this rational decision-maker will select option 3. The utility is the benefit the decision-maker derives from selecting a specific option.

The utility *U* for individual i based on choice j is broken into deterministic (observable) V_{ij} and random (unobservable) component ε_{ij}

$$U_{ij} = V_{ij} + \varepsilon_{ij}, \quad (j = 1, \dots, J; with\, J \geq 2) \qquad \text{Equation (1)}$$

The deterministic component is usually assumed to be a linear function of the attributes of the product and each respondent's characteristics. It is usually represented as

$$V_{ij} = X_{ij}'\beta + Z_i'\gamma \qquad \text{Equation (2)}$$

where X_{ij}' is the vector of attributes of product j as viewed by individual i, Z_i' is a vector of individual characteristics while β and γ are vectors of coefficients to be estimated [6,34,35, 36,37].

2.4.2 Multinomial Logit model (MNL)

The multinomial logit model (MNL), presented below, is a widely used discrete choice model.

$$P(Y_i = 1) = \frac{exp\lambda(X_{i1}'\beta + Z_i'\gamma)}{\sum_{j=1}^{J} exp\lambda(X_{ij}'\beta + Z_i'\gamma)}, j = 1 \qquad \text{Equation (3)}$$

where Y_i denotes the choice outcome and λ is a scale parameter usually normalized to 1 for any data set.

This model is derived under the assumption that each random variable follows a Gumbel distribution and are independently and identically distributed (IID). The IID or the independence –of –irrelevant alternatives (IIA) implies that respondents have the same preferences and/or that unobserved variation around these preferences are the same. This assumption, though restrictive, gives a convenient form for the choice probability making the model very popular [6,7,35].
In this study, the alternative specific constant (ASC) is assumed to be zero since the alternatives are generic.

2.4.3 Marginal Willingness To Pay (MWTP)

This is the marginal rate of substitution between the non-price attribute and the price attribute with the assumption that only one product is available and that it is chosen with 100% certainty. Within the context of mobile consumer issues, we estimate the amount (of the call rate) a consumer would be willing to forgo to secure improvements in other areas of the mobile network services. It is computed using equation (4) [7,38].

$$-1\left(\frac{\hat{\beta}_{attribute}}{\hat{\beta}_{price}}\right)$$ Equation (4)

Table 3. A sample choice set presented to participants

	A	B	C	D
Call rate/min	99c	79c	79c	99c
Data speed (Mbps)	21.63	22.22	22.22	21.63
Customer service	Not very good	Very good	Very good	Not very good
Premiums	Low	Low	High	High
Network coverage	Vast	Not vast	Vast	Not vast
I would choose				

3. RESULTS AND DISCUSSION

Socio-demographic information of the respondents are presented in Table 4. The age range of majority of the respondents (68.9%) is 19-23 years while 97.8% of them are single. The estimation of MNL model parameters, conducted using *R* software, is presented in Table 5. The expected effects are obtained for all variables and they are all statistically significant except for data speed. This might be due to the fact that the students had access to free Wi-Fi and so might not bother about data services provided by mobile network operators. [39] also found that most students from a South African University had access to free and adequate Wi-Fi

Table 4. Socio-demographic characteristics of the sample (N=180)

Socio-demographic variable	N (% of sample)
Gender	
Male	93 (51.7)
Female	87 (48.3)
Age	
14-18 years	10 (5.6)
19-23 years	124 (68.9)
24-28 years	40 (22.2)
28 years and above	6 (3.3)
Marital Status	
Married	4 (2.2)
Single	176 (97.8)
Others	0 (0)
Religion	
Christianity	129 (71.7)
Islam	3 (1.7)
Traditionalist	30 (16.7)
Others	18 (10)
Level of Study	
1st year	24 (13.3)
2nd year	11 (6.1)
3rd year	33 (18.3)
4th or final year	99 (55)
Postgraduate	13 (7.2)
Employed?	
Yes	25 (13.9)
No	155 (86.1)
Monthly Allowance	
Below R2,000	147 (81.7)
R2,000- R5,000	23 (12.8)
R6,000- R10,000	2 (1.1)
R11,000- R20,000	6 (3.3)
R21,000 and above	0 (0)

Note: N = number of respondents

Table 5. Estimation results of MNL model parameters

Variable	$\widehat{\beta}$ (SE)	z-value	Pr(>|z|)
Call rate	-0.022 (0.004)***	-4.9308	8.191e-07
Data speed	0.045 (0.088)	0.5069	0.6122
Customer service	1.137 (0.090)***	12.6788	< 2.2e-16
Premiums	0.288 (0.078)***	3.7027	0.0002
Network coverage	1.004 (0.084)***	11.9093	< 2.2e-16

*Log likelihood (MNL) = -807.13; SE = Standard error; *** P < .001*

Table 6. MWTP estimates

Variables	MWTP (SE)	t-value	Pr(>|t|)
Data speed	2.015 (3.967)	-0.508	0.6114
Customer service	51.36 (10.30)***	-4.986	6.177e-07
Premiums	13.02(4.347)**	-2.995	0.002741
Network coverage	45.32(9.922)***	-4.568	4.937e-06

*SE = Standard Error; ***P < .001; ** P < .01*

corroborating our result on the non-significance of data speed. The β coefficient for call rate was negative and significant, which meant that students derived higher utility from lower call rates. This corroborates the results of [1,2,40] where call rate was also significant. Also, [14,15] identified financial constraints as one of the difficulties students face on the purchase and use of mobile phones. Purchase, use and maintenance of mobile phones are mostly done out of their pocket money. Therefore, decreased call rate will lead to increase in the choice probability of a particular network provider. The parameter estimates for customer service, premiums and network coverage are all positive and significant. This implied that, the students preferred good customer service, more bonuses/freebies/premiums and superb network coverage. This is in line with the result of [40] which showed that Malaysian consumers value service quality, service availability and promotion in their choice of mobile phone service providers.

The MWTP estimates are presented in Table 6. Students are willing to pay extra 51 cents per minute to have good customer service rather than a bad one. The students are also willing to pay extra 13 cents for more premiums and 45 cents more for a better network coverage. The students are willing to pay just extra 2 cents per minute to have improved data speed, corroborating our earlier result on data speed.

These results have shown that though students prefer lower call rates, there are other things that can be used to compensate for lack of it. A good customer service is one of those. This is consistent with the outcome of [41] which stated that quality of customer services is the third major reason why customers may want to change their mobile network operator. Furthermore, some people prefer to have different mobile network lines for different purposes; one for making calls, another for receiving calls, one for browsing and so on. This is because they do not derive maximum satisfaction (utility) from any particular one. Thus, customers are all willing to try new network operators that have better offers.

Mobile telecommunication companies should focus more on providing lower call rates, good customer service, more premiums and better network coverage to achieve customer base enlargement and profit maximization among the student population of the Edgewood Campus of the University of KwaZulu-Natal, South Africa.

This study has two important limitations. Firstly, the study was targeted at students of the University of KwaZulu-Natal (Edgewood Campus). Results obtained can only be generalized for the student population on Edgewood Campus and not the entire student population of the University or the country as a whole. Secondly, the MNL model used in the study assumes that respondents have the same preferences and/or that unobserved variation around these preferences are the same. This assumption may not be true in real life.

4. CONCLUSION

Every business enterprise, including telecommunication companies, seeks to maximize profit. To achieve this objective, telecommunication companies need to identify their customers' needs and perceptions about price, product, promotion, service quality, customer service and other factors that may be influencing their choice of telecommunication service providers. Also, these companies need to prioritize meeting the needs and perceptions of young people so as to maintain a stable customer base into the future.

Thus, the aim of this paper was to use discrete choice experiments to identify students' preferences for mobile telecommunication plans. Readily available ideas from blocked fractional factorial designs were used to construct a locally optimal DCE for our choice sets in contrast to other approaches that may be more complex practically especially when the number of attributes is large. One hundred and eighty students of the University of KwaZulu-Natal, South Africa (Edgewood Campus) were randomly selected, via a two-stage sampling technique, for the study. Multinomial logit model was used to analyze the data and marginal willingness to pay estimates were obtained for the attributes.

All the attributes were statistically significant at 0.1% level except data speed. Students were willing to pay 51 cents more per minute to have a very good customer service. They were also willing to pay 13 and 45 cents more per minute respectively for more premiums and better network coverage.

The results provide empirical evidence of what students perceive as the most important factors influencing their choice of mobile network service providers. These may be useful for mobile telecommunication service providers in South Africa.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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