ANALYSIS OF PARTIALLY CONFOUNDED FACTORIAL CONJOINT CHOICE EXPERIMENT USING GENERALIZED LINEAR MIXED MODELS

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By

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ABSTRACT

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Ng Song Lin

Completely Confounded Factorial Conjoint Choice Experiment (CCFCCE) is a conjoint choice experiment that incorporates the confounded factorial designs and it was constructed by Yong (2004). This design enables us to estimate the main and interaction effects. Since some of the effects will be confounded with the blocks in completely confounded factorial design, the conjoint choice designs were extended to use the partially confounded factorial designs, it is then call the Partially Confounded Factorial Conjoint Choice Experiments (PCFCCE). In PCFCCE, each replicate does not share the same confounded effects, therefore, all the effects can be estimated.

In this dissertation, Visual Basic routines have been used to construct the Confounded Factorial Conjoint Choice Experiments and produce the corresponding survey questionnaires. 16 sets of tablet preferences survey form were created using the visual basic routines.

480 students from Faculty of Engineering and Science (FES) and Faculty of Creative Industry (FCI) of University Tunku Abdul Rahman were interviewed. Eventually, 406 sets of survey form were completed by the students. In total, 19,448 responses have been observed and 768 observed proportions were calculated from the responses.

A simulation using D-efficiency was conducted to compare the efficiency between some of the constructed PCFCCE designs and the corresponding CCFCCE designs. The D-errors were smaller in PCFCCE as compare D-error in CFCCE. This indicated that PCFCCE designs were more

efficient than CCFCCE designs.

The Generalized Linear Mixed Models (GLMMs) are useful tools in the analysis of partially confounded factorial conjoint choice experiments. GLMMs are extensions of generalized linear models that permit random effects as well as fixed effects in the linear predictor. Although generalized linear mixed models have been powerful and widely used statistical tools, the likelihood function of GLMMs remain a topic of debate.

When the model contains a large number of random effects, the marginal likelihood in GLMMs which appears in calculation of the log likelihood can involve very high-dimensional integrals and that are often intractable analytically. Monte Carlo Newton-Raphson (MCNR) approximation was used to account for high dimensional random components.

In this dissertation, a 2^8 partially confounded factorial design with two replicate was applied to Conjoint Choice Experiment (CCE). Generalized Linear Mixed Models method was then used for analyzing to find significant effects. In order to estimate the fixed effects, the random effects $\boldsymbol{u}$ need to be estimated before the fixed effects are estimated. Metropolis-Hastings algorithm was used to estimate the random effects $\boldsymbol{u}$, then together with Monte Carlo Newton-Raphson, the fixed effects $\boldsymbol{\beta}$, were then estimated. The result showed that all main effects (price, 3G, warranty, memory, flexibility, battery, camera and ram) and some of the first order interaction effects (price and 3G, price and warranty, price and flexibility) were significant.

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APPROVAL SHEET

This dissertation entitled "**ANALYSIS OF PARTIALLY CONFOUNDED FACTORIAL CONJOINT CHOICE EXPERIMENT USING GENERALIZED LINEAR MIXED MODELS**" was prepared by NG SONG LIN and submitted as partial fulfillment of the requirements for the degree of Master of Science at Universiti Tunku Abdul Rahman.

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DECLARATION

I hereby declare that the dissertation is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

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SUBMISSION OF DISSERTATION

It is hereby certified that **NG SONG LIN** (ID No: **12UEM01219**) has completed this thesis entitled **ANALYSIS OF PARTIALLY CONFOUNDED FACTORIAL CONJOINT CHOICE EXPERIMENT USING GENERALIZED LINEAR MIXED MODELS** under the supervision of Dr. Yong Chin Khian from the Department of Mathematical and Actuarial Sciences, Lee Kong Chain Faculty of Engineering and Science, and Dr. Liew How Hui from the Department of Mathematical and Actuarial Sciences, Lee Kong Chain Faculty of Engineering and Science.

I understand that University will upload softcopy of my thesis in pdf format into UTAR Institutional Repository, which may be made accessible to UTAR community and public.

Yours truly,

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(NG SONG LIN)

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CHAPTER 1

INTRODUCTION

1.1 PCFCCE Design and Survey

Conjoint Choice Experiment (CCE) has become a popular approach of data collection in conjoint analysis (Haaijer et al., 2001). It was introduced by Louviere and Woodworth in 1983 (Yong, 2004). The word conjoint means joint together and sometimes has interpreted by marketer as "considered jointly" that refers to respondents evaluate attributes of product or service jointly (Orme, 2010). It is called as stated preference analysis in transportation research.

Conjoint analysis is an efficient, cost-effective, and most widely used quantitative method in marketing research to understand consumer preferences and value trade-off (Intelliquest, 2000). Value can be interpreted by consumer as the received of multiple benefits from a price that is paid. In reality, a consumer wants the most preferable attributes or features at the lowest possible price while an organization wants maximize profits by minimizing cost of providing those features and to ahead of its competitors. Conjoint analysis involves more complex survey design and analysis, and more effort by respondents since they are forced to make difficult trade-offs. By this, company, organization or researchers can access what consumers truly value in reality or their willingness to trade off one attribute for another by using mathematical and statistical technique, rather than asking respondents to state the importance of each attribute.

In conjoint choice experiments, respondents choose from a set of product alternatives in choice set. A base alternative which is normally a "none" option is added to the set of product alternatives to make the choice more realistic (Haaijer et al., 2001). In a CCE, products are defined in terms of attributes (or factors) that play an important role in determining consumer's purchasing decisions. For example, in a tablet computer preference study, the relevant attributes of tablet computer may be 3G, warranty, memory, flexibility, battery, camera, ram and price, where all the attributes have two levels. Full profiles are product descriptions that specify a level for each attribute and a choice set is a set consisting of two or more full profiles. A choice set for the tablet computer is show in Table 1.1. The choice set has three alternatives two profiles and a neither. Depending on the experimental design, a choice set can have any number of alternatives. Given a number

Survey form			
	Option A	Option B	Option C
Price 3G Warranty Memory Flexibility Battery Camera Ram	RM 2250 No 1 year 32GB Yes 8 hours 3-Megapixel 512MB	RM 1750 Yes 2 year 64GB No 10 hours 5-Megapixel 1GB	Neither Option A or Option B

Table 1.1 Choice Set

of choice sets, the respondent's task is to choose the most preferred alternative from each choice set. The data generated provide important information about the utility of each level of each attribute which are then analyzed to determine the importance of the attributes on consumer preferences. Yong (2004) developed various Confounded Factorial Conjoint Choice Experiments Designs(CFCCE). In this study, visual basic routines will be used to construct the CFCCE and produce the corresponding survey questionnaires. The visual basic routines presented in this paper provides a quick way to construct CFCCE produce the corresponding survey questionnaires.

Completely Confounded Factorial Conjoint Choice Experiment (CCFCCE) had been constructed, by Yong (2004). This design allows estimation of main effect and interaction effects. Since some of the effects will be confounded with the blocks in completely confounded factorial design, the conjoint choice designs were extended to use the partially confounded factorial designs, it is then call the Partially Confounded Factorial Conjoint Choice Experiments (PCFCCE). In

PCFCCE, each replicate does not share the same confounded effects, therefore, all the effects can be estimated.

The increased quantity of information to better study of trade off can be obtained from lengthy questionnaires at higher cost but respondent fatigue and boredom can decrease the quality of the information (Sandor et al., 2001). Therefore, researchers are interested in constructing an efficient design of CCE to obtain maximum information from the minimum number of choice sets. The efficient design will provide more accurate estimate of conjoint choice parameters and reduce respondents' burden as well as sample size. In addition, Huber and Zwerina (1996) stated that the characteristics of an efficient experiment design are:

1. level balance (each level occurs equally often within each factor)
2. orthogonal (parameter estimates are uncorrelated)
3. utility balance (swapping and re-labeling of levels ensure no alternative will dominate the other alternative)
4. minimal level overlaps (minimal repeated level in each choice set)

Traditionally, the conjoint choice experiment was constructed using single fraction of full factorial design. The main limitation is that it does not allow estimation of interaction effects. Therefore, when interactions are not negligible, it will produce biased estimates of main effects. An alternative way to solve this problem is to use completely confounded factorial designs. Completely Confounded Factorial Conjoint Choice Experiment (CCFCCE), that had been constructed by Yong (2004) allowed estimation of main effects. Since some of the effects will be confounded with the blocks in complete confounded factorial design, the conjoint choice design were extended to use the partially confounded factorial designs, which are then called as Partially Confounded Factorial Conjoint Choice Experiment (PCFCCE) designs. In PCFCCE, each replicate does not share the same confounded effects. Therefore, all the effects can be estimated.

1.2 GLMM Algorithm and Analysis of Survey Data

The use of a partially confounded factorial conjoint choice experiment is consistent with random utility theory. For each choice set a consumer must choose between two products each with a different set of product attributes or neither. Presumably, the consumer chooses the alternative with largest utility. If the random components of the random utility function are assumed to be independent with a Gumbel distribution, then the probability that a consumer will choose one of the alternatives will follow multinomial logit model.

Multinomial logit model is one of multivariate Generalized Linear Model (GLM). Newton-Raphson method will be used to estimate the model coefficients. Since the coefficients in multinomial logit model are non-linear.

However, the respondents often response to number of choice sets and as a result the within-subject correlation and respondents are grouped into blocks which will cause correlation among subjects, so independence is violated (Yong, 2004). The Generalized Linear Mixed Models (GLMM) method will be used for accounting the correlations effects.

Chen and Kuo (2001) proposed an easy way of implementing the estimation of the multinomial logit model with simple within-subject correlation. They allow some or all the parameters in the multinomial logit model to vary randomly across subjects. This idea leads to the multinomial logit model with random effects where the choice probabilities for repeated observations of a subject share the same unobserved subject random effects and subjects within a block have the same block random effects (u_i). To include random effects in model, the model then falls into the class of generalized linear mixed model.

Generalized Linear Mixed Models (GLMM) are extensions of generalized linear models that permits random effects as well as fixed effects in the linear predictor. The use of generalized linear mixed models is growing in popularity in the modeling of correlated data. However, the parameter estimation in GLMM is very challenging because the likelihood may involve high-dimensional integrals that are analytically intractable. We will employ Monte Carlo Newton-Raphson (MCNR) approximation to account high dimensional random components.

In addition, this study will develop appropriate method to analyze the data from confounded factorial conjoint choice experiments. The statistical analysis in most studies on conjoint choice experiments assumes independent responses within-subjects across choice sets. It is unrealistic to believe that responses on different choice sets from the same respondent are uncorrelated. In this study, we will incorporate the within subject dependence in the estimation procedure. Also, since confounded factorial designs are incomplete block designs, we will also assume the 16 blocks to be random and incorporate the random block effects into the estimation procedure. Since the model contains random effects, the model then falls into the class of generalized linear mixed model.

Although generalized linear mixed models are a rich class of model for statistical analysis, their use in practice has been limited by the complexity of the likelihood function. This has led to the development of several methods using analytical approximations to the likelihood. Current methods available can be categorized broadly as follows:

1. Gauss-Hermite quadrature (Numerical quadrature)
2. Expectation Maximization (EM) algorithm
3. Markov Chain Monte Carlo algorithms
4. Stochastic approximation algorithms
5. Simulated maximum likelihood

In this study, we used the Monte Carlo Newton-Raphson method, which is a Monte-Carlo implementation of the Newton-Raphson procedure. In Monte Carlo Newton-Raphson, Metropolis-Hastings algorithm was used to generate random effects.

1.3 Objectives and Overview of Dissertation

The objectives of this dissertation are as follow:

1. To construct 2^n Partially Confounded Factorial Conjoint Choice Experiment.

2. Collect data using the survey form.

3. To develop a method to analyze PCFCCE with correlated structure by using generalized linear mixed models.

4. Apply the method to UTAR student's preference for tablet computer.

In Chapter 2, we review the conjoint choice experiments. This will be used in Chapter 4. In Chapter 3, I have achieved the first objective by developing an Excel VBA (CFCCE.xlsm) to generate all the survey forms (which can be found in Appendix C). It took me a month to conduct the survey and I have accomplished the second objective in 2012. The numerical method to analyze PCFCCE were implemented in Chapter 4 using R language. The survey data are then analyzed using the PCFCCE program.

CHAPTER 2

LITERATURE REVIEW OF CONJOINT CHOICE EXPERIMENTS

2.1 Factorial Design

Conjoint Choice Experiment (CCE) are special type of factorial experiment. A full factorial experiment with n factors or attributes where the i^{th} factor (or attribute) has A_i levels, has a total of $A_1\ A_2\ ....A_n$ treatment combinations. The main effect of a factor is defined to be the change in the response produced by a change in the level of the factor. Interaction between the factors occur when the difference in response between the levels of one factor is not the same at all levels of the other factors (Montgomery, 2001).

2.1.1 Confounded Factorial Design

The confounded factorial is a design technique for arranging a complete factorial experiment in blocks, where the block size is smaller than the number of treatment combinations in a full factorial design. Suppose we are interested in constructing 2^n factorial designs confounded in 2^p blocks ($p\ \leq n$), where each block contains exactly 2^{n-p} experimental units, where n is the number of factors, and p is the number of independent defining effects. We select p independent effects to be confounded, where by "independent" we mean that no effect chosen is the generalized interaction of the others. The blocks may be generated by the use of the p defining contrasts $L_1, L_2, ..., L_p$ associated with these effects. By doing this, $2^p - p - 1$ other effects will be confounded with blocks. These effects are the generalized interactions of those p independent effects initially chosen (Montgomery 2001). One must ensure that the selected $[p + (2^p - p - 1)]$ effects to be confounded with blocks are not the effects needed for estimations. Failing to do this may cause the effects to be biased by the block effects.

Let consider an example of single replicate 2^5 design (32 treatment combinations) with five factors (A, B, C, D, E, F) confounded in $2^2\ =\ 4$ blocks of $2^{5-2} = 8$ treatment combinations. The defining contrasts are $ABCD$ and $BCDE$, (Montgomery, 2001). A represent factor 1, B represent factor 2, C represent factor 3, D represent factor 4 and E represent factor 5. There is $2^2-2-1 = 1$ generalized interaction, giving by $ABCD * BCDE = AB^2C^2D^2E = AE$. The linear combinations corresponding to both defining contrasts are:

$$L_1 = x_1 + x_2 + x_3 + x_4 \quad and \quad L_2 = x_2 + x_3 + x_4 + x_5 \qquad (1)$$

where x_i is the level (0 or 1) for the i^{th} factor. Each of the 32 treatments combinations will yield a particular pair of values of $L1(mod2)$ and $L2(mod2)$, that is either $(L1, L2) = (0,0), (0,1), (1,0)$ or $(1,1)$. Treatment combinations yielding the same values of $(L1, L2)$ are assigned to the same block as below:

$L1 = 0,\ L2 = 0$ assigned to Block 1

$L1 = 0,\ L2 = 1$ assigned to Block 2

$L1 = 1,\ L2 = 0$ assigned to Block 3

$L1 = 1,\ L2 = 1$ assigned to Block 4.

(L_1, L_2)	(0,0) Block 1		(0,1) Block 2		(1,0) Block 3		(1,1) Block 4
	00000		11000		10000		01000
	01100		10100		11100		00100
	01010		10010		11010		00010
	00110		11110		10110		01110
	11001		00001		01001		10001
	10101		01101		00101		11101
	10011		01011		00011		11011
	11111		00111		01111		10111

Table 2.1 Blocks Design

2.1.2 Partially Confounded Factorial Design

The design is said to be completely confounded, if the same confounded interactions are used to confound with blocks in each replicate. Unless experimenters have a prior estimate of error or are willing to assume certain interaction to be negligible, otherwise they should to different effects to confound with block in different replicates if the resources are sufficient to allow replication.

Consider the design mentioned above as replicate I, three effects were selected to confound with the block. Replicate II, we select ABDE and ACDE to be confound with block, while one generalized interaction effect given by BC.

	Replicate I	Replicate II
	Selected effect	Selected effect
(1)	$ABCD$	$ABDE$
(2)	$BCDE$	$ACDE$
	Generalized interaction	Generalized interaction
(1)*(2)	$AB^2C^2D^2E = AE$	$A^2BCD^2E^2 = BC$

Table2.2 Generalized interaction effects

Since different effects confound with block in different replicates. There are 3 effects confound with the block in replicate I, can be obtained partial information in replicate II; while 3 effects confound with the block in replicate II, can be obtained partial information in replicate I.

This approach allows some information on the confounded effects to be obtained from other replicates except the replicates where consist of the blocks they are confounded with. The information obtained from other replicates is called "relative information for the confounded effect" by Yates in 1937, (Montgomery, 2001), this approach or design is called partially confounding.

2.2 Statistical Method in Conjoint Choice Experiment

Multinomial logit model (MNL) is one of the most commonly model used in analyzing data in conjoint choice experiment (Hausman et al., 1984), (Huber et al., 1996). In a Conjoint Choice Experiment, respondents are responding to several choice sets that consisting of alternatives. Alternative with the largest utility will be selected by a respondent. Utility refers to attribute level. The choice probabilities can be calculated analytically rather than numerically. A random utility model had proposed by Thurstone in 1926 as a result of his work of choice probabilistic choice models in psychometric. In random utility model, each alternative in a choice set is a random variable and alternative with the largest utility will be selected by respondent. Multinomial logit model is useful in modeling utility. A random utility function, U_{ijk} may be expressed by:

$$U_{ijk} = \mathbf{x_{ij}}'\boldsymbol{\beta} + \epsilon_{ijk} \tag{2}$$

where U_{ijk} is the utility of i respondent for alternative j in choice set k, $\mathbf{x'_{ij}}$ is a p-dimensional vector of the attributes of alternative j and $\boldsymbol{\beta}$ is a p-dimensional parameter vector. The scalar $\mathbf{x'_{ij}}\beta$ is a constant while ϵ_{ijk} is the random component.

According to McFadden (1974), the random utility model is a multinomial logit model if ϵ_{ijk} or the error term is independent and identicaly distributed Gumbel. The probability density function and the cumulative distribution function of the Gumbel random variable are

$$f(\epsilon_i) = exp(-\epsilon_i - e^{-\epsilon}) \tag{3}$$

$$F(\epsilon \leq \epsilon) = exp(-e^{-\epsilon}) \tag{4}$$

If the random components are assumed to be independent with a Gumbel distribution. Then the number of alternatives within choice set is J, the probability that alternative j is chosen from choice set i, the multinomial logit model follow McFadden (1974):

$$P_{ij} = \frac{exp(\mathbf{x_{ij}}'\boldsymbol{\beta})}{\sum_{j=1}^{J} exp(\mathbf{x_{ij}}'\boldsymbol{\beta})}. \tag{5}$$

The responses in CCE are multinomial distributed since each respondent only choose one alternative from choice set. If it is assumed that all I respondents are responding on the same choice set and the selected alternatives among different choice sets are independent, then the log-likelihood function for the multinomial logit model is:

$$lnL(\boldsymbol{\beta}) = \sum_{i=1}^{I}\sum_{j=1}^{J}\sum_{k=1}^{K} y_{ijk} ln p_{ij}. \tag{6}$$

The maximum likelihood estimates $\hat{\beta}$ which maximize the log-likelihood is then use to estimate the parameter coefficients of multinomial logit models.

Multinomial logit model is one of multivariate Generalized Linear Model (GLM). Newton-Raphson will be used to estimate the model coefficients. Since the coefficients in multinomial logit model are non-linear.

However, the respondents often response to number of choice sets and as a result the within-subject correlation and respondents are grouped into blocks which will cause correlation among subjects, so independence is violated (Yong, 2004). The Generalized Linear Mixed Models (GLMM)s has been suggested for accounting the correlations effects.

2.2.1 Generalized Linear Models (GLMs)

GLMs extend ordinary regression models to encompass non-normal response distributions and modeling function of the mean (Alan, 2002). GLMs encompass models for discrete response data which takes one of several values rather than being measured on a continuous scale. Nelder and Wedderburn (1972) were the first to propose the generalized linear model to encompass these different models under one unified mathematical framework.

Generalized linear models are defined by the following three components: Let $\mathbf{Y}$ be the vector of N observations.

(i) *The Random Component*

The response Y has a distribution in the exponential family, where the probability density function can be written in the form

$$f(y_i;\theta_i) = exp\left(\frac{y_i\theta_i \ - \ b(\theta_i)}{a(\phi)} \ + \ c(y_i,\phi)\right) \tag{7}$$

where θ is called the natural parameter ϕ is a known dispersion parameter Several important distributions are special cases, including the Poisson and

Binomial.

(ii) *The Systematic Component*

The systematic component of a GLM relate a vector $(\eta_1, ..., \eta_n)$, to explanatory variable through a linear model.

$$\eta_i = \sum_j \beta_j x_{ij}, i = 1, ..., n \tag{8}$$

x_{ij} denote the value of the predictor $j(j = 1, 2, ..., p)$ and β denote parameter.

This linear combination of explanatory variables is callas the *linear predictor*.

(iii) *The Link Function*

A monotonic differentiable *link function g* describes how the expected response $\mu_i = E(Y_i)$ is connects to the linear predictor η_i.

$$g(\mu_i) = \eta_i, i = 1, ..., n \tag{9}$$

The link function also transforms the mean to the natural parameter which $g(\mu_i) = \theta$.

$Y \sim$	Normal($\mu,\ \sigma^2$)	Poisson(λ)	Bin($n,\ \pi$)/m
θ	$\theta = \mu$	$\log \lambda$	$\log \frac{\pi}{1-\pi}$
$a(\phi)$	σ^2	1	$\frac{1}{m}$
$b(\theta)$	$\frac{\theta^2}{2}$	$\exp(\theta)$	$\log(1 + e^\theta)$
$c(y,\ \phi)$	$-\frac{1}{2}(\frac{y^2}{\phi} + \log(\mu\phi))$	$-\log(y!)$	$\log({}_nC_{ny})$

Table 2.3 Type of Genetalized Linear Model

Mean and Variance Functions for the Random Component

Let $L_i = \log f(y_i; \theta_i, \phi)$ denote the contribution of y_i to the log likelihood, then the log-likelihood function is $L = \sum_i L_i$.

$$L_i = [y_i\theta_i - b(\theta_i)]/a(\phi) + c(y_i, \phi) \quad (10)$$

Then take the first two derivative with respect to the θ_i.

$$\partial L_i/\partial\theta_i = [y_i - b'(\theta_i)]/a(\phi)] \quad (11)$$

$$\partial^2 L_i/\partial\theta_i^2 = -b''(\theta_i)/a(\phi) \quad (12)$$

Apply the general likelihood results such that

$$E(\partial L/\partial\theta) = 0 \text{ and } -E(\partial^2 L/\partial\theta^2) = E(\partial L/\partial\theta)^2 \quad (13)$$

then

$$\mu_i = E(Y_i) = b'(\theta_i) \text{ and } V(Y_i) = b''(\theta_i)a(\phi) \quad (14)$$

Table below gives the mean and variance functions for the random component of the GLMs

Y	Normal($\mu,\ \sigma^2$)	Poisson(λ)	Bin($m,\ q/m$)
$E(Y) = b'(\theta)$	$\theta = \mu$	$\exp(\theta) = \lambda$	$\frac{e^\theta}{1+e^\theta} = \pi$
$V(Y) = b''(\theta)a(\phi)$	σ^2	$\exp(\theta) = \lambda$	$\frac{\pi(1-\pi)}{m}$

Fitting generalized linear models

The GLMs likelihood equations are usually nonlinear in $\hat{\boldsymbol{\beta}}$. However, solving a system of nonlinear equations is not easy. The solution cannot be derived algebraically as it did in the case of linear equations. The solution must be numerically estimated using an iterative process. The most popular method for solving systems of nonlinear equations is the Newton-Raphson method.

The Newton's method is to take the first degree Taylor polynomial as an approximation for f, which we want to set equal to zero, then solving for β:

$$\begin{aligned} f(x_0) + f'(x_0) * (x - x_0) &= 0 \\ x &= x_0 - f(x_0)/f'(x_0) \end{aligned} \tag{15}$$

This new value of x is the next approximation for the root. We let $x_1 = x$ and continue in the same manner to generate $x_2, x_3, ...,$ until successive approximations converge.

Solving $\boldsymbol{\beta}$ in GLMs by Newton's method:

$$\begin{aligned} \boldsymbol{\beta}^{(1)} &= \boldsymbol{\beta}^{(0)} + [-l''(\boldsymbol{\beta}^{(0)})]^{-1} * l'(\boldsymbol{\beta}^{(0)}) \\ l'(\boldsymbol{\beta}^{(0)}) &= \partial L(\boldsymbol{\beta})/\partial \beta_j \\ l''(\boldsymbol{\beta}^{(0)}) &= \partial^2 L(\boldsymbol{\beta})/(\partial \beta_j \partial \beta_h) \end{aligned} \tag{16}$$

In order to solve $\boldsymbol{\beta}$ in the above procedure, we need to determine systematic component and link function. From the systematic component and link function, the first second derivative of $L(\boldsymbol{\beta})$ can be obtained.

A systematic component of a GLM relate a vector ($\eta_1, ..., \eta_n$), to explanatory variable through a linear model.

$$\eta_i = \sum_j \beta_j x_{ij}, i = 1, ..., N \tag{17}$$

In addition, a link function, connects the random component and systematic components. A link function $g(.)$ is defined by

$$g(\mu_i) \ = \ \eta_i \text{ ; where } \ \mu_i \ = \ E(Y_i)$$

and hence

$$g(\mu_i) = \eta_i = \sum_j \beta_j x_{ij}. \tag{18}$$

Since the link function also transforms the mean to the natural parameter where $g(\mu_i) = \theta$ then the natural parameter equal to linear predictor, $\theta = \sum_j \beta_j x_{ij}$.

For n independent observations, the log likelihood is

$$L(\boldsymbol{\beta}) = \sum_i^n L_i = \sum_i logf(y_i; \theta_i, \phi) = \sum_i [y_i\theta_i - b(\theta_i)]/a(\phi) + c(y_i, \phi) \quad (19)$$

Here, we observed that $L(\boldsymbol{\beta})$ reflects the dependence of θ on the model parameters $\boldsymbol{\beta}$.

To differentiate the log likelihood, use the chain rule,

$$\frac{\partial L_i}{\partial \beta_j} = \frac{\partial L_i}{\partial \theta_i} \times \frac{\partial \theta_i}{\partial \mu_i} \times \frac{\partial \mu_i}{\partial \eta_i} \times \frac{\partial \eta_i}{\partial \beta_j} \quad (20)$$

$$\begin{array}{llll}
1 & \partial L_i/\partial \theta_i & = & [y_i - b'(\theta_i)]/a(\phi) \\
 & & = & [y_i - \mu_i]/a(\phi) \qquad where\ \ \mu_i = b'(\theta_i) \\
2 & \mu_i & = & b'(\theta_i) \\
 & \partial \mu_i/\partial \theta_i & = & b''(\theta_i) \\
 & & = & Var(Y_i)/a(\phi) \qquad where\ \ Var(Y_i) = b''(\theta_i)a(\phi_i) \\
3 & \eta_i & = & g(\mu_i) \\
 & \partial \eta_i/\partial \mu_i & = & g'(\mu_i) \\
 & \partial \mu_i/\partial \eta_i & = & [g'(\mu_i)]^{-1} \\
4 & \eta_i & = & \sum_j \beta_j x_{ij} \\
 & \partial \eta_i/\partial \beta_j & = & x_{ij}
\end{array} \quad (21)$$

Substituting the above to equation:

$$\frac{\partial L_i}{\partial \beta_j} = \frac{y_i - \mu_i}{a(\phi)} \times \frac{a(\phi)}{Var(Y_i)} \times \frac{\partial \mu_i}{\partial \eta_i} \times x_{ij} = \frac{(y_i - \mu_i)x_{ij}}{Var(Y_i)} \times \frac{\partial \mu_i}{\partial \eta_i} \quad (22)$$

The likelihood equation are

$$\frac{\partial L}{\partial \beta} = \sum_{i=1}^{n} \left[\frac{(y_i - \mu_i)x_{ij}}{Var(Y_i)} \times \frac{\partial \mu_i}{\partial \eta_i} \right] = 0, j = 1, ..., p. \tag{23}$$

Although $\boldsymbol{\beta}$ does not appear in these equations, it is there implicitly through μ_i, since $g(\mu_i) = \sum_j (\beta_j x_{ij})$. Different link functions yield different sets of equations. Generalizing from this typical element to the entire matrix, the first derivative of $\boldsymbol{\beta}$ matrix has the form

$$l'(\boldsymbol{\beta}) = \frac{\partial L(\boldsymbol{\beta})}{\partial \beta} = \left(\frac{X}{Var(Y)} \times \frac{\partial \mu}{\partial \eta} \right)^T (Y - \mu) \tag{24}$$

The second derivative of $\boldsymbol{\beta}$ can be obtained from the estimate asymptotic covariance of $\boldsymbol{\beta}$, $\widehat{cov}(\hat{\boldsymbol{\beta}})$, i.e

$$\begin{array}{lccl} & [-l''(\beta)]^{-1} & = & \widehat{cov}(\hat{\boldsymbol{\beta}}) \\ & \widehat{cov}(\hat{\boldsymbol{\beta}}) & = & (X^T \hat{W} X)^{-1} \\ where & W & = & diag(w_i) \\ and & w_i & = & (\partial \mu_i / \partial \eta_i)^2 / Var(Y_i)) \end{array} \tag{25}$$

Together with the first and second derivative of $L(\beta)$. The Newton-Raphson procedures can be applied as follows.

$$\beta^{(1)} = \beta^{(0)} + [-l''(\beta^{(0)})]^{-1} * l'(\beta^{(0)}) \tag{26}$$

$$= \beta^{(0)} + (X^T W X)^{-1} \left(\frac{X}{Var(Y)} \times \frac{\partial \mu}{\partial \eta} \right)^T (Y - \mu)$$

The new value of $\beta^{(1)}$ is the next approximation for the root. We let $\beta^{(0)} = \beta^{(1)}$ and continue in the same manner to generate $\beta^{(1)}, \beta^{(2)}, ...,$ until successive approximations converge.

2.2.2 Generalized Linear Mixed Model (GLMM)

Generalized linear mixed models are extensions of generalized linear models that permits random effects as well as fixed effects in the linear predictor. Although generalized linear mixed model had become a very powerful and widely used statistical tool, the likelihood function of GLMMs remain a topic of debate.

In the early 1980's McCulloch (1994), Breslow and Clayton (1993), researchers were developing generalized linear mixed models as a way to account for over-dispersion in data (Breslow, 1984). Over-dispersion is often seen in Poisson or binomial data. It occurs when an assumed mean-variance relationship, such as mean = variance = μ as for the Poisson case is not satisfied, an important covariate is omitted, or the covariates are measured with error (Follmann et al., 1989). For example, data collected by Ochi and Prentice (1984) on radiation was considered to be over-dispersed because the variance was affected by individual differences in susceptibility to radiation damage, or perhaps substantial random errors in the estimated radiation exposure levels. Not accounting for over-dispersion can lead to underestimates of standard errors associated with regression parameters (Ochi et al., 1984), (Stiratell et al., 1984) and (Zeger et al., 1988) developed GLMM's modeling the dependence seen in binary and other outcome variables for longitudinal, clustered and repeated-measures studies. Further application of GLMM's include shrinkage estimates of parameter in spatial studies (Leroux, 2000), (Clayton et al., 1987) and meta-analysis (Aitken, 1999), (Berkey et al., 1996).

A GLMM consists of the following components:

Let $\mathbf{Y}$ be the vector of N observations and $\mathbf{u}$ a vector of random effects.

(i) The conditional distribution of $\mathbf{Y}$ given the random effects $\mathbf{u}$ belonging to the exponential family, talking the form

$$f(y_i|\mathbf{u};\ \boldsymbol{\beta}, D) \quad = \quad \exp\left[\frac{y_i\theta_i - b(\theta_i)}{a(\phi)} + c(y_i, \phi)\right] \tag{27}$$

where $a(\phi)$ is a known dispersion parameter, θ is called the natural parameter.

(ii) Given the random effects **u**, $Y_1, Y_2, ...Y_n$ are independent:

$$f(\mathbf{Y}|\mathbf{u}) = \prod_{i=1}^{n} f(\mathbf{y}_i|\mathbf{u}) \tag{28}$$

(iii) The random effects $\mathbf{u}$ follow multivariate normal distribution with mean = 0, variance = D.

$$\mathbf{u} \sim \; MVN(0, \; D) \tag{29}$$

(iv) Let $E(\mathbf{Y}_i|u) \; = \; \mu_i$ and $g(\mu_i) \; = \; \eta_i \; = \; \boldsymbol{x_i'\beta} + \boldsymbol{z_i'}\mathbf{u}$, where $\boldsymbol{\beta}$ is a vector of unknown parameter, $\mathbf{u}$ is a vector of random effects, x_i' and z_i' is the model vector for the fixed effects and random effects.

The marginal likelihood function for the generalized linear mixed model can be obtained by integrating out the unobserved random effects u from the joint density function $f(\mathbf{y}, \; u; \; \theta)$

$$L(\theta, \; \mathbf{y}) = \int f(\mathbf{y}, \; u; \; \theta)du = \int \prod_{i} f_{\mathbf{y}i|U}(\mathbf{y}_i|u; \; \theta)f_U(u; \theta)du \tag{30}$$

An example of a generalized linear mixed model for Bernoulli data, with a random intercept is a model motivated by data collected in an Indonesian children's health study on the effects of vitamin A intake on the probability of getting respiratory disease (Diggle et al., 1994). The model used here assumes that every child has their own probability for getting respiratory disease but that the effect of vitamin A on the probability for getting respiratory disease is the same for every child. The model is

$$logitPr(Y_{ij} = 1|u_i) \; = \; \beta_0 \; + \; \beta_1 x_{ij} \; + \; u_i, \tag{31}$$

where the random intercepts, u_i are iid Normal(0,D),$i \; = \; 1, ..., \; n, \; \beta \; = \; (\beta_0, \beta_1)$ is the vector of fixed effects, x_{ij} is a covariate measuring whether child i is vitamin A deficient, and Y_{ij} is an indicator response variable indicating whether a child had a respiratory infection at time t_{ij} An additional assumption for the model used here is that given u_i, the repeated observations for the ith child are independent of one another. The intercept coefficient β_0 would be interpreted as the log odds of respiratory infection for a typical child with random effect $u_i = 0$ and $x_{ij} = 0$. The parameter β_1 is the log odds ratio for respiratory infection when a child is vitamin A deficient relative to when that same child is not (Diggle et al., 1994).

One of the main difficulty in making inference about GLMM is it's computational evaluation of high-dimensional integrals. The integral has dimension equal to the number of levels of random factors, $\mathbf{u}$.

Due to the high dimensional integration in the likelihood. A number of estimation method have been proposed by McCulloch with the key point of using the Metropolis-Hastings algorithm to simulate from the distribution of $\mathbf{u}|\mathbf{y}$ (McCulloch, 1997). One of the method is Monte Carlo Newton-Raphson(MCNR).

Monte Carlo Newton-Raphson (MCNR)

McCulloch (1997) set up an Eepectation Maximization (EM) algorithm, assuming that random effects ($\mathbf{u}$) as missing data. The log-likelihood can be split into two part:

$$\ln L(\boldsymbol{\beta}, \phi, \mathbf{D}|\mathbf{y}) = \sum_i \ln f_{\mathbf{y}_i|u}(\mathbf{y}_i|\mathbf{u};\ \boldsymbol{\beta}) + \ln f_u(\mathbf{u}|\mathbf{D}) \qquad (32)$$

Condition on $\mathbf{u}$, the $\mathbf{y}_i$ are independent. $\boldsymbol{\beta}$ appears only in the first portion of the log likelihood, whereas $\mathbf{D}$ appears only through f_U. The algorithm takes the following forms:

1. Choose starting Values $\boldsymbol{\beta}^{(0)}$ and $\mathbf{D}^{(0)}$ and set $m = 0$..

2. Calculate (with expectations evaluated under current values)

   (i) $\boldsymbol{\beta}^{(m+1)}$, which maximize E[$\ln f_{\mathbf{y}|u}(\mathbf{y}|\mathbf{u},\ \boldsymbol{\beta})|\mathbf{y}$].

   (ii) $\mathbf{D}^{(m+1)}$, which maximize E[$\ln f_u(\mathbf{u}|\mathbf{D})|\mathbf{y}$].

(iii) set $m = m + 1$.

3. If convergence is achieved, declare the current values to be the MLEs, otherwise return to step 2.

Again, McCulloch suggest that the random sample draw through Metropolis algorithm, a candidate distribution $h_u(u)$ must be selected, from which potential new values are drawn and acceptance function is given by

$$A(\mathbf{u},\ \mathbf{u}^*) \quad = \quad \min\left[1,\ \frac{f_{u|\mathbf{y}}(\mathbf{u}^*|\mathbf{y},\ \boldsymbol{\beta},\ \mathbf{D})h_{\mathbf{u}}(\mathbf{u})}{f_{\mathbf{u}|\mathbf{y}}(\mathbf{u}|\mathbf{y},\ \boldsymbol{\beta},\ \mathbf{D})h_{\mathbf{u}}(\mathbf{u}^*)}\right]. \tag{33}$$

The acceptance function, which gives the probability of accepting a new value. On choosing $h_{\mathbf{u}} = f_{\mathbf{u}}$, the second term can be simplifies to

$$\frac{f_{\mathbf{u}|\mathbf{y}}(\mathbf{u}^*|\mathbf{y},\ \boldsymbol{\beta},\ \mathbf{D})h_{\mathbf{u}}(\mathbf{u})}{f_{\mathbf{u}|\mathbf{y}}(\mathbf{u}|\mathbf{y},\ \boldsymbol{\beta},\ \mathbf{D})h_{\mathbf{u}}(\mathbf{u}^*)} = \frac{\prod_{i=1}^{n} \frac{f(\mathbf{y}_i,\ \mathbf{u}^*|\boldsymbol{\beta},\ \mathbf{D})}{f_{\mathbf{Y}}(\mathbf{y}_i|\boldsymbol{\beta})} f_{\mathbf{u}}(\mathbf{u}|\mathbf{D})}{\prod_{i=1}^{n} \frac{f(\mathbf{y}_i,\ \mathbf{u}|\boldsymbol{\beta},\ \mathbf{D})}{f_{\mathbf{Y}}(\mathbf{y}_i|\boldsymbol{\beta})} f_{\mathbf{u}}(\mathbf{u}^*|\mathbf{D})} = \frac{\prod_{i=1}^{n}\ f_{\mathbf{y}_i|\mathbf{u}}(\mathbf{y}_i|\mathbf{u}^*,\ \boldsymbol{\beta})}{\prod_{i=1}^{n}\ f_{\mathbf{y}_i|\mathbf{u}}(\mathbf{y}_i|\mathbf{u}^*,\ \boldsymbol{\beta})} \tag{34}$$

This calculation involves only the ratio the two conditional distributions, $\mathbf{y}|\mathbf{u}^*$ and $\mathbf{y}|\mathbf{u}$.

Through EM framework, the marginal density of $\mathbf{y}$ is formed as a mixture of $f_{\mathbf{Y}|\mathbf{U}}$ and $f_{\mathbf{U}}$, those the ML equation for $\boldsymbol{\beta}$ and $\mathbf{D}$ take the following form

$$E\left[\frac{\partial f_{\mathbf{Y}|\mathbf{U}}(\mathbf{y}|\mathbf{u},\boldsymbol{\beta})}{\partial \boldsymbol{\beta}}|\mathbf{y}\right] \quad = \quad 0 \tag{35}$$

$$E\left[\frac{\partial f_{\mathbf{U}}(\mathbf{u}|\mathbf{D})}{\partial \mathbf{D}}|\mathbf{y}\right] \quad = \quad 0 \tag{36}$$

EM is a standard technique for linear mixed models, but generalized linear models are usually fit with a Newton-Raphson or scoring algorithm (McCulloch, 1997). We estimate the coefficient as

$$\boldsymbol{\beta}^{(m+1)} \quad = \quad \boldsymbol{\beta}^m \ + \ (X'E[W|\mathbf{y}]X)^{-1}X'E[W\Delta(\mathbf{Y}-\mu)|\mathbf{y}] \tag{37}$$

Maximized the log-likelihood of $f_{\mathbf{U}}$, we obtained

$$\mathbf{D} \;=\; \tfrac{1}{Mk}\textstyle\sum_{i=1}^{m} U^{(i)\prime}U^{(i)} \tag{38}$$

using Markov Chain Monte Carlo (MCMC), where, M is the size of MCMC sample and k is the dimension of $\mathbf{D}$. The MCNR can be summarized as follow:

(i) Choose starting value $\boldsymbol{\beta}^{(0)}$ and $\mathbf{D}^{(0)}$. Set $m \;=\; 0$.

(ii) Generate M values, $\mathbf{u}^{(1)},\ \mathbf{u}^{(2)}$, ... $\mathbf{u}^{(M)}$, using the Metropolis algorithm and use them to form Monte Carlo estimates of the expectations:

- Calculate

$$\boldsymbol{\beta}^{(m+1)} \;=\; \boldsymbol{\beta}^{m} \;+\; (X'E[W|\mathbf{y}]X)^{-1}X'E[W\Delta(\mathbf{Y}-\mu)|\mathbf{y}] \tag{39}$$

  where $E[W|\mathbf{y}]X) = \frac{1}{M}\sum_{i=1}^{M} W^{(i)}$
  and $E[W\Delta(\mathbf{Y}-\mu)|\mathbf{y}] = \frac{1}{M}\sum_{i=1}^{M} W^{(i)}\Delta^{(i)}(\mathbf{Y}-\mu^{(i)})$

- Calculate $\mathbf{D}^{(m+1)}$ through

$$\mathbf{D} \;=\; \tfrac{1}{Mk}\textstyle\sum_{i=1}^{m} U^{(i)\prime}U^{(i)} \tag{40}$$

- Set $m = m + 1$

(iii) Stop if convergence is achieved otherwise go to step (ii).

2.2.3 Sampling Performance of Approximate Maximum Likelihood Methods by Other Authors

Other authors have carried out simulation studies to compare a range of methods. Goldstein and Rasbash (1996) carried out a simulation study of 200 datasets on a binary data model with two separate random effects and three nested levels for the model as follows

$$logitp_{ijk} \;=\; \beta_0 \;+\; \beta_1 x_{1ijk} \;+\; \beta_2 x_{2jk} \;+\; \beta_3 x_{3k} \;+\; u_{jk} \;+\; u_k \quad \text{where}$$

$$u_{jk} \sim N(0, \sigma_{u2}^2) \text{ and } u_k \sim N(0, \sigma_{u3}^2)$$

to compare the performance of Marginal Quasi-Likelihood (MQL) with first- and second-order corrected Penalized Quasi-Likelihood (PQL). MQL is a method described by Breslow and Clayton (1993). PQL is useful to calculate the estimates of the covariate effects on population average instead of specific subjects (Breslow et al., 1993). The most distinction between the 2 methods is that the MQL is estimating equations that do not contain the random effects within the linear predictor, whereas the PQL do.

Base on the results given in Table 2.4, Goldstein and Rasbash (1996) found that the second-order corrected PQL outperformed the MQL and the first-order corrected PQL in terms of bias. However, this was not true standard errors. Standard errors and the variance components still showed some negative bias.

Rodriguez and Goldman (1995) examined binary models using a large number of simulations with variable hierarchical data structures. Their results unconcealed substantial biases within the estimates of the fixed effects and also the variance components or both whenever the random effects were sufficiently large, or the quantity of observations among a given level of clustering was small.

Parameter	True value	MQL	CPQL (1st-order)	CPQL(2nd-order)
β_0	0.665	0.512	0.548	0.660
β_1	1.0	0.738	0.795	0.965
β_2	1.0	0.745	0.805	0.968
β_3	1.0	0.767	0.837	1.002
σ_{u2}	1.0	0.119	0.457	0.802
σ_{u3}	1.0	0.748	0.800	0.968

Table 2.4 Summary of Goldstein and Rasbash (1996) results

A simulation study on binary data model in the content of animal breeding study was done by Engel and Buist (1998). This study was to analyze the performance of Iteratively Reweighted Residual Maximum Likelihood (IRREML). This paper also provide the algorithm for corrected and uncorrected bias as well as a third method using different weight within the IRREML. It was found that the corrected and uncorrected IRREML worked well when large numbers of sires and offspring per sire were enclosed within the model, whereas additional bias was present for a moderate number of fixed effects. The author recommend for small number of fixed effects and large number of random effects the Breslow and Lin may be used.

Neuhaus and Segal (1996) investigated the performance of approximate maximum likelihood for a matched pairs data example based on pulmonary function using a binomial model. The objective was to examine whether an individual‘s propensity to experience respiratory symptoms changed with exposure to ozone. It was found that the bias-corrected PQL estimates are near to the maximum likelihood estimates. However, the bias of variance component was high.

Parameter	Maximum Likelihood	PQL	Correlated Penalized Quasi-Likelihood (CPQL)
β_0	-2.69	-1.52	-1.92
β_1	1.61	0.93	1.15
σ^2	6.78	1.26	
ρ	0.44		

Table 2.5 Summary of Goldstein and Rasbash (1996) results

A study applied by Sutradhar and Qu (1998) compared three approaches for the analysis of a count data set. The three approaches are PQL, a proposed likelihood method based on a small σ^2-based approximate likelihood function, and a Waclawiw methods. Fairly intensive simulations were applied for two completely different cluster sizes, four and six, and a range of σ^2 worth from 0.1 to 1.0. It was found that fixed effects were estimated equally well by all three methods, the variance components were estimated with least bias, with the proposed likelihood approximation method exhibiting the least bias, and therefore the Waclawiw approach being the most biased.

PQL and other approximate procedures are proving to be popular methods for estimating parameters in the generalized linear mixed model setting, especially with high computer efficient, that provide good estimates in many situations, and can be fairly simple to program.

2.2.4 McCulloch's model

McCulloch (1997) simulated one hundred datasets for binary model, he compared his regression coefficient and variance component estimates using PQL, MCEM, MCNR, SML, MCNR+SML and MCNR+2SML methods. The model used was:

$$logit(p_{ij}) \ = \ \beta_0 \ + \ \beta_1 x_{ij} \ + \ u_i \text{ where } u_i \sim \ iid\, N(0, \sigma^2).$$

These results are Summarized in Table 2.6

Method	Average estimated σ^2	Average estimated β_1
PQL	0.96	4.630
MCEM	1.41	4.990
MCNR	1.39	4.990
SML	1.14	4.420
MCNR+SML (hybrid)	1.41	4.446
MCNR+2SML (hybrid)	1.42	4.443
True value	1.5	5.000

Table 2.6 Results for McCulloch's (1997) binary simulations.

Based on the results shown on Table 2.6, it was found that PQL was biased in an attenuated manner for both the beta coefficients and variance component. Whereas the MCEM and MCNR algorithms, which were close to the exact maximum likelihood estimates (allowing for Monte-Carlo error), were less biased and also have smaller standard errors. Furthermore,the SML and hybrid method did not appear to contribute any improvement over the MCEM and MCNR estimation procedures.

CHAPTER 3

CONSTRUCTION OF PCFCCE

In this chapter, a 2^n partially confounded factorial designing is used in designing the conjoint choice experiment. While visual basic routines will be used to construct the Confounded Factorial Conjoint Choice Experiment (CFCCE) and produce the corresponding survey questionnaires.

3.1 Constructing Confounded Factorial Conjoint Choice Experiments

The technique of confounded factorials is based on confounding certain effects, usually higher-order interactions, to be confounded with blocks, thus making it impossible to separate confounded effects from block effects (Montgomery, 2001). A treatment combination or profile is a particular combination of the levels for each of the factors, where two or more treatment combinations are arranged in a choice set, where each combination is one of the alternative (or option). When designing conjoint choice experiment as confounded factorials, it is necessary

1. to determine how to assign treatment combination to blocks to assure main effects and lower order interactions are not confounded with block and,

2. to determine how to identify choice sets (Yong, 2004).

Since two treatment combination are included in a choice set, no information on a factor will be obtained if a choice set contains alternatives with the same level of an attribute. Thus, for each choice set we should choose the treatment combinations so that no two alternatives have the same level of any factor. Again, since some of the effects will be confounded with the blocks in confounded factorial design, the conjoint choice designs were extended to the use of partially confounded factorial designs, which are called as Partially Confounded Factorial Conjoint Choice Experiment (PCFCCE) designs. In this method, there will be at least two replicates and each replicate does not share the same confounded effects.

This approach allows some information on the confounded effects to be obtained partially from other replicates except the replicates where consist of the blocks they are confounded with. Therefore, all the effects can be estimated.

3.1.1 Identifying Blocks

Let n be the number of factor, and p be the number of independent defining effects, to develop 2^n designs, we first arrange the treatment combinations into the required block size in a confounded factorial. Suppose we are interested in constructing 2^n factorial designs confounded in 2^p blocks ($p < n$), where each block contains exactly 2^{n-p} treatment combinations. We select p independent defining effects (or contrasts) to be confounded, where by "independent" we mean that no effect chosen is the generalized interaction of the others. The blocks may be generated by the use of the p defining contrasts and the modular equations $L_1,\ L_2\ ,....,\ L_p\ (mod\ 2)$ associated with these effects. By doing this, $2^p - p - 1$ other effects will be confounded with blocks. These effects are generalized interaction of those p independent effects initially chosen. One must ensure that the $[p\ +\ (2^p - p - 1)]$ effects to be confounded with blocks are not effects that might be non-negligible. Failing to do this will cause the main and lower order interaction effects to be biased.

3.1.2 Identifying choice sets

The second aspect of design construction involves selecting choice sets so that the criterion of all alternatives representing different factor levels, discussed above, is met. For this condition to hold, both alternatives in a choice set must be complements of each other. For example 001010 and 110101 are complements. To ensure each treatment combination has its complement in the same block, it is necessary for the word length of all defining contrasts to be even, where word length is the number of letters (the name of the factors denoted by $1, 2, ...k$ or $A, B, ...$) in the defining contrast.

Let us consider an example of single replicate 2^5 design (32 treatment combinations) with five factors (A, B, C, D, E, F) confounded in $2^2\ =\ 4$ blocks of

$2^{5-2} = 8$ treatment combinations. The defining contrasts are ABCD and BCDE. A represent factor 1, B represent factor 2, C represent factor 3, D represent factor 4 and E represent factor 5. There is $2^2-2-1 = 1$ generalized interaction, giving by $ABCD * BCDE = AB^2C^2D^2E = AE$. The linear combinations L_1 and L_2 corresponding to both defining contrasts are:

$$L_1 = x_1 + x_2 + x_3 + x_4 \quad and \quad L_2 = x_2 + x_3 + x_4 + x_5 \tag{41}$$

where x_i is the level (0 or 1) for the i^{th} factor. Each of the 32 treatment combinations will yield a particular pair of values of $r_1 = L_1 \ (mod\ 2)$ and $r_2 = L_2 \ (mod\ 2)$, that is $(r_1, r_2) = (0,0), (0,1), (1,0)$ or (1,1). Treatment combinations with same (r_1, r_2) are assigned to the same block as shown in Table 3.1 below. Notice that the word length formed by the 2 defining contrasts is even and when all word lengths of the defining contrasts are even, treatment combinations and their respective complement are in a same block. In this example, the treatment combination (00000) and its complement (11111) are both in block 1.

(r_1, r_2)	(0,0) Block 1		(0,1) Block 2		(1,0) Block 3		(1,1) Block 4
	00000 11111 01100 10011 01010 10101 00110 11001		11000 00111 10100 01011 10010 01101 11110 00001		10000 01111 11100 00011 11010 00101 10110 01001		01000 10111 00100 11011 00010 11101 01110 10001

Table 3.1 Blocks Design

To apply the design in Table 3.1 to CCE, a separate questionnaire is developed for each block. Each questionnaire contains 4 choice sets where a treatment combination is paired with its complement to form a choice set. If needed, respondents may be grouped to form blocks. For example a questionnaire for a block could be assigned to panel or some other blocking criteria. However, if blocking is not feasible, respondents can be randomly assigned to questionnaires.

3.1.3 The use of CFCCE.xlsm

It is easy to implement the CFCCE block design in the previous subsection using Excel VBA 2007. The implementation called CFCCE.xlsm.

1. Open the file CFCCE.xlsm.

2. To enable the macro, click on the “Option” button and choose “Enable this content”. Then, click “OK” to close the window.

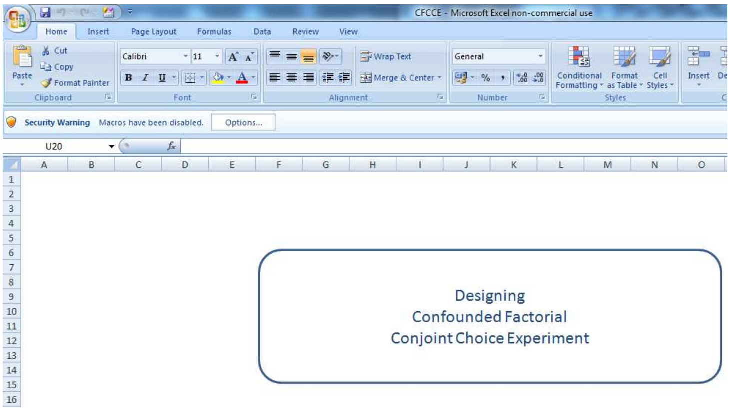


Figure 3.1 Begin

3. The first worksheet “Begin” displays a textbox with the title of this project, “Designing Confounded Factorial Conjoint Choice Experiment”. Click on the textbox to enter. You will be taken to the worksheet, “Full Fac” as shown in Figure 3.2.

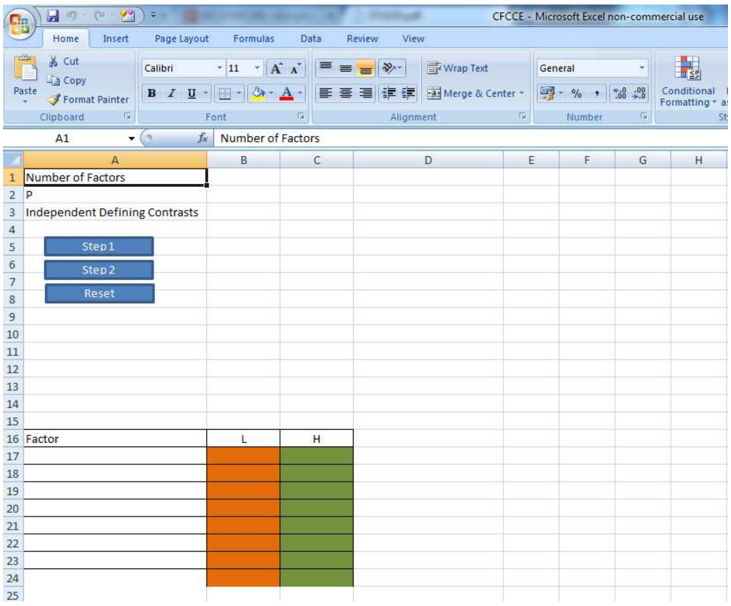


Figure 3.2 Full Fac

4. Enter the number of Factors into cell B1, the number of independent defining contrasts, p, into cell B2, and the name of the n attributes together with

it's low and high levels into cell A17, B17 and C17 respectively.

5. Click on "Step 1" to construct the 2^n factorial combination.

6. Step 2 is to form 2^p of blocks. Each combination is followed by it's compliment. Before clicking on Step2, you need to enter the P independent defining contrast into cell C3, C4,.... C(3+P-1). Click on "Step2", the corresponding blocks will be displayed in worksheet "Block Combina".

7. Click on the "CCE" button. The conjoint choice set will then be displayed in worksheet "Choice set". Note that each choice set is displayed in a randomized ordered as shown in Figure3.3.

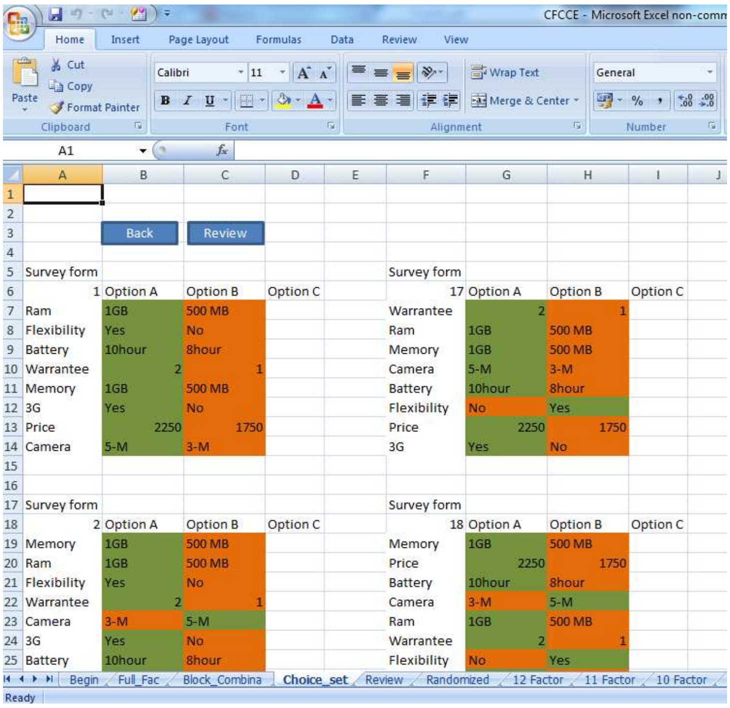
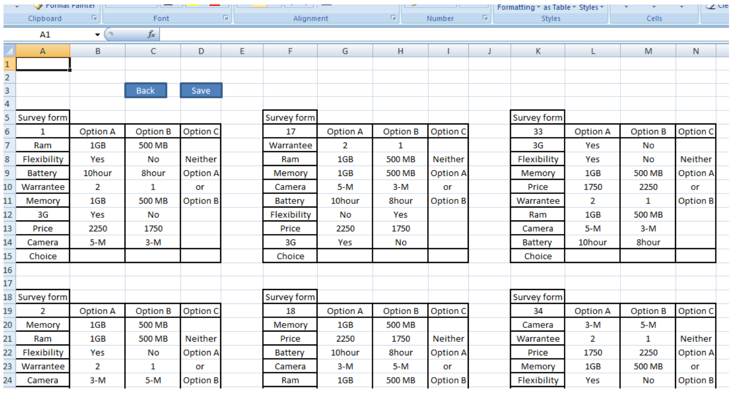


Figure 3.3 Choice set

8. In order to include the grid line for all the choice sets. Clicked on "Review". The complete design questionnaires will be displayed as shown in Figure 3.4.

9. Click on Save button on this page to save the questionnaires.



Back | Save

Survey form			
1	Option A	Option B	Option C
Ram	1GB	500 MB	
Flexibility	Yes	No	Neither
Battery	10hour	8hour	Option A
Warrantee	2	1	or
Memory	1GB	500 MB	Option B
3G	Yes	No	
Price	2250	1750	
Camera	5-M	3-M	
Choice			

Survey form			
17	Option A	Option B	Option C
Warrantee	2	1	
Ram	1GB	500 MB	Neither
Memory	1GB	500 MB	Option A
Camera	5-M	3-M	or
Battery	10hour	8hour	Option B
Flexibility	No	Yes	
Price	2250	1750	
3G	Yes	No	
Choice			

Survey form			
33	Option A	Option B	Option C
3G	Yes	No	
Flexibility	Yes	No	Neither
Memory	1GB	500 MB	Option A
Price	1750	2250	or
Warrantee	2	1	Option B
Ram	1GB	500 MB	
Camera	5-M	3-M	
Battery	10hour	8hour	
Choice			

Survey form			
2	Option A	Option B	Option C
Memory	1GB	500 MB	
Ram	1GB	500 MB	Neither
Flexibility	Yes	No	Option A
Warrantee	2	1	or
Camera	3-M	5-M	Option B

Survey form			
18	Option A	Option B	Option C
Memory	1GB	500 MB	
Price	2250	1750	Neither
Battery	10hour	8hour	Option A
Camera	3-M	5-M	or
Ram	1GB	500 MB	Option B

Survey form			
34	Option A	Option B	Option C
Camera	3-M	5-M	
Warrantee	2	1	Neither
Price	1750	2250	Option A
Memory	1GB	500 MB	or
Flexibility	Yes	No	Option B

Figure 3.4 Review

3.1.4 Visual basic routines

Traditionally, in physical and engineering sciences, fractions have been used to identify important factors and effects that will be further evaluated in more complete designs with fewer factors. However, it is common for a CCE to be conducted only once with no follow up experiments. Thus it is useful to have CCE designs that allow for unbiased estimation of all effects in a single experiment while keeping to a minimum, the number of choice sets that respondents must answer. In this regard, there has been no work on CCE designs that allow for estimation of all effects, while keeping the number of choice sets respondent must answer to a minimum. This is where confounded factorial CCE designs are most useful. An advantage of confounded factorial conjoint choice experiments is that it is easy to construct since confounded factorial is well known in statistics. The defining contrasts are easy to obtain, and thus the choice set can be easily obtained.

Yong (2004) used CCE to conduct a survey to access the consumer preferences for rib-eye steak characteristics. The effects of price country-of-origin labeling, marbling, tenderness guarantee, traceable-to-the frame labeling, class discipline and the possibility of receiving a gift on preferences toward beef rib-eye were found to have significant impact on consumer preferences. In addition, the large number of significant interactions indicated the ability to evaluate these interactions with confounded factorial conjoint experiments demonstrated the importance of using these experimental designs.

The visual basic routines presented below provides a quick way to construct CFCCE VBA produce the corresponding survey questionnaires.

```
Sub Full_FAC()
'Full_FAC: To Construct 2^n Factorial Conbinations.
'Number of Factor
n = Sheet1.Cells(1, 2)
'Construct 2^n Factorial Conbinations
Sheet1.Cells(1, 4) = "Full Factorial Combination"
For j = 1 To n
    i = 1
    For k = 1 To 2 ^ (j - 1)
        For r = 1 To 2 ^ (n - j)
            Sheet1.Cells(1 + i, 4 + j) = 1
            i = i + 1
        Next r
        For r = 1 To 2 ^ (n - j)
            Sheet1.Cells(1 + i, 4 + j) = 0
            i = i + 1
        Next r
    Next k
Next j
'Construct Conbination Code
For k = 1 To 2 ^ n
    code = 0
    For j = 1 To n
        code = Sheet1.Cells(1 + k, 4 + j) * 10 ^ (n - j) + code
    Next j
    Sheet1.Cells(1 + k, 4) = code
Next k
' Number of p independent difining contrasts
p = Sheet1.Cells(2, 2)
For j = 1 To p
    Sheet1.Cells(2 + j, 2) = j
Next j
End Sub


Sub block_n_combina()
'block_n_combina: To form 2^p of blocks, ecah combination is followed
by it's compliment.
n = Sheet1.Cells(1, 2)
p = Sheet1.Cells(2, 2)
For j = 1 To p
    Sheet1.Cells(1, 4 + n + j) = Sheet1.Cells(2 + j, 2)
    For k = 1 To 2 ^ n
        i = Sheet1.Cells(2 + j, 3)
        L_i = 0
        For r = 1 To n
```

```
            If (i - 10 ˆ (n - r) < 0) Then
                i = i
            Else
                i = i - 10 ˆ (n - r)
                If (Sheet1.Cells(1 + k, 4 + r) = 1) Then
                    L_i = L_i + 1
                End If
            End If
        Next r
        Sheet1.Cells(1 + k, 4 + n + j) = L_i Mod 2
    Next k
Next j
'To assign number to the blocks
For j = 1 To 2 ˆ n
    Block = 0
    For k = 1 To p
        If (Sheet1.Cells(1 + j, 4 + n + k) = 1) Then
            Block = Block + 2 ˆ (k - 1)
        End If
    Next k
    Sheet1.Cells(1 + j, 4 + n + k) = Block + 1
Next j
Sheet2.Range("A1:FF100000").ClearContents
Sheet2.Cells(3 + 2 ˆ (n - p), 1) = "Original Blocks"
'To assign each combination to the corresponding block and each
combination is followed by it's compliment
For j = 1 To 2 ˆ p
    Sheet2.Cells(3 + 2 ˆ (n - p), 1 + j) = j
    i = 1
    For k = 1 To 2 ˆ n
        If (Sheet1.Cells(1 + k, 4 + n + p + 1) = j) Then
            Sheet2.Cells(3 + 2 ˆ (n - p) + i, 1 + j) = Sheet1.Cells(1 + k, 4)
            i = i + 1
        End If
    Next k
Next j
Sheet2.Cells(1, 1) = "Rearranged Blocks"
For j = 1 To 2 ˆ p
    Sheet2.Cells(1, 1 + j) = j
    For k = 1 To 2 ˆ (n - p - 1)
        Sheet2.Cells(1 + 2 * k - 1, 1 + j) = Sheet2.Cells(3 + 2 ˆ (n -
p) + k, 1 + j)
        Sheet2.Cells(1 + 2 * k, 1 + j) = Sheet2.Cells(4 + 2 ˆ (n - p +
1) - k, 1 + j)
    Next k
Next j
Application.Goto reference:=Sheet2.Range("A1")
End Sub
Sub project_choice_set()
```

```
Sheet3.Range("A1:EE500").ClearFormats
Sheet3.Range("A1:EE500").ClearContents
Sheet4.Range("A1:G500").ClearContents
Sheet6.Range("A1:EE500").ClearContents
'project_choice_set: Construct conjoint choice set
n = Sheet1.Cells(1, 2)
p = Sheet1.Cells(2, 2)
'use rearrange code, n use 4 loopping(j, k, iii & r), which loopping
iii to do the Randomized
For j = 1 To 2 ^ p
    For k = 1 To 2 ^ (n - p - 1)
        Sheet3.Cells((k - 1) * (n + 4) + 5, (j - 1) * 5 + 1) = "Survey form"
        Sheet3.Cells((k - 1) * (n + 4) + 6, (j - 1) * 5 + 1) = (j - 1)
* 2 ^ (n - p - 1) + k
        Sheet3.Cells((k - 1) * (n + 4) + 6, (j - 1) * 5 + 2) = "Option A"
        Sheet3.Cells((k - 1) * (n + 4) + 6, (j - 1) * 5 + 3) = "Option B"
        Sheet3.Cells((k - 1) * (n + 4) + 6, (j - 1) * 5 + 4) = "Option C"
        project = Sheet2.Cells(2 * k, 1 + j)
        For l = 1 To n
            Sheet4.Cells(l, 1) = Rnd()
            Sheet4.Cells(l, 2) = l
            Sheet4.Cells(l, 3) = l
            Sheet4.Cells(l, 4) = WorksheetFunction.RoundDown(project /
10 ^ (n - l), 0)
            If (Sheet4.Cells(l, 4) < 1) Then
                Sheet4.Cells(l, 5) = 1
            Else
                Sheet4.Cells(l, 5) = 0
            End If
            project = project - Sheet4.Cells(l, 4) * 10 ^ (n - l)
        Next l
        Sheet4.Range("A:B").Sort key1:=Sheet4.Columns("A")
        Sheet4.Range("B:C").Sort key1:=Sheet4.Columns("B")
        Sheet4.Range("B:E").Sort key1:=Sheet4.Columns("C")
        racode = 0
        cbcode = 0
        cpcode = 0
        For r = 1 To n
            RA = Sheet4.Cells(r, 2)
            CB = Sheet4.Cells(r, 4)
            CP = Sheet4.Cells(r, 5)
            Sheet3.Cells((k - 1) * (n + 4) + 6 + r, (j - 1) * 5 + 1) =
Sheet1.Cells(RA + 16, 1)
            Sheet3.Cells((k - 1) * (n + 4) + 6 + r, (j - 1) * 5 +
1).Interior.Color = Sheet1.Cells(RA + 16, 1).Interior.Color
            Sheet3.Cells((k - 1) * (n + 4) + 6 + r, (j - 1) * 5 + 2) =
Sheet1.Cells(RA + 16, 2 + CB)
            Sheet3.Cells((k - 1) * (n + 4) + 6 + r, (j - 1) * 5 +
2).Interior.Color = Sheet1.Cells(RA + 16, 2 + CB).Interior.Color
```

```
            Sheet3.Cells((k - 1) * (n + 4) + 6 + r, (j - 1) * 5 + 3) =
Sheet1.Cells(RA + 16, 2 + CP)
            Sheet3.Cells((k - 1) * (n + 4) + 6 + r, (j - 1) * 5 +
3).Interior.Color = Sheet1.Cells(RA + 16, 2 + CP).Interior.Color
            racode = RA * 10 ^ (n - r) + racode
            cbcode = CB * 10 ^ (n - r) + cbcode
            cpcode = CP * 10 ^ (n - r) + cpcode
        Next r
            Sheet6.Cells(k + 2, j) = racode
            Sheet6.Cells(2 * k + 1, 2 + 2 ^ p - 1 + j) = cbcode
            Sheet6.Cells(2 * k + 2, 2 + 2 ^ p - 1 + j) = cpcode
    Next k
Next j
Sheet6.Cells(2, 1) = "Randomized Code"
Sheet6.Cells(2, 2 + 2 ^ p) = "Randomized Projection"
Application.Goto reference:=Sheet3.Range("A1")
End Sub
```

3.2 Questionnaire Design

Application of using 2^n partial confounded factorial design used in the conjoint choice experiment was constructed to study consumer's preferences about Tablet for University Students.

A tablet is great multipurpose equipment for college and university students. The tablet is convenient to carry, it is a tool that combine a notebook and smart phone, it is also useful in word-processing, Internet surfing, entertainment, digital books, SMS, etc.

In this study, eight attributes of tablet with two level each were used to evaluate consumer's purchasing decisions toward tablet by using PCFCCE. The associated attributes are price (factor A), 3G (factor B), warranty (factor C), internal memory (factor D), flexibility (factor E), life of battery (factor F), quality of camera (factor G) and Ram (factor H) as shown in Table 3.2.

Three defining contrast are used to construct eight blocks of size 32 for each replicate. The defining contrasts are: ABCDEF, DEFG and CDEH for replicate I, and ABCD, ABEF and ABCDEFGH for replicate II. For each replicate there are 8 fractions and each fraction contained 16 choice sets. Each choice set consisted of

	Attributes	Low level	High level
1	Price	RM 2250	RM 1750
2	3G	No	Yes
3	Warranty	1 year	2 year
4	Memory	32GB	64GB
5	Flexibility	No	Yes
6	Battery	8 hours	10 hours
7	Camera	3-Megapixel	5-Megapixel
8	Ram	512MB	1GB

Table 3.2 Attributes of the Tablet

three options, two tablet descriptions and a neither.

The word lengths of all defining contrasts are even, then each treatment combination has its complement in the same block. All the treatment combinations are arranged in such a way that each pair of compliment combinations is assigned to the same choice set. This is to ensure that no overlap of levels will occur in each choice set. The differences between attribute levels are informative. The tables in Appendix A showed the 2^8 design of replicate I followed by replicate II.

In addition, the orders of the choice sets and the attributes are randomized to avoid the response bias. Each student answered 17 choice sets where one choice set served as an internal reliability check. It is not used in the analysis of confounded factorial CCE but is used to check if the respondents answered the questions sincerely or not. A set of the survey forms is attached in Appendix B.

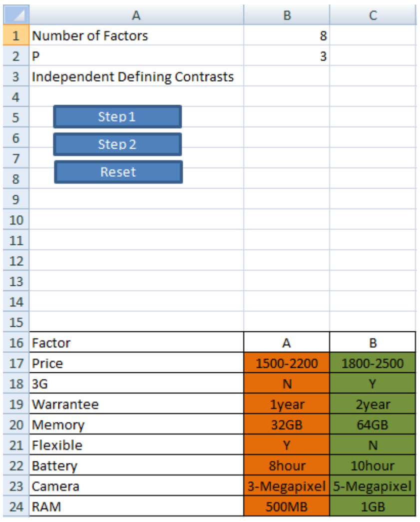
Each student was responded to 17 choice sets with 3 alternatives each but only 16 choice sets were used in the data analysis. Hence, there are 19,448 responses in total with each block of students responded to 48 (16 choice sets x 3 alternatives) responses. Therefore, there are 48 observed proportions for each block or fraction and a total 768 observed proportions.

3.2.1 Questionnaire construction using visual basic

Below we will show the procedures to construct replicate I, where the defining contrasts were: ABCDEF, DEFG and CDEH, by using CFCCE.xlsm to construct the corresponding survey questionnaires.

1. Open the file CFCCE.xlsm. To enable the macro, click on the “Option” button and choose “Enable this content”. Then, click “OK” to close the window. The first worksheet “Begin” displays a textbox with the title of this project, “Designing Confounded Factorial Conjoint Choice Experiment”. Click on the textbox to enter. You will be taken to the worksheet.

2. Since we have eight factors, enter 8 in cell B1, three independent defining contrasts, enter 3 in cell B2, and the name of the 8 attributes together with it’s low and high levels into cell A17, B17 and C17 respectively as shown in Figure 3.5.



	A	B	C
1	Number of Factors	8	
2	P	3	
3	Independent Defining Contrasts		
4			
5	Step 1		
6	Step 2		
7			
8	Reset		
9			
10			
11			
12			
13			
14			
15			
16	Factor	A	B
17	Price	1500-2200	1800-2500
18	3G	N	Y
19	Warrantee	1year	2year
20	Memory	32GB	64GB
21	Flexible	Y	N
22	Battery	8hour	10hour
23	Camera	3-Megapixel	5-Megapixel
24	RAM	500MB	1GB

Figure 3.5 Enter number of factor, number of defining contrasts and attributes

3. Click on “Step 1” to construct the 2^n factorial combination. Step 2 is to form 2^3 of blocks. Each combination is followed by it’s compliment. Before clicking on Step2, we need to enter the 3 independent defining contrasts ABCDEF, DEFG and CDEH into cell C3, C4,.... C(3+P-1). Enter ABCDEF as 11111100, DEFG as 11110 and CDEH as 101001. Click on “Step2”, the corresponding blocks will be displayed in worksheet “Block Combina” as shown in Figure 3.6.

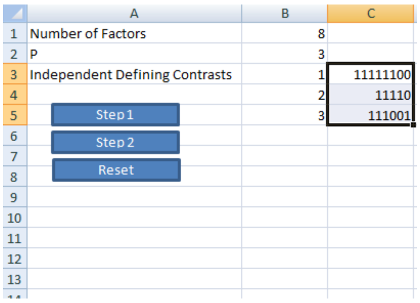
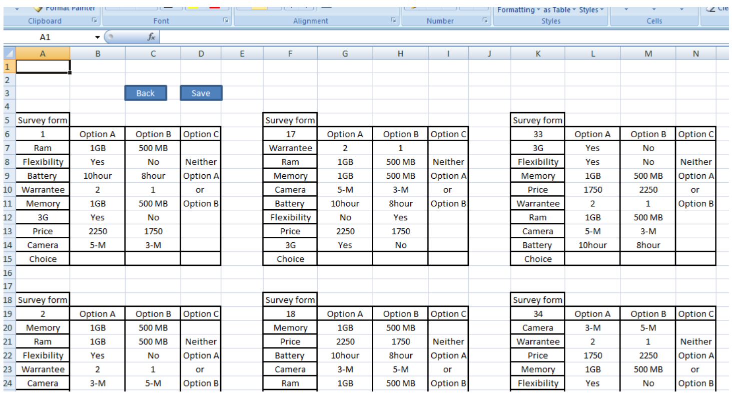


Figure 3.6 Enter generalized interaction

4. Click on the “CCE” button. The conjoint choice set will then be displayed in worksheet “Choice set”. Note that each choice set is displayed in a randomized ordered. In order to include the grid line for all the choice sets. Clicked on “Review”. The complete design questionnaires will be displayed as shown in Figure 3.7. Click on Save button on this page to save the questionnaires.



Figures 3.7 Review

3.3 Efficiency of PCFCCE versus CCFCCE

In CCFCCE, same defining contrasts are used to construct the CCE for all replicates. Thus, not all the effects can be estimated. However PCFCCE uses different defining contrasts to construct CCE for different replicates. Thus, all the effects can be estimated and hence more information can be obtained by using PCFCCE. We would expect that PCFCCE were be more efficient than CCFCCE. D-efficiency will be used to compare the efficiency between PCFCCE and CCFCCE. In this study, D-error is defined by:

$$D - error = (det(\hat{Cov}(\hat{\beta})))^{1/m} = det(X'E[W|y]X))^{-1^{1/m}} \quad (42)$$

where m is the number of parameters in β, $X'E[W|y]X$ is the information matrix. In the absence of data, we assume the following values of $\boldsymbol{\beta}$:

Case	$\boldsymbol{\beta}$
I	1 for all elements in $\boldsymbol{\beta}$
II	-1 for all elements in $\boldsymbol{\beta}$
III	mixing of 1 and -1 for elements in $\boldsymbol{\beta}$

Base on the assumed values of $\boldsymbol{\beta}$, $\pi_i = \frac{\exp(X_i\beta)}{1+\exp(X_1\beta)+\exp(X_2\beta)}, i = 1, 2$ is computed to generate the respond variable $\mathbf{Y}$, where $\mathbf{Y} \sim Multinomial(\pi_1, \pi_2, \pi_3 = 1 - \pi_1 - \pi_2)$. A sample of size 25 is drawn. This procedure is repeated for $R = 100$ times.

The expected efficiency measure is

$$E_\beta(D - error) = E_\beta(det\hat{Cov}(\hat{\beta}^e))^{1/m} = E_\beta(det(X'E[W|y]X)^{-1^{1/m}}. \quad (43)$$

This expectation is approximated by

$$\sum_{r=1}^{R}(\det\{X'[\hat{Cov}(Y)]^{-1}X\})^{1/m}/R \quad (44)$$

Table 3.3 shows the D-errors (D-efficiencies) for several CCFCCE and PCFCCE designs with 3 different cases as described above and the corresponding efficiency gains (% gains). Based on the results, two observations can be made, first, when the number of factors increase, the D-error decrease. For instance in case I, when the number of factor increases from 6 to 7, the D-error of CCFCCE design for $p = 2$ decreases from 0.0166 to 0.0044, similarly the D-error of PCFCCE design decreases from 0.0080 to 0.0022. This result holds for other cases. This implied that the more the factors in a design, the more efficiencies will be gained.

Second, PCFCCE designs are more efficiency than CCECCF designs. This can be seen from the positive % gain in D-error and smaller D-error of PCFCCE when compare to the D-error CCFCCE designs. For instance in case I, a 2^6 design with $p = 1$, the D-error for CCFCCE design is 0.0172, versus the D-error for PCFCCE is 0.0082, this indicate that a 52.33% gain in the D-error of PCFCCE design. All the other designs also show that PCFCCE designs have at least 50% gain in D-error.

Case		P	D-error for CCFCCE Design	D-error for PCFCCE Design	% Gain in D-error
I	2^6	1	0.0172	0.0082	52.33%
		2	0.0166	0.0080	51.81%
I	2^7	2	0.0044	0.0022	50.00%
		3	0.0045	0.0022	51.11%
II	2^6	1	0.0151	0.0072	52.32%
		2	0.0151	0.0072	52.32%
II	2^7	2	0.0091	0.0044	51.65%
		3	0.0092	0.0045	51.09%
III	2^6	1	0.0099	0.0048	51.52%
		2	0.0097	0.0046	52.58%
III	2^7	2	0.0052	0.0025	51.92%
		3	0.0052	0.0025	51.92%
III	2^8	3	0.0027	0.0013	51.85%
III	2^9	3	0.0014	0.0007	50%

Table 3.3 D-error calculation for PCFCCE Design versus CCFCCE Design

According to Toubia and Hauser (2007), one of the criteria for maximum efficiency is the corresponding error (D-error) is minimized. Results above indicated that, the D-errors for PCFCCE designs are smaller than those of CCFCCE designs. Therefore, we can conclude that PCFCCE designs are more efficient than CCFCCE designs. This is due to the ability of partially confounded factorial designs that can estimate confounded effects from other replicates with increasing efficiency of the PCFCCE design.

CHAPTER 4

ANALYSIS FOR PARTIALLY CONFOUNDED FACTORIAL CONJOINT CHOICE EXPERIMENTS

The use of Partially Confounded Factorial Conjoint Choice Experiment (PCFCCE) is consistent with random utility theory. For each choice set a consumer must choose between two products each with a different set of product attributes or neither. Probably, the consumer chooses the alternative with largest utility. A random utility function, U_{iskj} may be expressed by:

$$\mathbf{U}_{iscj} \ = \ V_{iscj} \ + \ \epsilon_{iscj} \ \ (i = 1, ...16; \ s = 1, ..., S; \ c = 1, ..., 16; \ j = 1, ...3), \tag{45}$$

where $\mathbf{U}_{iscj}$ is the s^{th} consumer's utility of choosing alternative j from the c^{th} choice set of the i^{th} block, V_{iscj} is the systematic portion of the utility function, and ϵ_{ijcj} is the random component. The probability that a consumer will choose alternative j for a particular choice set is given by:

Prob $\{j$ is chosen$\}$ = prob$\{V_{iscj} + \ \epsilon_{iscj} \ \geq \ V_{iscl} \ + \ \epsilon_{iscl}$, for all $l \in \ C_{isc}\}$

where C_{isc} is the relevant choice set.

If the random components are assumed to be independent with a Gumbel distribution, the multinomial logit model follows:

$$\text{Prob}\{j \text{ is chosen}\} = \frac{e^{v_{iscj}}}{\sum_{j \in C_{isk}} e^{v_{iscl}}}.$$

If v_{iksj} is assumed to be linear in the parameters, it may be decomposed into additive parts so that the utility of an alternative may be represented as a linear function of its own attributes. The model equation for the systematic component of the utility, V_{iscj}, may be expressed as

$$V_{iscj} = \mathbf{x}'_{iscj}\boldsymbol{\beta} \tag{46}$$

where $\mathbf{x}_{iscj}$ is the vector of attribute levels, and $\boldsymbol{\beta}$ is a vector of parameter coefficients to be estimated. This additive decomposition allows estimation of interaction term if the design permits.

With PCFCCE, independence is not a realistic assumption since each subject will answer a number of choice sets causing correlation among responses within subjects and because subjects are grouped into blocks which will cause correlation among subjects. To account for the correlation among responses, we can allow some of the parameters in the multinomial logit model to be random effects and to vary across subjects and blocks. By conditioning on the random effects $\mathbf{u} = \left(\mathbf{u}_i' \; \mathbf{u}_{is}' \; \mathbf{u}_{isj}'\right)$ where $\mathbf{u}_i$ is the random effects due to block, $\mathbf{u}_{is}$ is the random effects due to the subjects within blocks and $\mathbf{u}_{isj}$ is the random effects due to the choice sets with subjects and blocks. The $\mathbf{u}$ is assumed to be a multivariate normal distribution $N(0, \mathbf{D})$, where $\mathbf{D}$ is the covariance matrix for the random effects $\mathbf{u}$.

The form of the models is:

$$\begin{aligned} \mathbf{y}_{iscj}|\mathbf{u}_i,\ \mathbf{u}_{is},\ \mathbf{u}_{isj} &\sim \text{indep. multinomial}\ (\pi_1,\ \pi_2,\ \pi_3) \\ f_{\mathbf{y}_{iscj}|\mathbf{u}}(\mathbf{y}_{iscj}|\mathbf{u}) &= \prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16}\prod_{j=1}^{3}\pi_{iscj}^{\mathbf{y}_{iscj}}. \qquad (47) \\ \mathbf{u}_i,\ \mathbf{u}_{is},\ \mathbf{u}_{isj} &\sim \text{MVN}\ (mean = 0,\ variance = \Sigma_B,\ \Sigma_S,\ \Sigma_J) \end{aligned}$$

The density function can be modified as

$$\begin{aligned} f_{\mathbf{y}_{iscj}|\mathbf{u}}(\mathbf{y}_{iscj}|\mathbf{u}) &= \prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16}\prod_{j=1}^{3}\pi_{iscj}^{\mathbf{y}_{iscj}} \\ &= \prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16}\left[\left(\frac{\pi_{isc1}}{\pi_{isc3}}\right)^{\mathbf{y}_{isc1}}\left(\frac{\pi_{isc2}}{\pi_{isc3}}\right)^{\mathbf{y}_{isc2}}\pi_{isc3}\right] \\ &= \prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16}\{\exp\left[\sum_{j=1}^{2}\mathbf{y}_{iscj}\log\left(\frac{\pi_{iscj}}{\pi_{isc3}}\right)+\log(\pi_{isc3})\right]\}. \qquad (48) \end{aligned}$$

where $\theta_{iscj} = \log\left(\frac{\pi_{iscj}}{\pi_{isc3}}\right), \quad b(\theta_{iscj}) = \log(1+\sum_{j=1}^{2}\exp(\theta)), \quad a(\phi) = 1$ (49)

$$\text{Let } \pi_{iscj} = E[\mathbf{Y}_{iscj}|\mathbf{U}], \text{ then}$$

$$g(\pi_{iscj}) = \log\left(\frac{\pi_{iscj}}{\pi_{isc3}}\right) \tag{50}$$

$$= \mathbf{x_{iscj}}'\boldsymbol{\beta} + \mathbf{z_{iscj}}'\mathbf{u}$$

$f_{\mathbf{y}_{iscj}|\mathbf{u}}(\mathbf{y}_{iscj}|\mathbf{u}) = \prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16}$

$$\exp[\mathbf{y}_{isc1}\sum_{j=1}^{2}(\mathbf{x_{iscj}}'\boldsymbol{\beta}+\mathbf{z_{iscj}}'\mathbf{u}) - \log(1+\sum_{j=1}^{2}\exp(\mathbf{x_{iscj}}'\boldsymbol{\beta}+\mathbf{z_{iscj}}'\mathbf{u}))] \tag{51}$$

This model belong to the class of generalized linear mixed models.

4.1 PCFCCE Monte Carlo Newton-Raphson

The likelihood for the model:

$$L = \prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16}\int f(\mathbf{y}|\mathbf{u}) * f(\mathbf{u})du$$

$$= \prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16}\int\{\exp\left[\sum_{j=1}^{2}\mathbf{y}_{iscj}\left(\mathbf{x_{iscj}}'\boldsymbol{\beta}+\mathbf{z_{iscj}}'\mathbf{u}\right)\right] \tag{52}$$

$$-\log(1+\sum_{j=1}^{2}\exp(\mathbf{x_{iscj}}'\boldsymbol{\beta}+\mathbf{z_{iscj}}'\mathbf{u})\}f(\mathbf{u})du.$$

We use Monte Carlo Newton-Raphson to estimate the parameter.

For the metropolis algorithm, a Candidate distribution $h_{\mathbf{U}}(\mathbf{u})$ must be selected, from which potential new values are drawn and the acceptance function that gives the probability of accepting the new value. The acceptance function is:

$$A_k(\mathbf{u}^*,\mathbf{u}) = min\left(1, \ \frac{f_{U|\mathbf{Y}}(u^*|\mathbf{y};\boldsymbol{\beta},\phi,\mathbf{D})h_U(u)}{f_{U|\mathbf{Y}}(u|\mathbf{y};\boldsymbol{\beta},\phi,\mathbf{D})h_U(u^*)}\right) \tag{53}$$

where $u^* = (u_1, u_2, ..., u_k^*, u_{k+1}, ..., u_q)$, which is the candidate new value and has all entries equal to the previous value except the k^{th}.

Thus the acceptance function is

$$\frac{f_{U|\mathbf{Y}}(u^*|\mathbf{y};\boldsymbol{\beta},\phi,\mathbf{D})h_U(u)}{f_{U|\mathbf{Y}}(u|\mathbf{y};\boldsymbol{\beta},\phi,\mathbf{D})h_U(u^*)} = \frac{\prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16} f_{\mathbf{y}_i|u}(\mathbf{y}_i|u^*;\boldsymbol{\beta},\phi)f_u(u^*|\mathbf{D})f_u(u|\mathbf{D})}{\prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16} f_{\mathbf{y}_i|u}(\mathbf{y}_i|u;\boldsymbol{\beta},\phi)f_u(u^*|D)f_u(u^*|\mathbf{D})}$$

$$= \frac{\prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16} f_{\mathbf{y}_i|u}(\mathbf{y}_i|u^*;\boldsymbol{\beta},\phi)}{\prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16} f_{\mathbf{y}_i|u}(\mathbf{y}_i|u;\boldsymbol{\beta},\phi)} \quad (54)$$

$$= \prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16}$$

$$\exp\left[\sum_{j=1}^{2} y_{iscj}\left(\mathbf{z_{iscj}}'\mathbf{u} - \mathbf{z_{iscj}}'\boldsymbol{u^*}\right) - \log\left(\frac{1+\sum_{j=1}^{2}\exp(\mathbf{x_{iscj}}'\boldsymbol{\beta}+\mathbf{z_{iscj}}'\mathbf{u})}{1+\sum_{j=1}^{2}\exp(\mathbf{x_{iscj}}'\boldsymbol{\beta}+\mathbf{z_{iscj}}'\boldsymbol{u^*})}\right)\right]$$

Again, Newton-Raphson was used to estimate the coefficients. Let:

$$\boldsymbol{\beta}^{(m+1)} = \boldsymbol{\beta}^{(m)} + (X'E[W|\mathbf{y}]X)^{-1}X'E[W\Delta(\mathbf{y} - \mu)|\mathbf{y}]. \quad (55)$$

where $W = \{_d[v(\mu)g_\mu^2(\mu)]^2\}$, $\Delta = \{_d g_\mu(\mu)\}$ and that W, Δ and μ are all function of u with all parameters evaluated at $\theta = \theta_0$.

With the analog to Newton-Raphson were used as below:

1. Choose starting value $\boldsymbol{\beta}^{(0)}$ and $\mathbf{D}^{(0)}$. Set $m = 0$.
2. Generate N values, $u^{(l)}, u^{(2)}, ..., u^{(N)}$, from the conditional distribution of u given $\mathbf{y}$ using the Metropolis algorithm described previously.
   (a) Calculate

   $$\boldsymbol{\beta}^{(m+1)} = \boldsymbol{\beta}^{(m)} + (X'E[W|\mathbf{y}]X)^{-1}X'E[W\Delta(\mathbf{y} - \mu)|\mathbf{y}]. \quad (56)$$

   (b) $\mathbf{D}^{(m+1)}$ which maximizes $1/N\sum_{k=1}^{N}\ln f_u(u^{(k)}|\mathbf{D})$
   (c) Set $m = m + 1$.
3. If convergence is achieved, declare $\boldsymbol{\beta}^{(m+1)}$ and $\mathbf{D}^{(m+l)}$ to be maximum likelihood estimators (MLE's); otherwise, return to step 2.

4.1.1 The Metropolis-Hastings algorithm

Applying Metropolis-Hastings algorithm to generating simulated samples of random effects vectors, u, is a little more involved, depending on the complexity of the random effects structure. For the generalized linear mixed model structure, where only a random intercept u_i is modeled, a random effects vector is generated at each step of the Markov chain. The random effects vector u is $(u_1,\ u_2,\ ....,u_n)$, where n is the number of subjects or clusters. For example, if we wish to generate a single random effects for each of n subjects, there will be N random effects vectors(one for each Monte-Carlo simulation), where $u_i^{(j)}$ is the random effect for the ith subject at the jth Monte-Carlo simulation.

We use one of the Hasting methods for this algorithm when the target distribution is multi-dimensional . Since the target distribution is multi-dimensional, as in the situation when we have n random effects to sample at the jth Monte-Carlo iteration. Choose n candidate values u_i^* and compare the new values to the original u_i values $i\ =\ 1,....,\ n$ all at once, i.e. $(u_1^*,\ u_2^*,....\ ,\ u_n^*)$ versus $(u_1,\ u_2,....,\ u_n)$.

The acceptance probability was neatly formulated by McCulloch (1997) for generalized linear mixed model as follows:

1. Initialize $\boldsymbol{u}\ =\ (u_1,\ u_2,\ ....\ ,u_n)\ =\ (0,\ 0,\ ....\ ,0)$
2. Randomly generate $u^* \sim\ MVN(0,\ D)$
3. Accept $\boldsymbol{u^*}\ =\ (u_1^*,\ u_2^*,....\ ,\ u_n^*)$ with probability A, where

$$\begin{aligned}
A_k(\mathbf{u}^*,\mathbf{u}) &= min\left(1,\ \frac{f_{U|\mathbf{Y}}(u^*|\mathbf{y};\boldsymbol{\beta},\phi,\mathbf{D})h_U(u)}{f_{U|\mathbf{Y}}(u|\mathbf{y};\boldsymbol{\beta},\phi,\mathbf{D})h_U(u^*)}\right)\\
&= min\left(1,\ \frac{\prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16}\ f_{\mathbf{y}_i|u}(\mathbf{y}_i|u^*;\boldsymbol{\beta},\phi)f_u(u^*|\mathbf{D})f_u(u|\mathbf{D})}{\prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16}\ f_{\mathbf{y}_i|u}(\mathbf{y}_i|u;\boldsymbol{\beta},\phi)f_u(u^*|D)f_u(u^*|\mathbf{D})}\right)\\
&= min\left(1,\ \prod_{i=1}^{16}\prod_{s=1}^{S}\prod_{c=1}^{16}\ \frac{f_{\mathbf{y}_i|u}(\mathbf{y}_i|u^*;\boldsymbol{\beta},\phi)}{f_{\mathbf{y}_i|u}(\mathbf{y}_i|u;\boldsymbol{\beta},\phi)}\right)
\end{aligned} \tag{57}$$

where $\frac{f_{\mathbf{y}_i|u}(\mathbf{y}_i|u^*;\boldsymbol{\beta},\phi)}{f_{\mathbf{y}_i|u}(\mathbf{y}_i|u;\boldsymbol{\beta},\phi)} =$
$\exp\left[\sum_{j=1}^{2} y_{iscj}\left(\mathbf{z_{iscj}}'\mathbf{u} - \mathbf{z_{iscj}}'\boldsymbol{u^*}\right) - \log\left(\frac{1+\sum_{j=1}^{2}\exp(\mathbf{x_{iscj}}'\boldsymbol{\beta}+\mathbf{z_{iscj}}'\mathbf{u})}{1+\sum_{j=1}^{2}\exp(\mathbf{x_{iscj}}'\boldsymbol{\beta}+\mathbf{z_{iscj}}'\boldsymbol{u^*})}\right)\right]$

(a) $\boldsymbol{u} = (u_1^*,\ u_2^*, ... ,\ u_n^*)$ with probability A, else

(b) $\boldsymbol{u} = (u_1,\ u_2, ... ,\ u_n)$ with probability $1 - A$

Repeat 2 and 3 sequentially for N sample of time of the vector $\boldsymbol{u}$.

4.2 Result

A survey in the form of partially confounded conjoint choice experiment was conducted to collect the data of respondent's preferences on eight attributes of tablet. There are (2^8 = 256) descriptions (treatment combinations) of the product and it is impossible for a respondent to answer all the descriptions. With the use of Conjoint Choice Experiment (CCE), information on attributes associated with respondents preference or choice can be obtained without asking each respondent more than a moderate number of choice sets. PCFCCE divides the descriptions within each replicate into eight fractions of each with 16 choice sets. Two replicates are used and the partial information of effects that are confounded with blocks in a replicate can be obtained from another replicate.

Students from Faculty of Engineering and Science (FES) and Faculty of Creative Industry (FCI) of University Tunku Abdul Rahman were chosen randomly as the respondents for this survey. There were 406 students from the two faculties with each responded only once to the survey. In average each fraction was responded by about 26 students. Each student was responded to 17 choice sets with 3 alternatives each but only 16 choice sets were used in the data analysis. Hence, there were 19,448 responses in total with each block of students responded to 48 (16 choice sets x 3 alternatives) responses. Therefore, there were 48 observed proportions for each block or fraction and a total 768 observed proportions.

From the result obtained in Table 4.1, all main effects (Price, 3G, Warranty, etc.) and some of the first-order interation effects (Price and 3G, Price and

effect	betahat	secovbhat	t.ratio	p.value
Intercept	1.033058	0.03583	28.835391	0.000000
Price	0.113969	0.01415	8.056083	0.000000
3G	0.087323	0.01414	6.175791	0.000000
Warranty	0.122852	0.01414	8.687167	0.000000
Memory	0.120599	0.01415	8.522988	0.000000
Flexibility	-0.078389	0.01414	-5.543231	0.000000
Battery	0.088316	0.01415	6.240399	0.000000
Camera	0.095795	0.01414	6.772586	0.000000
Ram	0.111921	0.01416	7.906782	0.000000
Price 3G	0.198660	0.03519	5.645569	0.000000
Price Warranty	0.095742	0.03521	2.719382	0.006558
Price Memory	0.006384	0.03514	0.181674	0.855845
Price Flexibility	-0.077230	0.03538	-2.182906	0.029079
Price Battery	-0.084591	0.03511	-2.409034	0.016023
Price Camera	0.059764	0.03514	1.700720	0.089044
Price Ram	-0.027483	0.03502	-0.784712	0.432652
3G Warranty	0.062154	0.03517	1.767031	0.077270
3G Memory	0.016593	0.03508	0.473046	0.636196
3G Flexibility	-0.107495	0.03523	-3.051036	0.002290
3G Battery	0.018248	0.03506	0.520438	0.602776
3G Camera	0.008321	0.03508	0.237177	0.812527
3G Ram	-0.024801	0.03496	-0.709487	0.478048
Warranty Memory	0.110092	0.03481	3.162345	0.001572
Warranty Flexibility	-0.073833	0.03507	-2.105291	0.035305
Warranty Battery	0.010350	0.03489	0.296686	0.766716
Warranty Camera	0.011680	0.03488	0.334826	0.737767
Warranty Ram	-0.018433	0.03476	-0.530265	0.595947
Memory Flexibility	0.006945	0.03499	0.198500	0.842660
Memory Battery	-0.000853	0.03478	-0.024533	0.980428
Memory Camera	0.043259	0.03476	1.244336	0.213421
Memory Ram	-0.083192	0.03464	-2.401634	0.016350
Flexibility Battery	0.137263	0.03495	3.927655	0.000087
Flexibility Camera	-0.105389	0.03495	-3.015294	0.002577
Flexibility Ram	-0.032849	0.03488	-0.941689	0.346387
Battery Camera	-0.063018	0.03481	-1.810560	0.070255
Battery Ram	0.010713	0.03470	0.308719	0.757545
Camera Ram	-0.032223	0.03470	-0.928727	0.353065

Table 4.1 Result

Warranty, Price and Ram, etc.) were statistically significant (p-value < 0.05). The estimates of the elements of $\boldsymbol{\beta}$, the standard errors of the estimates and the p-value are also provided in Table 4.1. The significant first-order interaction effects are price and 3G, price and warranty, price and flexibility, price and battery, 3G and flexibility, warranty and memory, warranty and flexibility, memory and ram, flexibility and battery and flexibility and camera. These coefficients were estimated based sum to zero restriction. Thus, the other coefficients not shown in the table can be obtained using this restriction. For instance, the coefficient for lower price of tablet, is 0.114. Since there are only two level for the price of tablet, the higher price of tablet is -0.114. Similarly, the coefficients for other effects were obtained in the same manner.

Base on the results, the estimation of all the main effects were expected. For instance, consumer are prefer lower price tablet, the tablet that have 3G, longer duration warranty, higher capacity memory, consumer prefer Apple tablet, longer life of battery, higher megapixel tablet and high capacity of RAM. The main effects of the attributes may be interpreted using the estimated coefficients. Base on the table, the effect of lower price of tablet computer is (1.033 + 0.114 = 1.147) and the odds of choosing it is ($e^{1.147}$ = 3.149), while the effects of higher price of tablet computer is (1.033 - 0.114 = 0.919) which translated into an odds of ($e^{0.919}$ = 2.507). Thus the odds ratio for a consumer choosing the tablet when the lower price tablet versus higher price tablet is (3.149/2.507 = 1.256). This also indicates that the odds of a respondent choosing a lower price tablet s 1.256 times the odds of a respondent choosing a higher tablet.

	Coefficient	Least Square Mean	Odds	Odds Ratio
Intercept	1.1033			
Lower Price	0.114	1.147	3.149	1.256
Higher Price	-0.114	0.919	2.507	

Table 4.2 The value of least square mean, odds and odds ratio for price

Base on the result, the effect of tablet with 3G is 1.120 and the odds of choosing it was 3.066, while the effects of tablet with no 3G is 0.946 which translated into an odds of 2.575. Thus the odds ratio for a consumer choosing the tablet with 3G versus with no 3G tablet is 1.191. This also indicated respondent prefer the tablet with 3G.

	Coefficient	Least Square Mean	Odds	Odds Ratio
Intercept	1.1033			
With 3G	0.087	1.120	3.066	1.191
Without 3G	-0.087	0.946	2.575	

Table 4.3 The value of least square mean, odds and odds ratio for 3G

Base on the result, the effect of 2 year warranty of tablet computer is 1.226 and the odds of choosing it is 3.177, while the effects of 1 year warranty of tablet computer is 0.910 which translated into an odds of 2.485. Thus the odds ratio for a consumer choosing the tablet when 2 year warranty tablet versus 1 year warranty tablet is 1.279. This also indicated respondent prefer longer duration warranty of tablet.

	Coefficient	Least Square Mean	Odds	Odds Ratio
Intercept	1.1033			
2 Year warranty	0.123	1.226	3.177	1.279
1 Year warranty	-0.123	0.910	2.485	

Table 4.4 The value of least square mean, odds and odds ratio for Warranty

Base on the result also shown that the effects of 64GB memory of tablet computer is 1.154 and the odd of choosing it is 3.170, while the effects of 32GB memory of tablet computer is 0.910 which translated into an odd of 2.490. Thus the odds ratio for a consumer choosing the tablet with 64GB memory tablet versus 32GB tablet computer is 1.273. this also indicated respondent prefer larger capacity of memory.

	Coefficient	Least Square Mean	Odds	Odds Ratio
Intercept	1.1033			
64GB Memory	0.121	1.154	3.170	1.273
32GB Memory	-0.121	0.912	2.490	

Table 4.5 The value of least square mean, odds and odds ratio for Memory

The tablet with flexibility mean Android tablet, while tablet with non flexibility mean Apple tablet. Result shown that the effect of flexibility tablet is 0.955 and the odds of choosing it is 2.598, while the effects of non flexibility tablet is 1.111 which translated into on odds of 3.039. Thus the odds ratio for a consumer choosing the tablet when with flexibility tablet versus non flexibility tablet is 0.855. This indicated consumer are prefer Apple tablet more than Android tablet.

	Coefficient	Least Square Mean	Odds	Odds Ratio
Intercept	1.1033			
Flexibility	-0.0784	0.955	2.598	0.855
Non Flexibility	0.0784	1.111	3.039	

Table 4.6 The value of least square mean, odds and odds ratio for Flexibility

The result of the effect of battery life to the tablet shows that consumer prefer longer battery life. The odd of the effects of 10 hours tablet is 3.069, while the odd of the effects of 8 hours tablet is 2.572. Thus the odds ratio for a consumer choosing the tablet with 10 hours battery life versus 8 hours battery life tablet is 1.193.

	Coefficient	Least Square Mean	Odds	Odds Ratio
Intercept	1.1033			
10 hours battery life	0.088	1.121	3.069	1.193
8 hours battery life	-0.088	0.945	2.572	

Table 4.7 The value of least square mean, odds and odds ratio for Battery life

Base on the result, tablet with 5-megapixel camera are more competitor than tablet with 3 megapixel camera. Because the result of the odd ratio for a consumer choosing the 5 megapixel tablet versus 3 megapixel tablet is 1.211.

	Coefficient	Least Square Mean	Odds	Odds Ratio
Intercept	1.1033			
5-Megapixel	0.096	1.129	3.092	1.211
3-Megapixel	-0.096	0.921	2.512	

Table 4.8 The value of least square mean, odds and odds ratio for Camera

Finally the result of the effects of the Ram of the tablet shown consumer preferred higher capacity Ram tablet. Result shown that the effect of 1GB Ram of tablet is 1.145 which translated into on odds of 3.142, while the effect of 500MB Ram of tablet is 0.921 which translated into on odds of 2.512. The odd of the 1GB Ram versus 500MB Ram is 1.251.

	Coefficient	Least Square Mean	Odds	Odds Ratio
Intercept	1.1033			
1GB Ram	0.112	1.145	3.142	1.251
500MB Ram	-0.112	0.921	2.512	

Table 4.9 The value of least square mean, odds and odds ratio for Ram

The odd ratio for a respondent choosing the product with 3G versus without 3G is 1.772 when the price was low. When the price is high, the odd ratio for a respondent choosing the product with 3G versus no 3G is 0.6721. This indicated that when the price of tablet is low, consumer were more concerned about 3G as compared when the price of tablet is high.

	Least Squares Mean	Odds	Odds Ratio
$Price_1 3G_1$	1.433	4.191	1.772
$Price_1 3G_0$	0.861	2.366	
$Price_0 3G_1$	0.633	1.884	0.672
$Price_0 3G_0$	1.030	2.802	

Table 4.10The value of least square mean, odds and odds ratio for Price versus 3G

Figure 4.1 Odd ratio (Price vs 3G)

The odd ratio for a respondent choosing the product with 2 year warranty versus 1 year warranty is 1.525 when the price is low. When the price higher, the odd ratio for a respondent choosing the product with 2 years warranty versus 1 year warranty is 1.072. This indicated that when the price is low the consumers are more concern about the warranty. This is true as when the price is low, the warranty may not be granted, thus the consumers are more concern about the existence of the warranty.

	Least Squares Mean	Odds	Odds Ratio
$Price_1 Warranty_1$	1.358	3.888	1.525
$Price_1 Warranty_0$	0.936	2.550	
$Price_0 Warranty_1$	0.954	2.596	1.072
$Price_0 Warranty_0$	0.884	2.421	

Table 4.11 The value of least square mean, odds and odds ratio for Price versus Warranty

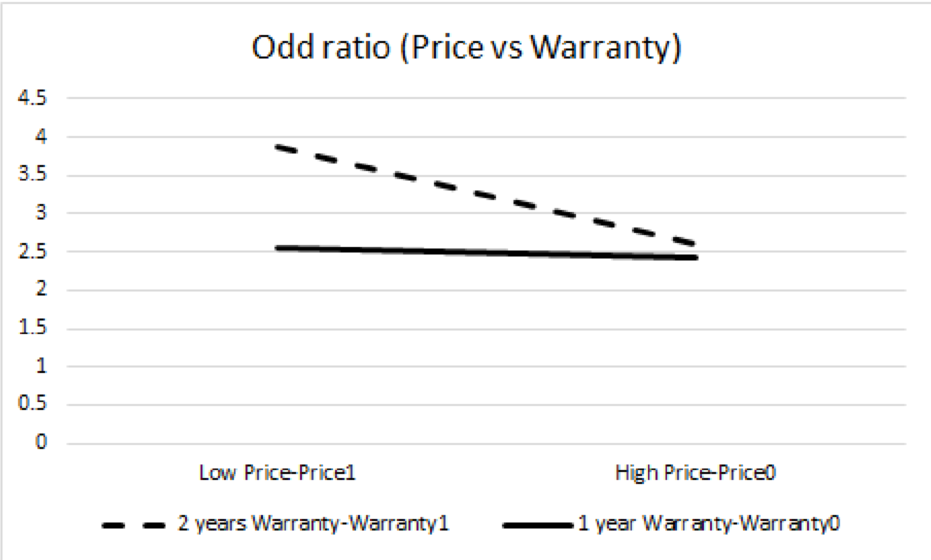


Figure 4.2 Odd ratio (Price vs Warranty)

The odd ratio for a respondent choosing Android tablet versus Apple tablet, when price of tablet is low is 0.7404. At high price tablet, the odd ratio for a respondent choosing Android versus Apple tablet is 0.987. This indicated that when the price is high, the consumers are more concerned about the choice between Android and Apple tablet.

	Least Squares Mean	Odds	Odds Ratio
$Price_1 Flexibility_1$	0.997	2.709	0.740
$Price_1 Flexibility_0$	1.297	3.660	
$Price_0 Flexibility_1$	0.913	2.491	0.987
$Price_0 Flexibility_0$	0.926	2.523	

Table 4.12 The value of least square mean, odds and odds ratio for Price versus Flexibility

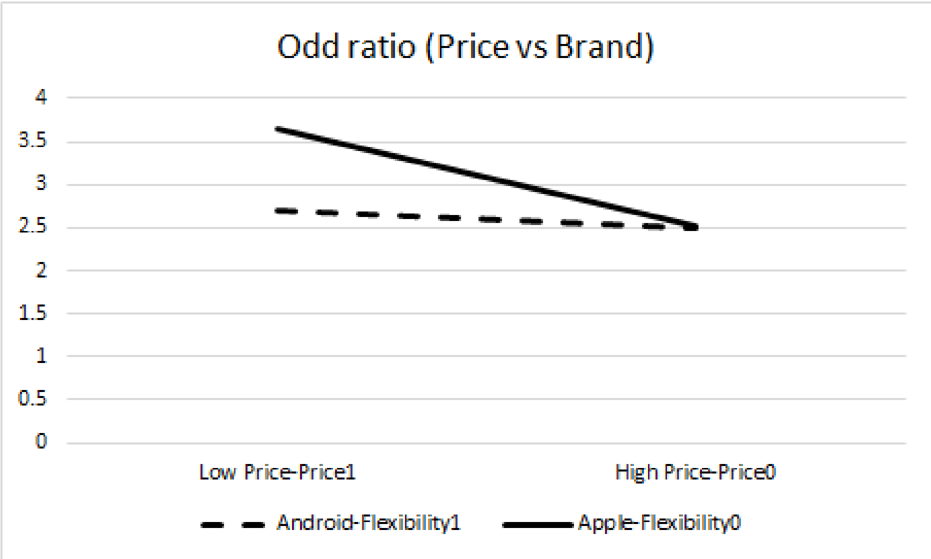


Figure 4.3 Odd ratio (Price vs Brand)

The odd ratio for respondent choosing the tablet with 10 hours battery life versus 8 hours battery is 1.008 when the price of tablet is low. When the price of tablet was high, the odd ratio for a respondent choosing the tablet with 10 hours battery life versus 8 hours battery life is 1.412. This indicated that when the price is high, the consumers more concerned about the life of battery.

	Least Squares Mean	Odds	Odds Ratio
$Price_1Battery_1$	1.151	3.162	1.008
$Price_1Battery_0$	1.143	3.136	
$Price_0Battery_1$	1.092	2.979	1.412
$Price_0Battery_0$	0.7466	2.110	

Table 4.13 The value of least square mean, odds and odds ratio for Price versus Battery

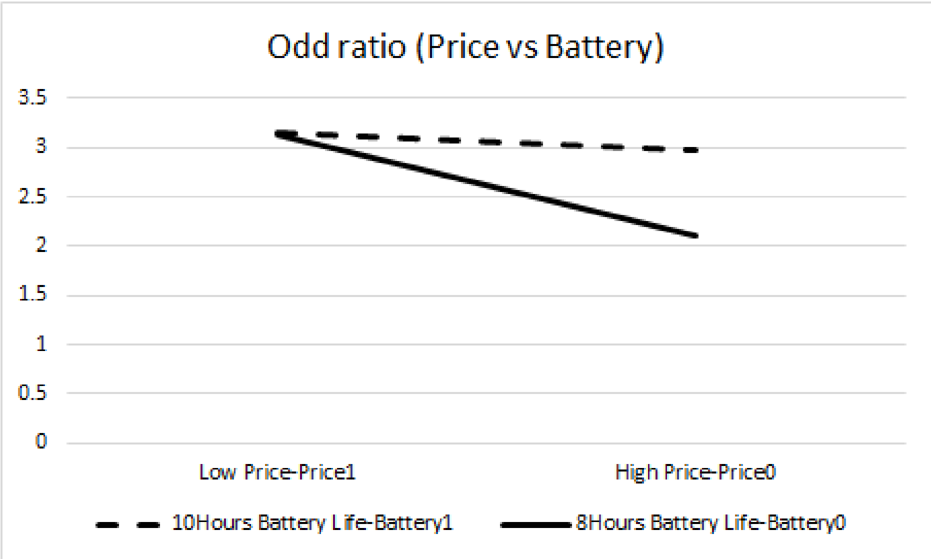


Figure 4.4 Odd ratio (Price vs Battery)

The odd ratio for a respondent choosing Android tablet versus Apple tablet is 0.689 for tablet with 3G. When the tablet with no 3G, the odd ratio for a respondent choosing Android tablet versus Apple tablet is 1.061. This indicates that consumers who choose Apple tablet will be more concerned about the existence of 3G.

	Least Squares Mean	Odds	Odds Ratio
$3G_1Flexibility_1$	0.934	2.545	0.689
$3G_1Flexibility_0$	1.307	3.694	
$3G_0Flexibility_1$	0.975	2.652	1.061
$3G_0Flexibility_0$	0.916	2.500	

Table 4.14 The value of least square mean, odds and odds ratio for 3G versus Flexibility

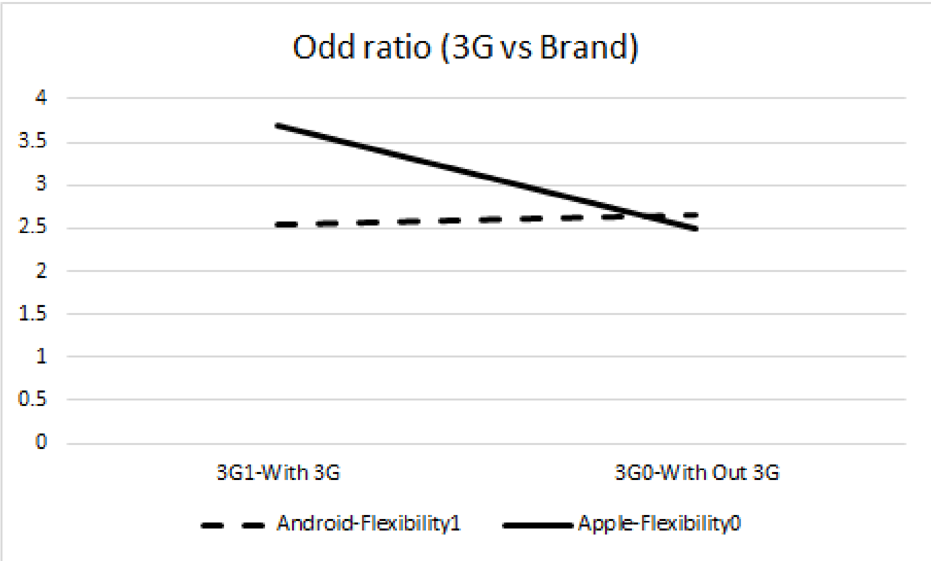


Figure 4.5 Odd ratio (3G vs Brand)

The odd ratio for a respondent choosing the product with 64GB versus 32GB is 1.544 when the warranty is 2 years. When the warranty is 1 year, the odd ratio for a respondent choosing the product with 64GB versus 32GB is 1.049. This indicates that respondents who concerns about the duration of the warranty is also concern about memory source. As the duration from 1 year increases to 2 years, the odds values for choosing the product with 64GB memory and 32GB memory increase. Thus, most of the respondents who preferred 2 years warranty will have higher preferences on 64GB tablet.

	Least Squares Mean	Odds	Odds Ratio
$Warranty_1Memory_1$	1.3731	3.9477	1.5441
$Warranty_1Memory_0$	0.9387	2.5566	
$Warranty_0Memory_1$	0.9342	2.5451	1.0491
$Warranty_0Memory_0$	0.8862	2.4260	

Table 4.15 The value of least square mean, odds and odds ratio for Warranty versus Memory

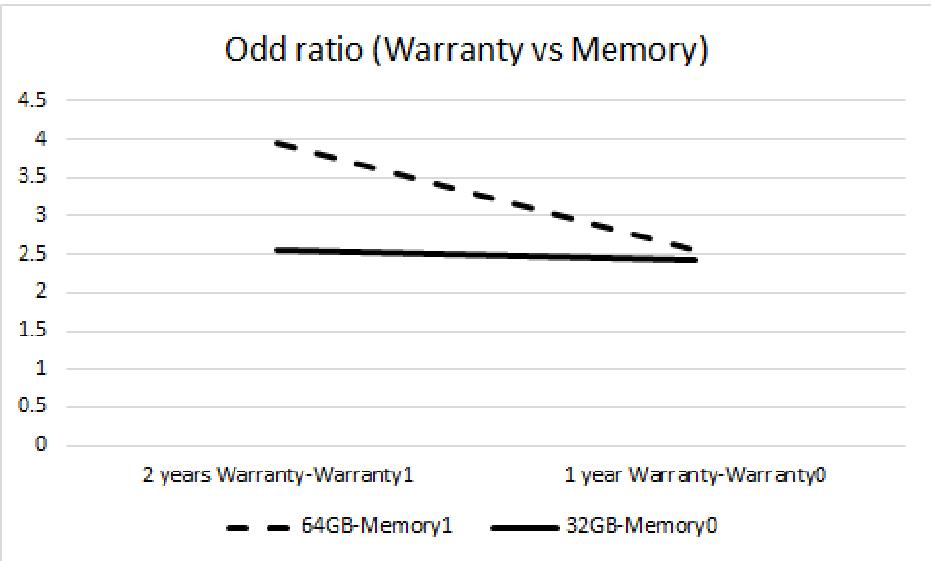


Figure 4.6 Odd ratio (Warranty vs Memory)

The odd ratio for a respondent choosing Android tablet versus Apple tablet is 0.743 when the warranty of tablet is 2 years. When the warranty of tablet is 1 years, the odd ratio for a respondent choosing Android tablet versus Apple tablet is 0.983. This indicated consumer will choose Apple tablet, when the duration of warranty are longer. When shorter duration of warranty for tablet, consumer also will choose Apple, but of the consumer will shift to Android tablet, Because the odd ratio for a respondent choosing Android tablet versus Apple tablet increase when the duration of warranty decrease.

	Least Squares Mean	Odds	Odds Ratio
$Warranty_1 Flexibility_1$	1.008	2.739	0.743
$Warranty_1 Flexibility_0$	1.304	3.685	
$Warranty_0 Flexibility_1$	0.902	2.464	0.983
$Warranty_0 Flexibility_0$	0.919	2.506	

Table 4.16 The value of least square mean, odds and odds ratio for Warranty versus Flexibility

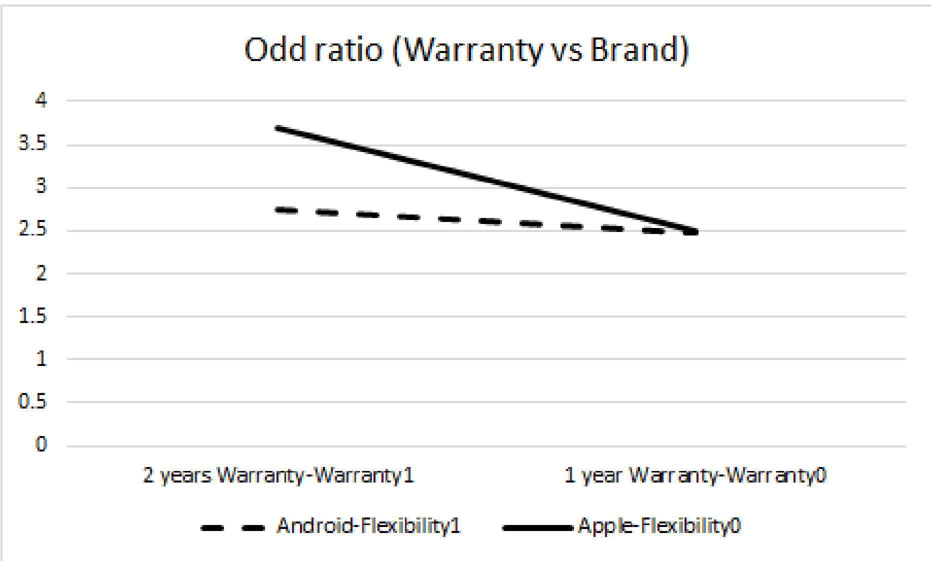


Figure 4.7 Odd ratio (Warranty vs Brand)

The odd ratio for a respondent choosing product with 1GB Ram versus 500MB Ram is 1.064 when the internal memory of tablet is 64GB. When the internal memory of tablet is 32GB, the odd ratio for a respondent choosing product with 1GB Ram versus 500MB Ram is 1.470. This indicated respondents who choose 32GB of memory are more concerned about the RAM.

	Least Squares Mean	Odds	Odds Ratio
$Memory_1Ram_1$	1.185	3.027	1.064
$Memory_1Ram_0$	1.123	3.073	
$Memory_0Ram_1$	1.105	3.020	1.470
$Memory_0Ram_0$	0.720	2.054	

Table 4.17 The value of least square mean, odds and odds ratio for Memory versus Ram

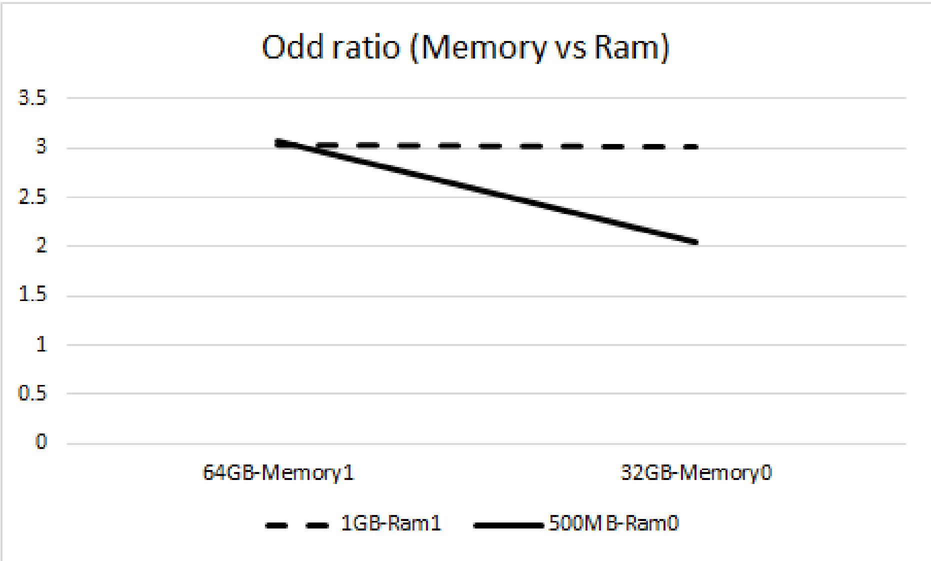


Figure 4.8 Odd ratio (Memory vs Ram)

For a respondents choosing Android tablet, the odd ratio for 10 hours battery life tablet versus 8 hours battery life tablet is 1.554. Whereas, a respondent choosing Apple tablet, the odd ratio for 10 hours battery life tablet versus 8 hours battery life tablet is 0.916. This indicates that for consumers who choose Android tablet, they will be more concerned about the battery life.

	Least Squares Mean	Odds	Odds Ratio
$Flexibility_1 Battery_1$	1.175	3.238	1.554
$Flexibility_1 Battery_0$	0.734	2.084	
$Flexibility_0 Battery_1$	1.068	2.909	0.916
$Flexibility_0 Battery_0$	1.155	3.175	

Table 4.18 The value of least square mean, odds and odds ratio for Flexibility versus Battery

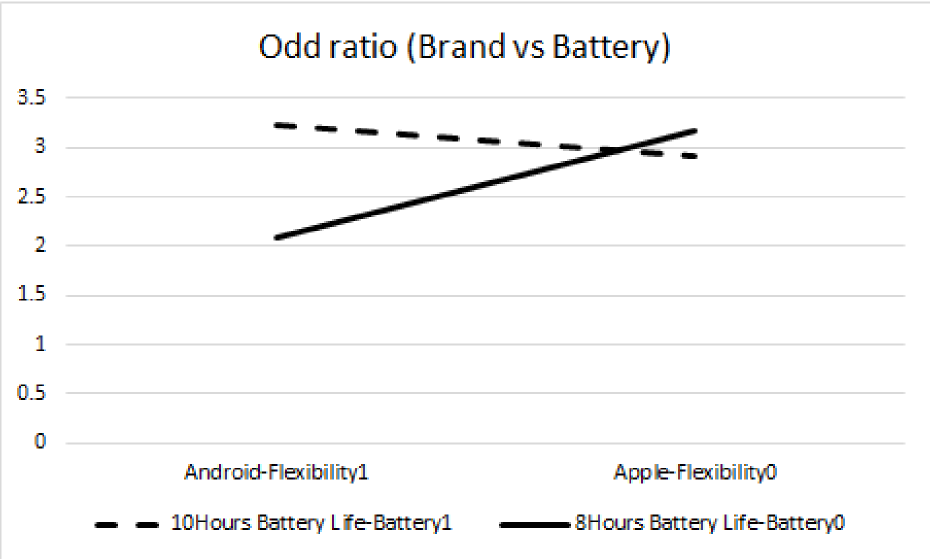


Figure 4.9 Odd ratio (Brand vs Battery)

For a respondents choosing Android tablet, the odd ratio for 5-Megapixel camera versus 3-Megapixel camera is 1.554. Whereas, a respondents choosing Apple tablet, the odd ratio for 5-Megapixel camera versus 3-Megapixel camera is 0.916. This indicates that for consumers who choose Android tablet, they will be more concerned about the quality of camera.

	Least Squares Mean	Odds	Odds Ratio
$Flexibility_1 Camera_1$	1.175	3.238	1.554
$Flexibility_1 Camera_0$	0.734	2.084	
$Flexibility_0 Camera_1$	1.068	2.909	0.916
$Flexibility_0 Camera_0$	1.155	3.175	

Table 4.19 The value of least square mean, odds and odds ratio for Flexibility versus Camera

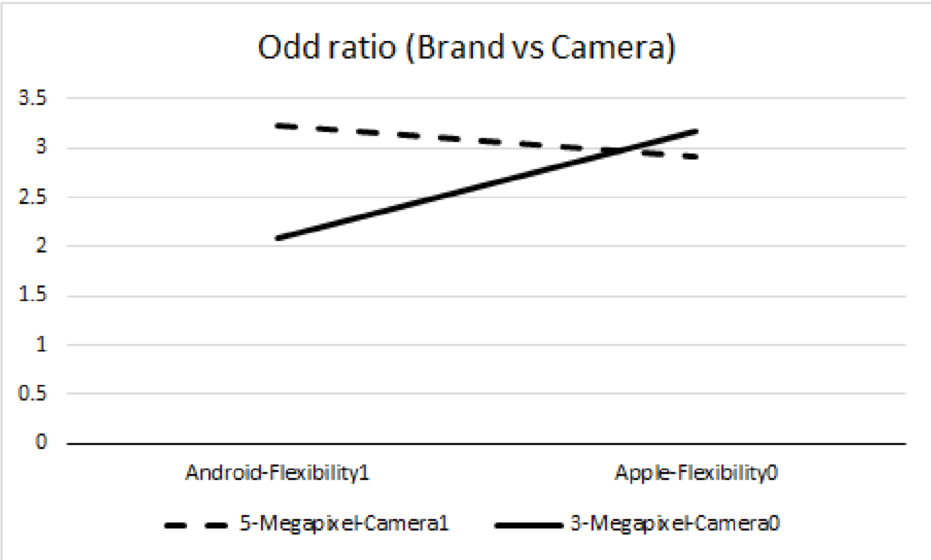


Figure 4.10 Odd ratio (Brand vs Camera)

CHAPTER 5

CONCLUSION

Conjoint choice experiments help researchers understand how people make complex judgments such as purchase decisions and product valuation by posing a series of choices about products or services. After the survey for is designed, then the respondent is asked to choose a series of choice sets, where the task is to choose the most preferred alternative from a series of choice sets. Conjoint choice designs are frequently based on single fractions of full factorial designs that generally do not allow estimation of interaction effects, have complex aliasing and produce biased estimates of main effects when interactions are not negligible. As an alternative to fractional factorials, 2^n confounded factorial designs for conjoint choice experiments with the purpose of estimating main effects and first order interactions has been developed by the author in previous study. In this study, the visual basic routines was presented and provided a quick way to construct confounded factorial conjoint choice experiment produce the corresponding survey questionnaires.

In this dissertation, we also studied the efficiency between Partially Confounded Factorial Conjoint Choice Experiment (PCFCCE) versus Completely Confounded Factorial Conjoint Choice Experiment (CCFCCE) by using D-error. Result founded out that PCFCCE is 50% gain in D-error. So that PCFCCE is more efficiency by CCFCCE. Since as we know, in partially confounded factorial gain more information than confounded factorial factorial design.

In this study, consumer preference on tablet was conducted using PCFCCE design. A 2^8 PCFCCE design was applied to 8 attributes of the tablet. The 8 attributes were : Price, 3G, Duration of Warranty, Capacity of Memory, Flexibility, Battery life, Quality of Camera and Ram. Data were collected by asking respondents to answer a questionnaire of 17 choice sets and 3 alternatives each. A total of 406 respondents were responded to the questionnaire.

CCFCCE design allows estimation of main effects and interaction effects. Since some of the effects will be confounded with the blocks in completely confounded factorial design, the conjoint choice design was extended to use of partially confounded factorial design, which is call PCFCCE. A 2^8 partially confounded factorial design with two replicate was applied to CCE in this study. If all the responses were assume to be independent, then the multinomial logit model follows. While in this study, within-subjects, block effects and choice set were treated as random effect in the model, and hence we have multinomial mixed model. This model belongs to the class of generalized linear mixed models. In this dissertation, we used the Monte Carlo Newton-Raphson method, and Metropolis-Hastings algorithm to generate random effects. R Codes were used to generate the Monte Carlo Newton-Raphson procedures. Convergent estimates of main and interaction effects were obtained. Estimation was done on main effects and first order interactions, higher order interactions are neglected. From the result obtained, all the main effects and ten first order interaction are significant (p-value $< \alpha = 0.05$). The significant first-order interaction effects were price and warranty, price and flexibility, price and battery, 3G and flexibility, warranty and memory, warranty and flexibility, memory and ram, flexibility and battery and flexibility and camera. These coefficients are estimated based sum to zero restriction.

The main effects of the attributes may be interpreted using the estimated coefficients. The effect of flexibility was 0.955 and the odds of choosing it was 2.598, while the effects of not flexibility was 1.111 which translated into an odds of 3.039. The odds ratio for a consumer choosing the tablet when the tablet is flexible versus not flexible was 0.855. This also means the odds of a respondent choosing a flexible tablet was 0.855 times the odds of a respondent choosing the not flexible tablet. Similarly, the odds of choosing a tablet with 3G was 1.191 times of the odds of choosing a tablet without 3G. The odds of choosing a tablet with longer duration warranty was 1.279 times of the odds of choosing a tablet with short duration warranty.

The significant interaction effects indicated that including interactions in the model was important. The significant effects between price and warranty showed that the odd ratios for a respondent choosing a 2 years warranty versus 1 year warranty was 1.525 when the tablet with lower price. When choosing a higher price tablet, the respondent choosing a 2 years warranty versus 1 year warranty was 1.072. This means that respondents will pay more attention to warranty, when the tablet price was low.

In the Monte Carlo Newton-Raphson procedures, the matrix of the second order derivative in this study was a square matrix of dimension 12,992. This is consider a really huge matrix. In the R, we have to use “SparseM” function for the square matrix to reduce memory usage to avoid out of memory error, else the computer will out of memory. In the procedures, MCMC sample size was 200 for first 19 iteration, 500 for iteration between 20-39 and 1000 for each iteration after 39. When the sample size increases, the time consumed for each iteration increases. Around 250 iterations were implemented to estimate all the fixed and random effects in the procedures of our study. Hence, 7 days or more were needed to complete the estimation when using R. Procedures that can reduce the time of estimation should be recommended in future research.

In addition, in the Monte Carlo Newton-Raphson procedures, the structure of variance components in the models were based on compound symmetry structure. Future research that use other variance structure sure as Autoregressive (AR1), Toeplitz (TOEP) and Unstructured (UN) may be used in order to increases the efficiency.

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APPENDIX A1 2^8 DESIGN OF REPLICATE I

1	2	3	4	5	6	7	8
11111111	11111001	11111101	11111011	11111110	11111000	11111100	11111010
0	110	10	100	1	111	11	101
11110010	11110100	11110000	11110110	11110011	11110101	11110001	11110111
1101	1011	1111	1001	1100	1010	1110	1000
11101010	11101100	11101000	11101110	11101011	11101101	11101001	11101111
10101	10011	10111	10001	10100	10010	10110	10000
11100111	11100001	11100101	11100011	11100110	11100000	11100100	11100010
11000	11110	11010	11100	11001	11111	11011	11101
11011000	11011110	11011010	11011100	11011001	11011111	11011011	11011101
100111	100001	100101	100011	100110	100000	100100	100010
11010101	11010011	11010111	11010001	11010100	11010010	11010110	11010000
101010	101100	101000	101110	101011	101101	101001	101111
11001101	11001011	11001111	11001001	11001100	11001010	11001110	11001000
110010	110100	110000	110110	110011	110101	110001	110111
11000000	11000110	11000010	11000100	11000001	11000111	11000011	11000101
111111	111001	111101	111011	111110	111000	111100	111010
10111001	10111111	10111011	10111101	10111000	10111110	10111010	10111100
1000110	1000000	1000100	1000010	1000111	1000001	1000101	1000011
10110100	10110010	10110110	10110000	10110101	10110011	10110111	10110001
1001011	1001101	1001001	1001111	1001010	1001100	1001000	1001110
10101100	10101010	10101110	10101000	10101101	10101011	10101111	10101001
1010011	1010101	1010001	1010111	1010010	1010100	1010000	1010110
10100001	10100111	10100011	10100101	10100000	10100110	10100010	10100100
1011110	1011000	1011100	1011010	1011111	1011001	1011101	1011011
10011110	10011000	10011100	10011010	10011111	10011001	10011101	10011011
1100001	1100111	1100011	1100101	1100000	1100110	1100010	1100100
10010011	10010101	10010001	10010111	10010010	10010100	10010000	10010110
1101100	1101010	1101110	1101000	1101101	1101011	1101111	1101001
10001011	10001101	10001001	10001111	10001010	10001100	10001000	10001110
1110100	1110010	1110110	1110000	1110101	1110011	1110111	1110001
10000110	10000000	10000100	10000010	10000111	10000001	10000101	10000011
1111001	1111111	1111011	1111101	1111000	1111110	1111010	1111100

APPENDIX A2 2^8 DESIGN OF REPLICATE II

1	2	3	4	5	6	7	8
11111111	11101110	11111010	11101011	11111110	11101111	11111011	11101010
0	10001	101	10100	1	10000	100	10101
11111100	11101101	11111001	11101000	11111101	11101100	11111000	11101001
11	10010	110	10111	10	10011	111	10110
11110011	11100010	11110110	11100111	11110010	11100011	11110111	11100110
1100	11101	1001	11000	1101	11100	1000	11001
11110000	11100001	11110101	11100100	11110001	11100000	11110100	11100101
1111	11110	1010	11011	1110	11111	1011	11010
11001111	11011110	11001010	11011011	11001110	11011111	11001011	11011010
110000	100001	110101	100100	110001	100000	110100	100101
11001100	11011101	11001001	11011000	11001101	11011100	11001000	11011001
110011	100010	110110	100111	110010	100011	110111	100110
11000011	11010010	11000110	11010111	11000010	11010011	11000111	11010110
111100	101101	111001	101000	111101	101100	111000	101001
11000000	11010001	11000101	11010100	11000001	11010000	11000100	11010101
111111	101110	111010	101011	111110	101111	111011	101010
10101010	10111011	10101111	10111110	10101011	10111010	10101110	10111111
1010101	1000100	1010000	1000001	1010100	1000101	1010001	1000000
10101001	10111000	10101100	10111101	10101000	10111001	10101101	10111100
1010110	1000111	1010011	1000010	1010111	1000110	1010010	1000011
10100110	10110111	10100011	10110010	10100111	10110110	10100010	10110011
1011001	1001000	1011100	1001101	1011000	1001001	1011101	1001100
10100101	10110100	10100000	10110001	10100100	10110101	10100001	10110000
1011010	1001011	1011111	1001110	1011011	1001010	1011110	1001111
10011010	10001011	10011111	10001110	10011011	10001010	10011110	10001111
1100101	1110100	1100000	1110001	1100100	1110101	1100001	1110000
10011001	10001000	10011100	10001101	10011000	10001001	10011101	10001100
1100110	1110111	1100011	1110010	1100111	1110110	1100010	1110011
10010110	10000111	10010011	10000010	10010111	10000110	10010010	10000011
1101001	1111000	1101100	1111101	1101000	1111001	1101101	1111100
10010101	10000100	10010000	10000001	10010100	10000101	10010001	10000000
1101010	1111011	1101111	1111110	1101011	1111010	1101110	1111111

APPENDIX B R-CODE

```
library(MASS)
library(SparseM)

*********************************************************
# construct X matrix
M_X=function(number_choice,x,num_z,p,r)
{
  i=0
  while(i<ncol(x)/2/(2^p*r))
  {
    j=0
    while(j<2^p*r)
    {
      c_X=rep(1,num_z[i+1])%x%
      t(x[,(2^p*r*i*2+2*j+1):(2^p*r*i*2+2*j+2)])
      if(i==0 & j==0)
        {X=c_X}
      else
        {X=rbind(X,c_X)}
      j=j+1
    }
    i=i+1
  }
  return(X)
}

# construct Y matrix
M_Y=function(num_c,y,x)
{
  i=0
  while(i<ncol(x)/2)
  {
    c_y=rep(0,num_c-1)
    j=0
    while(j<num_c-1)
    {
      c_Y=c_y
      c_Y[j+1]=1
      if(i==0 & j==0)
        {Y=t(rep(c(c_Y),y[(num_c*i+j+1)]))}
      else
        {Y=cbind(Y,t(rep(c(c_Y),y[(num_c*i+j+1)])))}
      j=j+1
    }
    Y=cbind(Y,t(rep(c(c_y),y[(num_c*i+j+1)])))
    i=i+1
  }
  return(Y)
```

```
}

# construct Z matrix
M_Z=function(number_z, num_c,Y)
{
  i=0
  while(i<(ncol(t(number_z))))
  {
    z=matrix(1,number_z[i+1]*16,1)%x%matrix(1,num_c-1,1)
    if (i==0)
      {Z=z}
    else
      {Z=block_i(as.matrix.csr(Z),as.matrix.csr(z))}
    i=i+1
  }
  return(Z)
}
# construct Z_i matrix
M_Zi=function(z_ij,number_z,num_c)
{
  rr=1
  for(i in seq(1,ncol(t(number_z)),1))
  {
    r=1
    zij=matrix(0,16*number_z[i],number_z[i])
    for(j in seq(1,ncol(t(number_z)),1))
    {
      for(k in seq(1,number_z[(i)]))
      {
        zij[r,z_ij[rr]]=1
r=r+1
        rr=rr+1
      }
    }
    if (i==1)
      {Zij=zij%x%matrix(1,num_c-1,1)}
    else
      {Zij=block_i(as.matrix.csr(Zij),as.matrix.csr(zij%x%matrix(1,num_c-1,1)))}
  }
  return(Zij)
}

# construct Z_ij matrix
M_Zij=function(number_z,num_c)
{
  for(i in seq(1,ncol(t(number_z)),1))
  {
    zijk=diag((number_z[i]*16))
    if(i==1)
```

```
      {Zijk=zijk%x%matrix(1,num_c-1,1)}
    else
      {Zijk=block_i(as.matrix.csr(Zijk),as.matrix.csr(zijk%x%matrix(1,num_c-1,1)))}
  }
  return(Zijk)
}

# calculate mean
M_Mean=function(X,B,num_choice,U,Ui,Uij,Z,Zi,Zij)
{
  eta=exp(X%*%B+Z%*%U+Zi%*%Ui+Zij%*%Uij)
  m_m=t(matrix(eta,number_choice-1,nrow(eta)/(number_choice-1)))
  b_m=(1+m_m[,1]+m_m[,2])%x%matrix(1,number_choice-1,1)
  mean=eta/b_m
  return(mean)
}

# construct covariance of Y
CV_matrix=function(mean,number_choice,number_z)
{
  i=0
  while(i<2^p*r)
  {
    a=t(mean[(sum(number_z[0:i])*32+1):(sum(number_z[0:(i+1)])*32)])
    A=diag(c(a*(1-a)))
    mm=t(matrix(a,number_choice-1,ncol(a)/(number_choice-1)))
    B=diag(c(-mm[,1]*mm[,2]))%x%(matrix(1,number_choice-1,number_choice-1)
        -diag(number_choice-1))
    if(i==0)
      {w=(A+B)}
    else
      {w=block_i(as.matrix.csr(w),as.matrix.csr(A+B))}
    i=i+1
    }
  return(w)
}

# Block Design
block_i=function(Z,zz)
{
  TF=as.matrix.csr(matrix(0,nrow(Z),ncol(zz)))
  T=cbind(Z,TF)
  BR=as.matrix.csr(matrix(0,nrow(zz),ncol(Z)))
  B=cbind(BR,zz)
  TB=rbind(T,B)
  return(TB)
}

# Metropolis Algorithm
```

```
Metropolis=function(nsam,Z,Zi,Zij,su,sui,suij)
{
  U=matrix(0,2*nsam,ncol(Z))
  Ui=matrix(0,2*nsam,ncol(Zi))
  Uij=matrix(0,2*nsam,ncol(Zij))
  U[1,]=rnorm(ncol(U),0,sqrt(su))
  Ui[1,]=rnorm(ncol(Ui),0,sqrt(sui))
  Uij[1,]=rnorm(ncol(Uij),0,sqrt(suij))
  for(i in seq(2,2*nsam,1))
  {
    U[i,]=rnorm(ncol(U),0,sqrt(su))
    Ui[i,]=rnorm(ncol(Ui),0,sqrt(sui))
    Uij[i,]=rnorm(ncol(Uij),0,sqrt(suij))
    if(runif(1,0,1)>alpha(U[i,],U[(i-1),],Ui[i,],Ui[(i-1),],Uij[i,],Uij[(i-1),]))
    {
      U[i,]=U[(i-1),]
      Ui[i,]=Ui[(i-1),]
      Uij[i,]=Uij[(i-1),]
    }
  }
  return(cbind(U[(nsam+1):(2*nsam),],Ui[(nsam+1):(2*nsam),],Uij[(nsam+1):(2*nsam),]))
}

# Acceptance Function
alpha=function(u1,u2,ui1,ui2,uij1,uij2)
{
  eta1=X%*%B+(Z%*%c(u1)+Zi%*%c(ui1)+Zij%*%c(uij1))
  eta2=X%*%B+(Z%*%c(u2)+Zi%*%c(ui2)+Zij%*%c(uij2))
  m_m1=t(matrix(eta1,number_choice-1,nrow(eta1)/(number_choice-1)))
  m_m2=t(matrix(eta2,number_choice-1,nrow(eta2)/(number_choice-1)))
  b_m1=(1+exp(m_m1[,1])+exp(m_m1[,2]))
  b_m2=(1+exp(m_m2[,1])+exp(m_m2[,2]))
  p1=exp(t(Y)*eta1-log(b_m1)%x%matrix(c(1,0),2,1))
  p2=exp(t(Y)*eta2-log(b_m2)%x%matrix(c(1,0),2,1))
  test=prod(p1/p2)
  return(min(1,test))
}

# Include interaction effects in to X matrix
interaction=function(x)
{
  i=1
  while(i<nrow(x))
  {
    j=i+1
    while(j<nrow(x)+1)
    {
      int_x=x[i,]*x[j,]
      if (j==2)
```

```
        {INT_X=int_x}
      else
        {INT_X=rbind(INT_X,int_x)}
      j=j+1
    }
    i=i+1
  }
  return(INT_X)
}

*********************************************************
# MCNR Generalized Linear Mixed Models
Mcmc_glmm=function(y,x,num_z,p,r,z_ij)
{
  number_choice=ncol(t(y))ncol(x)
  x=t(x)%x%(matrix(c(-1,1),2,1))
  x=t(rbind(t(x),interaction(t(x))))
  x=t(cbind(1,x))
  B=rep(0.01,nrow(x))
  X=M_X(number_choice,x,number_z,p,r)
  Y=M_Y(number_choice,y,x)
  Z=M_Z(number_z,number_choice,Y)
  Zi=M_Zi(z_ij,number_z,number_choice)
  Zij=M_Zij(number_z,number_choice)
  su=1
  sui=1
  suij=1
  Con=1
  fa=0
  k=1
  while(Con5)
  {
    if(k40) {nsam=200} else {nsam=1000}
    if(k20) {nsam=50}
    Uij=Metropolis(nsam,Z,Zi,Zij,su,sui,suij)
    U=Uij[,1ncol(Z)]
    Ui=Uij[,(ncol(Z)+1)(ncol(Z)+ncol(Zi))]
    Uij=Uij[,(ncol(Z)+ncol(Zi)+1)(ncol(Z)+ncol(Zi)+ncol(Zij))]
    j=0
    S=rep(0,nrow(X))
    Su=0
    Sui=0
    Suij=0
    while(jncol(t(Ui)))
    {
      mean=M_Mean(X,B,number_choice,U[j+1,],Ui[j+1,],Uij[j+1,],Z,Zi,Zij)
      s=(Y-t(mean))
      w=CV_matrix(mean,number_choice,number_z)
      if(j==0) {W=w} else {W=W+w}
```

```
  S=S+s
  Su=Su+1ncol(Z)t(U[j+1,])%%U[j+1,]
  Sui=Sui+1ncol(Zi)t(Ui[j+1,])%%Ui[j+1,]
  Suij=Suij+1ncol(Zij)t(Uij[j+1,])%%Uij[j+1,]
  j=j+1
}
W=W1/ncol(t(Ui))
S=S1/ncol(t(Ui))
Su=Su/ncol(t(U))
Sui=Sui/ncol(t(Ui))
Suij=Suij/ncol(t(Uij))
B1=B+(solve(as.matrix(t(X)%%W%%X),t(X)%%c(S)))
if (k40)
{
  test=max(abs(B-B1)/(abs(B)+0.001))
  test2=abs(su-Su)/(su+0.001)
  test3=abs(sui-Sui)/(sui+0.001)
  test4=abs(suij-Suij)/(suij+0.001)
  tcov=0.0001
}
else
{
  test=max(abs(B-B1)/(abs(B)+0.001))
  test2=abs(su-Su)/(su+0.001)
  test3=abs(sui-Sui)/(sui+0.001)
  test4=abs(suij-Suij)/(suij+0.001)
  tcov=0.005
}
if (test<tcov & test2<tcov & test3<tcov & test4<tcov)
{
  Con=6
}
else
{
  su=Su
  sui=Sui
  suij=Suij
  B=B1
  W_old=diag(solve(as.matrix(t(X)%%W%%X)))ˆ0.5
  print(k)
  print(B)
  print(test)
  print(test2)
  print(test3)
  print(test4)
  print(c(su,sui, suij))
  fa[k]=su
  k=k+1
}
```

```
  }
  print(done estimation)
  print(B1)
  print(su)
  print(sui)
  print(suij)
  return(B1)
}
```

APPENDIX C SURVEY FORMS

Survey Form

Tablet Computer is a mobile computer which is larger than a hand-phone and is integrated with a flat touch screen. It is primarily operated by touching the screen rather than using a physical key board. Nowadays, tablet computers are a popular source of entertainment as the user can surf the internet, play games, take pictures, play music, watch movies, etc. Besides that, the table computer is thin and light making it very easy to carry. In the corporate world, professionals can use the table computer to present proposals to their client.

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The following information are key features of the tablet computer.

Price	The unit price of a tablet computer.
3G	An additional place to put a sim card.
Warrantee	An assurance by the seller of property that the goods are as epresented or will be as promised.
Memory	The size of built-in storage.
Flexible	Can run other applications of other softwares.
Battery	The duration that the battery of a tablet computer can last before it needs to be recharged.
Camera	The quality of the picture.
Ram	The form of integrated circuits that allows stored data to be accessed in any order with a worst case performance of constant time.

The following information are the 17 different choice sets for the features of Tablet Computer. Please choose your preferred option for each feature.

Gender : Female ◯ Campus : FICT ◯
Male ◯ FES ◯

Survey form			
1	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Memory	64GB	32GB	Neither
Flexible	Y	N	Option A
3G	Y	N	or
Warrantee	2year	1year	Option B
Price	1500-2200	1800-2500	
RAM	1GB	500MB	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
2	Option A	Option B	Option C
Warrantee	2year	1year	
Camera	5-Megapixel	3-Megapixel	Neither
Memory	64GB	32GB	Option A
3G	Y	N	or
Battery	8hour	10hour	Option B
Price	1500-2200	1800-2500	
Flexible	N	Y	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
3	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
3G	Y	N	Neither
Memory	32GB	64GB	Option A
Flexible	Y	N	or
RAM	500MB	1GB	Option B
Battery	8hour	10hour	
Price	1500-2200	1800-2500	
Warrantee	2year	1year	
Choice	◯	◯	◯

Survey form			
4	Option A	Option B	Option C
Flexible	N	Y	
Battery	10hour	8hour	Neither
3G	Y	N	Option A
Price	1500-2200	1800-2500	or
Warrantee	2year	1year	Option B
Memory	32GB	64GB	
RAM	1GB	500MB	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
5	Option A	Option B	Option C
Memory	64GB	32GB	
Camera	3-Megapixel	5-Megapixel	Neither
RAM	500MB	1GB	Option A
Price	1500-2200	1800-2500	or
Flexible	Y	N	Option B
Warrantee	1year	2year	
Battery	8hour	10hour	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
6	Option A	Option B	Option C
Memory	64GB	32GB	
Battery	10hour	8hour	Neither
Camera	3-Megapixel	5-Megapixel	Option A
Price	1500-2200	1800-2500	or
Flexible	N	Y	Option B
Warrantee	1year	2year	
RAM	1GB	500MB	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
7	Option A	Option B	Option C
3G	Y	N	
Price	1500-2200	1800-2500	Neither
Warrantee	1year	2year	Option A
Flexible	Y	N	or
Memory	32GB	64GB	Option B
RAM	1GB	500MB	
Battery	10hour	8hour	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
8	Option A	Option B	Option C
3G	Y	N	
Warrantee	1year	2year	Neither
Price	1500-2200	1800-2500	Option A
RAM	500MB	1GB	or
Flexible	N	Y	Option B
Battery	8hour	10hour	
Memory	32GB	64GB	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
9	Option A	Option B	Option C
Flexible	Y	N	
Warrantee	2year	1year	Neither
3G	N	Y	Option A
RAM	1GB	500MB	or
Battery	8hour	10hour	Option B
Memory	64GB	32GB	
Price	1500-2200	1800-2500	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
10	Option A	Option B	Option C
RAM	500MB	1GB	
Warrantee	2year	1year	Neither
3G	N	Y	Option A
Camera	3-Megapixel	5-Megapixel	or
Battery	10hour	8hour	Option B
Flexible	N	Y	
Price	1500-2200	1800-2500	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
11	Option A	Option B	Option C
Flexible	Y	N	
RAM	500MB	1GB	Neither
Battery	10hour	8hour	Option A
Price	1500-2200	1800-2500	or
3G	N	Y	Option B
Memory	32GB	64GB	
Warrantee	2year	1year	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
12	Option A	Option B	Option C
RAM	1GB	500MB	
Camera	3-Megapixel	5-Megapixel	Neither
Flexible	N	Y	Option A
Battery	8hour	10hour	or
Memory	32GB	64GB	Option B
3G	N	Y	
Warrantee	2year	1year	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
13	Option A	Option B	Option C
Warrantee	1year	2year	
Camera	5-Megapixel	3-Megapixel	Neither
Price	1500-2200	1800-2500	Option A
Flexible	Y	N	or
Memory	64GB	32GB	Option B
RAM	500MB	1GB	
Battery	10hour	8hour	
3G	N	Y	
Choice	◯	◯	◯

Survey form			
14	Option A	Option B	Option C
Memory	64GB	32GB	
Price	1500-2200	1800-2500	Neither
RAM	1GB	500MB	Option A
Camera	5-Megapixel	3-Megapixel	or
Warrantee	1year	2year	Option B
3G	N	Y	
Battery	8hour	10hour	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
15	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Price	1500-2200	1800-2500	Neither
RAM	1GB	500MB	Option A
Warrantee	1year	2year	or
Flexible	Y	N	Option B
Memory	32GB	64GB	
3G	N	Y	
Battery	8hour	10hour	
Choice	◯	◯	◯

Survey form			
16	Option A	Option B	Option C
Flexible	N	Y	
Price	1500-2200	1800-2500	Neither
3G	N	Y	Option A
Memory	32GB	64GB	or
Warrantee	1year	2year	Option B
Battery	10hour	8hour	
RAM	500MB	1GB	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

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Gender : Female ◯ Campus : FICT ◯

Male ◯ FES ◯

Survey form			
17	Option A	Option B	Option C
3G	Y	N	
Camera	3-Megapixel	5-Megapixel	Neither
Warrantee	2year	1year	Option A
Battery	8hour	10hour	or
Flexible	Y	N	Option B
Memory	64GB	32GB	
RAM	1GB	500MB	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
18	Option A	Option B	Option C
Warrantee	2year	1year	
RAM	500MB	1GB	Neither
Flexible	N	Y	Option A
Battery	10hour	8hour	or
Camera	3-Megapixel	5-Megapixel	Option B
3G	Y	N	
Memory	64GB	32GB	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
19	Option A	Option B	Option C
3G	Y	N	
Battery	10hour	8hour	Neither
Memory	32GB	64GB	Option A
RAM	500MB	1GB	or
Price	1500-2200	1800-2500	Option B
Camera	3-Megapixel	5-Megapixel	
Warrantee	2year	1year	
Flexible	Y	N	
Choice	○	○	○

Survey form			
20	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
Battery	8hour	10hour	Neither
Flexible	N	Y	Option A
Warrantee	2year	1year	or
RAM	1GB	500MB	Option B
Memory	32GB	64GB	
3G	Y	N	
Price	1500-2200	1800-2500	
Choice	○	○	○

Survey form			
21	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Warrantee	1year	2year	Neither
Flexible	Y	N	Option A
3G	Y	N	or
Battery	10hour	8hour	Option B
Memory	64GB	32GB	
RAM	500MB	1GB	
Price	1500-2200	1800-2500	
Choice	○	○	○

Survey form			
22	Option A	Option B	Option C
RAM	1GB	500MB	
Price	1500-2200	1800-2500	Neither
Battery	8hour	10hour	Option A
Camera	5-Megapixel	3-Megapixel	or
Warrantee	1year	2year	Option B
Memory	64GB	32GB	
3G	Y	N	
Flexible	N	Y	
Choice	○	○	○

Survey form			
23	Option A	Option B	Option C
Memory	32GB	64GB	
RAM	1GB	500MB	Neither
Camera	5-Megapixel	3-Megapixel	Option A
3G	Y	N	or
Battery	8hour	10hour	Option B
Price	1500-2200	1800-2500	
Flexible	Y	N	
Warrantee	1year	2year	
Choice	○	○	○

Survey form			
24	Option A	Option B	Option C
Flexible	N	Y	
Memory	32GB	64GB	Neither
3G	Y	N	Option A
Battery	10hour	8hour	or
Price	1500-2200	1800-2500	Option B
Camera	5-Megapixel	3-Megapixel	
RAM	500MB	1GB	
Warrantee	1year	2year	
Choice	○	○	○

Survey form			
25	Option A	Option B	Option C
RAM	1GB	500MB	
3G	N	Y	Neither
Price	1500-2200	1800-2500	Option A
Flexible	Y	N	or
Battery	10hour	8hour	Option B
Memory	64GB	32GB	
Warrantee	2year	1year	
Camera	5-Megapixel	3-Megapixel	
Choice	○	○	○

Survey form			
26	Option A	Option B	Option C
Memory	64GB	32GB	
3G	N	Y	Neither
Flexible	N	Y	Option A
Price	1500-2200	1800-2500	or
RAM	500MB	1GB	Option B
Battery	8hour	10hour	
Warrantee	2year	1year	
Camera	5-Megapixel	3-Megapixel	
Choice	○	○	○

Survey form			
27	Option A	Option B	Option C
Warrantee	2year	1year	
RAM	500MB	1GB	Neither
Price	1500-2200	1800-2500	Option A
Flexible	Y	N	or
3G	N	Y	Option B
Memory	32GB	64GB	
Battery	8hour	10hour	
Camera	5-Megapixel	3-Megapixel	
Choice	○	○	○

Survey form			
28	Option A	Option B	Option C
Warrantee	2year	1year	
Flexible	N	Y	Neither
3G	N	Y	Option A
Price	1500-2200	1800-2500	or
Camera	5-Megapixel	3-Megapixel	Option B
Memory	32GB	64GB	
Battery	10hour	8hour	
RAM	1GB	500MB	
Choice	○	○	○

Survey form			
29	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
3G	N	Y	Neither
Price	1500-2200	1800-2500	Option A
Flexible	Y	N	or
Warrantee	1year	2year	Option B
Memory	64GB	32GB	
Battery	8hour	10hour	
RAM	500MB	1GB	
Choice	○	○	○

Survey form			
30	Option A	Option B	Option C
Memory	64GB	32GB	
Warrantee	1year	2year	Neither
RAM	1GB	500MB	Option A
Price	1500-2200	1800-2500	or
Battery	10hour	8hour	Option B
Camera	3-Megapixel	5-Megapixel	
Flexible	N	Y	
3G	N	Y	
Choice	○	○	○

Survey form			
31	Option A	Option B	Option C
Warrantee	1year	2year	
Price	1500-2200	1800-2500	Neither
3G	N	Y	Option A
Camera	3-Megapixel	5-Megapixel	or
RAM	1GB	500MB	Option B
Flexible	Y	N	
Battery	10hour	8hour	
Memory	32GB	64GB	
Choice	○	○	○

Survey form			
32	Option A	Option B	Option C
Battery	8hour	10hour	
Warrantee	1year	2year	Neither
Camera	3-Megapixel	5-Megapixel	Option A
RAM	500MB	1GB	or
Flexible	N	Y	Option B
Price	1500-2200	1800-2500	
3G	N	Y	
Memory	32GB	64GB	
Choice	○	○	○

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Male ◯ FES ◯

Survey form			
33	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Memory	64GB	32GB	Neither
Warrantee	2year	1year	Option A
RAM	1GB	500MB	or
3G	Y	N	Option B
Camera	3-Megapixel	5-Megapixel	
Battery	10hour	8hour	
Flexible	Y	N	
Choice	◯	◯	◯

Survey form			
34	Option A	Option B	Option C
Battery	8hour	10hour	
3G	Y	N	Neither
RAM	500MB	1GB	Option A
Warrantee	2year	1year	or
Memory	64GB	32GB	Option B
Camera	3-Megapixel	5-Megapixel	
Price	1500-2200	1800-2500	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
35	Option A	Option B	Option C
Warrantee	2year	1year	
Price	1500-2200	1800-2500	Neither
3G	Y	N	Option A
Memory	32GB	64GB	or
Camera	3-Megapixel	5-Megapixel	Option B
Battery	8hour	10hour	
Flexible	Y	N	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
36	Option A	Option B	Option C
Battery	10hour	8hour	
Price	1500-2200	1800-2500	Neither
Memory	32GB	64GB	Option A
3G	Y	N	or
Warrantee	2year	1year	Option B
Flexible	N	Y	
Camera	3-Megapixel	5-Megapixel	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
37	Option A	Option B	Option C
Battery	8hour	10hour	
Memory	64GB	32GB	Neither
Price	1500-2200	1800-2500	Option A
Warrantee	1year	2year	or
Flexible	Y	N	Option B
RAM	500MB	1GB	
Camera	5-Megapixel	3-Megapixel	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
38	Option A	Option B	Option C
Battery	10hour	8hour	
3G	Y	N	Neither
Warrantee	1year	2year	Option A
Memory	64GB	32GB	or
Price	1500-2200	1800-2500	Option B
Camera	5-Megapixel	3-Megapixel	
RAM	1GB	500MB	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
39	Option A	Option B	Option C
3G	Y	N	
RAM	1GB	500MB	Neither
Flexible	Y	N	Option A
Price	1500-2200	1800-2500	or
Memory	32GB	64GB	Option B
Camera	5-Megapixel	3-Megapixel	
Battery	10hour	8hour	
Warrantee	1year	2year	
Choice	◯	◯	◯

Survey form			
40	Option A	Option B	Option C
Battery	8hour	10hour	
Price	1500-2200	1800-2500	Neither
RAM	500MB	1GB	Option A
Camera	5-Megapixel	3-Megapixel	or
Flexible	N	Y	Option B
Memory	32GB	64GB	
Warrantee	1year	2year	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
41	Option A	Option B	Option C
Warrantee	2year	1year	
RAM	1GB	500MB	Neither
Memory	64GB	32GB	Option A
3G	N	Y	or
Camera	5-Megapixel	3-Megapixel	Option B
Price	1500-2200	1800-2500	
Flexible	Y	N	
Battery	8hour	10hour	
Choice	◯	◯	◯

Survey form			
42	Option A	Option B	Option C
Flexible	N	Y	
Camera	5-Megapixel	3-Megapixel	Neither
Warrantee	2year	1year	Option A
3G	N	Y	or
Battery	10hour	8hour	Option B
Memory	64GB	32GB	
RAM	500MB	1GB	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
43	Option A	Option B	Option C
RAM	500MB	1GB	
3G	N	Y	Neither
Warrantee	2year	1year	Option A
Camera	5-Megapixel	3-Megapixel	or
Flexible	Y	N	Option B
Price	1500-2200	1800-2500	
Memory	32GB	64GB	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
44	Option A	Option B	Option C
Battery	8hour	10hour	
Memory	32GB	64GB	Neither
3G	N	Y	Option A
Warrantee	2year	1year	or
Flexible	N	Y	Option B
Camera	5-Megapixel	3-Megapixel	
RAM	1GB	500MB	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
45	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
Price	1500-2200	1800-2500	Neither
Warrantee	1year	2year	Option A
RAM	500MB	1GB	or
Battery	10hour	8hour	Option B
3G	N	Y	
Flexible	Y	N	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
46	Option A	Option B	Option C
Flexible	N	Y	
RAM	1GB	500MB	Neither
Warrantee	1year	2year	Option A
Price	1500-2200	1800-2500	or
Battery	8hour	10hour	Option B
3G	N	Y	
Memory	64GB	32GB	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
47	Option A	Option B	Option C
3G RAM Camera Flexible Memory Battery Price Warrantee	N 1GB 3-Megapixel Y 32GB 8hour 1500-2200 1year	Y 500MB 5-Megapixel N 64GB 10hour 1800-2500 2year	Neither Option A or Option B
Choice	◯	◯	◯

Survey form			
48	Option A	Option B	Option C
3G Flexible Battery Camera Warrantee RAM Memory Price	N N 10hour 3-Megapixel 1year 500MB 32GB 1500-2200	Y Y 8hour 5-Megapixel 2year 1GB 64GB 1800-2500	Neither Option A or Option B
Choice	◯	◯	◯

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Survey form			
49	Option A	Option B	Option C
Memory	64GB	32GB	
Battery	8hour	10hour	Neither
Warrantee	2year	1year	Option A
Price	1500-2200	1800-2500	or
3G	Y	N	Option B
Camera	5-Megapixel	3-Megapixel	
Flexible	Y	N	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
50	Option A	Option B	Option C
Price	1500-2200	1800-2500	
RAM	500MB	1GB	Neither
Memory	64GB	32GB	Option A
Flexible	N	Y	or
Battery	10hour	8hour	Option B
Camera	5-Megapixel	3-Megapixel	
Warrantee	2year	1year	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
51	Option A	Option B	Option C
Battery	10hour	8hour	
Memory	32GB	64GB	Neither
Price	1500-2200	1800-2500	Option A
Camera	5-Megapixel	3-Megapixel	or
3G	Y	N	Option B
Warrantee	2year	1year	
Flexible	Y	N	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
52	Option A	Option B	Option C
Flexible	N	Y	
3G	Y	N	Neither
Camera	5-Megapixel	3-Megapixel	Option A
Battery	8hour	10hour	or
Memory	32GB	64GB	Option B
Price	1500-2200	1800-2500	
RAM	1GB	500MB	
Warrantee	2year	1year	
Choice	◯	◯	◯

Survey form			
53	Option A	Option B	Option C
Flexible	Y	N	
Memory	64GB	32GB	Neither
Battery	10hour	8hour	Option A
Warrantee	1year	2year	or
RAM	500MB	1GB	Option B
Camera	3-Megapixel	5-Megapixel	
3G	Y	N	
Price	1500-2200	1800-2500	
Choice	○	○	○

Survey form			
54	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
Flexible	N	Y	Neither
Battery	8hour	10hour	Option A
Warrantee	1year	2year	or
Memory	64GB	32GB	Option B
RAM	1GB	500MB	
3G	Y	N	
Price	1500-2200	1800-2500	
Choice	○	○	○

Survey form			
55	Option A	Option B	Option C
RAM	1GB	500MB	
Warrantee	1year	2year	Neither
Memory	32GB	64GB	Option A
Flexible	Y	N	or
Camera	3-Megapixel	5-Megapixel	Option B
Price	1500-2200	1800-2500	
3G	Y	N	
Battery	8hour	10hour	
Choice	○	○	○

Survey form			
56	Option A	Option B	Option C
RAM	500MB	1GB	
Price	1500-2200	1800-2500	Neither
Memory	32GB	64GB	Option A
3G	Y	N	or
Battery	10hour	8hour	Option B
Flexible	N	Y	
Camera	3-Megapixel	5-Megapixel	
Warrantee	1year	2year	
Choice	○	○	○

Survey form			
57	Option A	Option B	Option C
3G	N	Y	
Camera	3-Megapixel	5-Megapixel	Neither
Price	1500-2200	1800-2500	Option A
RAM	1GB	500MB	or
Battery	10hour	8hour	Option B
Memory	64GB	32GB	
Warrantee	2year	1year	
Flexible	Y	N	
Choice	○	○	○

Survey form			
58	Option A	Option B	Option C
Flexible	N	Y	
RAM	500MB	1GB	Neither
Warrantee	2year	1year	Option A
3G	N	Y	or
Battery	8hour	10hour	Option B
Camera	3-Megapixel	5-Megapixel	
Memory	64GB	32GB	
Price	1500-2200	1800-2500	
Choice	○	○	○

Survey form			
59	Option A	Option B	Option C
Price	1500-2200	1800-2500	
3G	N	Y	Neither
Battery	8hour	10hour	Option A
RAM	500MB	1GB	or
Flexible	Y	N	Option B
Warrantee	2year	1year	
Memory	32GB	64GB	
Camera	3-Megapixel	5-Megapixel	
Choice	○	○	○

Survey form			
60	Option A	Option B	Option C
Price	1500-2200	1800-2500	
3G	N	Y	Neither
Camera	3-Megapixel	5-Megapixel	Option A
Memory	32GB	64GB	or
Battery	10hour	8hour	Option B
Flexible	N	Y	
Warrantee	2year	1year	
RAM	1GB	500MB	
Choice	○	○	○

Survey form			
61	Option A	Option B	Option C
Warrantee	1year	2year	
RAM	500MB	1GB	Neither
Battery	8hour	10hour	Option A
3G	N	Y	or
Memory	64GB	32GB	Option B
Price	1500-2200	1800-2500	
Flexible	Y	N	
Camera	5-Megapixel	3-Megapixel	
Choice	○	○	○

Survey form			
62	Option A	Option B	Option C
Flexible	N	Y	
Warrantee	1year	2year	Neither
Battery	10hour	8hour	Option A
Memory	64GB	32GB	or
Price	1500-2200	1800-2500	Option B
RAM	1GB	500MB	
3G	N	Y	
Camera	5-Megapixel	3-Megapixel	
Choice	○	○	○

Survey form			
63	Option A	Option B	Option C
Camera Warrantee Memory RAM Price 3G Flexible Battery	5-Megapixel 1year 32GB 1GB 1500-2200 N Y 10hour	3-Megapixel 2year 64GB 500MB 1800-2500 Y N 8hour	Neither Option A or Option B
Choice	◯	◯	◯

Survey form			
64	Option A	Option B	Option C
3G Battery Price Warrantee Flexible Memory Camera RAM	N 8hour 1500-2200 1year N 32GB 5-Megapixel 500MB	Y 10hour 1800-2500 2year Y 64GB 3-Megapixel 1GB	Neither Option A or Option B
Choice	◯	◯	◯

Survey Form

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The following information are key features of the tablet computer.

Price	The unit price of a tablet computer.
3G	An additional place to put a sim card.
Warrantee	An assurance by the seller of property that the goods are as epresented or will be as promised.
Memory	The size of built-in storage.
Flexible	Can run other applications of other softwares.
Battery	The duration that the battery of a tablet computer can last before it needs to be recharged.
Camera	The quality of the picture.
Ram	The form of integrated circuits that allows stored data to be accessed in any order with a worst case performance of constant time.

The following information are the 17 different choice sets for the features of Tablet Computer. Please choose your preferred option for each feature.

Gender : Female ◯ Campus : FICT ◯

Male ◯ FES ◯

Survey form			
65	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Memory	64GB	32GB	Neither
RAM	500MB	1GB	Option A
Flexible	Y	N	or
Battery	10hour	8hour	Option B
3G	Y	N	
Price	1500-2200	1800-2500	
Warrantee	2year	1year	
Choice	◯	◯	◯

Survey form			
66	Option A	Option B	Option C
Flexible	N	Y	
Camera	5-Megapixel	3-Megapixel	Neither
RAM	1GB	500MB	Option A
Battery	8hour	10hour	or
Price	1500-2200	1800-2500	Option B
3G	Y	N	
Warrantee	2year	1year	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
67	Option A	Option B	Option C
Memory	32GB	64GB	
RAM	1GB	500MB	Neither
3G	Y	N	Option A
Camera	5-Megapixel	3-Megapixel	or
Warrantee	2year	1year	Option B
Price	1500-2200	1800-2500	
Battery	8hour	10hour	
Flexible	Y	N	
Choice	◯	◯	◯

Survey form			
68	Option A	Option B	Option C
Warrantee	2year	1year	
3G	Y	N	Neither
Memory	32GB	64GB	Option A
Camera	5-Megapixel	3-Megapixel	or
RAM	500MB	1GB	Option B
Price	1500-2200	1800-2500	
Flexible	N	Y	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
69	Option A	Option B	Option C
3G	Y	N	
Flexible	Y	N	Neither
Memory	64GB	32GB	Option A
Battery	8hour	10hour	or
Price	1500-2200	1800-2500	Option B
Warrantee	1year	2year	
Camera	3-Megapixel	5-Megapixel	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
70	Option A	Option B	Option C
Flexible	N	Y	
3G	Y	N	Neither
Camera	3-Megapixel	5-Megapixel	Option A
RAM	500MB	1GB	or
Price	1500-2200	1800-2500	Option B
Warrantee	1year	2year	
Battery	10hour	8hour	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
71	Option A	Option B	Option C
Warrantee	1year	2year	
Memory	32GB	64GB	Neither
Battery	10hour	8hour	Option A
Camera	3-Megapixel	5-Megapixel	or
RAM	500MB	1GB	Option B
Flexible	Y	N	
Price	1500-2200	1800-2500	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
72	Option A	Option B	Option C
Memory	32GB	64GB	
Warrantee	1year	2year	Neither
Flexible	N	Y	Option A
3G	Y	N	or
Battery	8hour	10hour	Option B
RAM	1GB	500MB	
Price	1500-2200	1800-2500	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
73	Option A	Option B	Option C
RAM	500MB	1GB	
Warrantee	2year	1year	Neither
Price	1500-2200	1800-2500	Option A
Battery	8hour	10hour	or
Flexible	Y	N	Option B
Camera	3-Megapixel	5-Megapixel	
Memory	64GB	32GB	
3G	N	Y	
Choice	◯	◯	◯

Survey form			
74	Option A	Option B	Option C
3G	N	Y	
Camera	3-Megapixel	5-Megapixel	Neither
Battery	10hour	8hour	Option A
RAM	1GB	500MB	or
Warrantee	2year	1year	Option B
Price	1500-2200	1800-2500	
Flexible	N	Y	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
75	Option A	Option B	Option C
Warrantee	2year	1year	
3G	N	Y	Neither
RAM	1GB	500MB	Option A
Flexible	Y	N	or
Memory	32GB	64GB	Option B
Camera	3-Megapixel	5-Megapixel	
Battery	10hour	8hour	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
76	Option A	Option B	Option C
RAM	500MB	1GB	
Memory	32GB	64GB	Neither
Camera	3-Megapixel	5-Megapixel	Option A
Flexible	N	Y	or
Battery	8hour	10hour	Option B
3G	N	Y	
Price	1500-2200	1800-2500	
Warrantee	2year	1year	
Choice	◯	◯	◯

Survey form			
77	Option A	Option B	Option C
Memory	64GB	32GB	
Warrantee	1year	2year	Neither
RAM	1GB	500MB	Option A
Price	1500-2200	1800-2500	or
3G	N	Y	Option B
Flexible	Y	N	
Camera	5-Megapixel	3-Megapixel	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
78	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Flexible	N	Y	Neither
Battery	8hour	10hour	Option A
3G	N	Y	or
Camera	5-Megapixel	3-Megapixel	Option B
RAM	500MB	1GB	
Memory	64GB	32GB	
Warrantee	1year	2year	
Choice	◯	◯	◯

Survey form			
79	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Flexible	Y	N	Neither
Memory	32GB	64GB	Option A
RAM	500MB	1GB	or
Battery	8hour	10hour	Option B
3G	N	Y	
Camera	5-Megapixel	3-Megapixel	
Warrantee	1year	2year	
Choice	◯	◯	◯

Survey form			
80	Option A	Option B	Option C
RAM	1GB	500MB	
Battery	10hour	8hour	Neither
Camera	5-Megapixel	3-Megapixel	Option A
Price	1500-2200	1800-2500	or
Warrantee	1year	2year	Option B
Flexible	N	Y	
Memory	32GB	64GB	
3G	N	Y	
Choice	◯	◯	◯

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Camera	The quality of the picture.
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Gender : Female ◯ Campus : FICT ◯

Male ◯ FES ◯

Survey form			
81	Option A	Option B	Option C
RAM	500MB	1GB	
3G	Y	N	Neither
Memory	64GB	32GB	Option A
Battery	8hour	10hour	or
Warrantee	2year	1year	Option B
Camera	3-Megapixel	5-Megapixel	
Flexible	Y	N	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
82	Option A	Option B	Option C
Battery	10hour	8hour	
3G	Y	N	Neither
RAM	1GB	500MB	Option A
Price	1500-2200	1800-2500	or
Camera	3-Megapixel	5-Megapixel	Option B
Memory	64GB	32GB	
Warrantee	2year	1year	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
83	Option A	Option B	Option C
RAM	1GB	500MB	
Price	1500-2200	1800-2500	Neither
Battery	10hour	8hour	Option A
Camera	3-Megapixel	5-Megapixel	or
Warrantee	2year	1year	Option B
3G	Y	N	
Flexible	Y	N	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
84	Option A	Option B	Option C
3G	Y	N	
Memory	32GB	64GB	Neither
Warrantee	2year	1year	Option A
Camera	3-Megapixel	5-Megapixel	or
Battery	8hour	10hour	Option B
RAM	500MB	1GB	
Flexible	N	Y	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
85	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Flexible	Y	N	Neither
Camera	5-Megapixel	3-Megapixel	Option A
Battery	10hour	8hour	or
Warrantee	1year	2year	Option B
3G	Y	N	
Memory	64GB	32GB	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
86	Option A	Option B	Option C
Memory	64GB	32GB	
Battery	8hour	10hour	Neither
RAM	500MB	1GB	Option A
Flexible	N	Y	or
Warrantee	1year	2year	Option B
Price	1500-2200	1800-2500	
3G	Y	N	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
87	Option A	Option B	Option C
Warrantee	1year	2year	
Price	1500-2200	1800-2500	Neither
RAM	500MB	1GB	Option A
3G	Y	N	or
Camera	5-Megapixel	3-Megapixel	Option B
Battery	8hour	10hour	
Memory	32GB	64GB	
Flexible	Y	N	
Choice	◯	◯	◯

Survey form			
88	Option A	Option B	Option C
Flexible	N	Y	
Warrantee	1year	2year	Neither
3G	Y	N	Option A
Battery	10hour	8hour	or
Price	1500-2200	1800-2500	Option B
Camera	5-Megapixel	3-Megapixel	
RAM	1GB	500MB	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
89	Option A	Option B	Option C
3G	N	Y	
RAM	500MB	1GB	Neither
Battery	10hour	8hour	Option A
Camera	5-Megapixel	3-Megapixel	or
Warrantee	2year	1year	Option B
Price	1500-2200	1800-2500	
Flexible	Y	N	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
90	Option A	Option B	Option C
Battery	8hour	10hour	
Price	1500-2200	1800-2500	Neither
RAM	1GB	500MB	Option A
Memory	64GB	32GB	or
Warrantee	2year	1year	Option B
Flexible	N	Y	
Camera	5-Megapixel	3-Megapixel	
3G	N	Y	
Choice	◯	◯	◯

Survey form			
91	Option A	Option B	Option C
Price	1500-2200	1800-2500	
3G	N	Y	Neither
RAM	1GB	500MB	Option A
Memory	32GB	64GB	or
Battery	8hour	10hour	Option B
Camera	5-Megapixel	3-Megapixel	
Flexible	Y	N	
Warrantee	2year	1year	
Choice	◯	◯	◯

Survey form			
92	Option A	Option B	Option C
3G	N	Y	
Price	1500-2200	1800-2500	Neither
Flexible	N	Y	Option A
Warrantee	2year	1year	or
Camera	5-Megapixel	3-Megapixel	Option B
RAM	500MB	1GB	
Memory	32GB	64GB	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
93	Option A	Option B	Option C
3G	N	Y	
Price	1500-2200	1800-2500	Neither
Warrantee	1year	2year	Option A
Memory	64GB	32GB	or
Camera	3-Megapixel	5-Megapixel	Option B
Flexible	Y	N	
Battery	8hour	10hour	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
94	Option A	Option B	Option C
Memory	64GB	32GB	
Battery	10hour	8hour	Neither
Flexible	N	Y	Option A
Warrantee	1year	2year	or
3G	N	Y	Option B
Camera	3-Megapixel	5-Megapixel	
Price	1500-2200	1800-2500	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
95	Option A	Option B	Option C
Memory 3G Price Flexible Battery Camera RAM Warrantee	32GB N 1500-2200 Y 10hour 3-Megapixel 500MB 1year	64GB Y 1800-2500 N 8hour 5-Megapixel 1GB 2year	Neither Option A or Option B
Choice	○	○	○

Survey form			
96	Option A	Option B	Option C
3G Flexible Warrantee Camera Battery Memory RAM Price	N N 1year 3-Megapixel 8hour 32GB 1GB 1500-2200	Y Y 2year 5-Megapixel 10hour 64GB 500MB 1800-2500	Neither Option A or Option B
Choice	○	○	○

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Male ◯ FES ◯

Survey form			
97	Option A	Option B	Option C
Battery	10hour	8hour	Neither Option A or Option B
Warrantee	2year	1year	
Price	1500-2200	1800-2500	
Memory	64GB	32GB	
3G	Y	N	
Flexible	Y	N	
RAM	500MB	1GB	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
98	Option A	Option B	Option C
Flexible	N	Y	Neither Option A or Option B
Memory	64GB	32GB	
3G	Y	N	
Camera	3-Megapixel	5-Megapixel	
Battery	8hour	10hour	
Warrantee	2year	1year	
RAM	1GB	500MB	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
99	Option A	Option B	Option C
3G	Y	N	Neither Option A or Option B
Memory	32GB	64GB	
Camera	3-Megapixel	5-Megapixel	
Price	1500-2200	1800-2500	
Flexible	Y	N	
Battery	8hour	10hour	
Warrantee	2year	1year	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
100	Option A	Option B	Option C
Price	1500-2200	1800-2500	Neither Option A or Option B
Flexible	N	Y	
Camera	3-Megapixel	5-Megapixel	
Memory	32GB	64GB	
Warrantee	2year	1year	
3G	Y	N	
Battery	10hour	8hour	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
101	Option A	Option B	Option C
Flexible	Y	N	
RAM	1GB	500MB	Neither
Price	1500-2200	1800-2500	Option A
Warrantee	1year	2year	or
Memory	64GB	32GB	Option B
3G	Y	N	
Battery	8hour	10hour	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
102	Option A	Option B	Option C
Flexible	N	Y	
RAM	500MB	1GB	Neither
Price	1500-2200	1800-2500	Option A
3G	Y	N	or
Camera	5-Megapixel	3-Megapixel	Option B
Battery	10hour	8hour	
Memory	64GB	32GB	
Warrantee	1year	2year	
Choice	◯	◯	◯

Survey form			
103	Option A	Option B	Option C
Memory	32GB	64GB	
Battery	10hour	8hour	Neither
3G	Y	N	Option A
Warrantee	1year	2year	or
Camera	5-Megapixel	3-Megapixel	Option B
Price	1500-2200	1800-2500	
RAM	500MB	1GB	
Flexible	Y	N	
Choice	◯	◯	◯

Survey form			
104	Option A	Option B	Option C
Battery	8hour	10hour	
Price	1500-2200	1800-2500	Neither
Flexible	N	Y	Option A
Camera	5-Megapixel	3-Megapixel	or
RAM	1GB	500MB	Option B
3G	Y	N	
Warrantee	1year	2year	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
105	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Warrantee	2year	1year	Neither
Memory	64GB	32GB	Option A
RAM	500MB	1GB	or
Flexible	Y	N	Option B
3G	N	Y	
Camera	5-Megapixel	3-Megapixel	
Battery	8hour	10hour	
Choice	◯	◯	◯

Survey form			
106	Option A	Option B	Option C
Warrantee	2year	1year	
RAM	1GB	500MB	Neither
Camera	5-Megapixel	3-Megapixel	Option A
Price	1500-2200	1800-2500	or
Flexible	N	Y	Option B
Memory	64GB	32GB	
3G	N	Y	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
107	Option A	Option B	Option C
Battery	10hour	8hour	
Flexible	Y	N	Neither
3G	N	Y	Option A
RAM	1GB	500MB	or
Memory	32GB	64GB	Option B
Price	1500-2200	1800-2500	
Warrantee	2year	1year	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
108	Option A	Option B	Option C
Battery	8hour	10hour	
Camera	5-Megapixel	3-Megapixel	Neither
RAM	500MB	1GB	Option A
Flexible	N	Y	or
Warrantee	2year	1year	Option B
Price	1500-2200	1800-2500	
Memory	32GB	64GB	
3G	N	Y	
Choice	◯	◯	◯

Survey form			
109	Option A	Option B	Option C
Flexible	Y	N	
Memory	64GB	32GB	Neither
Price	1500-2200	1800-2500	Option A
Warrantee	1year	2year	or
RAM	1GB	500MB	Option B
Battery	10hour	8hour	
3G	N	Y	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
110	Option A	Option B	Option C
Memory	64GB	32GB	
Camera	3-Megapixel	5-Megapixel	Neither
Battery	8hour	10hour	Option A
Warrantee	1year	2year	or
Flexible	N	Y	Option B
RAM	500MB	1GB	
Price	1500-2200	1800-2500	
3G	N	Y	
Choice	◯	◯	◯

Survey form			
111	Option A	Option B	Option C
Flexible	Y	N	
Warrantee	1year	2year	Neither
3G	N	Y	Option A
Battery	8hour	10hour	or
Price	1500-2200	1800-2500	Option B
RAM	500MB	1GB	
Camera	3-Megapixel	5-Megapixel	
Memory	32GB	64GB	
Choice	○	○	○

Survey form			
112	Option A	Option B	Option C
Memory	32GB	64GB	
3G	N	Y	Neither
RAM	1GB	500MB	Option A
Camera	3-Megapixel	5-Megapixel	or
Warrantee	1year	2year	Option B
Price	1500-2200	1800-2500	
Flexible	N	Y	
Battery	10hour	8hour	
Choice	○	○	○

Survey Form

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The following information are key features of the tablet computer.

Price	The unit price of a tablet computer.
3G	An additional place to put a sim card.
Warrantee	An assurance by the seller of property that the goods are as epresented or will be as promised.
Memory	The size of built-in storage.
Flexible	Can run other applications of other softwares.
Battery	The duration that the battery of a tablet computer can last before it needs to be recharged.
Camera	The quality of the picture.
Ram	The form of integrated circuits that allows stored data to be accessed in any order with a worst case performance of constant time.

The following information are the 17 different choice sets for the features of Tablet Computer. Please choose your preferred option for each feature.

Gender : Female ◯ Campus : FICT ◯

Male ◯ FES ◯

Survey form			
113	Option A	Option B	Option C
3G	Y	N	
Flexible	Y	N	Neither
Memory	64GB	32GB	Option A
Warrantee	2year	1year	or
RAM	500MB	1GB	Option B
Camera	5-Megapixel	3-Megapixel	
Price	1500-2200	1800-2500	
Battery	8hour	10hour	
Choice	◯	◯	◯

Survey form			
114	Option A	Option B	Option C
Warrantee	2year	1year	
Price	1500-2200	1800-2500	Neither
Battery	10hour	8hour	Option A
RAM	1GB	500MB	or
Flexible	N	Y	Option B
Memory	64GB	32GB	
3G	Y	N	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
115	Option A	Option B	Option C
Warrantee	2year	1year	
3G	Y	N	Neither
Battery	10hour	8hour	Option A
Flexible	Y	N	or
Memory	32GB	64GB	Option B
Camera	5-Megapixel	3-Megapixel	
Price	1500-2200	1800-2500	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
116	Option A	Option B	Option C
Memory	32GB	64GB	
Price	1500-2200	1800-2500	Neither
Warrantee	2year	1year	Option A
3G	Y	N	or
Camera	5-Megapixel	3-Megapixel	Option B
RAM	500MB	1GB	
Flexible	N	Y	
Battery	8hour	10hour	
Choice	◯	◯	◯

Survey form			
117	Option A	Option B	Option C
Flexible	Y	N	
Battery	10hour	8hour	Neither
Warrantee	1year	2year	Option A
3G	Y	N	or
RAM	1GB	500MB	Option B
Memory	64GB	32GB	
Price	1500-2200	1800-2500	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
118	Option A	Option B	Option C
RAM	500MB	1GB	
Warrantee	1year	2year	Neither
Camera	3-Megapixel	5-Megapixel	Option A
Flexible	N	Y	or
Memory	64GB	32GB	Option B
Price	1500-2200	1800-2500	
Battery	8hour	10hour	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
119	Option A	Option B	Option C
3G	Y	N	
Warrantee	1year	2year	Neither
Flexible	Y	N	Option A
Battery	8hour	10hour	or
RAM	500MB	1GB	Option B
Memory	32GB	64GB	
Price	1500-2200	1800-2500	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
120	Option A	Option B	Option C
RAM	1GB	500MB	
Camera	3-Megapixel	5-Megapixel	Neither
Warrantee	1year	2year	Option A
Battery	10hour	8hour	or
Flexible	N	Y	Option B
Memory	32GB	64GB	
3G	Y	N	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
121	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
Flexible	Y	N	Neither
Price	1500-2200	1800-2500	Option A
Warrantee	2year	1year	or
3G	N	Y	Option B
Battery	10hour	8hour	
Memory	64GB	32GB	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
122	Option A	Option B	Option C
3G	N	Y	
Flexible	N	Y	Neither
Price	1500-2200	1800-2500	Option A
Memory	64GB	32GB	or
Battery	8hour	10hour	Option B
Warrantee	2year	1year	
Camera	3-Megapixel	5-Megapixel	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
123	Option A	Option B	Option C
Price	1500-2200	1800-2500	
RAM	1GB	500MB	Neither
3G	N	Y	Option A
Flexible	Y	N	or
Camera	3-Megapixel	5-Megapixel	Option B
Battery	8hour	10hour	
Warrantee	2year	1year	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
124	Option A	Option B	Option C
Memory	32GB	64GB	
Battery	10hour	8hour	Neither
3G	N	Y	Option A
Flexible	N	Y	or
Price	1500-2200	1800-2500	Option B
RAM	500MB	1GB	
Warrantee	2year	1year	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
125	Option A	Option B	Option C
Battery	8hour	10hour	
Camera	5-Megapixel	3-Megapixel	Neither
RAM	1GB	500MB	Option A
Warrantee	1year	2year	or
Flexible	Y	N	Option B
Memory	64GB	32GB	
3G	N	Y	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
126	Option A	Option B	Option C
Warrantee	1year	2year	
Camera	5-Megapixel	3-Megapixel	Neither
Flexible	N	Y	Option A
RAM	500MB	1GB	or
3G	N	Y	Option B
Price	1500-2200	1800-2500	
Memory	64GB	32GB	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
127	Option A	Option B	Option C
3G	N	Y	Neither Option A or Option B
Price	1500-2200	1800-2500	
Memory	32GB	64GB	
Camera	5-Megapixel	3-Megapixel	
Battery	10hour	8hour	
Flexible	Y	N	
Warrantee	1year	2year	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
128	Option A	Option B	Option C
Price	1500-2200	1800-2500	Neither Option A or Option B
Flexible	N	Y	
Warrantee	1year	2year	
RAM	1GB	500MB	
Memory	32GB	64GB	
3G	N	Y	
Battery	8hour	10hour	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

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Gender : Female ◯ Campus : FICT ◯
Male ◯ FES ◯

Survey form			
1	Option A	Option B	Option C
Flexible	Y	N	
Memory	64GB	32GB	Neither
Warrantee	2year	1year	Option A
3G	Y	N	or
Price	1500-2200	1800-2500	Option B
Camera	5-Megapixel	3-Megapixel	
Battery	10hour	8hour	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
2	Option A	Option B	Option C
Price	1500-2200	1800-2500	
3G	Y	N	Neither
Flexible	Y	N	Option A
Camera	3-Megapixel	5-Megapixel	or
Memory	64GB	32GB	Option B
Warrantee	2year	1year	
Battery	10hour	8hour	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
3	Option A	Option B	Option C
Flexible	N	Y	
Price	1500-2200	1800-2500	Neither
RAM	1GB	500MB	Option A
Battery	8hour	10hour	or
Memory	64GB	32GB	Option B
Camera	5-Megapixel	3-Megapixel	
3G	Y	N	
Warrantee	2year	1year	
Choice	◯	◯	◯

Survey form			
4	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Warrantee	2year	1year	Neither
Memory	64GB	32GB	Option A
Flexible	N	Y	or
Camera	3-Megapixel	5-Megapixel	Option B
Battery	8hour	10hour	
3G	Y	N	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
5	Option A	Option B	Option C
Battery	10hour	8hour	
Memory	32GB	64GB	Neither
Price	1500-2200	1800-2500	Option A
Camera	5-Megapixel	3-Megapixel	or
Warrantee	1year	2year	Option B
RAM	1GB	500MB	
Flexible	Y	N	
3G	Y	N	
Choice	○	○	○

Survey form			
6	Option A	Option B	Option C
RAM	500MB	1GB	
Warrantee	1year	2year	Neither
Memory	32GB	64GB	Option A
Price	1500-2200	1800-2500	or
Flexible	Y	N	Option B
Camera	3-Megapixel	5-Megapixel	
Battery	10hour	8hour	
3G	Y	N	
Choice	○	○	○

Survey form			
7	Option A	Option B	Option C
Memory	32GB	64GB	
Warrantee	1year	2year	Neither
3G	Y	N	Option A
Camera	5-Megapixel	3-Megapixel	or
Battery	8hour	10hour	Option B
Flexible	N	Y	
RAM	1GB	500MB	
Price	1500-2200	1800-2500	
Choice	○	○	○

Survey form			
8	Option A	Option B	Option C
Warrantee	1year	2year	
RAM	500MB	1GB	Neither
Price	1500-2200	1800-2500	Option A
Camera	3-Megapixel	5-Megapixel	or
Flexible	N	Y	Option B
Battery	8hour	10hour	
3G	Y	N	
Memory	32GB	64GB	
Choice	○	○	○

Survey form			
9	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Warrantee	2year	1year	Neither
3G	N	Y	Option A
Memory	32GB	64GB	or
Flexible	Y	N	Option B
RAM	500MB	1GB	
Price	1500-2200	1800-2500	
Battery	8hour	10hour	
Choice	○	○	○

Survey form			
10	Option A	Option B	Option C
Flexible	Y	N	
Memory	32GB	64GB	Neither
Camera	3-Megapixel	5-Megapixel	Option A
3G	N	Y	or
Battery	8hour	10hour	Option B
RAM	1GB	500MB	
Warrantee	2year	1year	
Price	1500-2200	1800-2500	
Choice	○	○	○

Survey form			
11	Option A	Option B	Option C
Warrantee	2year	1year	
Camera	5-Megapixel	3-Megapixel	Neither
Price	1500-2200	1800-2500	Option A
Flexible	N	Y	or
RAM	500MB	1GB	Option B
3G	N	Y	
Battery	10hour	8hour	
Memory	32GB	64GB	
Choice	○	○	○

Survey form			
12	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
Price	1500-2200	1800-2500	Neither
Memory	32GB	64GB	Option A
Flexible	N	Y	or
Battery	10hour	8hour	Option B
RAM	1GB	500MB	
3G	N	Y	
Warrantee	2year	1year	
Choice	○	○	○

Survey form			
13	Option A	Option B	Option C
Memory	64GB	32GB	
3G	N	Y	Neither
RAM	500MB	1GB	Option A
Camera	5-Megapixel	3-Megapixel	or
Warrantee	1year	2year	Option B
Flexible	Y	N	
Price	1500-2200	1800-2500	
Battery	8hour	10hour	
Choice	○	○	○

Survey form			
14	Option A	Option B	Option C
Battery	8hour	10hour	
Camera	3-Megapixel	5-Megapixel	Neither
3G	N	Y	Option A
Price	1500-2200	1800-2500	or
RAM	1GB	500MB	Option B
Memory	64GB	32GB	
Flexible	Y	N	
Warrantee	1year	2year	
Choice	○	○	○

Survey form			
15	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Camera	5-Megapixel	3-Megapixel	Neither
Memory	64GB	32GB	Option A
3G	N	Y	or
Flexible	N	Y	Option B
RAM	500MB	1GB	
Battery	10hour	8hour	
Warrantee	1year	2year	
Choice	○	○	○

Survey form			
16	Option A	Option B	Option C
Flexible	N	Y	
Warrantee	1year	2year	Neither
3G	N	Y	Option A
Camera	3-Megapixel	5-Megapixel	or
Battery	10hour	8hour	Option B
Memory	64GB	32GB	
Price	1500-2200	1800-2500	
RAM	1GB	500MB	
Choice	○	○	○

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Gender : Female ◯ Campus : FICT ◯
Male ◯ FES ◯

Survey form			
17	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Battery	10hour	8hour	Neither
Price	1500-2200	1800-2500	Option A
Memory	32GB	64GB	or
3G	Y	N	Option B
Flexible	Y	N	
Warrantee	2year	1year	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
18	Option A	Option B	Option C
RAM	1GB	500MB	
Battery	10hour	8hour	Neither
3G	Y	N	Option A
Warrantee	2year	1year	or
Memory	32GB	64GB	Option B
Camera	3-Megapixel	5-Megapixel	
Price	1500-2200	1800-2500	
Flexible	Y	N	
Choice	◯	◯	◯

Survey form			
19	Option A	Option B	Option C
Memory	32GB	64GB	
Warrantee	2year	1year	Neither
3G	Y	N	Option A
Camera	5-Megapixel	3-Megapixel	or
Price	1500-2200	1800-2500	Option B
RAM	500MB	1GB	
Flexible	N	Y	
Battery	8hour	10hour	
Choice	◯	◯	◯

Survey form			
20	Option A	Option B	Option C
Battery	8hour	10hour	
Flexible	N	Y	Neither
Warrantee	2year	1year	Option A
RAM	1GB	500MB	or
3G	Y	N	Option B
Memory	32GB	64GB	
Camera	3-Megapixel	5-Megapixel	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
21	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Battery	10hour	8hour	Neither
Warrantee	1year	2year	Option A
Flexible	Y	N	or
3G	Y	N	Option B
RAM	500MB	1GB	
Price	1500-2200	1800-2500	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
22	Option A	Option B	Option C
3G	Y	N	
Camera	3-Megapixel	5-Megapixel	Neither
RAM	1GB	500MB	Option A
Memory	64GB	32GB	or
Battery	10hour	8hour	Option B
Flexible	Y	N	
Price	1500-2200	1800-2500	
Warrantee	1year	2year	
Choice	◯	◯	◯

Survey form			
23	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Battery	8hour	10hour	Neither
3G	Y	N	Option A
Memory	64GB	32GB	or
Flexible	N	Y	Option B
Warrantee	1year	2year	
Price	1500-2200	1800-2500	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
24	Option A	Option B	Option C
3G	Y	N	
Flexible	N	Y	Neither
Battery	8hour	10hour	Option A
Camera	3-Megapixel	5-Megapixel	or
Warrantee	1year	2year	Option B
RAM	1GB	500MB	
Memory	64GB	32GB	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
25	Option A	Option B	Option C
Flexible	Y	N	
Price	1500-2200	1800-2500	Neither
Memory	64GB	32GB	Option A
Camera	5-Megapixel	3-Megapixel	or
Warrantee	2year	1year	Option B
RAM	1GB	500MB	
3G	N	Y	
Battery	8hour	10hour	
Choice	◯	◯	◯

Survey form			
26	Option A	Option B	Option C
3G	N	Y	
Price	1500-2200	1800-2500	Neither
Camera	3-Megapixel	5-Megapixel	Option A
Memory	64GB	32GB	or
RAM	500MB	1GB	Option B
Battery	8hour	10hour	
Flexible	Y	N	
Warrantee	2year	1year	
Choice	◯	◯	◯

Survey form			
27	Option A	Option B	Option C
Warrantee	2year	1year	
Memory	64GB	32GB	Neither
Camera	5-Megapixel	3-Megapixel	Option A
RAM	1GB	500MB	or
Price	1500-2200	1800-2500	Option B
3G	N	Y	
Battery	10hour	8hour	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
28	Option A	Option B	Option C
Memory	64GB	32GB	
Price	1500-2200	1800-2500	Neither
Warrantee	2year	1year	Option A
Flexible	N	Y	or
Camera	3-Megapixel	5-Megapixel	Option B
Battery	10hour	8hour	
RAM	500MB	1GB	
3G	N	Y	
Choice	◯	◯	◯

Survey form			
29	Option A	Option B	Option C
Memory	32GB	64GB	
RAM	1GB	500MB	Neither
Warrantee	1year	2year	Option A
Battery	8hour	10hour	or
Flexible	Y	N	Option B
3G	N	Y	
Price	1500-2200	1800-2500	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
30	Option A	Option B	Option C
RAM	500MB	1GB	
Memory	32GB	64GB	Neither
Warrantee	1year	2year	Option A
Camera	3-Megapixel	5-Megapixel	or
Price	1500-2200	1800-2500	Option B
Battery	8hour	10hour	
Flexible	Y	N	
3G	N	Y	
Choice	◯	◯	◯

Survey form			
31	Option A	Option B	Option C
3G	N	Y	Neither Option A or Option B
RAM	1GB	500MB	
Warrantee	1year	2year	
Battery	10hour	8hour	
Camera	5-Megapixel	3-Megapixel	
Price	1500-2200	1800-2500	
Flexible	N	Y	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
32	Option A	Option B	Option C
Price	1500-2200	1800-2500	Neither Option A or Option B
Memory	32GB	64GB	
Battery	10hour	8hour	
3G	N	Y	
RAM	500MB	1GB	
Camera	3-Megapixel	5-Megapixel	
Flexible	N	Y	
Warrantee	1year	2year	
Choice	◯	◯	◯

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Ram	The form of integrated circuits that allows stored data to be accessed in any order with a worst case performance of constant time.

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Gender : Female ◯ Campus : FICT ◯
Male ◯ FES ◯

Survey form			
33	Option A	Option B	Option C
3G	Y	N	
Battery	8hour	10hour	Neither
Memory	64GB	32GB	Option A
Warrantee	2year	1year	or
RAM	500MB	1GB	Option B
Camera	5-Megapixel	3-Megapixel	
Flexible	Y	N	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
34	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Camera	3-Megapixel	5-Megapixel	Neither
Flexible	Y	N	Option A
Warrantee	2year	1year	or
3G	Y	N	Option B
RAM	1GB	500MB	
Memory	64GB	32GB	
Battery	8hour	10hour	
Choice	◯	◯	◯

Survey form			
35	Option A	Option B	Option C
Battery	10hour	8hour	
RAM	500MB	1GB	Neither
Warrantee	2year	1year	Option A
Camera	5-Megapixel	3-Megapixel	or
Price	1500-2200	1800-2500	Option B
3G	Y	N	
Flexible	N	Y	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
36	Option A	Option B	Option C
Memory	64GB	32GB	
Battery	10hour	8hour	Neither
RAM	1GB	500MB	Option A
Warrantee	2year	1year	or
Flexible	N	Y	Option B
Camera	3-Megapixel	5-Megapixel	
3G	Y	N	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
37	Option A	Option B	Option C
Price	1500-2200	1800-2500	
RAM	500MB	1GB	Neither
Camera	5-Megapixel	3-Megapixel	Option A
Warrantee	1year	2year	or
Memory	32GB	64GB	Option B
3G	Y	N	
Flexible	Y	N	
Battery	8hour	10hour	
Choice	◯	◯	◯

Survey form			
38	Option A	Option B	Option C
Warrantee	1year	2year	
RAM	1GB	500MB	Neither
Battery	8hour	10hour	Option A
Camera	3-Megapixel	5-Megapixel	or
Price	1500-2200	1800-2500	Option B
Flexible	Y	N	
3G	Y	N	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
39	Option A	Option B	Option C
RAM	500MB	1GB	
Battery	10hour	8hour	Neither
Flexible	N	Y	Option A
3G	Y	N	or
Price	1500-2200	1800-2500	Option B
Warrantee	1year	2year	
Memory	32GB	64GB	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
40	Option A	Option B	Option C
Price	1500-2200	1800-2500	
3G	Y	N	Neither
Memory	32GB	64GB	Option A
Warrantee	1year	2year	or
RAM	1GB	500MB	Option B
Camera	3-Megapixel	5-Megapixel	
Flexible	N	Y	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
41	Option A	Option B	Option C
Flexible	Y	N	
3G	N	Y	Neither
Camera	5-Megapixel	3-Megapixel	Option A
Memory	32GB	64GB	or
Price	1500-2200	1800-2500	Option B
RAM	1GB	500MB	
Warrantee	2year	1year	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
42	Option A	Option B	Option C
Battery	10hour	8hour	
Warrantee	2year	1year	Neither
3G	N	Y	Option A
Memory	32GB	64GB	or
Flexible	Y	N	Option B
RAM	500MB	1GB	
Camera	3-Megapixel	5-Megapixel	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
43	Option A	Option B	Option C
Battery	8hour	10hour	
3G	N	Y	Neither
Warrantee	2year	1year	Option A
Memory	32GB	64GB	or
Camera	5-Megapixel	3-Megapixel	Option B
Price	1500-2200	1800-2500	
RAM	1GB	500MB	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
44	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
Warrantee	2year	1year	Neither
Price	1500-2200	1800-2500	Option A
3G	N	Y	or
Memory	32GB	64GB	Option B
Flexible	N	Y	
RAM	500MB	1GB	
Battery	8hour	10hour	
Choice	◯	◯	◯

Survey form			
45	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Camera	5-Megapixel	3-Megapixel	Neither
Flexible	Y	N	Option A
3G	N	Y	or
Warrantee	1year	2year	Option B
Battery	10hour	8hour	
Memory	64GB	32GB	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
46	Option A	Option B	Option C
3G	N	Y	
Flexible	Y	N	Neither
Camera	3-Megapixel	5-Megapixel	Option A
Warrantee	1year	2year	or
Price	1500-2200	1800-2500	Option B
RAM	500MB	1GB	
Memory	64GB	32GB	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
47	Option A	Option B	Option C
RAM	1GB	500MB	
Camera	5-Megapixel	3-Megapixel	Neither
Memory	64GB	32GB	Option A
3G	N	Y	or
Battery	8hour	10hour	Option B
Flexible	N	Y	
Price	1500-2200	1800-2500	
Warrantee	1year	2year	
Choice	○	○	○

Survey form			
48	Option A	Option B	Option C
RAM	500MB	1GB	
Battery	8hour	10hour	Neither
Flexible	N	Y	Option A
Memory	64GB	32GB	or
Price	1500-2200	1800-2500	Option B
Camera	3-Megapixel	5-Megapixel	
Warrantee	1year	2year	
3G	N	Y	
Choice	○	○	○

Survey Form

Tablet Computer is a mobile computer which is larger than a hand-phone and is integrated with a flat touch screen. It is primarily operated by touching the screen rather than using a physical key board. Nowadays, tablet computers are a popular source of entertainment as the user can surf the internet, play games, take pictures, play music, watch movies, etc. Besides that, the table computer is thin and light making it very easy to carry. In the corporate world, professionals can use the table computer to present proposals to their client.

In this survey form, we will identify the preferences of university students on several features of a Tablet Computer. For each feature, students will be given two choices, Option A and Option B and they are to state their preference. However, they may choose neither Option A nor Option B if they dislike both.

The following information are key features of the tablet computer.

Price	The unit price of a tablet computer.
3G	An additional place to put a sim card.
Warrantee	An assurance by the seller of property that the goods are as epresented or will be as promised.
Memory	The size of built-in storage.
Flexible	Can run other applications of other softwares.
Battery	The duration that the battery of a tablet computer can last before it needs to be recharged.
Camera	The quality of the picture.
Ram	The form of integrated circuits that allows stored data to be accessed in any order with a worst case performance of constant time.

The following information are the 17 different choice sets for the features of Tablet Computer. Please choose your preferred option for each feature.

Gender : Female ◯ Campus : FICT ◯

Male ◯ FES ◯

Survey form			
49	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Warrantee	2year	1year	Neither
RAM	1GB	500MB	Option A
3G	Y	N	or
Battery	8hour	10hour	Option B
Price	1500-2200	1800-2500	
Flexible	Y	N	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
50	Option A	Option B	Option C
Flexible	Y	N	
Price	1500-2200	1800-2500	Neither
Memory	32GB	64GB	Option A
Battery	8hour	10hour	or
Camera	3-Megapixel	5-Megapixel	Option B
3G	Y	N	
Warrantee	2year	1year	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
51	Option A	Option B	Option C
RAM	1GB	500MB	
3G	Y	N	Neither
Price	1500-2200	1800-2500	Option A
Memory	32GB	64GB	or
Flexible	N	Y	Option B
Warrantee	2year	1year	
Battery	10hour	8hour	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
52	Option A	Option B	Option C
Flexible	N	Y	
RAM	500MB	1GB	Neither
Battery	10hour	8hour	Option A
Price	1500-2200	1800-2500	or
Camera	3-Megapixel	5-Megapixel	Option B
Warrantee	2year	1year	
Memory	32GB	64GB	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
53	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Flexible	Y	N	Neither
RAM	1GB	500MB	Option A
Warrantee	1year	2year	or
Memory	64GB	32GB	Option B
Battery	8hour	10hour	
3G	Y	N	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
54	Option A	Option B	Option C
Flexible	Y	N	
Camera	3-Megapixel	5-Megapixel	Neither
Warrantee	1year	2year	Option A
Battery	8hour	10hour	or
RAM	500MB	1GB	Option B
Price	1500-2200	1800-2500	
Memory	64GB	32GB	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
55	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Battery	10hour	8hour	Neither
Memory	64GB	32GB	Option A
RAM	1GB	500MB	or
Flexible	N	Y	Option B
3G	Y	N	
Warrantee	1year	2year	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
56	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
Battery	10hour	8hour	Neither
RAM	500MB	1GB	Option A
Memory	64GB	32GB	or
Flexible	N	Y	Option B
Price	1500-2200	1800-2500	
Warrantee	1year	2year	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
57	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Warrantee	2year	1year	Neither
Flexible	Y	N	Option A
3G	N	Y	or
RAM	500MB	1GB	Option B
Camera	5-Megapixel	3-Megapixel	
Memory	64GB	32GB	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
58	Option A	Option B	Option C
Memory	64GB	32GB	
Battery	10hour	8hour	Neither
RAM	1GB	500MB	Option A
Flexible	Y	N	or
Camera	3-Megapixel	5-Megapixel	Option B
Price	1500-2200	1800-2500	
3G	N	Y	
Warrantee	2year	1year	
Choice	◯	◯	◯

Survey form			
59	Option A	Option B	Option C
Battery	8hour	10hour	
3G	N	Y	Neither
Price	1500-2200	1800-2500	Option A
Memory	64GB	32GB	or
Flexible	N	Y	Option B
RAM	500MB	1GB	
Camera	5-Megapixel	3-Megapixel	
Warrantee	2year	1year	
Choice	◯	◯	◯

Survey form			
60	Option A	Option B	Option C
RAM	1GB	500MB	
Memory	64GB	32GB	Neither
Price	1500-2200	1800-2500	Option A
Battery	8hour	10hour	or
Warrantee	2year	1year	Option B
3G	N	Y	
Flexible	N	Y	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
61	Option A	Option B	Option C
Memory	32GB	64GB	
Camera	5-Megapixel	3-Megapixel	Neither
Warrantee	1year	2year	Option A
Flexible	Y	N	or
Battery	10hour	8hour	Option B
3G	N	Y	
RAM	500MB	1GB	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
62	Option A	Option B	Option C
Warrantee	1year	2year	
Flexible	Y	N	Neither
RAM	1GB	500MB	Option A
Price	1500-2200	1800-2500	or
Camera	3-Megapixel	5-Megapixel	Option B
Battery	10hour	8hour	
3G	N	Y	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
63	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Warrantee	1year	2year	Neither
Price	1500-2200	1800-2500	Option A
3G	N	Y	or
Battery	8hour	10hour	Option B
RAM	500MB	1GB	
Memory	32GB	64GB	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
64	Option A	Option B	Option C
Memory	32GB	64GB	
Battery	8hour	10hour	Neither
3G	N	Y	Option A
Warrantee	1year	2year	or
Camera	3-Megapixel	5-Megapixel	Option B
Flexible	N	Y	
Price	1500-2200	1800-2500	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey Form

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Memory	The size of built-in storage.
Flexible	Can run other applications of other softwares.
Battery	The duration that the battery of a tablet computer can last before it needs to be recharged.
Camera	The quality of the picture.
Ram	The form of integrated circuits that allows stored data to be accessed in any order with a worst case performance of constant time.

The following information are the 17 different choice sets for the features of Tablet Computer. Please choose your preferred option for each feature.

Gender : Female ◯ Campus : FICT ◯
Male ◯ FES ◯

Survey form			
65	Option A	Option B	Option C
Flexible	Y	N	
Warrantee	2year	1year	Neither
Price	1500-2200	1800-2500	Option A
Memory	64GB	32GB	or
Camera	5-Megapixel	3-Megapixel	Option B
Battery	10hour	8hour	
RAM	500MB	1GB	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
66	Option A	Option B	Option C
Battery	10hour	8hour	
Camera	3-Megapixel	5-Megapixel	Neither
Warrantee	2year	1year	Option A
Memory	64GB	32GB	or
Flexible	Y	N	Option B
3G	Y	N	
Price	1500-2200	1800-2500	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
67	Option A	Option B	Option C
RAM	500MB	1GB	
Memory	64GB	32GB	Neither
Battery	8hour	10hour	Option A
Price	1500-2200	1800-2500	or
Camera	5-Megapixel	3-Megapixel	Option B
Warrantee	2year	1year	
Flexible	N	Y	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
68	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
3G	Y	N	Neither
RAM	1GB	500MB	Option A
Memory	64GB	32GB	or
Price	1500-2200	1800-2500	Option B
Warrantee	2year	1year	
Battery	8hour	10hour	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
69	Option A	Option B	Option C
Warrantee	1year	2year	
Battery	10hour	8hour	Neither
Price	1500-2200	1800-2500	Option A
Flexible	Y	N	or
3G	Y	N	Option B
RAM	500MB	1GB	
Camera	5-Megapixel	3-Megapixel	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
70	Option A	Option B	Option C
Flexible	Y	N	
Battery	10hour	8hour	Neither
RAM	1GB	500MB	Option A
Warrantee	1year	2year	or
3G	Y	N	Option B
Camera	3-Megapixel	5-Megapixel	
Memory	32GB	64GB	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
71	Option A	Option B	Option C
Warrantee	1year	2year	
Flexible	N	Y	Neither
Memory	32GB	64GB	Option A
Price	1500-2200	1800-2500	or
Battery	8hour	10hour	Option B
RAM	500MB	1GB	
3G	Y	N	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
72	Option A	Option B	Option C
RAM	1GB	500MB	
Warrantee	1year	2year	Neither
Battery	8hour	10hour	Option A
3G	Y	N	or
Camera	3-Megapixel	5-Megapixel	Option B
Flexible	N	Y	
Price	1500-2200	1800-2500	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
73	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Memory	32GB	64GB	Neither
Flexible	Y	N	Option A
3G	N	Y	or
Warrantee	2year	1year	Option B
Battery	8hour	10hour	
Price	1500-2200	1800-2500	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
74	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
Flexible	Y	N	Neither
RAM	500MB	1GB	Option A
Battery	8hour	10hour	or
Warrantee	2year	1year	Option B
3G	N	Y	
Price	1500-2200	1800-2500	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
75	Option A	Option B	Option C
RAM	1GB	500MB	
Camera	5-Megapixel	3-Megapixel	Neither
Flexible	N	Y	Option A
Memory	32GB	64GB	or
Warrantee	2year	1year	Option B
Battery	10hour	8hour	
3G	N	Y	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
76	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
Battery	10hour	8hour	Neither
Price	1500-2200	1800-2500	Option A
Warrantee	2year	1year	or
RAM	500MB	1GB	Option B
Flexible	N	Y	
3G	N	Y	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
77	Option A	Option B	Option C
RAM	1GB	500MB	
Camera	5-Megapixel	3-Megapixel	Neither
Memory	64GB	32GB	Option A
Flexible	Y	N	or
3G	N	Y	Option B
Price	1500-2200	1800-2500	
Battery	8hour	10hour	
Warrantee	1year	2year	
Choice	◯	◯	◯

Survey form			
78	Option A	Option B	Option C
RAM	500MB	1GB	
Price	1500-2200	1800-2500	Neither
Camera	3-Megapixel	5-Megapixel	Option A
Flexible	Y	N	or
Warrantee	1year	2year	Option B
Battery	8hour	10hour	
3G	N	Y	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
79	Option A	Option B	Option C
Battery	10hour	8hour	
Price	1500-2200	1800-2500	Neither
Flexible	N	Y	Option A
Memory	64GB	32GB	or
Warrantee	1year	2year	Option B
RAM	1GB	500MB	
3G	N	Y	
Camera	5-Megapixel	3-Megapixel	
Choice	○	○	○

Survey form			
80	Option A	Option B	Option C
RAM	500MB	1GB	
Camera	3-Megapixel	5-Megapixel	Neither
Price	1500-2200	1800-2500	Option A
Warrantee	1year	2year	or
3G	N	Y	Option B
Flexible	N	Y	
Memory	64GB	32GB	
Battery	10hour	8hour	
Choice	○	○	○

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Battery	The duration that the battery of a tablet computer can last before it needs to be recharged.
Camera	The quality of the picture.
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The following information are the 17 different choice sets for the features of Tablet Computer. Please choose your preferred option for each feature.

Gender : Female ◯ Campus : FICT ◯

Male ◯ FES ◯

Survey form			
81	Option A	Option B	Option C
RAM	1GB	500MB	
3G	Y	N	Neither
Warrantee	2year	1year	Option A
Price	1500-2200	1800-2500	or
Memory	32GB	64GB	Option B
Battery	10hour	8hour	
Camera	5-Megapixel	3-Megapixel	
Flexible	Y	N	
Choice	◯	◯	◯

Survey form			
82	Option A	Option B	Option C
Flexible	Y	N	
Price	1500-2200	1800-2500	Neither
3G	Y	N	Option A
Battery	10hour	8hour	or
Camera	3-Megapixel	5-Megapixel	Option B
Memory	32GB	64GB	
RAM	500MB	1GB	
Warrantee	2year	1year	
Choice	◯	◯	◯

Survey form			
83	Option A	Option B	Option C
Warrantee	2year	1year	
Memory	32GB	64GB	Neither
Price	1500-2200	1800-2500	Option A
3G	Y	N	or
Camera	5-Megapixel	3-Megapixel	Option B
Flexible	N	Y	
Battery	8hour	10hour	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
84	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Memory	32GB	64GB	Neither
Battery	8hour	10hour	Option A
RAM	500MB	1GB	or
Camera	3-Megapixel	5-Megapixel	Option B
3G	Y	N	
Warrantee	2year	1year	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
85	Option A	Option B	Option C
Battery	10hour	8hour	
Price	1500-2200	1800-2500	Neither
3G	Y	N	Option A
Flexible	Y	N	or
Camera	5-Megapixel	3-Megapixel	Option B
Memory	64GB	32GB	
Warrantee	1year	2year	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
86	Option A	Option B	Option C
Battery	10hour	8hour	
RAM	500MB	1GB	Neither
Price	1500-2200	1800-2500	Option A
3G	Y	N	or
Flexible	Y	N	Option B
Memory	64GB	32GB	
Camera	3-Megapixel	5-Megapixel	
Warrantee	1year	2year	
Choice	◯	◯	◯

Survey form			
87	Option A	Option B	Option C
Warrantee	1year	2year	
Camera	5-Megapixel	3-Megapixel	Neither
Flexible	N	Y	Option A
Price	1500-2200	1800-2500	or
Battery	8hour	10hour	Option B
Memory	64GB	32GB	
RAM	1GB	500MB	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
88	Option A	Option B	Option C
Battery	8hour	10hour	
Flexible	N	Y	Neither
Price	1500-2200	1800-2500	Option A
Memory	64GB	32GB	or
RAM	500MB	1GB	Option B
3G	Y	N	
Camera	3-Megapixel	5-Megapixel	
Warrantee	1year	2year	
Choice	◯	◯	◯

Survey form			
89	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Battery	8hour	10hour	Neither
3G	N	Y	Option A
RAM	500MB	1GB	or
Flexible	Y	N	Option B
Warrantee	2year	1year	
Price	1500-2200	1800-2500	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
90	Option A	Option B	Option C
3G	N	Y	
Camera	3-Megapixel	5-Megapixel	Neither
Memory	64GB	32GB	Option A
Flexible	Y	N	or
Battery	8hour	10hour	Option B
RAM	1GB	500MB	
Warrantee	2year	1year	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
91	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Warrantee	2year	1year	Neither
Flexible	N	Y	Option A
Battery	10hour	8hour	or
RAM	500MB	1GB	Option B
3G	N	Y	
Price	1500-2200	1800-2500	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
92	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Battery	10hour	8hour	Neither
Flexible	N	Y	Option A
3G	N	Y	or
Warrantee	2year	1year	Option B
Memory	64GB	32GB	
Camera	3-Megapixel	5-Megapixel	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
93	Option A	Option B	Option C
Flexible	Y	N	
Memory	32GB	64GB	Neither
3G	N	Y	Option A
Camera	5-Megapixel	3-Megapixel	or
Price	1500-2200	1800-2500	Option B
Battery	8hour	10hour	
Warrantee	1year	2year	
RAM	500MB	1GB	
Choice	◯	◯	◯

Survey form			
94	Option A	Option B	Option C
3G	N	Y	
Battery	8hour	10hour	Neither
Flexible	Y	N	Option A
Price	1500-2200	1800-2500	or
RAM	1GB	500MB	Option B
Camera	3-Megapixel	5-Megapixel	
Warrantee	1year	2year	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
95	Option A	Option B	Option C
RAM	500MB	1GB	
Camera	5-Megapixel	3-Megapixel	Neither
Battery	10hour	8hour	Option A
Warrantee	1year	2year	or
3G	N	Y	Option B
Flexible	N	Y	
Price	1500-2200	1800-2500	
Memory	32GB	64GB	
Choice	○	○	○

Survey form			
96	Option A	Option B	Option C
RAM	1GB	500MB	
Warrantee	1year	2year	Neither
3G	N	Y	Option A
Price	1500-2200	1800-2500	or
Battery	10hour	8hour	Option B
Flexible	N	Y	
Memory	32GB	64GB	
Camera	3-Megapixel	5-Megapixel	
Choice	○	○	○

Survey Form

Tablet Computer is a mobile computer which is larger than a hand-phone and is integrated with a flat touch screen. It is primarily operated by touching the screen rather than using a physical key board. Nowadays, tablet computers are a popular source of entertainment as the user can surf the internet, play games, take pictures, play music, watch movies, etc. Besides that, the table computer is thin and light making it very easy to carry. In the corporate world, professionals can use the table computer to present proposals to their client.

In this survey form, we will identify the preferences of university students on several features of a Tablet Computer. For each feature, students will be given two choices, Option A and Option B and they are to state their preference. However, they may choose neither Option A nor Option B if they dislike both.

The following information are key features of the tablet computer.

Price	The unit price of a tablet computer.
3G	An additional place to put a sim card.
Warrantee	An assurance by the seller of property that the goods are as epresented or will be as promised.
Memory	The size of built-in storage.
Flexible	Can run other applications of other softwares.
Battery	The duration that the battery of a tablet computer can last before it needs to be recharged.
Camera	The quality of the picture.
Ram	The form of integrated circuits that allows stored data to be accessed in any order with a worst case performance of constant time.

The following information are the 17 different choice sets for the features of Tablet Computer. Please choose your preferred option for each feature.

Gender : Female ◯ Campus : FICT ◯
Male ◯ FES ◯

Survey form			
97	Option A	Option B	Option C
3G	Y	N	
Camera	5-Megapixel	3-Megapixel	Neither
Price	1500-2200	1800-2500	Option A
Battery	8hour	10hour	or
Warrantee	2year	1year	Option B
Memory	64GB	32GB	
Flexible	Y	N	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
98	Option A	Option B	Option C
Battery	8hour	10hour	
Camera	3-Megapixel	5-Megapixel	Neither
Price	1500-2200	1800-2500	Option A
Memory	64GB	32GB	or
3G	Y	N	Option B
Flexible	Y	N	
RAM	500MB	1GB	
Warrantee	2year	1year	
Choice	◯	◯	◯

Survey form			
99	Option A	Option B	Option C
Warrantee	2year	1year	
Price	1500-2200	1800-2500	Neither
3G	Y	N	Option A
Memory	64GB	32GB	or
Flexible	N	Y	Option B
Camera	5-Megapixel	3-Megapixel	
Battery	10hour	8hour	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
100	Option A	Option B	Option C
Flexible	N	Y	
Battery	10hour	8hour	Neither
Camera	3-Megapixel	5-Megapixel	Option A
3G	Y	N	or
Warrantee	2year	1year	Option B
Price	1500-2200	1800-2500	
RAM	500MB	1GB	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
101	Option A	Option B	Option C
Battery	8hour	10hour	
Memory	32GB	64GB	Neither
Camera	5-Megapixel	3-Megapixel	Option A
Warrantee	1year	2year	or
RAM	1GB	500MB	Option B
Flexible	Y	N	
3G	Y	N	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
102	Option A	Option B	Option C
Memory	32GB	64GB	
Warrantee	1year	2year	Neither
Flexible	Y	N	Option A
RAM	500MB	1GB	or
Battery	8hour	10hour	Option B
3G	Y	N	
Price	1500-2200	1800-2500	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
103	Option A	Option B	Option C
RAM	1GB	500MB	
Battery	10hour	8hour	Neither
Warrantee	1year	2year	Option A
3G	Y	N	or
Price	1500-2200	1800-2500	Option B
Camera	5-Megapixel	3-Megapixel	
Memory	32GB	64GB	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
104	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Warrantee	1year	2year	Neither
RAM	500MB	1GB	Option A
3G	Y	N	or
Battery	10hour	8hour	Option B
Flexible	N	Y	
Camera	3-Megapixel	5-Megapixel	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
105	Option A	Option B	Option C
Price	1500-2200	1800-2500	
RAM	500MB	1GB	Neither
Camera	5-Megapixel	3-Megapixel	Option A
Battery	10hour	8hour	or
Memory	32GB	64GB	Option B
Warrantee	2year	1year	
Flexible	Y	N	
3G	N	Y	
Choice	◯	◯	◯

Survey form			
106	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
Flexible	Y	N	Neither
3G	N	Y	Option A
Warrantee	2year	1year	or
Battery	10hour	8hour	Option B
Price	1500-2200	1800-2500	
RAM	1GB	500MB	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
107	Option A	Option B	Option C
RAM	500MB	1GB	
Memory	32GB	64GB	Neither
Warrantee	2year	1year	Option A
Price	1500-2200	1800-2500	or
Camera	5-Megapixel	3-Megapixel	Option B
3G	N	Y	
Battery	8hour	10hour	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
108	Option A	Option B	Option C
Price	1500-2200	1800-2500	
Memory	32GB	64GB	Neither
Warrantee	2year	1year	Option A
Camera	3-Megapixel	5-Megapixel	or
3G	N	Y	Option B
Battery	8hour	10hour	
Flexible	N	Y	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
109	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Price	1500-2200	1800-2500	Neither
3G	N	Y	Option A
Battery	10hour	8hour	or
RAM	500MB	1GB	Option B
Warrantee	1year	2year	
Memory	64GB	32GB	
Flexible	Y	N	
Choice	◯	◯	◯

Survey form			
110	Option A	Option B	Option C
Battery	10hour	8hour	
RAM	1GB	500MB	Neither
Memory	64GB	32GB	Option A
Camera	3-Megapixel	5-Megapixel	or
Warrantee	1year	2year	Option B
Flexible	Y	N	
Price	1500-2200	1800-2500	
3G	N	Y	
Choice	◯	◯	◯

Survey form			
111	Option A	Option B	Option C
RAM	500MB	1GB	
Memory	64GB	32GB	Neither
Warrantee	1year	2year	Option A
3G	N	Y	or
Camera	5-Megapixel	3-Megapixel	Option B
Flexible	N	Y	
Price	1500-2200	1800-2500	
Battery	8hour	10hour	
Choice	◯	◯	◯

Survey form			
112	Option A	Option B	Option C
Flexible	N	Y	
Memory	64GB	32GB	Neither
Battery	8hour	10hour	Option A
RAM	1GB	500MB	or
Price	1500-2200	1800-2500	Option B
3G	N	Y	
Warrantee	1year	2year	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

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Battery	The duration that the battery of a tablet computer can last before it needs to be recharged.
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Gender : Female ◯ Campus : FICT ◯
Male ◯ FES ◯

Survey form			
113	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Battery	8hour	10hour	Neither
Flexible	Y	N	Option A
Price	1500-2200	1800-2500	or
Warrantee	2year	1year	Option B
RAM	500MB	1GB	
3G	Y	N	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
114	Option A	Option B	Option C
Warrantee	2year	1year	
Price	1500-2200	1800-2500	Neither
3G	Y	N	Option A
Flexible	Y	N	or
Memory	32GB	64GB	Option B
RAM	1GB	500MB	
Battery	8hour	10hour	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
115	Option A	Option B	Option C
Camera	5-Megapixel	3-Megapixel	
Memory	32GB	64GB	Neither
Warrantee	2year	1year	Option A
Flexible	N	Y	or
Battery	10hour	8hour	Option B
RAM	500MB	1GB	
Price	1500-2200	1800-2500	
3G	Y	N	
Choice	◯	◯	◯

Survey form			
116	Option A	Option B	Option C
Warrantee	2year	1year	
Memory	32GB	64GB	Neither
Price	1500-2200	1800-2500	Option A
Battery	10hour	8hour	or
RAM	1GB	500MB	Option B
3G	Y	N	
Camera	3-Megapixel	5-Megapixel	
Flexible	N	Y	
Choice	◯	◯	◯

Survey form			
117	Option A	Option B	Option C
Warrantee	1year	2year	
RAM	500MB	1GB	Neither
Price	1500-2200	1800-2500	Option A
3G	Y	N	or
Memory	64GB	32GB	Option B
Flexible	Y	N	
Battery	8hour	10hour	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
118	Option A	Option B	Option C
Warrantee	1year	2year	
RAM	1GB	500MB	Neither
Memory	64GB	32GB	Option A
3G	Y	N	or
Price	1500-2200	1800-2500	Option B
Flexible	Y	N	
Battery	8hour	10hour	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
119	Option A	Option B	Option C
RAM	500MB	1GB	
Flexible	N	Y	Neither
Price	1500-2200	1800-2500	Option A
Camera	5-Megapixel	3-Megapixel	or
3G	Y	N	Option B
Battery	10hour	8hour	
Warrantee	1year	2year	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
120	Option A	Option B	Option C
3G	Y	N	
Memory	64GB	32GB	Neither
Price	1500-2200	1800-2500	Option A
Camera	3-Megapixel	5-Megapixel	or
Warrantee	1year	2year	Option B
Flexible	N	Y	
Battery	10hour	8hour	
RAM	1GB	500MB	
Choice	◯	◯	◯

Survey form			
121	Option A	Option B	Option C
Battery	10hour	8hour	
Price	1500-2200	1800-2500	Neither
RAM	1GB	500MB	Option A
3G	N	Y	or
Camera	5-Megapixel	3-Megapixel	Option B
Flexible	Y	N	
Warrantee	2year	1year	
Memory	64GB	32GB	
Choice	◯	◯	◯

Survey form			
122	Option A	Option B	Option C
Price	1500-2200	1800-2500	
3G	N	Y	Neither
Battery	10hour	8hour	Option A
RAM	500MB	1GB	or
Memory	64GB	32GB	Option B
Warrantee	2year	1year	
Flexible	Y	N	
Camera	3-Megapixel	5-Megapixel	
Choice	◯	◯	◯

Survey form			
123	Option A	Option B	Option C
Flexible	N	Y	
3G	N	Y	Neither
Battery	8hour	10hour	Option A
RAM	1GB	500MB	or
Memory	64GB	32GB	Option B
Warrantee	2year	1year	
Price	1500-2200	1800-2500	
Camera	5-Megapixel	3-Megapixel	
Choice	◯	◯	◯

Survey form			
124	Option A	Option B	Option C
Flexible	N	Y	
Battery	8hour	10hour	Neither
RAM	500MB	1GB	Option A
Memory	64GB	32GB	or
Camera	3-Megapixel	5-Megapixel	Option B
Warrantee	2year	1year	
3G	N	Y	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
125	Option A	Option B	Option C
Battery	10hour	8hour	
Price	1500-2200	1800-2500	Neither
Flexible	Y	N	Option A
Warrantee	1year	2year	or
3G	N	Y	Option B
RAM	1GB	500MB	
Camera	5-Megapixel	3-Megapixel	
Memory	32GB	64GB	
Choice	◯	◯	◯

Survey form			
126	Option A	Option B	Option C
Camera	3-Megapixel	5-Megapixel	
Memory	32GB	64GB	Neither
3G	N	Y	Option A
Warrantee	1year	2year	or
Price	1500-2200	1800-2500	Option B
Flexible	Y	N	
RAM	500MB	1GB	
Battery	10hour	8hour	
Choice	◯	◯	◯

Survey form			
127	Option A	Option B	Option C
Battery	8hour	10hour	
Flexible	N	Y	Neither
3G	N	Y	Option A
RAM	1GB	500MB	or
Memory	32GB	64GB	Option B
Warrantee	1year	2year	
Camera	5-Megapixel	3-Megapixel	
Price	1500-2200	1800-2500	
Choice	◯	◯	◯

Survey form			
128	Option A	Option B	Option C
Battery	8hour	10hour	
Flexible	N	Y	Neither
Memory	32GB	64GB	Option A
Warrantee	1year	2year	or
Price	1500-2200	1800-2500	Option B
RAM	500MB	1GB	
Camera	3-Megapixel	5-Megapixel	
3G	N	Y	
Choice	◯	◯	◯