

## **Factors Affecting on the Usage Pattern of Cloud Storage in Vadodara City of Gujarat**

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### **Abstract**

Cloud Computing is the trending topic in the field of research as well as in commercial environment. Currently there has been a focus on cloud storage and cloud security. Cloud computing model facilitates data backup, minimised cost, data centralization, free storage, data sharing capabilities and many more which leads to company's high performance. The purpose of this paper is to study the proportion of people's awareness on cloud storage, investigate the factors contributing to the usage of cloud storage, predicting the future scope of cloud storage usage using Multinomial Logistic Regression and to provide an overall security perspective of cloud computing and highlight the security concerns needed to be addressed. A survey based on questionnaire was used to gather data from determined sample size and some relevant hypothesis were derived and tested. Chi-square test for Multiple Response Analysis to study the data was done. Statistical Package for Social Sciences (SPSS) software and R- Programming was used for statistical analysis.

*Key words:* Cloud storage; Cloud security; Multinomial logistic regression; Multiple response analysis.

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### **1. Introduction**

In an era of information technology and globalisation, the great computing power is expected to develop business insights and competitive benefit. A customary way for enterprises to process their data is to use the computing power provided by their own in-house data centres. However, intervening a private data centre to keep up with rapidly growing data processing requests can be complicated and costly. Cloud computing vanishes the complexity of IT infrastructure to physically store data and manage huge data which is time consuming and demands huge man power. The challenge nowadays is to acquire, store and manage the data generating at every second. Cloud storage is the service model which not only maintains the data but also manages the data by storing the data on the internet via the cloud computing provider that operates and manages data storage as a service. It also provides anytime and anywhere data access facility. It assures to provide on-demand computing power with quick implementation, low maintenance, fewer IT staff, and consequently lower cost. Among the various definitions, the one by the National Institute of Standards and Technology (NIST) has gained recent recognition and popularity. Yang *et al.* (2012) define cloud storage is a model for enabling convenient, on-demand network access to

a shared pool of configurable computing resources (*e.g.*, networks, servers, applications, storage, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. It also suggested that a cloud computing model should be composed of five vital characteristics, three service levels, and four deployment models. Those five essential characteristics are on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service. The service levels are software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS). And the deployment models are public cloud, private cloud, hybrid cloud and community cloud.

In this paper, from the questionnaire-based survey, the proportion of the people's awareness about cloud storage was found using proportion test and multinomial logistic regression was used to predict whether the user would go for paid cloud storage or not.

## 2. Review of Literature

Mohd Rahul *et al.* (2012) defines cloud computing as a concept where files and applications are hosted on a "cloud" consisting of thousands of computers and servers, all linked together and accessible via the Internet. Further he says a cloud is a pool of virtualized computer resources. Cloud Computing is the long-held dream of computing as a utility, has the embryonic to transform a large part of the IT industry, making software even more attractive as a service and framing the way for designing IT hardware. Cloud Computing can be considered as a pay and use service. More you Pay, more services you get. It has become the 5th essential utility (after water, electricity, gas, and telephone) with its growing features and demands the day is not far when the world would become the slave of cloud computing. Tinani *et al.* (2019) observes that cloud computing provides a surrounding for resource sharing in terms of ascendance frameworks, middleware's and application development platforms, and business applications. The operation models of cloud computing grasp free infrastructure services with value another platform services, subscription-based infrastructure services with supplemental application services, and free services for sellers. Pankaj Sareen (2013) concluded cloud computing infrastructures are next generation platforms that can provide tremendous value to companies of any size. Cloud computing provides platform, software, infrastructure, storage, security, data, test environment etc. as a service. Clients or customer would be able to access their applications and data from anywhere at any time. Data wouldn't be enclosing to a hard drive on one user's computer or even a corporation's internal network. It would also lead hardware costs down. You would not need a huge hard drive because you would store all your information on a remote computer. However, the substantial concerns about cloud computing are security and privacy. Since the idea of handling over significant data to another company worries some people. With the rapid development of cloud storage technology and applications, it has broken through the single point of the original IaaS (Infrastructure as a Service) layer definition. It establishes a technical system, contains three layers of cloud computing infrastructure services (IaaS, PaaS, SaaS). At present, cloud computing services are mainly concentrated in the IaaS and SaaS layers. The contents of IaaS and SaaS are not the same. From the viewpoint of IaaS, cloud storage provides a service for data storage, archiving, and backup. From the SaaS point of view, cloud storage service is very diverse, the service has online backup document notes save network disk business photo preservation and sharing home video. Cloud storage is the small layer of cloud computing system which supports the service of the other layers above it. In addition, it is an important way to save and manage large data. So, it occupied even more attentions from some researchers. Cloud storage is catering for pervasive storage requirements and massive storage wishes. The persistency and operation are supported by the

storage systems. Programs, texts, data, pictures, videos, etc. are all needed to accumulate in the storage systems. Mobile terminals, PC, consume electronics such as smart phones, cameras; MP3/MP4, etc. are all need more and more storage resources. Usually, local storage is not sufficient to store, and lost easily. Therefore, the necessary and pervasiveness of storage requirements results to that the properties of cloud storage must be low cost, easy maintenance, reliable, security, recoverable, *etc.* Spoorthy *et al.* (2014) defined importance of cloud storage as no need to invest any capital on storage devices, no need for technical expert to maintain the storage, backup, replication and importantly disaster management, grant others to access your data will result with collaborative working style instead of individual work. Aized Amin Soofi (2014) discussed about data security which plays major concern for the users who want to use cloud computing. Proper security measures are expected to be taken in order to eliminate this concern. It was found that many of the cloud services users have concerns about their private data that it may be used for other purposes or sent to other cloud service providers.

### **3. Problem Statement**

This research study is aimed to identify the various factors which affect the usage of public cloud storage. The research is further aimed to find the proportion among users of cloud storage in different area, to find the association among those factors, finding most influencing factors among all those factors, developing model whether the user will use paid version or not and potential risk for the user.

### **4. Objectives**

The objective of this paper is to gain insight about the usage patterns of public cloud storage by the people of Vadodara city. To know the facilities which are mostly used by people gender wise, age wise, profession wise.

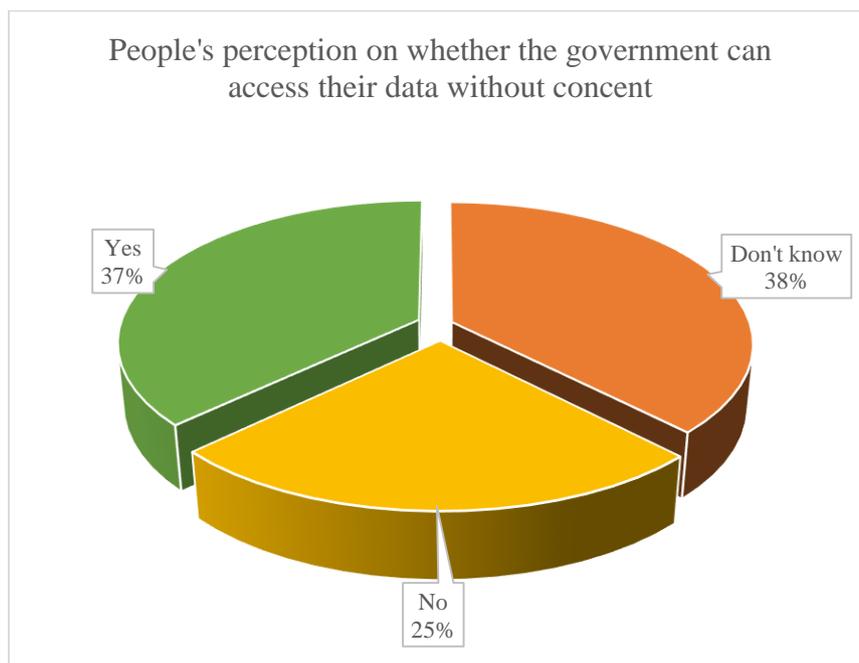
- a) To check whether the proportion of cloud storage users is same in 6 wards of Vadodara city.
- b) To check whether any association between specific cloud storage facilities usage on cloud company.
- c) To check whether use of different cloud storage facilities depends on profession or not.
- d) To predict whether the user will use paid version cloud storage or not.
- e) To gain insight whether users are aware of the associated potential risk or not with respect to gender wise and profession.

### **5. Research Methodology**

The research is done by the methods of survey, based on the questionnaire which gives the quantitative and qualitative data such as age, gender, education, profession of users, the cloud storage facilities they use, the cloud service provider they prefer and other related questions. The review held with explicit sampling technique and sample size determination technique. Sample Size determination is technique used to choose the number of observations to include in a statistical sample study. It is significant for any statistical study to make inference about the population based on a sample. Practically sample size is usually determined based on the cost, time or method of collecting the data and the need for it to

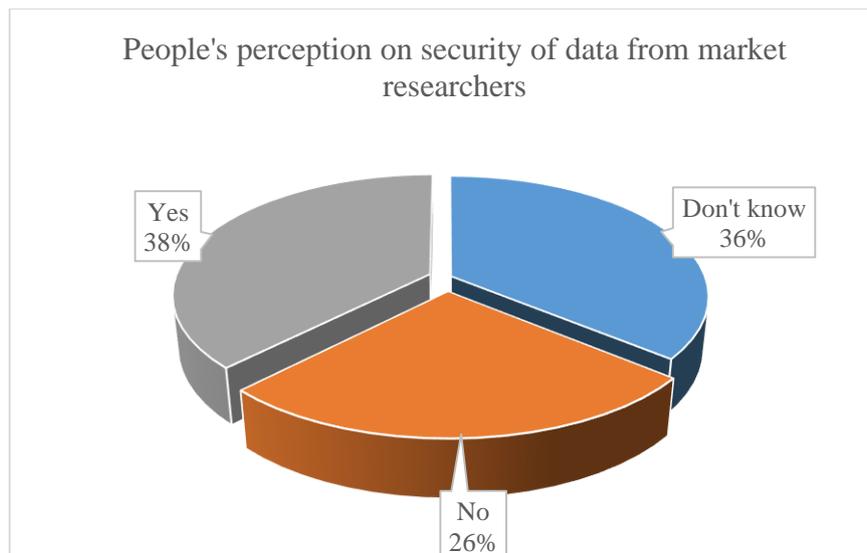
offer sufficient statistical power. For our research study the sample size is dependent on the pilot survey results. In the pilot survey study, the sample of size 30 was selected, from the pilot survey study the proportion of cloud storage users were 0.7 and of non-users was 0.3. The sample size is estimated from the pilot survey by proportion method where  $p =$  proportion of users = 0.7 and  $q =$  proportion of non-users taking margin of error  $e = 0.05$ , thus sample size of the main survey study was 364. For this study the primary data was collected and investigated using the questionnaire. This research survey was conducted in 6 clusters which were selected randomly in Vadodara city *i.e.*, Raopura, Karelibaug, Waghodiya, Akota, Harni and Alkapuri. Two stage sampling technique was used for collecting the data. The population of Vadodara city was divided into 13 clusters based on wards. In the first stage cluster sampling and in the second stage probability proportion to size (PPS) sampling method were used. To draw a sample with PPS, cumulative total method was used to determine the number of samples selected from each ward. Thus, as a result we got the sample size 29 out of 43555 population from Raopura, the sample size 62 out of 98723 population from Karelibaug, the sample size 72 out of 236097 population from Waghodiya, the sample size 41 out of 130715 population from Akota, the sample size 89 out of 122741 population from Harni and the sample size 71 out of 177287 population from Alkapuri.

## 6. Data Visualization



**Figure 1: People's perception on cloud storage data access by government without their consent**

From the above graph we observe that 38% of people don't know whether government can access their cloud storage data without their consent or not. Further 37% of people says government access their data without their consent.



**Figure 2: People's perception on security of their cloud storage data from market researchers**

From Figure 2 we observe that 38% of people in our study says our cloud storage data is secure from market researchers and further follows that 36% of people don't know about it.

## 7. Results and Discussion

### 7.1. Proportion test Analysis

- a) Objective: To check whether the proportion of cloud storage users is same in 6 wards of Vadodara city

In our research study, based on sample size we consider 6 areas of Vadodara city that is Raopura, Karelibaug, Waghodiya, Akota, Harni, and Alkapuri. There is total 178 users out of 364 total sample size. We observe that there are 11 users in Raopura out of 29 samples, 37 users in Karelibaug out of 62 samples, 27 users in Waghodiya out of 72 samples, 26 users in Akota out of 41 samples, 42 users in Harni out of 89 samples and 35 users in Alkapuri out of 71 samples. Hence to check equality of users proportion of 6 wards of Vadodara city we use proportion test in R programming by the function `prop.test()`.

$H_0: P_1 = P_2 = P_3 = P_4 = P_5 = P_6$

$H_1$ : at least one may differ significantly.

*#Proportion test is done using R programming.*

*#List of cloud storage users from each of 6 wards.*

```
users <- c(11,37,27,26,42,35)
```

*#List of total number of samples from each of 6 wards.*

```
total <- c(29,62,72,41,89,71)
```

*#Using prop.test function to perform multiple proportion test.*

*#syntax of prop.test function*

```

str(prop.test)

## function (x, n, p = NULL, alternative = c("two.sided", "less", "greater"),
##   conf.level = 0.95, correct = TRUE)

prop.test(x = users, n = total, alternative = "two.sided")

##
## 6-sample test for equality of proportions without continuity
## correction
##
## data: users out of total
## X-squared = 11.588, df = 5, p-value = 0.04089
## alternative hypothesis: two.sided
## sample estimates:
## prop 1 prop 2 prop 3 prop 4 prop 5 prop 6
## 0.3793103 0.5967742 0.3750000 0.6341463 0.4719101 0.4929577

```

Since  $p$ -value  $<$  alpha (0.05) there is sufficient evidence to reject the null hypothesis ( $H_0$ ) and hence we conclude that proportion of users is not same in all the wards. We observe that maximum proportion of cloud storage users are in ward 4 that is in Akota.

## 7.2. Chi-square test for multiple response analysis

- b) Objective: To check whether any association between specific cloud storage facilities usage on cloud company

Q1) which public cloud company you use? (Allow to tick multiple answers)

(a) Google Drive (b) Dropbox (c) One Drive (d) iCloud (e) Others (specify)-----

Q2) which are the cloud storage drive facilities you mostly use? (Allow to tick multiple ans.)

(a) Sync folder (b) Selective Sync (c) Folder sharing (d) Mobile Apps (e) Deleted file retention (f) File Editing (g) Versioning (h) others [specify]-----

$H_0$ : There is no association between Cloud Company and specific cloud storage facilities usage.

$H_1$ : There is association between Cloud Company and specific cloud storage facilities usage.

Facilities	Company				
	Google Drive	Dropbox	OneDrive	iCloud	Other company
Sync Folder	74	32	26	27	7
Selective sync	46	13	17	16	2
Folder sharing	65	32	20	17	3
Mobile apps	84	32	21	26	3
Deleted file retention	40	22	17	18	0
File editing	38	19	15	17	1
Versioning	5	5	5	2	0
Others	2	0	0	1	0

Pearson Chi-Square Tests	
Facilities	Company
Chi-square	143.442
Df	40
Sig.	0.000

Since  $p$ -value  $<$  alpha (0.05) the test provides enough evidence to reject the null hypothesis ( $H_0$ ) and hence we conclude that there is association between cloud company and specific cloud storage facilities usage.

### 7.3. Chi-square test for multiple response analysis

c) Objective: To check whether the use of different cloud storage facilities depends on profession or not.

Q1) What is your profession?

(a) Student (b) Job (c) Business (d) Unemployed

Q2) Which are the cloud storage drive facilities you mostly use? (Allow to tick multiple answers)

(a) Sync folder (b) Selective Sync (c) Folder sharing (d) Mobile Apps (e) Deleted file retention (f) File Editing (g) Versioning (h) others [specify]-----

$H_0$ : There is no association between profession and different cloud storage facilities usage.

$H_1$ : There is association between profession and different cloud storage facilities usage.

Facilities	Profession			
	Student	Job	Business	Unemployed
Sync Folder	31	47	8	9
Selective sync	14	25	5	9
Folder sharing	28	42	5	2
Mobile apps	29	51	10	10
Deleted file retention	9	24	7	5
File editing	13	25	5	3
Versioning	3	2	0	0
Others	1	0	1	0

Pearson Chi-Square Tests	
Facilities	Profession
Chi-square	41.243
Df	24
Sig.	0.016

Since  $p$ -value  $<$  alpha (0.05) the test provides enough evidence to reject null hypothesis ( $H_0$ ) and hence we conclude that there is association between profession and use of different cloud storage facilities.

#### 7.4. Multinomial Logistic Regression analysis

d) Objective: To predict whether the user will use paid version cloud storage or not.

As per our domain knowledge the factors which may affect for the usage of paid version of cloud storage are: Income, profession, cloud storage usage, type of data on cloud, etc.

Using survey data, the response variable and 15 explanatory variables are as follows:

$Y$  = Use of paid version (1 = Yes, 2 = No, 3 = May be)

$X_1$  = Income (1= No, 2 = Below one lac, 3 = 1-3 lac, 4 = 3-6 lac, 5 = 6-9 lac, 6 = Above 9 lac),  $X_2$  = Profession (1 = Student, 2 = Job, 3 = Business, 4 = Unemployed),

$X_3$ = Upload videos (1 = Yes, 2 = No),  $X_4$  = Upload songs (1 = Yes, 2 = No),

$X_5$  = Upload images (1 = Yes, 2 = No),  $X_6$  = Upload documents (1 = Yes, 2 = No),

$X_7$  = How frequently they use cloud (1 = (once in a week), 2 = (twice in a week), 3 = (thrice in a week), 4 = (four times in a week), 5 = (five times in a week)),

$X_8$ = Apps backup on cloud (1= Yes with media, 2 = Without media, 3 = No),

$X_9$ = Apps media backup on cloud (1= Yes with media, 2 = Without media, 3 = No),

$X_{10}$  = No. of cloud accounts they have (1 = 1, 2 = 2, 3 = 3, 4 = More than 3),

$X_{11}$  = It provides me extra space (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5=Strongly agree),

$X_{12}$  = Easy and convenient (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5=

Strongly agree),  $X_{13}$  = I can access my data from anywhere from any device (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5=Strongly agree),

$X_{14}$  = I can easily share information with others (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5=Strongly agree),

$X_{15}$  = I won't loss my data if my computer fails (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5=Strongly agree)

In order to predict whether user will use paid version cloud storage or not, Multinomial logistic regression was used.

For multinomial logistic Regression,  $Y$ : Yes = 1, May be = 2 and No = 3.

No = 3 is taken as the base with ascending order of categories.

Model is fitted by using forward stepwise multinomial logistic regression.

Step Summary						
Model	Action	Effect(s)	Model Fitting Criteria	Effect Selection Tests		
			-2 Log Likelihood	Chi-Square <sup>a</sup>	Df	Sig.
0	Entered	Intercept	372.201	.		
1	Entered	X15	346.012	26.189	8	0.001
2	Entered	X11	327.889	18.122	8	0.020
3	Entered	X1	308.477	19.412	10	0.035
Stepwise Method: Forward Entry						
a. The chi-square for entry is based on the likelihood ratio test.						

The fitted model gives the following hypothesis results.

H<sub>0</sub>: No significance between null model (model with only intercept) and final model (model with all variable)

H<sub>1</sub>: Significance between null model (model with only intercept) and final model (model with all variables)

Model Fitting Information				
Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept	372.201			
Final	308.477	63.724	26	0.000

Here  $p$ -value < alpha (0.05) therefore the data provides enough evidence to reject null hypothesis (H<sub>0</sub>) at 5% level of significance, thus the fitted model is significant.

Pseudo R-Square	
Cox and Snell	0.301
Nagelkerke	0.343
McFadden	0.171

Here Cox and Snell = 0.301, 30.1% of variation in  $Y$  is explained by fitted model.

Likelihood Ratio Tests				
Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	308.477 <sup>a</sup>	0.000	0	0.000
X15	333.134	24.657	8	0.002
X11	326.186	17.709	8	0.024
X1	327.889	19.412	10	0.035

Since the probability is smaller than 0.05, hence it can be concluded that the three variables are significantly different from zero at 5 % level of significance.

## Parameter Estimation

Future use		B	Std. Error	Wald	DF	P-value
Yes	Intercept	0.372	1.157	0.103	1	0.748
	[X15 = 1]	2.744	1.486	3.411	1	0.065
	[X15 = 2]	-0.134	1.096	0.015	1	0.902
	[X15 = 3]	1.798	1.02	3.107	1	0.078
	[X15 = 4]	-0.805	0.612	1.73	1	0.188
	[X15 = 5]	0	-	-	0	-
	[X11 = 1]	-1.886	1.206	2.447	1	0.118
	[X11 = 2]	-2.104	1.387	2.301	1	0.129
	[X11 = 3]	-2.429	1.079	5.067	1	0.024
	[X11 = 4]	0.648	0.781	0.688	1	0.407
	[X11 = 5]	0	-	-	0	-
	[X1 = 1]	1.173	1.047	1.256	1	0.262
	[X1 = 2]	1.915	1.198	2.555	1	0.11
	[X1 = 3]	0.584	1.071	0.297	1	0.586
	[X1 = 4]	0.893	1.124	0.631	1	0.427
	[X1 = 5]	1.471	1.806	0.663	1	0.415
[X1 = 6]	0	-	-	0	-	
May be	Intercept	2.831	0.927	9.327	1	0.002
	[X15 = 1]	2.692	1.665	2.615	1	0.106
	[X15 = 2]	-3.314	1.614	4.214	1	0.04
	[X15 = 3]	0.814	0.979	0.692	1	0.406
	[X15 = 4]	-0.936	0.572	2.675	1	0.102
	[X15 = 5]	0	-	-	0	-
	[X11 = 1]	-4.159	1.441	8.334	1	0.004
	[X11 = 2]	-0.618	1.49	0.172	1	0.679
	[X11 = 3]	-1.878	0.934	4.041	1	0.044
	[X11 = 4]	-1.149	0.731	2.466	1	0.116
	[X11 = 5]	0	-	-	0	-
	[X1 = 1]	-0.161	0.809	0.04	1	0.842
	[X1 = 2]	-0.672	1.071	0.394	1	0.53
	[X1 = 3]	-1.13	0.85	1.766	1	0.184
	[X1 = 4]	-0.512	0.907	0.318	1	0.573
	[X1 = 5]	1.892	1.441	1.726	1	0.189
[X1 = 6]	0	-	-	0	-	

Classification				
Observed	Predicted			
	Yes	Maybe	No	Percent Correct
Yes	22	27	6	40.0%
Maybe	9	69	7	81.2%
No	3	20	15	39.5%
Overall Percentage	19.1%	65.2%	15.7%	59.6%

59.6% times the fitted model does the correct classification.

Fitted Model in Logit Form

$P$ : Whether user will use paid version in future or not.

= "Yes" or "May be" or "No"

Let  $A$  = Yes,  $B$  = May be,  $C$  = No

First logistic function is  $A$  with  $C$

$$\log\left(\frac{P(A)}{1-P(A)}\right) = 0.372 + 1.173X_{1_1} + 1.915X_{1_2} + 0.584X_{1_3} + 0.893X_{1_4} + 1.471X_{1_5} - 1.886X_{11_1} - 2.104X_{11_2} - 2.429X_{11_3} - 0.648X_{11_4} + 2.744X_{15_1} - 0.134X_{15_2} + 1.798X_{15_3} - 0.805X_{15_4}$$

where  $X_{ij}$  is the value of  $i^{\text{th}}$  variable at  $j^{\text{th}}$  level,

$$\log\left(\frac{P(A)}{P(C)}\right) = P(A_{RHS})$$

Then logit function is written for  $B$  with  $C$ ,

$$\log\left(\frac{P(B)}{1-P(B)}\right) = 2.831 - 0.161X_{1_1} - 0.672X_{1_2} - 1.130X_{1_3} - 0.512X_{1_4} + 1.892X_{1_5} - 4.159X_{11_1} - 0.618X_{11_2} - 1.871X_{11_3} - 1.149X_{11_4} + 2.692X_{15_1} - 3.314X_{15_2} + 0.814X_{15_3} - 0.936X_{15_4}$$

$$\log\left(\frac{P(B)}{P(C)}\right) = P(B_{RHS})$$

$$P(A) = \frac{P(A_{RHS})}{1 + P(A_{RHS}) + P(B_{RHS})}$$

$$P(B) = \frac{P(B_{RHS})}{1 + P(A_{RHS}) + P(B_{RHS})}$$

$$P(C) = \frac{1}{1 + P(A_{RHS}) + P(B_{RHS})}$$

The equation  $P(A)$  can be used to calculate the probability that whether the cloud storage user will use paid version in future or not.

### 7.5. Frequency analysis for security related issues

- e) To gain insight whether users are aware of the associated potential risk or not with respect to gender wise and profession

Sr. No.	Security related issue	Category	GENDER		PROFESSION			
			Male	Female	Business	Job	Student	Unemployment
1.	People's perception on Security of data from market research	YES	39%	35%	30%	67%	35%	17%
		NO	27%	25%	4g5%	33%	24%	8%
		DON'T KNOW	34%	40%	25%	0%	41%	75%
2.	People's perception whether the government can access their data without their consent	YES	40%	30%	45%	100%	38%	17%
		NO	26%	24%	25%	0%	26%	0%
		DON'T KNOW	34%	46%	30%	0%	36%	83%
		NO	110	52	18	2	52	12
		DON'T KNOW	-	-	-	-	-	-

### 8. Conclusions

From the survey and above analysis, it can be concluded that proportion of users is not same in all the wards. We observe that maximum proportion of cloud storage users are in ward 4 that is in Akota. Usage of different cloud storage facilities depends on the cloud company. From multiple response analysis we observe that there is association between profession and different cloud storage facilities usage. In multinomial logistic regression, from equation  $P(A)$ ,  $P(B)$ ,  $P(C)$  we can predict whether the user will use paid version of cloud in future or not. We observe that perception of males and females on the security of data are nearby same, business profession are less aware about the risk of data on cloud, and IT profession people are more aware about the risk of data on cloud.

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