DEFECTION ANALYSIS OF MIGRANT CUSTOMERS: STUDY OF POST-PAID TELEPHONE SUBSCRIBERS USING MAXIMUM LIKELIHOOD ESTIMATION OF SURVIVAL PERIODS

ABSTRACT

This study examines the migrant status of 48583 WLL based post-paid type fixed telephone customers of a telephone company registered and activated under 7 different categories from 19 September 2003 to 31 March 2008 and analyzed their defection pattern till 27 March 2015. Based on the continuously increasing hazard of defection, Weibull duration model with multiple regression equations have been used to estimate the defection and debt pattern using maximum likelihood. The result shows migrant people cancel their service early by at least 4.3% of their survival period compared to non migrants. Furthermore, this research identified migrant customers have 26.56 % more chance to defect without paying the last bill compared to non migrants in post-paid type WLL based fixed phones.

INTRODUCTION

In consumer behavior study, defection is the action that a customer cancels her service relationship with provider. With respect to satisfying customers, Jones and Sasser (1995) categorized types of customers as loyalists, Apostoles, defectors, hostages and mercenaries. They defined defectors are those customers who feel neutral or merely satisfied as are just stop doing business with the company.

The advantages of customer retention had been raised with evident for the first time by Reichheld and Sasser (1990). They highlighted on big profit drains due to customer defections.

Their conclusion caused a change in the marketing theory and many firms focused on retaining customers. Their findings were not consensual (Dowling and Uncles, 1997; East et al., 2006; Gupta et al., 2006) and many researchers argue to link retention with the customer life time value (CLV) and customer relationship management (CRM). CRM is taken as a measure of customer satisfaction, loyalty and defection. However, research study of Pearce and Pearce (2002) suggest that a vast majority of companies that have invested in CRM have not gone much ahead with regard to customer retention.

In telecommunications services, ITU-ICT facts & figures (2015) reported 7 billion cellular mobile subscriptions up by 97% with reference to the figures in 2000. ITU has mentioned technological progress, infrastructure deployment, and falling prices as reasons behind this unexpected growth. Researchers Nath & Behara (2003) identified telecom service provider's customer strategy "make big networks, get customers" and "make new services, please customers" to achieve such growth. However, the market of fixed telecommunications service reached at saturation and reported the declining trend.

In Nepal, as per the Management Information System reports published by Nepal Telecommunications Authority NTA-MIS-1 (2003), and NTA-MIS-101 (2015), cellular mobile subscriptions reached to 100.7% at the end of 2015 as compared to less than 1% in 2003 whereas fixed telecommunications service has increased 3.17% in 2015 from 1.8% in 2003. Statistics show no increment in the subscriptions in fixed telecommunications in last few years rather declination is the trend.

Global telecommunications subscriptions density is high in urban areas where majority of people are migrants. People leave one's own place in search of education, employment, and

socio-economic development. Globally such chances are high in cities. The latest census of Nepal in 2011 reported population change ranged from -31.8% in Manang district to +61.2% in Kathmandu district. Out of 75 districts, 27 districts had reported out-migration while 48 districts reported in-migration. The migration trend is into urban cities of all regions.

Kathmandu, the capital of Nepal, is a Valley with parts of three districts Kathmandu, Lalitpur and Bhaktapur. As per the 2011 census, the population of Kathmandu, Lalitpur and Bhaktapur has been recorded a growth of 61.2%, 38.6%, and 35.1% to the census in 2001. This change depicts the rate of in-migration inside capital city from other districts. National Institute of Development Studies (NIDS) 2009 survey reported 28.2% internal life time migration in Nepal. According to CBS (2002) report, the internal migrant population in all four cities in Kathmandu valley reported 42% in Kathmandu, 32% in Lalitpur, 27.6% in Madhyapur, and 23.2% in Kirtipur 23.2%. These statistics shows internal migrants are major part of total Kathmandu valley population.

The scientific and systematic study on migration has its root from the end of 18th century from the study of Ravenstein's (1885, 1889) papers but these studies have taken acceleration from 1930 onwards. The reason behind the impediments on such studies has been the availability of data. Most of such studies on migration have been carried out from the economics perspectives. Referring to the studies on migration, Marshal (1948) mentioned the desire to reach into the knowledge of economic phenomena. There are limited studies carried out from the marketing perspectives.

Portela and Menezes (2008) studied defection pattern of residential type customers with large number of covariates that include customer's basic information, demographics, defection

flag, historical information about usage, billing, subscription, credit, and other. In their following research, Portela and Menezes (2011) studied customer defection of Portugal's fixed telecommunications industry and concluded that it is crucial to prevent the defection of profitable customers in order to ensure financial performance of firms. However they found that customer satisfaction is not an important reason of customer defection where as pricing strategy impacts customer retention and need to be focused more.

The topics consumer behavior and migration behavior receive separate attention in most of the literatures but their interrelationship has not got significant attention. This research analyzed the consumer behavior of defection and involuntary pattern in relation to their migrant status. This paper studies the migrant status of 48583 WLL based post-paid type fixed telephone customers of a telephone company registered and activated under 7 different categories from 19 September 2003 to 31 March 2008 and analyzed their defection pattern till 27 March 2015. This study analyzed defection pattern along with involuntary defection (defaulter) of these customers in seven different categories residential, business, PCOs, students, business, special subscribers, and employees based on their migrant status. This research has been carried out using Maximum Likelihood Estimation (MLE) of survival period of these customers under Weibull distribution.

DATA

Data has been taken from a telephone company of Nepal providing CDMA based WLL Fixed Wireless Phones (FWP) in post-paid billing category. The service provider had started its services with CDMA WLL post-paid service in 2003. The record of a subscriber contained telephone number, date of activation, subscriber category, current status, name, identity number of customer as well as user, address, balance amount, blocked date, and closure date.

A total of 49,871 post paid fixed phone customer's records registered and activated in Kathmandu valley (01 area code) from 19 September 2003 to 13 February 2015 had been found and observed for their status till 27 March 2015. While observing the company's business pattern, the post-paid subscriber acquisition trend has flattened drastically from first quarter of the year 2008. A total of 48662 subscribers found activated from 19 September 2003 to 31 March 2008 in the period of four year and six months while only 1209 activations found from 1st April 2008 to 13th February 2015 in a period of 6 years and 10 months. The reason behind this acquisition pattern has been introduction and promotion of pre-paid based FWP service where government ownership charges need not to be paid at initial activation.

With this normalization the researcher has an opportunity to observe customer's defection behavior for a maximum period of 4172 days (from 19 September 2003 to 27 March 2015) and minimum period of 2552 days (from 31 March 2008 to 27 March 2015). During the period, a total of 48662 subscribers found registered and activated under 12 different categories which comprised 43003 Residential, 2987 Business, 755 Special Customers, 873 Public telephones, 329 Employee, 5 Non Government Agency, 7 Government Official; 10 Foreigner, 352 Student; 51 Senior Citizen, 10 Military/Police, and 284 Shop Keeper. Due to minimum count of subscribers in categories of Non Government Agency, Government Official, Foreigner, Senior citizen and Military/Police, these records had not been carried for further analysis. Thus, a total of 48583 subscribers registered under 7 different categories had been analyzed further.

Out of 48583 subscribers, 1351 subscribers' were found active as non defectors till 27 March 2015 still using their services with outgoing and incoming services. Therefore, the number of defector customers analyzed was 47232. Also, for the purpose of survival analysis 1351 subscribers were right censored by taking 27 March 2015 as the end date. Out of 47232

defectors, total of 26689 subscribers has been found undergone involuntary defection (bill default), while 20543 had gone voluntary defection opting formal cancellation.

IDENTIFICATION OF MIGRANT CUSTOMERS

As per Nepal's telephone system, three districts inside Kathmandu valley have the same area code '1' followed by seven digit subscriber number in fixed phone category. These subscribers can communicate to each other having a local call authority. Rests of all 72 districts have two digit area code followed by six digit subscriber number. Also, as per the license provision fixed phone service customers cannot have roaming facility between the districts except Kathmandu valley.

In this research, inter district migration of customers from 72 districts into Kathmandu valley (Kathmandu, Lalitpur, and Bhaktapur districts) have been taken. These districts have the same area code of '01' representing single geographical control in fixed phone service.

The selected telephone provides CDMA technology based WLL fixed phone services. In customer information record of customer care and billing system (CCBS) application of the company customer identity field ***'CID_number'*** was mandatory and contained customers' identity number along with place of issue of identity with acronym of district name from which their identity card of citizenship, driving license or passport had been issued.

In this research, the variable 'migrant status' has been identified by analyzing the data element of district acronym in the customer identity field. Fixed phone subscribers registered and activated under '1' area code had acronym for districts Kathmandu *'KTM'*, Lalitpur *'LLT'*, and Bhaktapur *'BKT'*. From the obtained data, customer records with telephone number having an area code '1' but not having the acronyms like KTM or LLT or BKT in their '*CID_number'* had been identified as migrant customers. In simple terms subscribers not having the citizenship of

above mentioned three districts but using the telephone in these districts which do not have roaming service had been identified as migrant customers.

Subscriber statistics for analysis

In the normalized data of 48583 customers, total of 28004 customers found migrants while 20579 non-migrants. The descriptive counts of customers are in table 1.

Table 1

Subscriber Statistics as per migrant and defection status.

Subscriber category	Number of Subscribers	Migrants	Non Migrants	Voluntary defectors	Involuntary defectors	Censored subscribers
Residential	43003	26267	16736	18523	23601	879
Business	2987	385	2602	1229	1487	271
Special Customers	755	184	571	257	428	70
Public Telephones	873	600	273	171	595	107
Employee	329	172	157	106	217	6
Student	352	244	108	128	213	11
Shopkeeper	284	152	132	129	148	7
Total	48583	28004	20579	20543	26689	1351

The data elements

The data elements obtained from normalized data table with 48587 subscriber records had been analyzed in this study. A typical record of 10 subscribers among 48587 is shown in table 2.

The definition of each data element is defined as below

(i) Telephone number or Subscriber Identity (SID) as a nominal variable of a customer. (sid)

(ii) Date of activation (DOA) as a nominal variable for identification of an event at which customer established his relation with the company and start of survival time. (doa)

(iii) Category of customer (category) represents the typical business type of the subscriber. This variable takes value from 1 to 7; where 1: Residential; 2: Business; 3: Special Customers; 4: Public telephones; 5: Employee; 6: Student; 7: Shopkeeper; (subscat)

(iv) Next variable is a categorical variable named 'migrant'. This takes the value 0 and 1; where 0 represents non-migrant customer and 1 represents migrants. (mig)

Table 2

Typical normalized data of 10 customers according to research variables.

sid	Doa	Subscat	mig	defltr	dur	cen
012090001	2003-09-19	1	0	1	3646	0
012130001	2003-09-19	1	0	1	2583	0
012080001	2003-09-19	1	0	1	3645	0
012080002	2003-09-19	1	1	0	2337	0
012001001	2003-09-19	2	0	0	2337	0
012120014	2003-09-20	1	0	1	2581	0
012100014	2003-09-20	1	1	1	3375	0
012040014	2003-09-20	1	1	0	2336	0
012110010	2003-09-20	1	0	1	3645	0
012110012	2003-09-20	1	1	1	3645	0

(v) Another variable is defaulter that takes value 0 and 1. The value 0 represents non-defaulter and 1 takes defaulter (defltr). This field with value 0 contains the customer who is still active.

(vi) The most important variable is t, representing the survival duration in days. (dur)

(vii) Another variable is censured variable for active customers. This variable takes value 0, if customer has already gone defection and this takes value 1 if the customer is forced for defection with censoring (cen).

THE MODEL

Let the variable d_i denotes the status of i^{th} customer at any time *t* (in days) such that,

d_i = 1; if customer *i* survives until(T_i) time, and

d_i= 0, else; continues his/her service beyond(T_i).

Where $T_i : t_0, t_1, t_2, \dots, t_{n-1}$ denotes time in days of survival of any i[th] customers so that $t_1, t_2, \dots, t_n$ are the day of defections for those customers. Since the measurement of duration T_i is precise we can treat it as a continuous variable although it takes discrete values (Wooldridge, 1998, p.706). In this research, the period of observation of defection pattern is fairly long 4172 days (11 years 5 months and 7 days) the risk of defection had been taken as non-constant. Also the defection pattern has been taken as duration dependent.

In general the probability of defection of i^{th} customer at time t_i is given by the likelihood function;

$$l(t_i) = \prod_{i=1}^{n} f(t_i)^{d_i} . [1 - f(t_i)]^{1-d_i}$$

Now taking logarithms on both the sides,

$$\ln \{l(t_i)\} = \ln \{ \prod_{i=1}^{n} f(t_i)^{d_i} [1 - f(t_i)]^{1-d_i}\}$$

or, $$\ln \{l(t_i)\} = \sum_{i=1}^{n}\{d_i . f(t_i) + (1 - d_i). [1 - f(t_i)]\}$$ ------ (1)

Alternatively,

$$\ln\{l(t_i)\} = l_i = \begin{cases} \sum_{i=1}^{n}\{d_i . f(t_i) & ; \text{if } d_i = 1 \\ \sum_{i=1}^{n}\{1 - d_i\} \{ 1 - f(t_i)]\} & ; \text{if } d_i = 0 \end{cases}$$ ------- (2)

Where, $f(t_i)$ is the survival duration function of i^{th} customer.

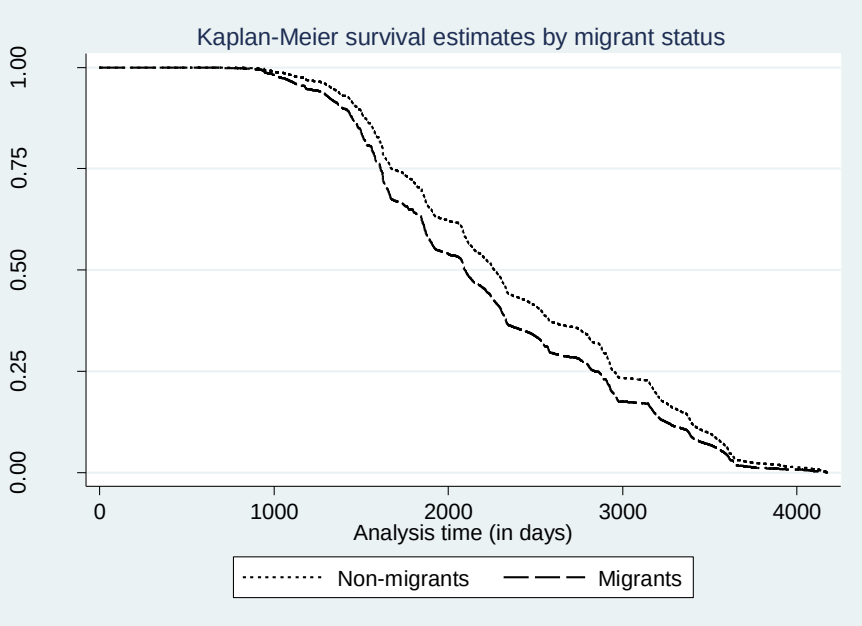
In duration analysis, time 't' can follow several known distributions, such as exponential, Weibull, Gompertz, log-normal, log-logistic, and gamma. Exponential and Weibull models can be parameterized as PH or AFT models; Gompertz is a PH model; and the others are AFT models (Portela, and Menezes, 2008). Parametric models are estimated by maximum likelihood.

In parametric models when the hazard rate is constant within a particular group of subjects under risk exponential distribution is used. The Weibull distribution is described for situations when the hazard rate is not constant but smoothly increasing (may stay the same or increase but never decreases) or decreasing with time. A graphical technique can be helpful to assess the validity of the assumption of a pattern of hazard rate. The survival models are analyzed using the method of multiple regression of dependent and independent variables.

So as to identify the nature of distribution of survival period of customers, considering the normal distribution of survival periods, a plot of survival probability (popularly known as Kaplan-Meier survival estimate) of migrant and non-migrant customers with respect to time in days has been plotted in STATA which is shown in figure-1.

Figure-1

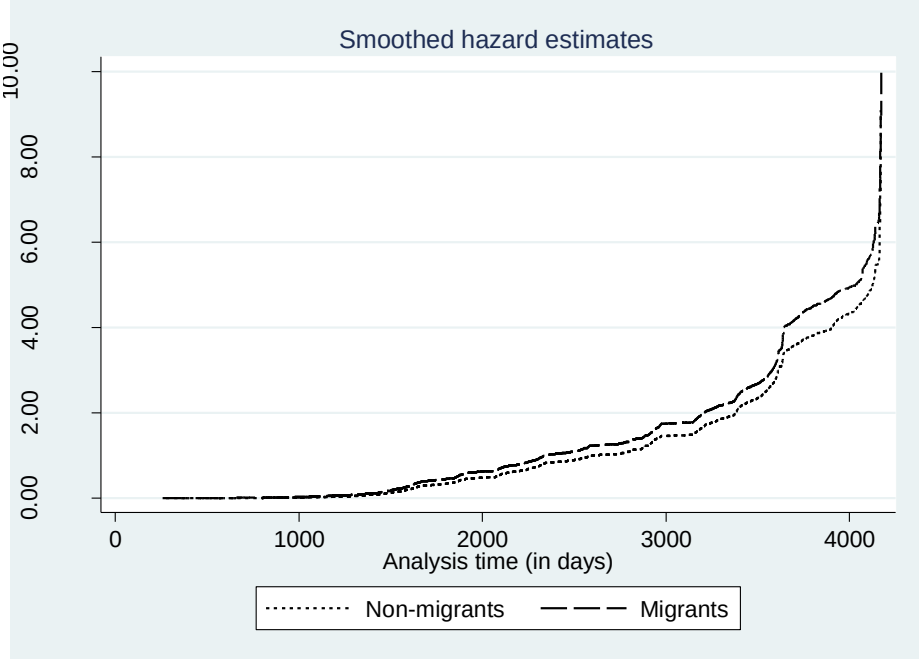
K-M survival estimates of migrant and non-migrant customers.



Above plot of survival probability indicates continuously decreasing survival probability for migrants as well as non-migrants with respect to analysis time in days. With similar considerations of normality in distribution of survival periods, a plot of hazard estimates of failure (defection) of migrant and non-migrant customers with respect to time in days has been obtained as shown in figure-2 below.

Figure-2

Smoothed hazard of defection estimates of migrant and non-migrant customers.



Above plots of survival probability and hazard estimates show continuous and higher risk of chances of defection by migrant customers to that of non-migrants throughout the period of observation. During the observed period, the telephone service subscription trend observed explosive growth throughout the world including the country of observation, Nepal and the nature of hazard rate of defection of telephone customers observed as smoothly increasing with time, the nature of distribution of survival period should follow the Weibull distribution.

In the Weibull model, the Weibull density function is

$$f(t_i;\eta_i,\gamma_i)\begin{cases} = \frac{\gamma_i}{\eta_i}\left(\frac{t_i}{\eta_i}\right)^{\gamma_i-1}\exp\{-\left(\frac{t_i}{\eta_i}\right)^{\gamma_i}\} & \text{for } (T<t_i)\ i.e.\ not-censored\ observation \\ = \exp\{-\left(\frac{t_i}{\eta_i}\right)^{\gamma_i}\} & \text{for } (T<t_i)\ i.e.\ censored\ observations. \end{cases} \text{----------(3)}$$

where η_i, γ_i are nonnegative parameters (Gould, Pitblado, & Sribney, 2006, p.214).

Thus the log likelihood for the i^{th} customer is from equation (2) and (3) is

$$ln\, l_i = \begin{cases} \sum_{i=1}^{n}\{d_i\,.\{ln\, \Upsilon_i - \ ln\, \eta_i + \ (\Upsilon_i - 1)(ln\, t_i - \ ln\, \eta_i) - \ (\frac{t_i}{\eta_i})^{\Upsilon_i} & \text{if } d_i = 1 \\ \sum_{i=1}^{n}(1 - d_i).\ \{-(\frac{t_i}{\eta_i})^{\Upsilon_i}\} & \text{if } d_i = 0 \end{cases}$$

For simplicity, modeling the parameters in log space, we can write the above equation in the form as follows:

$$\theta_{1i} = \ln \eta_i = x_{1i}\beta_1 + \ ..., \text{ and}$$

$$\theta_{2i} = \ln \Upsilon_i$$

$$ln\, l_i = \begin{cases} \sum_{i=1}^{n}\{d_i\,.\{\theta_{2i} - \ \theta_{1i} + \left(e^{\theta_{2i}} - 1\right)(ln\, t_i - \ \theta_{1i}) - \ (t_i e^{-\theta_{1i}})^{e^{\theta_{2i}}} & \text{if } d_i = 1 \\ \sum_{i=1}^{n}(1 - d_i).\ \{-(t_i e^{-\theta_{1i}})^{e^{\theta_{2i}}}\} & \text{if } d_i = 0 \end{cases}$$

----------(4)

Where, the regression **Model-1** to determine coefficient of defection due to migrant status is

$$\theta_{1i} = \ln \eta_i = x_{1i}\beta_1 + D_{1i}\alpha_1 + D_{2i}\alpha_2 + \cdots + D_{6i}\alpha_{6i} + \varepsilon_i$$

x_{1i} = the migrant status of i^{th} customer.

D_{1i} = Dummy variable for customer category 1 (Residential)

D_{2i} = Dummy variable for customer category 2 (Business), and so on

ε_i = Error term

$\theta_{2i} = \ln \sigma_{1i}$, standard deviation modeled as constant.

And, the regression **Model-2** to determine coefficient of migrant status with defaulter status (involuntary defection) is

Where $\theta_{1i} = \ln \eta_i = x_{1i}\beta_1 + x_{2i}\Upsilon_1 + D_{1i}\alpha_1 + D_{2i}\alpha_2 + \cdots + D_{6i}\alpha_{6i} + \varepsilon_i$

x_{1i} = the migrant status of i^{th} customer.

x_{2i} = the defaulter status of i^{th} customer.

D_{1i} = Dummy variable for customer category 1 (Residential)

D_{2i} = Dummy variable for customer category 2 (Business), and so on

ε_i = Error term

$\theta_{2i} = \ln \sigma_{2i}$, standard deviation modeled as constant.

To estimate the parameter coefficients of regression variables $\beta_1, \beta_2, \beta_{3,\dots}$ for corresponding $t_1, t_2, \dots, t_n$time (in days of survival) from model equation; the derivative of the equation (4) with respect the covariates x_{1i} needed to be obtained and equated to zero. The statistical application tool STATA had been used to estimate these values of β_1s, β_2s, and so on using maximum likelihood estimation in this research with research variables. The robustness of β_1s, β_2s, has been tested by estimating them along with dummy variables introduced for customer category.

Also the coefficient of involuntary defection by the migrant customers shall be estimated by the regression equation by taking defaulter status as x_{1i} variable in equation and its robustness had been checked by estimating its coefficients along with dummy variable D_{1i} for each customer category.

RESULTS

The survival duration has been observed to be 259 days of minimum survival period and 4159 days of maximum survival period for defectors out of total offered period of 4172 days. For censored subscriber's data maximum survival period was equal to total offered days. The mean value of survival period is 2283.595 days with standard deviation of 758.0851 days.

The score of log likelihood function as mentioned in equation (4) with regression equation of model-1 (eq1: *dur* d_i = *mig*); {that is the defection status d_i represented by censored

variable at the observed time of survival (depends on survival period *dur* which is dependent on migrant status *mig* of customer)} is computed using this model.

The coefficients of regression model-1 of equation (4) are presented in table 2. These scores have been computed with and without introducing dummy variables representing category of customers.

Table -2
Effect of migrant status on survival period resulting customer defection of WLL based fixed phone customers.

	(1) Beta, (std. error), (p-value)	(2) Beta, (std. error), (p-value)
Migrants (mig)	-0.0628479 (0.0029049) (0.000)	-0.0430897 (0.0029593) (0.000)
Residential customers (D1)		-0.0217457 (0.0185938) (0.248)
Business Customers (D2)		.1009762 (.019488) (0.005)
Special customers (D3)		.1999832 (.0219796) (0.000)
PCO (D4)		.1281091 (.0216263) (0.000)
Employee (D5)		.1754051 (.0252575) (0.000)
Student (D6)		.1172348 (.0238653)
Constant	7.884828 (.0022501) (0.000)	.12085 (.0249517) (0.000)
Log likelihood score	-382275.14	-381687.54
No. of observations	48583	48583

The above result in table 2 shows that the migrant customers are likely to survive less (defect early) by at least 4.3% days compared to non migrants. This effect is significant even

after introduction of dummy variables for category for residential customers. For another category of customers migrants customers are likely to survive more than non-migrants indicating migrants are economically more active than non-migrants in business professional and business fronts.

The regression analysis to estimate the coefficient of migration status of customer to cause defection along with last bill default (involuntary defection) based on survival duration had been evaluated using maximum likelihood estimation of regression model-2 of regression equation (4). The score of log likelihood function as mentioned in equation (4) with regression equation of model-2 (eq2: *dur* d_i = *mig dfltr*); {that is the defection status d_i represented by censored variable at the observed time of survival (depends on survival period *dur* which is dependent on migrant status *mig* along with defaulter status *dfltr* of customer)} is computed using this model.

The coefficients of migration status and defaulter status had been computed by introducing the dummy variables for each category of customers to ensure the robustness of the model. The result is in table-3 below.

Table-3

Effect of migrant status and defaulter status on survival period resulting customer defection of WLL based fixed phone customers.

	(1) Beta, (std. error), (p-value)	(2) Beta, (std. error), (p-value)
Migrants (mig)	-.0700959 (.0027422) (0.000)	-.0393353 (.0027694) (0.000)
Defaulter (dfltr)	.2535734 (.002749) (0.000)	.2655554 (.0027097) (0.000)

Residential customers (D1)		-.0305521 (.0173686) (0.079)
Business Customers (D2)		.1464618 (.0182132) (0.000)
Special customers (D3)		.2329298 (.0205398) (0.000)
PCO (D4)		.1438926 (.0202004) (0.000)
Employee (D5)		.1305498 (.0235981) (0.000)
Student (D6)		.109356 (.0233057) (0.000)
Constant	1.224732 (.0033877) (0.000)	7.710924 (.0174446) (0.000)
Log likelihood score	-378365.42	-377343.45
No. of observations	48583	48583

The above result shows that the migrant customers are likely to defect early by 3.93% of survival period without paying the last bill by 26.56 % more compared to non migrants. The result is highly significant even after introduction of dummy variable for each category of customers.

SUMMARY AND CONCLUSION

Population migration trend from rural Nepal to urban cities has been observed high in last decade in Nepal. The growth of telecommunications service has seen overwhelming growth during the period. After the introduction of pre-paid accounting system of billing in telecommunication service post-paid subscription has got retarded. Use of telephone service

using cellular mobile technology through hand held devices has led the fixed phone service (PSTN and WLL fixed) less relevant and customer defection has increased.

This research studied the consumer behavior of migrant population based on defection pattern of fixed phone subscription in comparison with non-migrants. By using the large data sets and observing their defection pattern for a period of more than 11 years and 5 months using maximum likelihood estimation of multiple regression equation.

This research studied on the defection pattern of customers based on their migrant status. Also, the risk of non-payment of last bill amount while cancelling the relationship with the service providers in case of substitutable products. This study found that migrant people cancel their service early by at least 4.3% days compared to non migrants. This effect is more significant on residential type subscriptions of migrant customers in case of post-paid type fixed phone service. Furthermore, this research identified that the migrant customers are likely to defect early without paying the last bill by 26.56 % more compared to non migrants.

The finding of this research is crucial in the study of consumer behavior from academic perspectives and has implications in all nature of business where credit is often a practice. Also, this study has managerial implications with the service providing companies where companies can estimate customer life time value and profitability of their business.

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