Application of System Dynamics to Mobile Telecommunication Customer Churn Management

P.K. Banda[1], S. Tembo[2]
[1]*Department of Electrical and Electronic Engineering, School of Engineering, University of Zambia. Box 32379, Zambia.*
[2]*Department of Electrical and Electronic Engineering, School of Engineering, University of Zambia. Box 32379, Zambia.*
patiencepaisons@yahoo.com

***Abstract*— In the mobile telecommunication industry, customer churn can be caused by factors which may arise from the interaction of subscribers with products and services or even employees of Mobile Network Operators (MNOs). If customer churn is not managed and prevented in good time, it can lead to significant loss of revenues and possibly make a business crumble. Most of the churn management strategies in use today segment mobile customers depending on factors such as their usage pattern and tenure to run prediction models or algorithms that keep the balance between churn rates and revenues. The data used in this study was collected from 700 mobile subscribers from 3 provinces of Zambia. This study combines factors that lead to customer churn, strategies of MNOs on churn management and demographic data collected from Central Statistical Office (CSO) and the Zambia ICT Agency (ZICTA) into a system dynamics simulation model. The result of this simulation shows that system dynamics can be used in making informed decisions to proactively manage customer churn.**

***Index Terms*—Churn Management; Customer Churn; System Dynamics; Zambia.**

I. INTRODUCTION

A. Introductory Background

There are many customer churn management approaches in use today. Most of these approaches use the method of segmenting customers and offering them incentives [1, 2, 3, 4]. The segmentation method lacks a maintenance strategy, which can be reviewed constantly to measure performance. Mattison [5] considers segmentation models as challenging because the factors surrounding customer churn are ever-changing, and customers do not announce their intentions in advance [6]. Since the nature of customer churn is dynamic it is imperative that it is modelled with causative factors in mind.

Referring to dynamism of causative factors in any system, Sterman [7] points out that if science were to go on doubling or quadrupling its complexities every 10 years, even mathematics should soon succumb. This brings the fact that systems get more complex and dynamic with time to the fore. The approaches used to maintain balance must therefore also change in order to meet the changes.

Systems thinking becomes important in churn management, especially in mobile customer churn management. The factors that cause customers to churn are ever changing. These factors also interact with each other and the external factors in a complex manner [8]. Hence, it is essential to use an approach that can guide in studying the behaviour of a system whose environment is challenging.

B. The Mobile Telecommunications Sector in Zambia

Mobile telecommunications in Zambia began in 1994 when ZAMTEL, a government owned MNO obtained the licence to provide mobile services to the public. Telecel now called MTN Zambia followed when it obtained its operating licence in 1995. The third entrant was Zamcell, now called Airtel Zambia, which got its operating licence in 1997 [9, 10]. The total number of mobile subscribers for the three MNOs evolved as shown in Table 1 for the years 2008 up to 2015. The mobile subscribers in the years 2013 and 2014 were lesser than those in 2012 due to the sim registration exercise which the MNOs embarked on. This exercise led to a minimization of multiple sim ownership for some of the subscribers. The mobile subscriber numbers began to grow in 2015 with 10.8 million subscribers, which put mobile penetration rate at 70 percent.

Table 1
Mobile subscribers' evolvement in Zambia *[9]*

Year	Mobile telephone subscribers [Million]	National Population [Million]
2008	3.2	11.8
2009	4.4	12.9
2010	5.4	13.1
2011	8.2	13.0
2012	10.5	13.5
2013	10.4	14.6
2014	10.1	15.1
2015	10.8	15.5

As of December 2015, there were still three MNOs on the Zambian mobile telecommunication market namely Airtel, MTN and ZAMTEL. Figure 1 shows the trend in market share for the three MNOs for the years 2007 up to 2015.

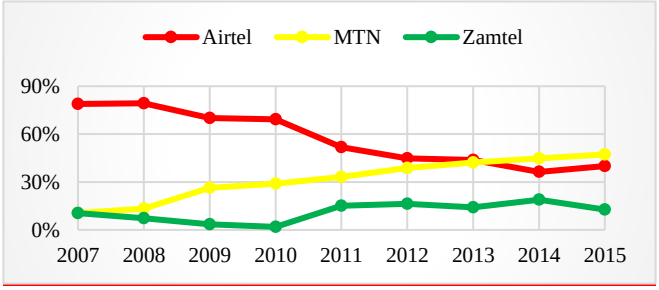

Figure 1: Market share for the three MNOs

II. Perspectives On Customer Churn

A. Mobile Customer Churn

In the mobile telecommunication industry, churn is defined as the number of customers who terminate their subscription to services with one MNO and sign up with another. Customer churn is calculated by dividing the aggregate number of mobile subscriber who cancelled service during a period by the total number of wireless subscriber connections at the beginning of that period as shown in Equation 1 [11, 12].

$$Churn\ rate = \left[\frac{C_0 + A_1 - C_1}{C_0}\right] * 100 \quad (1)$$

Where:

- C_0, is the number of customers at the start of a period
- C_1, is the number of customers at the end of a period
- A_1 is the gross new customers during the period.

Equation 1 defines churners as the difference between the sum of new gross additions and existing subscribers at the beginning of a period, from the subscribers at the end of that particular period. Customer churn is not only undesired in the mobile telecommunications industry, but also in most industries around the world. Over the years, the telecommunication industry has devised several models and plans to help take care of customer churn [11, 13]. Despite all the efforts that are made, the industry still suffers from customer churn and switching behaviour with global average annual churn rates between 10% and 67% [14, 15].

Some of the factors that lead to mobile customer churn are high cost of services, poor customer service, poor network coverage or quality, billing errors and many others [14, 16]. The key factor is that most customers terminate services because they are dissatisfied with a product or service [15]. Note that this number does not include customers who may churn involuntarily such as when they travel abroad temporarily but do not use any service on their sim connections for a certain period of time [17].

With specific mention to the mobile service providers, there are many effects of customer churn in such organizations.. Factors such as loss of brand value, loss of revenues, loss of market share and increased operational costs to win back customers may be visible almost immediately [6, 13]. There are however other subtle effects such as social influence due to mis-representation by churners in the community.

B. Overview of Churn Management Approaches

Mattison [5] proposed customer engagement as a means to manage churn. In his model, the MNO needs to know the customer, maintain a healthy relationship and keep alert to warning of would be churners. This acts as a preventive measure to churn so that if possible, it ensures that the customer does not terminate subscription. Other than using preventive measures, other approaches such as engaging customers (Customer Relationship Management (CRM)) [5] has of late taken centre stage in customer churn management. Organizations, scholars and researchers have used different segments of CRM model to prevent customer churn, with varying results [5]. For example, the perspective Mattison portrayed of churn resonates with that of Aufar [12], which points out that although churn leads to revenue losses, it also provides opportunities for organizations to learn. These results by the two scholars, in our analysis allows MNOs to have a much wider perspective and develop more resilient strategies to win the loyalty of their customers.

Other models such as the one developed by Kim and Yoon [18] explored customer churn prediction using the binomial logit model, which took into consideration demographic, economical and mobile phone usage variables of 973 mobile subscribers in Korea. The age and sex of a consumer defined the demographic variables while economic variables included income and average revenue spent on subscription to mobile services. Mobile phone usage variables included factors such as historical records of switching behaviour of customer, longevity of their subscription with a mobile operator and duration of current handset used. Others researchers such as Canale and Nicola [19] conducted a test on customers of the European Telecommunications Company. Customer behaviour was analyzed for a period of ten months. The result in customer prediction had less error as compared to such methods as linear regression, logistic regression, linear discriminant analysis, logistic additive model, a classification tree and a neural network.

Other researchers such as Lemmens and Gupta [1] used the model of gradient descent analysis using matrix simulation. This approach takes into account the value of the customer combined with a predicted figure of the probability response of the customer to any launched retention programs. Lemmens and Gupta [1] then used an algorithm called 'profit based loss function', whose local minima gives an indication of whether more can be done to improve the retention pattern of such a customer or not. The algorithm is optimized using the stochastic gradient boosting method, which is a machine learning concept, in an iterative manner. The testing of the model was done on Verizon Wireless, the largest wireless services provider in the United States with 111.3 million subscribers at the time of the study [1]. The gradient descent profit based loss function model gave a predictive performance that yielded a difference of more than $28 million, compared to the traditional classical loss function whose gradient descent was not taken into consideration. As a matter of fact, this approach yielded better profits ($3,700) more than the classical loss function ($1,718) across all scenarios. This represented an improvement in profit of equal to 115 percent on average. The limitation of this model, however, is that the profit-based loss function leads to more errors in terms of forecasting which customers are likely to churn [1].

Also of usage in churn management models are techniques based on data mining. Data mining is a data processing methodology, which uses sophisticated data search capabilities and algorithms to in order to discover patterns, associations and relationships in data. Examples of data mining techniques used in churn management are bagging classifiers by Canale and Nicola [19], the decision-centric ensemble by Baumann [20], deep learning by Catanedo [21], stream mining by Balle [22], clustering, probability trees and other methods [6, 23, 24]. In short the predictive capabilities of the data mining method paves way

for informed marketing strategies, real-time customer-retention strategies from promotions and mailings to direct customer contact, and new service plans. Therefore, mobile network operators can optimize their marketing intervention resources to prevent as many customers as possible from churning. In other words, if the telecom companies know which customers are at high risk of churn and when they will churn, they are able to design customized customer communication and treatment programs in a timely efficient manner [5].

C. Challenges with Existing Churn Prediction Models

Almana [23], Lemmens and Gupta [1] ,Mattison [5], and Oghojafor [14] all acknowledge the fact that due to the uncertainties in the behavioural patterns or decisions of the customer, it is not easy to determine the customers that are likely to churn, what factors would make them churn, and when they may churn with ultimate accuracy. Peighambari [4] summarized the factors that make predictions inaccurate into the four main categories listed below. Customer preferences continually evolve.

(i) Customer preferences continually evolve.
(ii) Customer demand for products varies continuously.
(iii) Major competitors in the market continually introduce new products.
(iv) Major competitors in the market continually devise new selling strategies.

Peighambari [4] argued that of all four factors considered in the study, environmental dynamism was the only one that had a negative effect on retention. This was because the more the dynamism in the environment, the harder it was to make customers stay with the company [4]. Peighambari stated that industries are bound to go through environmental dynamism. Hence, it becomes important for MNOs to have proper churn management models, especially so that they can manage competition [4].

Although Mattison acknowledged that churn is undesirable [5], he called it a 'golden opportunity' [5]. Mattison went on to say that the real problem is always that organizations are unable to make an appropriate assessment of the churn situation [5]. This means that it is not churn that needs to be managed, but the relationship that MNOs have with customers. Mattison condemned the approach of segmenting customers according to the factors that cause churn. He said, when customers churn, it is unlikely that they mention the real reason for their leaving when they are asked upfront by MNOs. People may be embarrassed by their real reasons, or may not want to hurt the feelings of the company employee or interviewer [5]. In agreement, Kuusik and Varblane [5], also speak against segmentation when they state that it is not accurate to treat all customers equally in terms of methods of increasing their loyalty [13].

Other researchers such as Sarkindaji, Abdullateef and Hashim [15] conducted a study on inconsistencies in Customer Relationship Management (CRM) implementations and establish their influence of CRM measurements on customer loyalty effectiveness. They emphasized that these implementations need to be reviewed from time to time to check factors surrounding the decision of the customer at different times [15]. CRM is not a once off exercise, otherwise it would not be possible to deduce whether the customer is satisfied or not. Sarkindaji, Abdullateef and Hashim [15] cited that this situation has led to the inability of the MNOs around the globe to manage relationships and retain long-term loyal customers [24]. They [15] concluded that this lack of feedback in customer churn management leads to high rates of customer churn and subsequently low revenue for the MNOs [15].

Hence, the churn management approaches used today lack feedback, generalize problems of customers, resolve symptoms and not actual problems, are not reviewed constantly to see if they are working and do not consider the fact that customer needs change constantly and abruptly.

D. Overview of System Dynamics

Sterman [7] defines system dynamics as a methodology for studying and managing complex feedback systems while Cai [8] describes system dynamics as an approach to understanding how systems can generate their own problems [8]. Jay Forrester initiated the field of system dynamics when he applied feedback theory to industrial systems around the year 1961 [25, 26]. It is a method that uses closed loop feedback systems in simulations. These feedback loops can give guidance on what measures need to be taken in order to achieve the desirable result.

System dynamics helps with simulations of facts that are already known, or may be assimilated over time through experience or literature. Instead of processing these facts one at a time and probably under differing circumstances, system dynamics meshes the interactions of mental and simulation models to form a complete system that is susceptible to external disturbances.

System dynamics finds a wide range of applications in analytics, business modelling, crisis management, decision-making, medicine, policy formulation, social behavioural patterns, strategic war planning and many more [7, 27, 8, 28, 26]. Fong, Matsumoto and Lun [29] used system dynamics for making decisions to control future carbon emissions and global warming in Malaysia [29]. Marjan van der Belt [27] used system dynamics in promoting mediated thinking among individuals in the environmental management sector. Marjan van der Belt [27] articulates that certain critical decisions need resources with integrated frameworks and orientations require management to put their thoughts together to arrive at a decision that benefits the entire organization. Sterman states, system dynamics has been applied to issues ranging from corporate strategy to the dynamics of diabetes, from the cold war arms race between the US and USSR to the combat between HIV and the human immune system [7]. Fabien [28] uses system dynamics in his study of constrained systems, kinematics and network systems analytical modelling. Chao and Zishan [30] applied a system dynamics view to road traffic engineering by designing a system dynamics model that employs system dynamics to study and predict the future evolution of the passenger transportation system in Shanghai city of China . In the past few years, the adoption of the system dynamics in science has increased. This is because its incorporation of changes is highly applicable almost in all areas of life.

Sterman [7], explains that system dynamics thinking studies the changes in systems over time that emerge from the interrelatedness of the parts. The changes that the interrelated parts have on the system can ripple throughout a system in ways that may be least expected [7]. Cai [8] states that the sure thing is that over time, a formidable structure, which create the system behaviour, forms [7, 8]. Marjan van der Belt [27] cites that this behaviour formation is by

changes in the system. These changes may ripple through in unpredicted circumstances [27]. The fact that it is hard to determine the rippling through of the change makes this approach quite fitting to handle the dynamism and uncertainty surrounding the factors that lead to mobile customer churn [1, 4, 14, 27].

E. Applicability of System Dynamics in Churn Management

Studies on customer churn, such as the ones done by Kuusik and Varblane [13], Mattison [5] and Peighambari [4] attest to the complexity of the network of factors that lead to customer churn. The system is not only complex but also constantly evolving depending on many factors that may not be so obvious [5]. This clearly points to the complexities that are faced in curbing churn, which calls for an approach of thinking about systems, how factors interact and keeping in mind that with a little more patience, these interactions can mature into structured patterns from which lessons can be drawn.

There is also a great need to assess the performance of strategies used to counteract churn. The study conducted by Sarkindaji, Abdullateef and bin Hashim [15] brings out the importance of constantly evaluating the performance of the implementations in churn management. Cai [8] states that the effects of ignoring long run feedback can lead to unintended consequences. Because this is a system, there is need to constantly evaluate the performance of the model and optimize it if need be so that it functions as purposed [15, 27]. There is a strong relationship that exists among the various factors that make up a system. What may work for one factor, might not work for another, or what may work for one factor, may have negative effects on the other factors in the system. A performance model therefore, needs regular evaluation until a desirable outcome is attained.

Ogata [31] defines a system as a combination of components acting together to perform a specific objective. Ogata further makes mention that a system is called dynamic if its present output depends on its current input [31]. This implies that a change in the input of a dynamic system results in a change of the output. If this does not happen, then the system does not qualify to be termed as dynamic but static instead. Another key quality of a system is that the components do not work in isolation but collaboratively to achieve the objective. Economic factors, actions of MNOs and their competitors have a large influence on the churn rates in the industry. This qualifies the churn management model to be called a system.

According to Ogata's [31] definition of a system, various components of a system interact with one another in different ways for the sole objective of producing an output from an input. This interaction among the components of the system results into system behaviour, which in turn produces the output. Ogata also acknowledges that a system interacts with the external environment through a well-defined boundary, which is part of the input. This interaction among the components of the system results into 'system behaviour', which in turn produces the output. Ogata also acknowledges that a system interacts with the external environment, which is part of the input. The interactions of the system with the outside environment happens through a well-defined boundary. A static system gives the same result for the same input, either by quantity, quality or rationality. This means that if the input is adjusted, the output also changes by the same rule as for a fixed input. This is not the case with a dynamic system where different outputs can be realised even while the input remains constant.

Remembering that the interactions of a system determines the output, it is logical to conclude that a static system has behaviour which is constant while a dynamic system has behaviour which is ever changing. Chao and Zishan [30], indicated that this feature allows system dynamics to be capable of predicting how systems are likely to evolve in future [30]. A dynamic system also has the ability to learn from memory. Hence, Ogata defines a dynamic system as one whose output depends on the present input and that of the past and if it has memory [31]. This factor becomes very useful in customer churn management.

The churn management model to be designed is a tool that management in the mobile telecommunications sector can use to make strategic decision making. The model applies step by step actions that can be taken for varying circumstances. For example, an MNO may determine that it has 10 key factors that are causing churn among its customers. In a case where the resources are not sufficient to address all of them at once, the MNO can use the model to have a foresight on how each of the factors is likely to affect them over a short or long period of time. This information can then help management make a decision on which factors become a priority. It may happen that 3 of the 10 factors are actually leading to most of the churn cases. The result of the churn management tool therefore should allow for logical conclusions to be drawn on the findings of the research.

There are two critical features of system dynamics, which further qualify it for use in churn management. Firstly, practitioners of system dynamics are interested in the interrelatedness within and among systems. Secondly, the time span of interest is such that patterns have a chance to become clear. Cai [8], stresses the point that structure creates behaviour, a feature which also relates to feedback structures [7, 8, 26]. It is this principle stated by Cai [8] that forms the backbone of this study. If structure can create behaviours, then there is a chance to learn from the interactions of challenges of the customers and actions of the MNOs over time. This pattern allows for formulation of a learning model that can be used for decision making in churn management.

In summary, system dynamics methodology is appropriate for this study as it gives structure to how factors that lead to customer churn interrelate. It also ascertains churn rate by factoring in external factors and the actions that MNOs take. Despite the fact that these factors may or may not be anticipated, a change on any of these factors is anticipated to induce a change on the churn rate. The performance of the system will also be evaluated by constant feedback, allowing for continued improvement and maintenance of the model. System dynamics can render a lot of help to mobile customer churn challenges in that it challenges the traditional way of doing things and accommodates changing aspects in the environment.

III. OBJECTIVES

The Objective of this study was to design a system dynamics model that can be used for decision making in mobile customer churn management.

IV. METHODOLOGY

Figure 2 presents a summary of the approach and design taken for this research. Data from three perspectives namely that of mobile subscribers, that of MNOs and that of ZICTA and government agencies such as CSO was collected.

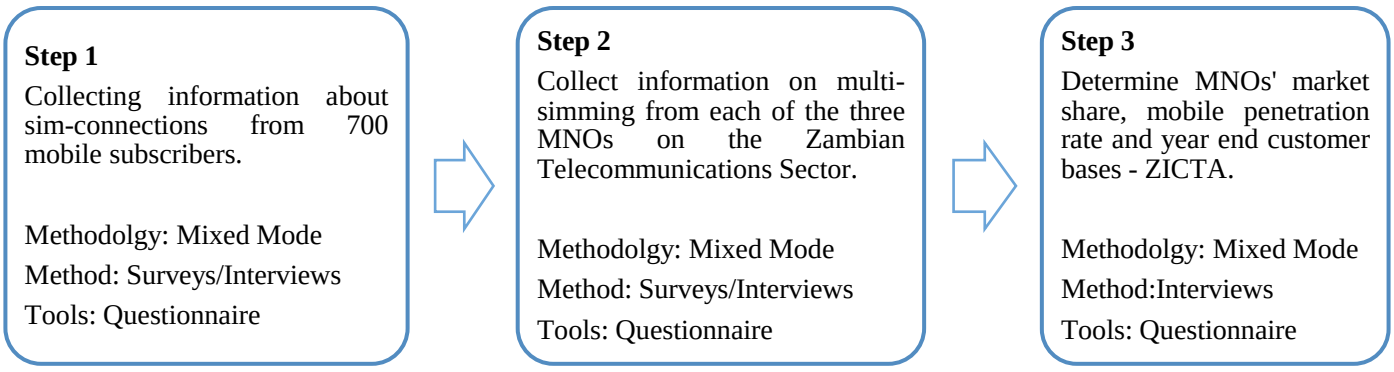

Figure 2: Methodology, methods and tools used in this study

The sampling technique used during data collection from mobile subscribers was stratified sampling. The samples were drawn from 6 districts in 3 different provinces of Zambia. From Lusaka province, Lusaka, Kafue, Chongwe and Luangwa districts were sampled from Lusaka district. Mbala and Mpulungu were sampled from Northern Province while Chibombo district was sampled from Central province.

The sample size per stratum or district was determined using Equation 2 [32], which relates number of sampling units to the population.

$$\textit{Sample size per stratum} = n_i = n.\ P_i = n.\left(\frac{N_i}{N}\right) \quad (2)$$

Where:

- n is the sample size or total number of samples to be drawn from the sample space.
- n_i is the number of samples to be drawn from the i^{th} stratum.
- N_i is the population per i^{th} stratum, which in this case as calculated as 70% of the population per district as ZICTA
  determined for the year 2015.
- N is the total population in a sampling frame. The national population of Zambia was determined as 13,092,666 during the 2010 Census as published by the Central Statistics Office (CSO).
- P_i is the ratio of the total number of samples in the i^{th} stratum

Using Equation 2, the sample sizes shown in Table 2 were determined. N in Equation 2 was represented by the total population subscribed to mobile services in the sampling frame. N_i Was represented by the population subscribed to mobile services per district or strata. The total number of samples desired to be drawn, n, was 700.

Table 2
Sample Sizes per Strata/District

District	Population	Mobile Subscribers (**Ni**)	Sample Size
Lusaka	1,715,032	1,205,667	458
Chongwe	181,816	127,817	34
Kafue	219,000	153,957	41
Luangwa	23,059	16,210	4
Mbala	192,636	135,423	57
Chibombo	290,556	204,261	38
Sampling Frame	2,622,099	1,843,336 [N]	700 [n]
Universe [Zambia]	13,092,666	9,164,866	

Using Equation 2 for example, the sample size for Lusaka district was determined as follows;

$$n_i = n.\ P_i = n.\left(\frac{N_i}{N}\right)$$

$$n_i = 700 * \left(\frac{\left(\frac{70}{100}\right) * 1715032}{\left(\frac{70}{100}\right)*1715032+\left(\frac{70}{100}\right)*181816+\left(\frac{70}{100}\right)*219000+\left(\frac{70}{100}\right)*23059+\left(\frac{70}{100}\right)*192636+\left(\frac{70}{100}\right)*290556}\right)$$

.

$$n_i = n_{Lusaka} = 700 * \frac{1205667}{1843336} = 458$$

V. SYSTEM TESTING AND ANALYSIS

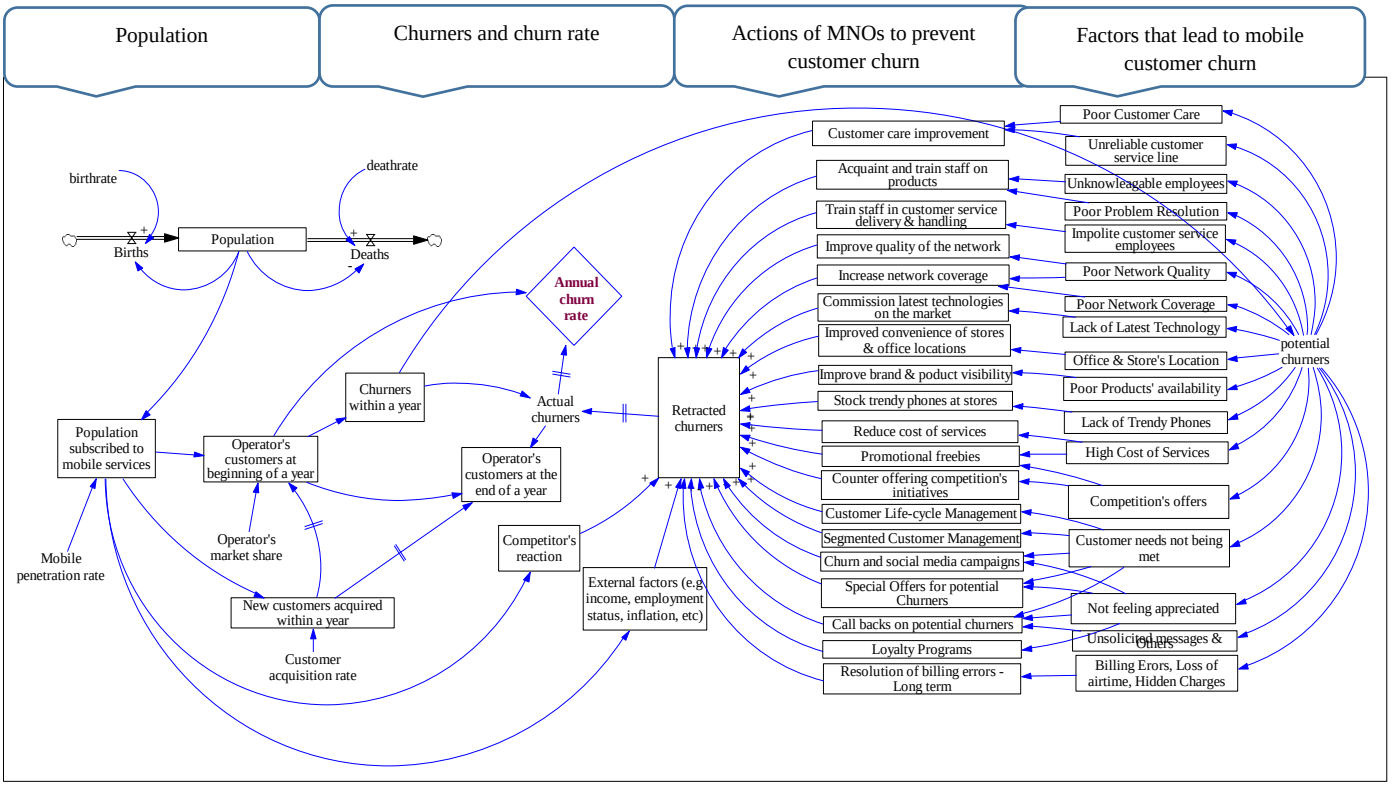

Figure 3: Designed churn management model

Figure 3 shows the system dynamics churn management model that was designed using Vensim software. The data used in this model is population statistics collected from the Central Statistical Office (CSO) of Zambia, factors that lead to customer churn, how MNOs manage different factors that led to customer churn and how effective these initiatives are. The annual churn rate is the main output of this model. The objective is not to run a simulation that will give same or similar results to those collected from the surveys, but to use those results as initial values in order to study the behaviour and future evolution of churn on the Zambian telecommunications market and propose a strategy to minimize it.

The designed churn management model was tested under four scenarios. Firstly, the simulation was done with a feedback loop that represents iterative measures taken by MNOs to manage churn. In the second scenario, the MNOs do not take action but leave churn to manage itself. In the third scenario, the MNOs delay to take action on churn management. In the final scenario, MNOs manage churn by addressing different factors that lead to churn according to their impact and priority.

The first and second test cases are represented in Figures 4 and 5 respectively. The contrast between these two scenarios is the presence and absence of the feedback loop that allows MNOs to take action on the problems that subscribers are facing. Equations 3 and 4 represent the translation of Equation 1 that was used to determine the annual churn rates MNOs would face in a case where they take actions to mitigate them.

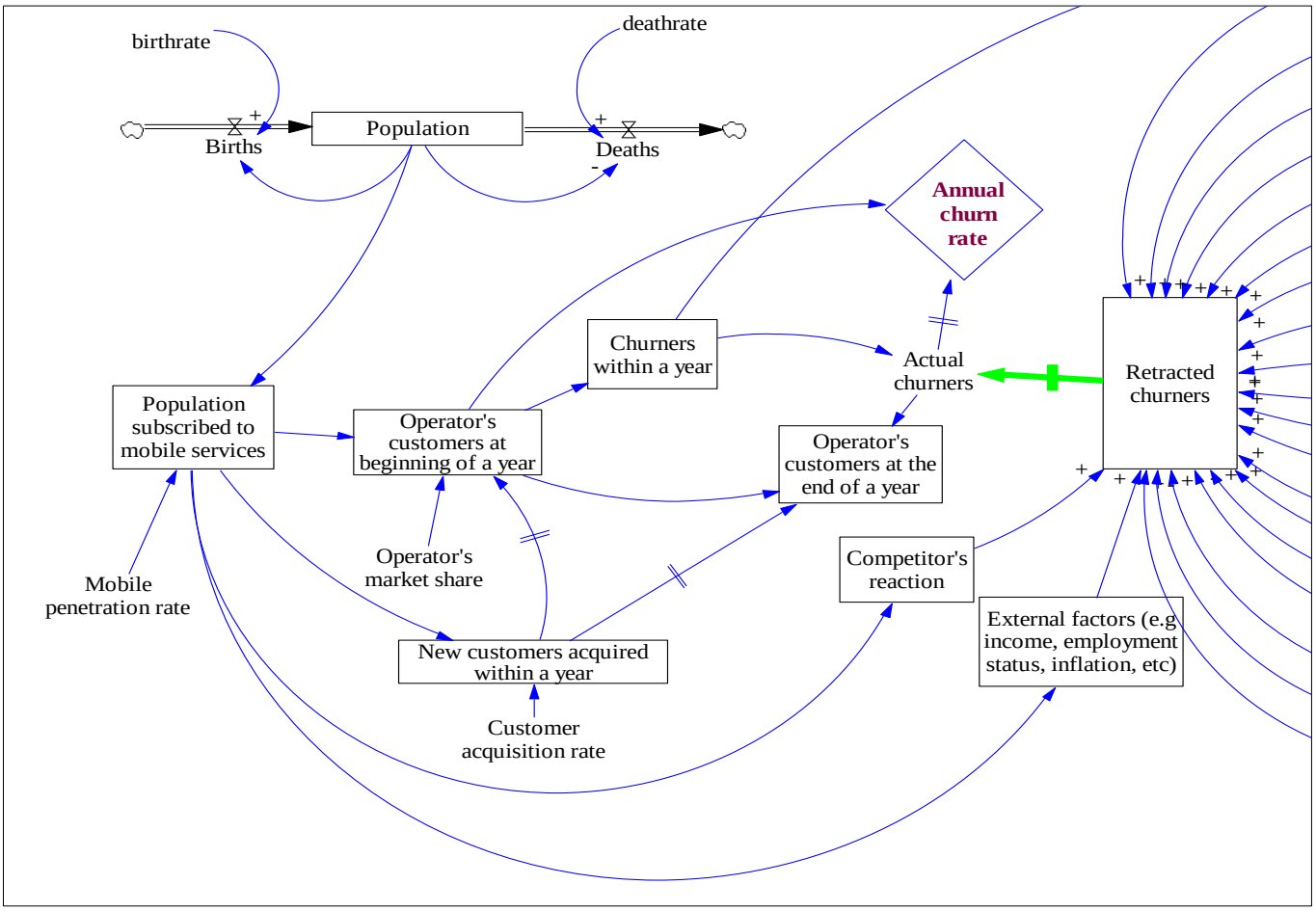

Figure 4: Churn management model with feedback

$$\text{Churn rate with feedback} = \left(\frac{\text{Actual churners}}{\text{Operator's customers at beginning of a year}} * 100\right) \quad (3)$$

$$\text{Churn rate with feedback} = \left(\frac{(\text{Churners}+\text{External factors}+\text{Competitor reaction}-\text{Retracted churners})}{\text{Operator's customers at beginning of a year}} * 100\right) \quad (4)$$

$$\text{Churn rate without feedback} = \left(\frac{(\text{Churners}+\text{External factors}+\text{Competitor reaction})}{\text{Operator's customers at beginning of a year}} * 100\right) \quad (5)$$

Equation 5 shows a variation of Equation 1 in a case where the MNOs do not take action against churn. In real life churn scenarios, external factors such as social and economic aspects would always affect the usage pattern of subscribers and eventually influence churn rates. There will always be customers leaving and competitors will always have an influence. Although these three factors can further be broadened, they have been summarized in Figure 4 and Equation 5. In contrast to Equation 4, Equation 5 does not have any customers who are won back by the actions of the MNOs. The MNOs do not intervene, hence the scenario is referred to as one without feedback. The result of the test cases in Figures 4 and 5, as well as the other two scenarios will be discussed in details under the results.

VI. Results And Discussion

Figure 5 shows the average annual churn rates that each MNO on the Zambian telecommunication sector experiences. This was a result of the interviews and surveys conducted on 700 subscribers. It represents the annual churn rates experienced between the years 2010 and 2015 for the distinct MNOs.

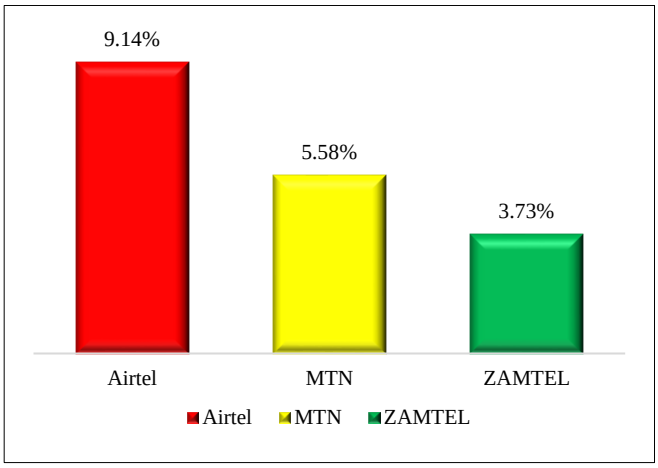

Figure 5: Average annual churn rates for the MNOs

For the purpose of the simulation, the initial churn rate used was the average churn rate of all three MNOs combined, which was determined to be 6.15 percent per year. This was the initial value used in the model designed under Figure 4 to give the result in Figure 6. During the course of the initial year, the MNO does not apply any action, thereby increasing the number of prospective churners. The MNO begins to apply actions to mitigate

churn in year 1, and as Figure 6 shows, the number of churners begins to decrease drastically. This is because in the feedback, the large number of churners reduce the effective customers that an MNO has at the end of the year.

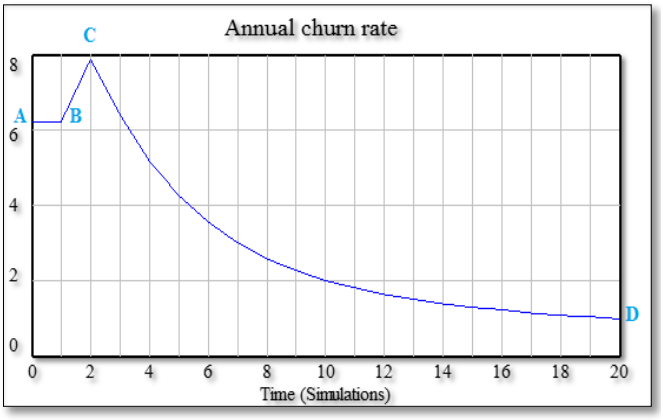

Figure 6: Annual churn rate with feedback

The result of Figure 6 shows what happens in a case where MNOs delay action and when they take action. Between points B and C, in year 1, churn rate rises because the MNO does not intervene. As year 2 commences, churn rate drops because of the MNO's intervention. At point D, the MNO would have reviewed the churn management model about 20 times in order to determine whether it is working or not. Although churn rate is not at zero percent at point D, it is less than it was at points B and C. The churn rate in this model does not drop to zero due to the fact that population keeps on growing and other external factors on which MNOs do not have a direct control also have an influence. For example, the MNOs may not directly be able to mitigate the impact that inflation may have on the spend and usage of the mobile subscribers. The MNOs may also not be able to stop the reports about their products and services that may be circulated by detractors in the communities.

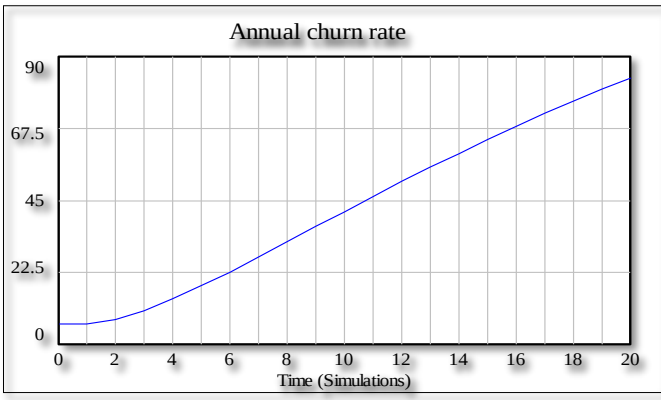

Figure 7: Annual churn rate without feedback

Figure 7 represents the churn rate result in a case where the MNO does not intervene at point C of Figure 6 and later in the future. If churn is not controlled, the MNO could risk losing its customers to the competitors. This is shown in Figure 7 where by the 20th simulation time, the churn rate rises to about 83 percent.

The result of the first two test cases become very important in customer churn. The business owners would use a forecast of the churn rate in a case where they take action and when they do not to determine what quantity of resources can be used in churn management.

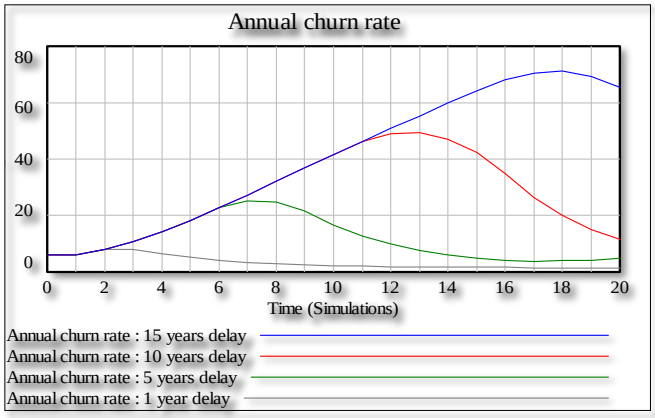

Figure 8: Annual churn rate with variable delay

Figure 8 shows how the churn rate evolves for variable delays by MNO to take action and resolve the problems customers are facing. It shows the churn rate when MNO delays for 1, 5, 10 and 15 years. This test case was run for an MNO that has of 4,000,000 mobile subscribers in the initial year. If the MNO takes action in the second year, the MNO has a maximum of about 1,500,000 churners. If the MNO takes action in the fifth year, the number of churners grows up to a maximum of about 1,900,000 in the fifth year.

In all of the years shown in Figure 8, when the MNO intervenes, the churners gradually reduce. The more the delay, the more the number of customers who defect to the competitors become. The impact of these variable delays on churn are represented by the peaks in Figure 8. The result of Figure 8 show that the number of churners rises with increasing delay on the part of the MNOs to take action.

The result of Figure 8 becomes very important to MNOs when determining the impact of their delay in taking preventive measures against churn. This is very insightful in that churn rate has a direct impact on the revenues that a firm realizes. Like other businesses, MNOs also want to be economical in their use of resources for them to remain profitable. The result of Figure 8 can help them to determine which factors leading to churn need to be addressed with the utmost urgency and which ones can delay. They can also do a forecast and determine the maximum possible delay they can put on implementing certain strategies with a tolerable loss on revenues.

In the fourth test case, the impact of different factors leading to churn were determined. As can be seen in Figure 9, the 'Result' label in the bottom line shows the churn rate evolution over 20 time spans or simulation in a case where all factors leading to customer churn are addressed. This was done for factors on which the MNOs' actions have an impact and not demographic, economic or social factors. The second from the bottom line shows the churn rate trend in a case where all other factors are addressed by MNOs, except poor customer care. In the third line from the bottom, poor customer care and poor network quality have not been addressed. In the second line from the top, poor customer care, poor network quality and high cost of services have not been addressed. In the top line, poor customer care and billing errors have not been resolved.

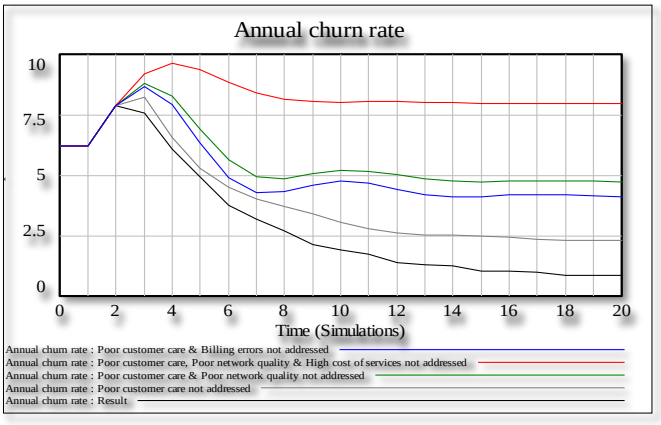

Figure 9: Annual churn rate with different priorities

The trends of Figure 9 provide very valuable information for customer churn managers and business owners. When subscribers face challenges, MNOs must be ready to spend in order for them to offer satisfying service and products. A result such as shown in Figure 9 can help MNOs to ascertain the contribution of these factors to mobile customer churn. If this was to be done at an individual mobile subscriber's level, it would consume a lot of time, resources and have a great impact on the brand value of the MNO. For example, let us assume that equal amounts of money were to be spent on resolving poor customer service, poor network quality, billing errors and high cost of services. If the MNO has resources to address only two of these challenges, they can use this model to determine which two take priority.

VII. Conclusion

Different aspects of the environment such as economic factors, delays by MNOs to take action and abrupt changes in terms of which problems take the most weight have differing effects on churn rate.

The results of Figures 7 and 8 show the churn rate cases when MNOs take actions to address challenges of subscribers and when they take no action respectively. The result of the simulation shows that when churn is not managed promptly, it has the potential to make a business crumble. The frustrations that customer's face need to be addressed using a system that can be reviewed consistently and in a proper manner.

Figure 8 shows a result of importance to business owners and churn managers in the mobile telecommunications industry. This result shows the impact that delay on the part of MNOs to take action has on churn rate. The longer MNOs take, the more frustrated customers get hence the higher the churn rate. In Figure 9, the impact of individual factors that lead to churn on churn rate was studied.

The results of Figures 9 and 10 become very beneficial to MNOs in terms of resource planning, strategic decision making and business sustenance among others. Resources are scarce and management would want to ensure that they are used in the best manner possible. Hence, churn managers can use this information to elaborate the impact that a delay on making certain decisions or not addressing key factors leading to churn can have on business performance. The business owners can also use this information to validate internal reporting and respond to business needs in due time and with high levels of confidence. System dynamics simulations can be forecasted to show the impact of certain decisions in the long and short terms to the business.

In conclusion, the aim of this research has been achieved. A churn management tool, which is usable in strategic decision making in churn management has been designed. The tool can be used in setting priorities when taking action on the problems that customers face. The behaviour of the model can be studied for several trading periods, a feature that MNOs can use when faced with making decisions related to opportunity cost and strategy. Like other corporations, MNOs are interested in maximizing the revenue returns. This can be achieved by maximizing their revenues, minimizing churn, growing their market share through acquisition of new customers and having a strategic roadmap on the development of their products and services.

Acknowledgment

I wish to render my gratitude to my supervisor, Dr. Simon Tembo who provided a lot of insight and support on this research. I also wish to thank my family, respondents to the surveys, CSO, the three MNOs in Zambia namely Airtel, MTN, ZAMTEL and the regulator, ZICTA. Your contributions, in word and deed, have great magnitude and significance to the success of this research.

References

[1] A. Lemmens and S. Gupta, "Managing Churn to Maximize Profits," *Working Paper*, vol. 14, no. 20, 2013.

[2] R. J. Jadhavi and U. T. Pawar, "Churn Prediction in Telecommunication Using Data Mining Technology," *International Journal of Advanced Computer Science and Applications (IJACSA)*, vol. 2, no. 2, February 2007.

[3] J. Ojasalo, "Customer Relationship Longevity and Satisfaction Sources in Professional Services," *The Journal of the Economic Society of Finland*, 1999.

[4] K. Peighambari, *Developing and Testing a model for explaining Customer Retention Formation; Case of Iranian Mobile Telecommunication Services*, Sweden: Master Thesis, Lulea University of Technology, 2007.

[5] R. Mattison, The Telco Churn Management Handbook, Illinois: XiT Press, 2005.

[6] *Predicting Customer Churn in the Mobile Telecommunication Industry, A case study of MTN Ghana, Kumasi*, 2011.

[7] J. D. Sterman, Business Dynamics, Systems Thinking and Modelling for Complex World, United States of America: McGraw Hill, 2000.

[8] Z. Cai, *System Dynamics (SD) and its Applications*, AMEC, Knutsford, Cheshire.

[9] "ICT Investiment Profile," Zambia ICT Agency (ZICTA) and Zambia Development Agency (ZDA), Lusaka, 2015.

[10] S. Habeenzu, "Telecommunications Regulatory Environment in Zambia ICT Sector Performance Review," Lusaka, 2010.

[11] Federal Communications Commission, "17th Report - Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services," Federal Communications Commission;, Washington DC, 2014.

[12] M. Aufar, "7th Asia-Pacific Business Research Conference," in *Study of Post-Churn Impacts on Brand Image in Telecommunication Sector*, Singapore, 2014.

[13] A. Kuusik and U. Varblane, "How to avoid customers leaving: the case of the Estonian telecommunication industry," *Baltic Journal of Management*, vol. 4, no. 1, pp. 66-79, 2009.

[14] B. Oghojafor, "Discriminant Analysis of Factors Affecting Telecoms Customer Churn," *International Journal of Business Administration*, vol. 3, no. 2, 15 March 2012.

[15] A. Abdullateef, A. N. Hashim and B. D. Sarkindaji, "A Review of the Inconsistency in CRM Measurement: Evidence from the Telecommunication Industry," *Journal of International Business and*

Economics, vol. 2, no. 2, pp. 107-131, June 2014.

[16] D. Y. Arthur, E. Harris and J. Annan, "Principal Component Analysis of Customer Churns in Ghanaian Telecommunication Industry," *American International Journal of Contemporary Research*, vol. 2, no. 12, 2012.

[17] R. Kreher, UMTS Performance Measurement; A Practical Guide to KPIs for the UTRAN Environment, Germany: John Wiley and Sons, 2006.

[18] H.S. Kim and C.H. Yoon, "Determinants of subscriber churn and customer loyalty in the Korean mobile telephony market," sciencedirect, Korea, 2004.

[19] A. Canale and L. Nicola, *Churn Prediction in Telecommunications Industry-A Study Based on Bagging Classifiers*, Moncalieri, Italy: Collegio Carlo Alberto., 2014.

[20] A. Baumann, et al, "Maximize What Matters: Predicting Customer Churn with Decision Centric Ensemble Selection".

[21] F. Catanedo, et al, *Using Deep Learning to Predict Customer Churn in a Mobile Telecommunication Network*, 2014.

[22] B. Balle, et al, *The Architecture of a Churn Prediction System Based on Stream Mining*, 2013.

[23] A. Almana, et al, "A Survey On Data Mining Techniques In Customer Churn Analysis For Telecom Industry," *International Journal of Engineering Research and Applications*, vol. 4, no. 5, pp. 165-171, 2014.

[24] A. A. Khan, M. M. Sepehri and S. Jamwal, "Applying Data Mining to Customer Churn Prediction in an Internet Service Provider," *International Journal of Computer Applications*, vol. 9, no. 7, 2010.

[25] J. W. Forrester, *Some Basic Concepts in System Dynamics*, United States: Sloan School of Management, Massachusetts Institute of Technology,, 2009.

[26] B. Richmond, "System Dynamics/Systems Thinking: Let's Just Get On With It," in *International Systems Dynamics Conference*, Sterling, Scotland, 1994.

[27] M. van den Belt, Mediated Modelling, A System Dynamics Approach to Environmental Consensus Building, Washington: Island Press, 2004.

[28] B. Fabien, Analytical System Dynamics: Modelling and Simulation, Spring Street: Springer Science+Business Media, LLC, 233, 2009.

[29] W. Fong, H. Matsumoto and Y. Lun, "Application of System Dynamics model as decision making tool in urban planning process toward stabilizing carbon dioxide emissions from cities," *Building and Environment*, vol. 44, pp. 1528-1537, 2009.

[30] Y. Chao and M. Zishan, "System Dynamics Model of Shanghai Passenger Transportation Structure Evolution," in *13th COTA International Conference of Transportation Professionals (CICTP2013)*, 2013.

[31] K. Ogata, System Dynamics, 4th ed., New Jersey: Pearson Prentice Hall, 2004.

[32] S. Rajasekar, *Research Methodology*, Tamilnadu, India: School of Physics, Bharathidasan University, 2014.