Dynamic Modelling to assist in the Understanding of Consumer Take-up and the Diffusion of New Telecommunications Services

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With the approaching new Millennium, the rate of telecoms evolution is continuing to grow with business and market opportunities in abundance. This in turn creates a necessity to understand the success or otherwise of the temporal take-up by consumers of new products and services, (innovations). Such issues not only have serious implications for the fundamental network infrastructure, dimensioning and traffic, but also for profitable revenue generation.

Traditionally, the Bass diffusion curve has been used to simulate customer take-up. This paper investigates the use of alternative methods to create different types of diffusion curves to simulate the take-up of an innovation by a customer base. A System Dynamics approach has been taken to examine the effect of different market diffusion processes on the take-up of innovations. Successful diffusion and take-up of any new innovation depends on a large number of attributes, such as perceived quality, perceived need, actual quality and actual need. One System Dynamics methodology discussed examines the drivers and attributes, which determine the particular type of diffusion curve that a new innovation will probably follow. This then indicates the likely success or otherwise of that innovation in the marketplace.

The paper also suggests future developments of the work, within the Telecommunications environment. This is to assist in the creation of models that are more accurate in modelling the diffusion of products and services into the UK market.

1 Introduction

Until recently, many of the System Dynamics models created in the telecoms environment, had based their product diffusion on the Bass model of innovation and imitation. The work described here attempts to progress that model further by suggesting alternative mathematical options to the Bass model.

With respect to this work, the diffusion of telecoms products and services is based on the assumption that: they are not substituting products/services already in the market, nor repeat purchases, nor Me2[i] products or services. This is an unrealistic situation. However, the importance here is to accurately model product diffusion before incorporating too many outside factors that are beyond the telecoms providers' immediate control. Similarly, competition has been excluded. This is to enable the investigation of effective modelling of a company's own products/services and their diffusion process before attempting to model the effects of the competitions' products/services.

This paper focuses particularly on the diffusion equations that could be used in Telecoms System Dynamics modelling and how they could be modified within the model to give a more realistic diffusion model of consumer take-up of telecoms products and services.

One of the main drivers for this research is that when a new product or service is launched, it is of great importance to understand the consequent effects on the network infrastructure, cost, revenue, etc. Therefore, accurately modelling of the diffusion process is essential when trying to manage issues such as the cost base and ensuring network availability.

Unfortunately, the methods used to model the diffusion of products/services within the telecommunications System Dynamics arena are often overly simplistic, leading to errors in the scenarios modelled.

Having recognised that there are weaknesses in the product/service diffusion methodology often used by telecoms modellers, some investigation into other methods has been undertaken. Alternative methods of modelling the diffusion of innovation are discussed in this paper. Please note that this paper is put forward as a discussion tool, it is intended to stimulate debate and invoke research into this area.

2 System Dynamics & Diffusion Curves in Telecoms Models: Factors Affecting Diffusion

There are a large number of issues, (both internal and external to the telco), that can affect product/service diffusion. A few of the external issues are shown in figure 2.0.1. An issue to note is that not only do they all affect the diffusion process in different ways, but do so by varying amounts. To accurately model the effects of certain issues on diffusion, it is important to state the assumptions that are being made and to justify why those being modelled have been chosen and why others have been left out.

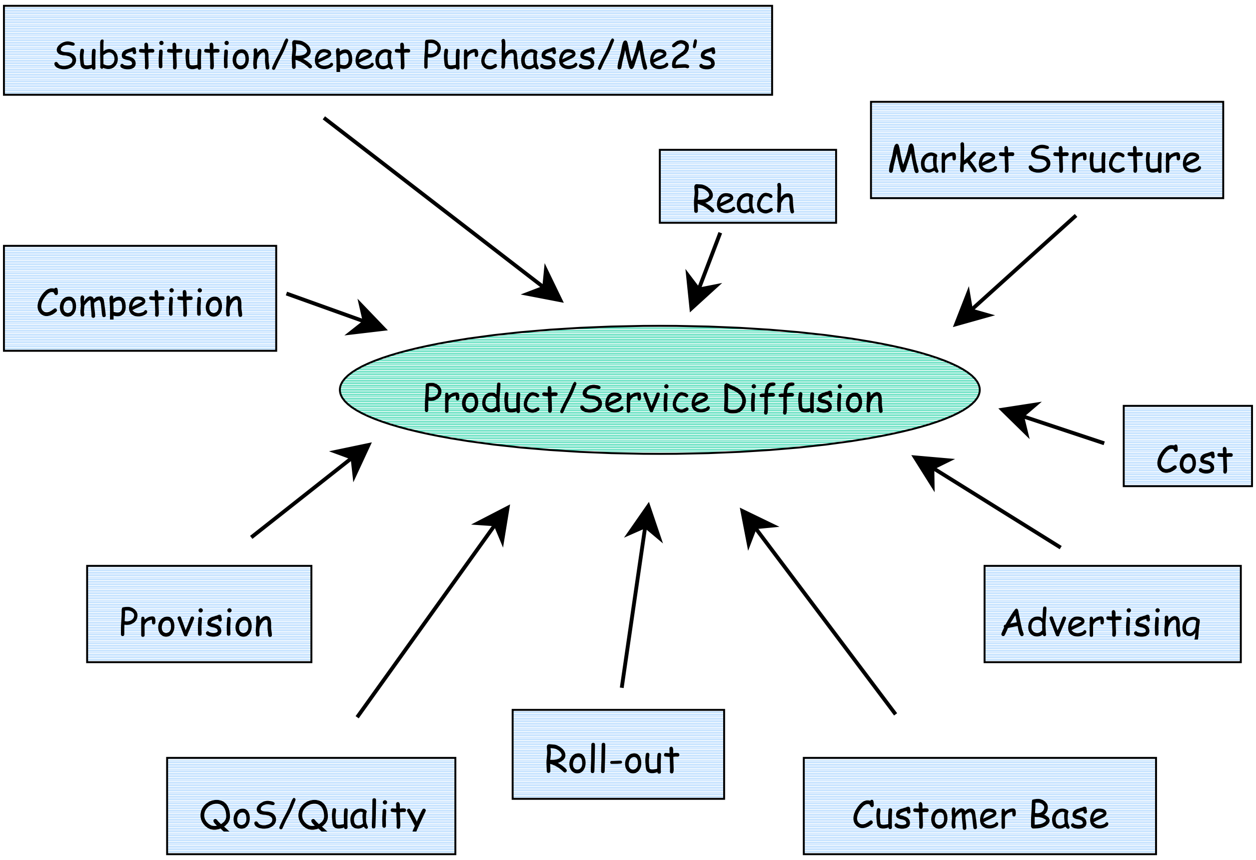

Figure 2.0.1 External Factors Affecting Diffusion

In addition to these external issues, there are a large number of company internal issues that contribute to the diffusion of innovation. For example, time to market, distribution channels, network capabilities. The internal factors are to an extent, easier to model than external ones. This is because internal information, (e.g. costs and provisioning), is easier to obtain than external information, (e.g. customer perception).

3 Bass Diffusion in Telecoms Models

The Bass diffusion equation is the most commonly used method of simulating the diffusion of innovation through a population or the flow of customers from one telecoms company to another. However, it is recognised that this is not a particularly accurate method of simulating diffusion, it uses the same curve, which is flexed, for each diffusion process. The diffusion equation used in most telecoms SD models can be seen in figure 3.0.1, (where "Att" represents the attractiveness of the product/service to the customer).

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Product/Service Take-Up =
    ((Non_Customer * Customer_Att) - (Customer * Non_Customer_Att)) * Inertia
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Figure 3.0.1 Traditional Diffusion Equation

This equation calculates the flow from being a customer without the product/service to becoming a customer with that product/service. This flow is determined by the size of the customer base having the product and the relative attractiveness of the service. This relative attractiveness of the product/service could be determined by a number of internal and external factors. The factors either have a positive or negative effect on the product/services relative attractiveness.

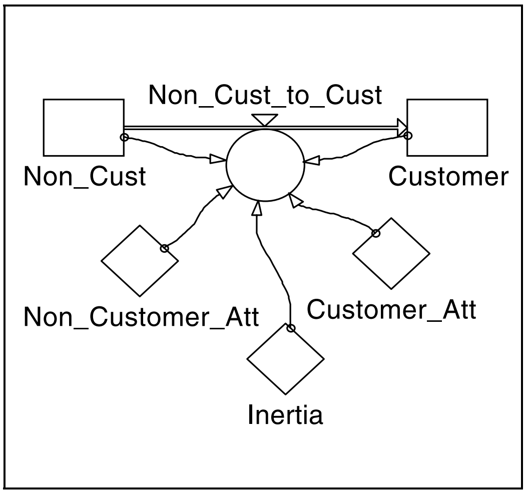

Figure 3.0.2 Powersim Model Structure

The model segment shown in figure 3.0.2 is the structure of that part of the model for the equation in figure 3.0.1.

4 Logistic Curves

One way of expanding on the diffusion equation discussed above is to incorporate an exponential element. The equation shown in figure 4.0.1 is a logistic curve with two variables that can be altered depending the type of product/service that is being offered.

$$\text{No. of Customers} = \text{Non\_Cust}*(1/(1+e^{(-1*\text{Gain}*((\text{AttCust}/\text{AttNon\_Cust})-\text{Barrier}))})) - \text{Cust}*(1/(1+e^{(-1*\text{Gain}*((\text{AttNon\_Cust}/\text{AttCust})-\text{Barrier}))}))$$

Figure 4.0.1 Logistic Curve

The key variables are the Barrier and the Gain. They determine the barrier to moving and the temptation to moving respectively. The Barrier moves the curve along the x-axis of the graph, whereas the Gain changes the shape of the curve. The smaller the Gain, the earlier the customer's take-up the product/service after it has been launched, but at a slower rate than if the Gain was higher. By being able to change the Gain and the Barrier, the different diffusion processes can be simulated through one equation. However, this requires a good understanding of the product/service being launched, so as to select the correct values for the Gain and the Barrier.

The graph shown in figure 4.0.2 plots a number of diffusion curves that have been generated from the equation shown in figure 4.0.1. This shows how a range of alternative diffusion equations could be easily incorporated into a model.

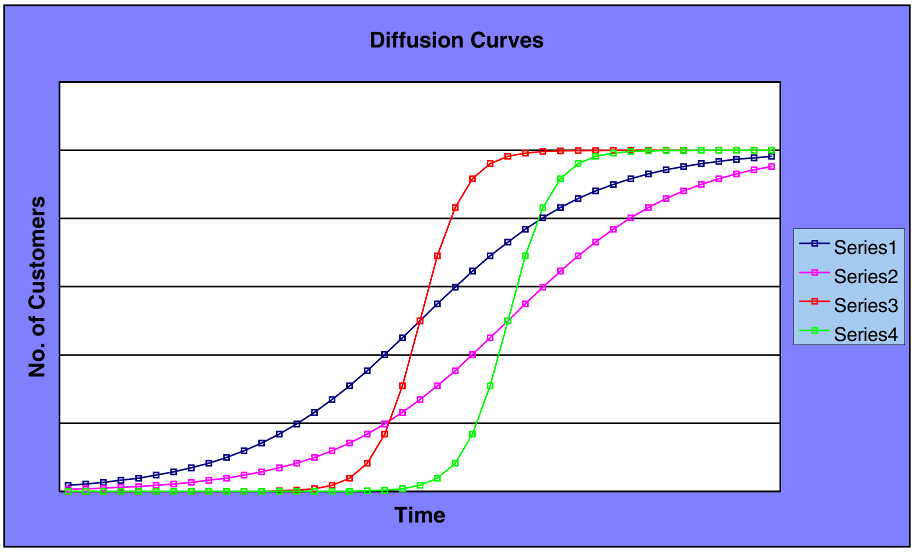

Figure 4.0.2 Outputs of the Logistic Equation

5 Other Techniques to Simulate Diffusion

An alternative method of generating new types of diffusion curves is based upon the actual market performance of real existing products/services. These could be achieved by creating a number of diffusion curves of different shapes based on the actual diffusion of historic products. Then depending on issues such as coverage, cost, customer base, QoS etc., the model would select the most likely historic diffusion curve to simulate the diffusion of the new product or service. This would obviously require a greater understanding of product diffusion of a number of analogous products and services already in the market and the diffusion curves that they have followed historically. Thus, further research into existing historic products and services with similar attributes to the new products/services would be encouraged. This new product/service would then be substituted into an adjusted version of the diffusion curve for the older product. This methodology would facilitate the modelling of the diffusion of products and services according to, which of the different curves is most appropriate.

Another way of simulating diffusion would be to use a random selector to chose one of a number of predefined diffusion curves for input into the simulation. Thus every time the model is run there is a, say, one in six chance of having a different diffusion curve. Obviously, to do this, 6 different diffusion curves would have to be incorporated into the model. This could simulate the changing environment into which the product/service is being launched and therefore the possible effects the change of environment would have on the diffusion of the product or service.

6 Future Developments

A way of moving this work further could be to incorporate even more modelling techniques into a System Dynamics model to simulate the diffusion process. This could be achieved, for instance, by using an Agent Based modelling approach. The agent model could simulate the product/service diffusing through a population and the diffusion curve generated from the agent model could feed into the SD model. This would assist in the simulation of the diffusion of a product or service, through a modelling approach that treated each agent/customer as an individual entity, rather than forcing segmentation patterns onto a population, (which is often how System Dynamics' is used to model customers/populations). This could be a more realistic method of generating a diffusion curve.

Other methods of generating diffusion curves could be to learn lessons from the world of diseases and Epidemiology, "A key feature of Epidemiology is the measurement of disease outcomes in relation to a population at risk", [1]. Essentially, this quote describes how many people in a population exposed to a disease are likely to succumb to that disease. This could be analogous to the diffusion of a product/service through a customer base. Consequently, the spread of diseases through a population is evidently one way of progressing the understanding the diffusion of an entity through a customer base. Further research into this field would appear to be very wise, in the effort to improve the simulation of the diffusion of product/service innovation.

7 Summary

This paper has discussed the use of alternative diffusion curves in telecoms System Dynamics models and has suggested how they could be improved through expanding on the work previously carried out in the telecoms industry. The alternative methods could include extending the use of Agent Based models and integrate them into to System Dynamics models to develop a more detailed model of product/service diffusion. Another route would be to investigate further the area of disease propagation and Epidemiology to help understand how and why disease's and therefore products and services spread throughout a population.

8 Acknowledgements

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9 References

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10 Other Reading

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[i] A Me2 product or service is one that enters the market in second place after another company already has a version of the same product/service on the market.