DYNAMIC DIFFUSION MODEL FOR MANAGING CUSTOMER'S EXPECTATION AND SATISFACTION

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Abstract: Being successful can be just as dangerous to long-term health as being unsuccessful. Even success can sow the seeds of failure by stressing and overburdening the current system. While suppliers may be tempted to hype up their products to obtain additional sales in the short term, those customers persuaded by 'hype' are often disappointed with their experiences, which in turn bears a negative impact in the long run. Starting from this point, this paper aims at answering to the generic question on how suppliers make the suitable and well-timed decisions in diffusing new technology effectively to adopters. To meet this research objective, the paper attempts first to investigate the entire process of the adoption and diffusion of technology innovation, and then proposes an integrated model by concatenating in structured manner the three prominent models for the management of technology innovation such as diffusion model, adoption model, and customer satisfaction model. An exploration of the dynamic mechanism underlying outward behaviors of the integrated model is presented in the study by introducing the system dynamics simulation technique.

Keywords: diffusion, innovation, customer satisfaction, system dynamics

1. INTODUCTION

Diffusion is defined as a process that innovation is communicated through certain channels over time among the members of a social system. Diffusion models attempt to analyze this process by which an innovation is diffused throughout a determined social system (Rogers, 1993). Many researchers that motivate the innovation and diffusion processes have used mathematical models in logistic functional form to study dynamic diffusion processes (Blackman, 1974; Mahajan and Peterson, 1979; Mahajan and Shoeman, 1977; Sharif and Ramanathan, 1981). Most of these models are deterministic, have a binomial form (adopt or not), and result in a typical S-shaped diffusion curve (Fisher et al., 2000). In the underlying diffusion process, the probability of a new user adopting technology depends on the quality of experience enjoyed by the existing users.

Some problems may draw from the prior researches discussed above. First, there may be a dilemma that suppliers have to consider whether they hype up customers' expectation to diffuse new technology or not. Second, it needs to clearly define the behaviors created by the causal relationships and feedbacks among variables in the system, prior to making decisions of 'technology infusion and diffusion.' Third, the behavior of diffusion may be different according to which feedback is dominant. Starting from these points, the paper aims at answering to the generic question on how suppliers make the suitable and well-timed decisions in diffusing new technology effectively to adopters. In probing the questions raised above, adopted is the systems thinking approach, an excellent tool for better understanding this type of complex management problems. According to Sharif and Ramanathan (1984), once a diffusion model takes on these factors, system dynamics should be used to ease the mathematical and computational complexity. Within this system dynamics paradigm three major attempts are made for the study: First, investigating the entire process of the adoption and diffusion of technology innovation; Second, proposing an integrated model by concatenating in structured manner the three prominent models for the management of technology innovation such as diffusion model, adoption model, and customer satisfaction model; Third, exploring the dynamic mechanism underlying outward behaviors of the integrated model proposed in the study which depicts the causal relationships that influence technology adoption and diffusion behaviors. These attempts made for the study and the results perhaps allow both researchers and practitioners to gain insight into the causal factors influencing customers' adoption decision making processes and thereby into the potential diffusion patterns resulting from those adoption processes.

2. BASIC MODELS AND AN INTEGRATION MODEL

2.1. Diffusion Model

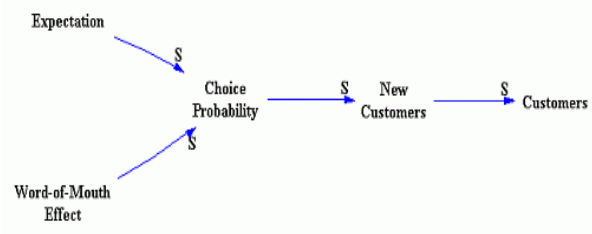
A diffusion model is based on the beliefs that good sales practice with hyped technology is expensive but leads to a high proportion of satisfied users, which is positive for subsequent diffusion; and that high choice probability makes new customers increase and in turn accumulate into total customers as shown [Figure 1]. But there are some missing pieces that show the relationships between expectation and word-of-mouth effect. It should be noted that the probability of a new user adopting technology also depends on the quality of experience enjoyed by existing users. These relationships behind the diffusion model appear in the customer satisfaction model discussed below.

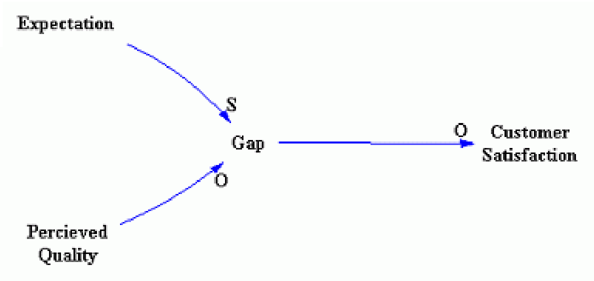
2.2 Customer Satisfaction Model

Parasuraman began a series of systematic and multi-phased research program in the mid-1980s, focusing on the concept and measurement of service quality. After the initial conception of their service quality "gaps model" in 1985, they began the process of developing an instrument for quantifying customers' assessment of service quality performance. SERVQUAL (Parasuraman et al., 1991, 1994) has become a reasonably well-accepted model for measuring the extent to which a company meets its customer's expectations. As shown in [Figure 2], however, SERVQUAL lacks a feedback structure which implies simply customer satisfaction depends upon the gap between customers' expectation and the service quality. It should be noted that as customers' expectation and the technology change, the method of assessing services quality and thus customer satisfaction also change continuously. This means that static evaluation on customer satisfaction does not help to make good decision any more. The missing implications behind the customer satisfaction model can perhaps be explained by growth and under-investment archetype.

2.3. Basic System Dynamics Archetype: Growth and Under-investment

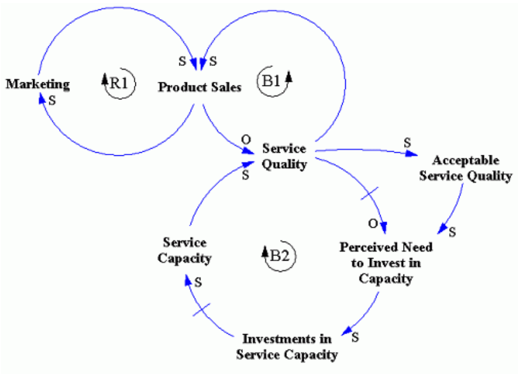
The "Growth and Under-investment" structure is a famous archetype to system dynamics researchers. The story line of the archetype can be described as follows: A company experiences a growth in demand that begins to outstrip the firm's capacity. When the capacity shortfall persists, the company's performance (such as on-time delivery) suffers and demand decreases. The fall in demand is further seen as a reason for not making future investments in capacity. This leads to a self-fulfilling cycle of continued under-investment and falling demand. This scenario is an example of the "Growth and Under-investment" archetype at work. At its core is a reinforcing loop that drives the growth of performance indicator and a balancing force which opposes that growth (loops R1 and B1 in "Growth and Under-investment Archetype") [Figure 3]. An additional loop (B2) links performance to capacity investments, and shows how deteriorating performance can justify under-investing in capacity needed to lift the limit to growth. Remainder of the paper is organized as follows. First, the feedback structures are divided and analyzed in detail. Second, based on the causal-loop diagram (CLD), a stock-flow diagram (SFD) is developed for the computer simulation runs.

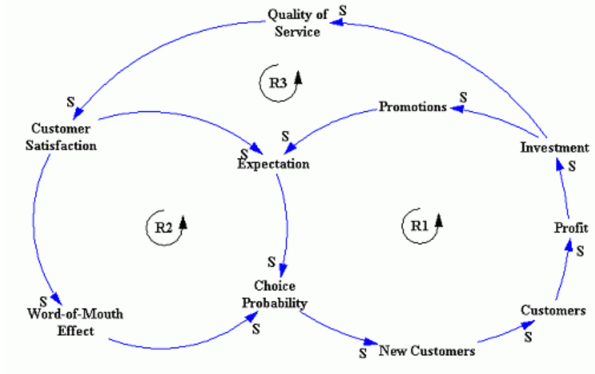




[Figure 1] Diffusion Model with unilateral causality

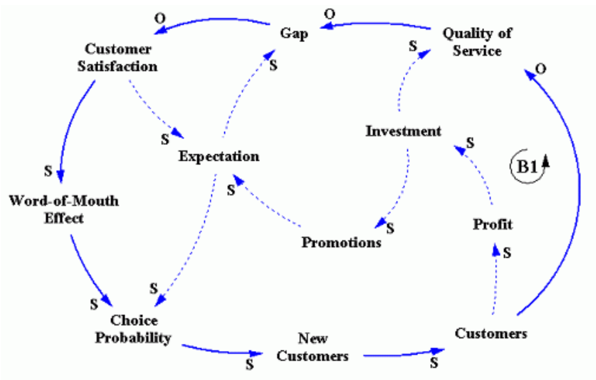
[Figure 2] Gap model with unilateral causality

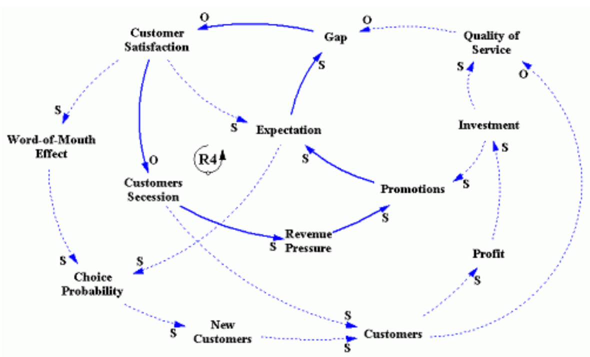




[Figure 3] Growth and Under-investment Model

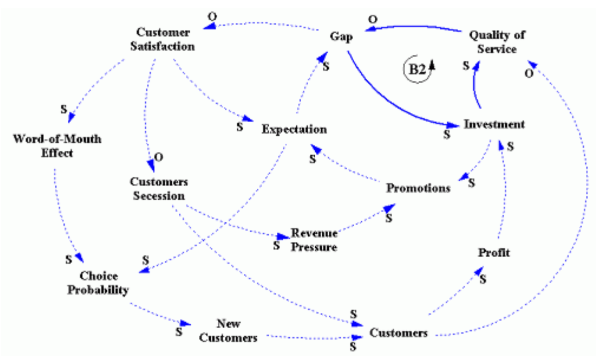
[Figure 4] Modified diffusion model with feedback loops

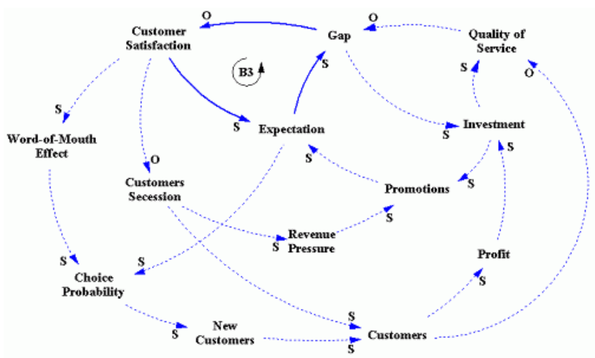




[Figure 5] Feedback loops between satisfaction and quality

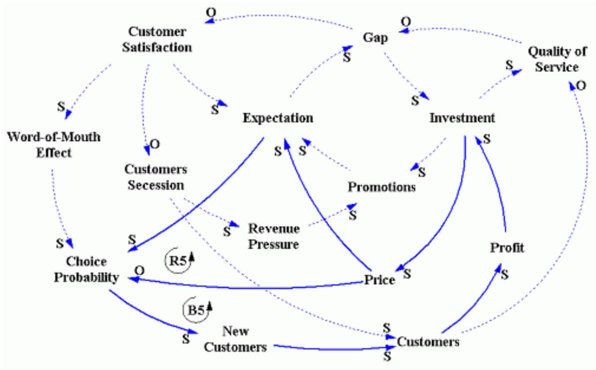
[Figure 6] Feedback loops with revenue pressure

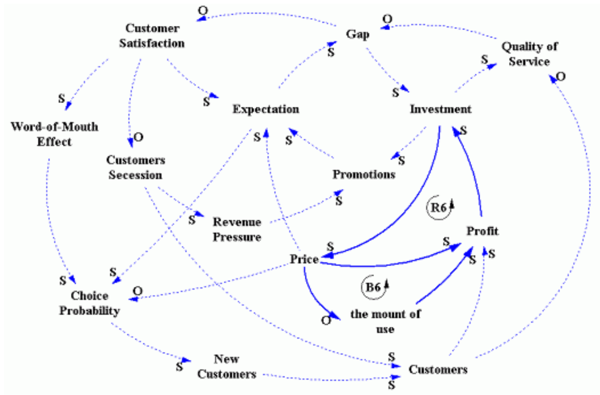




[Figure 7] Feedback loop with investment on quality

[Figure 8] Feedback loop of dynamic expectation





[Figure 9] Feedback loops with price effect on expectation [Figure 10] Feedback loops with price effect on profit

2.4. Detailed Explanation of Causal-loop Diagrams

Again, the ultimate goal of this paper is to develop a scheme for finding tentative answers to the generic question on how suppliers make a suitable and well-timed decision in diffusing new technology effectively to adopters with holistic view. To begin with, let's take a look at the modified feedback structure from the diffusion model to explain how to make new customers [Figure 4]. The expectation makes the probability of a new user adopting technology increase. High choice probability attracts new customers and in turn leads to total customers increase. Another important factor is 'word-of-mouth' effects. The probability of a new user adopting technology also depends on the quality of experience enjoyed by existing users. Therefore most of the market-oriented business firms in general often spend a lot of money in service quality in order to gain word-of-mouth effects. During the initial stage of the market, companies concentrate on the marketing through mass communications in order to get the attention of customers. As time goes by, the relative importance on the image of companies depends on the word-of-mouth effects. Moreover, as the market saturates, a company which has passed the point of critical mass of the customers and has entered into self-reinforcing feedback loop gains the word-of-mouth effects a lot greater than the others (Choi, 1996).

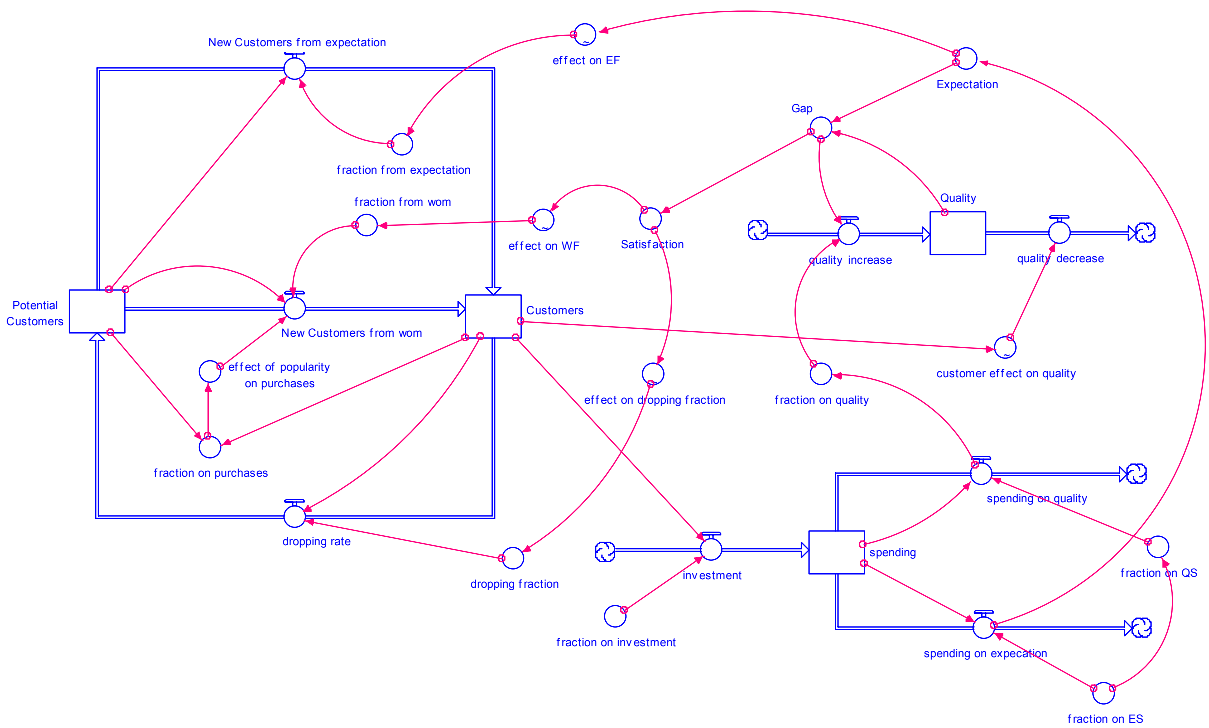
From the perspective of customer satisfaction model, the increase in the customers' expectation directly leads to the gap increase, which results from discrepancy between the expectation and the perceived service quality. Moreover, the increase of customers which is influenced by new customers makes service quality decrease naturally in under-investment archetype. Both high expectation and low service quality make a big discrepancy and in turn lead to the decrease in customer satisfaction. It means positive word-of-mouth effect does not work any more [Figure 5]. As dissatisfied customers secede, total number of customers also declines. This decrease of customers put the financial pressure on the company. Naturally they would be inclined to adopt different promotions to get new customers through higher expectation as shown in Figure 6. It makes a vicious cycle to customers dissatisfied. On the other hand, if the gap expands, to prevent the decrease in customer satisfaction, the company get desperate in providing better service quality. Improved functional quality increases customer's perception on quality with delay. As mentioned before, the increase in perceived service quality leads to the gap reduction. If the gap decreases, customer satisfaction will increase. Figure 7 shows the balancing loop that makes the gap decrease. Therefore the gap is narrower than before.

Another important loop, B3 is the relationship among gaps, customer satisfaction, and expectation. Gap is reduced by improvement of perceived quality that makes customer satisfied. But the increase in customer satisfaction makes the rise of expectation dramatically and in turn expands the gap between perceived quality and the expectation. Satisfied customers expect more than before. This expectation leads to the gap expansion repeatedly [Figure 8]. Moreover the expenditure spent to improve service quality makes pressure on the price of service to increase. Price in turn gives two effects on both expectation and choice probability in each. The higher price results in the higher expectation, which in turn lowers choice probability on the opposite side. The quantitative effect depends on price elasticity of demand. However, it draw that expectation also increases. It is a reason that makes the gap wider than before [Figure 9].

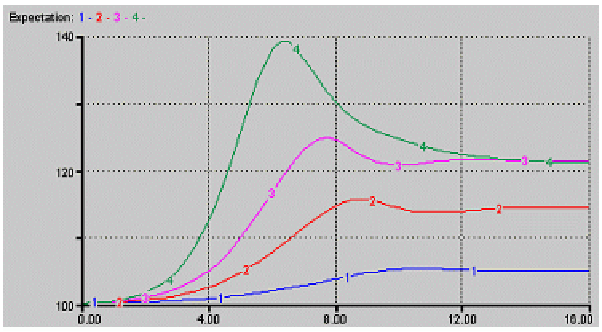
At the same time, price also has at least two effects on profit. It determines how much profit is generated per unit sold and it affects the number of units sold (Sterman, 2000). That is, higher prices reduce sales. In this case, the price elasticity of demand determines which causal pathway dominates. If demand is quite insensitive to price (the elasticity of demand is less than one), then price raises unit profit more than the net effect of an increase in price is an increase in profit. Conversely, if customers are quite price-sensitive (the elasticity of demand is greater than one), the lower path (B6) dominates [Figure 10]. The increase in profit per unit is more than offset by the decline in the number of units sold, so the net effect of a price rise is a drop in profit. Actually, separating the pathways specify different delays in each. There may be to be a long delay between a change in price and a change in sales, while there is little or no delay in the effect of price on profit according to the circumstance. During the initial stage of the market, it is a very important problem in diffusion process while the price of new products often falls significantly over time through learning curves, scale economics, and other feedbacks.

3. SIMULATION RUNS

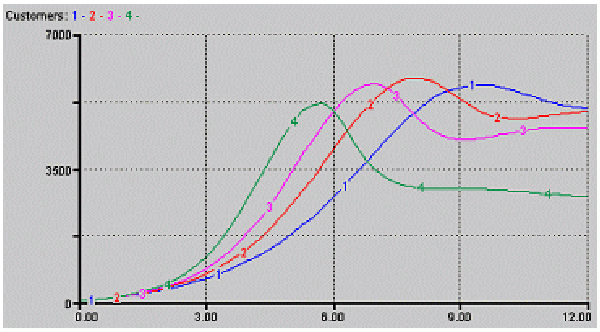
To understand the effects of the dynamics of expectation, the reference model was developed as shown [Figure 11]. This model includes decision-making about how to manage expectation to diffuse supplier's new technology successively. Decision-makers have a chance to change 'fraction on spending for increase of expectation'. At first, decision-makers determine the fraction on spending for the increase of expectation. This fraction determines how much effort to put on both expectation and quality, which has influence on the state of expectation and quality and in turn change the level of customers' satisfaction. Both expectation and customer satisfaction attract new customers, and thus total adopters will increase. If that is the case, what about the results from the alternatives? In [Figure 13], there are four behaviors of computer simulation performed under different situations by changing the values of ' Spending fraction on Expectation'. The initial simulation was run under the assumption that 'Spending fraction on Expectation' was 10%. It means 'Spending fraction on Quality' was 90% of spending of total investment for increasing perceived quality. The level of customers increases slowly and remains steady at the equilibrium as shown [Figure 13]. The other three results of simulation are run comparatively under different situation. According to change of 'fraction on ES', they shows that the number of customers grow sharply as 'fraction on ES' is getting bigger and collapse is getting deeper as behavior of expectation change as shown [Figure 12].



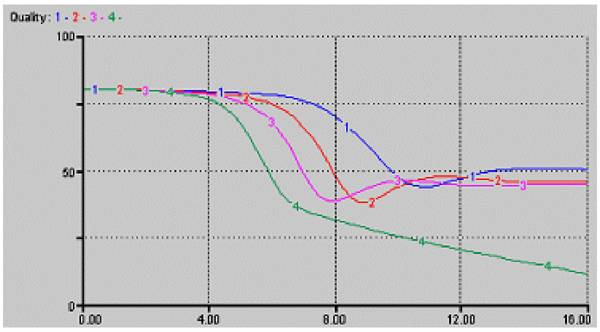
[Figure 11] Dynamic Diffusion Model



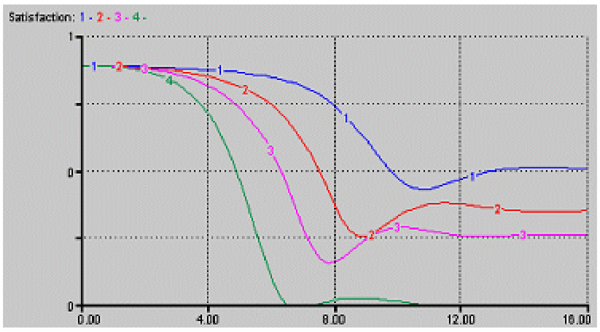
[Figure 12] Behaviors of Expectation



[Figure 13] Behaviors of Adopters



[Figure 14] Behaviors of Quality



[Figure 15] Behaviors of Satisfaction

Spending fraction on Expectation: Line 1 (0.1), Line 2 (0.3), Line 3 (0.5), Line 4 (0.9)

4. IMPLICATIONS AND CONCULSIONS

Some implications may be drawn from this model. 1) It becomes clear that everything in the system of technology diffusion is dynamic, complex, and interdependent. It reminds us that simplification, structure, and linear thinking have their limits, and can generate as many problems as they solve. The main point is that it is needed for decision-maker to be aware of all the system's relationships - both within it and external to it. 2) Both expectation and customer satisfaction have to be measured for successful growth. The more satisfied the customers are, the higher expectation they will have. That is why customers are not satisfied as before though the service quality has improved continuously. 3) Various behaviors of diffusion process are the results of complex feedback structure. The best approach is to strike a balance, to consider both short-term and long-term options and to look for the course of actions that encompass both. 4) The behavior of customers varies depending on which effect is dominated between the expectation and the word-of-mouth effects. Generic S-shape appears when the word-of-mouth effect dominates; while goal-seeking behavior does in case that the effect of expectation dominates the system. This is why the various types of diffusion behaviors exist in reality. 5) The speed of diffusion is influenced by the combinatory effects of expectation and customer satisfaction. The higher expectation, the faster speed of growth; and the higher customer satisfaction, the higher level of adopters. The extreme expectation generated by 'hype-up' makes the behavior of adopter overshoot and collapse.

In conclusion, a model from a single perspective is not enough to discover the source of a problem and understand better the technology diffusion process. Integrating related models by some means with wider perspective is prerequisite to find a more effective solution. An a possible alternative the paper attempts first to investigate the entire process of the adoption and diffusion of technology innovation, and then proposes an integrated model by concatenating in structured manner the three prominent models for the management of technology innovation such as diffusion model, adoption model, and customer satisfaction model. An exploration of the dynamic mechanism underlying outward behaviors of the integrated model is presented in the study by introducing the system dynamics simulation technique. The general scheme for dynamism of systems and the findings presented in the paper would perhaps provide some ideas and directions for further study.

5. REFERENCES

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