Research of User Innovation Diffusion based on System Dynamics

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Abstract. From a system dynamics perspective, the basic analysis frame of user innovation diffusion has been proposed, causality of diffusion is analyzed from three aspects of external environment, innovation user community and the influence of lead user, a flow chart and system dynamics model are established. Vensim PLE is used to simulate and test the model. The simulation results show that in the initial period of user innovation diffusion, the external environment is the main way, and then the innovation user community has gradually become the main way. Lead user diffusion play a crucial role in the whole user innovation diffusion system, after the initial fluctuations, it becomes the main way of later diffusion. Based on this, it can provide decision support for enterprises to make full use of user innovation and promote the transformation of user innovation.

Keywords: user innovation; innovation diffusion; system dynamics; casual loop diagram; simulation.

1. Introduction

With the rapid development of science and technology and the rise of the new economic information age, innovation has become the driving force of enterprise development and economic growth. Traditional enterprise innovation is led by manufacturers, who carry out enterprise innovation by surveying the demand of current users and predicting the future demand of the market based on market feedback information. However, along with the intensification of market competition and the development of consumer personalized demand, the manufacturer-led technology innovation faces many problems. On the one hand, the innovation ability of the enterprise itself is insufficient, and the innovation resources are in short supply. On the other hand, due to the shortening of product life cycle and the changing needs of users, it is difficult for enterprises to grasp the right direction of market innovation. Finally, with the development of consumers' personalized needs, enterprise innovation can hardly meet users' real needs[1]. Enterprise innovation is difficult to solve the above problems, the urgent need to change the mode of innovation. Eric Von Hippel of MIT creatively proposed the concept of user innovation[2]. Some scholars pointed out that one of the characteristics of the new economic era is the continuous integration of different knowledge. Enterprises good at integrating internal and external resources will have more opportunities for innovation and have more advantages[3]. For enterprises, user participation in innovation can develop new markets, clarify consumer preferences, and improve the survival rate of products[4-6]. At present, researches on user innovation mainly focus on user innovation motivation, user innovation performance and advantage, leading user and user toolbox, etc. These researches introduce the evolution mechanism and action mode of user innovation from different aspects, but seldom study the diffusion of user innovation.

In this paper, based on the dynamic Angle of view to discuss the user innovation diffusion, the principles of system dynamics to leading from the user, the user innovation community, external environment three aspects affect the causality of user innovation diffusion, building user innovation diffusion system flow chart and system dynamics model, the effective use of user innovation for the enterprise, promote the user innovation transformation to provide decision support.

2. Causal Analysis of User Innovation Diffusion

User innovation is a comprehensive system of innovation platform, external environment and enterprise including innovative users. User innovation diffusion also involves the whole system. On the one hand to see the impact of various parts of the system factors; On the other hand, it depends on the impact of the whole system on the diffusion of user innovation. In previous studies, the

innovation diffusion model is more concerned with the relationship between input and output, and the internal mechanism is treated as a "black box" treatment.

2.1 Leading User Diffusion Analysis

Von Hippel [7] grasp the market trend on users and the innovation ability of different study basis will lead user indistinguishable from the ordinary users, he thinks that lead users have two important characteristics: (1) the user is in the forefront of the market trend, leading to the market demand for months or even years before is aware of this demand; (2) leading users will develop products ahead of enterprises and expect relatively high profits. In this paper, we extract relevant conclusions that the increase of leading users is the result of the combined effect of internal and external environment. The development of science and technology improves the innovation ability of users, and the change of innovation concept enhances the innovation willingness of users. Under the combined action of the innovation ability of users and the innovation willingness of users, the innovation level of users increases.

2.2 Innovation User Community Diffusion Analysis

The communication channels between individual users are limited and can only be communicated within a small range. In the user innovation community, independent and dispersed users get rid of the limitation of region and time and are connected together through the Internet to share experience and interact in the innovation community. In the process of mutual communication and sharing, users not only enjoy the fun, but also improve their own ability, thus stimulating their willingness to act on product innovation and proposing solutions or ideas for product development [8-9], which greatly promotes the research and development of innovative achievements and the transformation of innovative achievements. The influence of user innovation community on innovation diffusion is mainly determined by the following three aspects :(1) the management of innovation community. The management of innovation community is the key to the normal operation of innovation community. The enterprise organizes employees to participate in the user innovation community management, discovers the problems in the user communication process and solves them in time, so as to facilitate the user communication channels. (2) member contact rate, which refers to the number of contacts each user has with other users on the innovation platform in unit time. The higher the member contact rate, the faster the information exchange, and the shorter the time of innovation achievement conversion. The establishment of innovative user community platform is to attract more users to participate in the platform communication. To achieve this, enterprises should encourage more users to participate in the communication of innovative user community through multi-channel publicity and encouragement. (3) adoption probability, which refers to the probability that potential adopters adopt their technological improvement plans or ideas on the innovation platform. The greater the probability of adoption, the stronger the diffusion effect. The total of adopters and potential adopters is the size of the innovation user community.

2.3 External Environment Diffusion Analysis

User innovation diffusion in addition to leading user diffusion and innovative user community diffusion, there are other ways of diffusion, such as advertising, user word-of-mouth effect, etc. Here we call it external environment diffusion. Compared with the diffusion of leading users and the diffusion of innovative user communities, the diffusion of external environment is deficient in both breadth and depth. However, with the enhancement of Internet media effect, advertising and celebrity effect still play a positive role in the diffusion of user innovation. In this paper, Bass diffusion model is used for reference to analyze the external environment diffusion. Using Bass diffusion model for reference, this paper divides the diffusion of external environment into advertising publicity and word of mouth, among which word of mouth is jointly influenced by external user contact rate and external user adoption rates.

3. Construction of Dynamic Model of User Innovation Diffusion System

Based on the influence of the above three aspects on the diffusion of user innovation, the system dynamics model of user innovation diffusion was constructed from the three modules of leading user diffusion, user innovation community diffusion and external environment diffusion, and the effect of user innovation diffusion under the action of these three modules was studied.

Potential adopters adopt user innovation under a certain role of adoption rates. At the same time, due to product life cycle and other reasons, users who have adopted user innovation will give up their adopted user innovation results at a certain loss rate, thus becoming potential adopters again. Adoption rates is affected by the diffusion of leading users, the diffusion of external environment and the diffusion of innovative user community. The mechanism of each influencing factor is introduced in the second part. In this model, market size, leading users, potential adopters and accumulative adopters are state variables. The increase of leading users, the change of market size, adoption rates and the turnover rate are flow variables. The diffusion affected by leading users, the diffusion of external environment, the diffusion of innovative user community, the level of user innovation, innovation incentive and word of mouth are auxiliary variables, while other factors such as leading user influence factor, market scale change rate, advertising effect and other factors that have no other influence are constant variables. Constant quantity is selected according to the actual value of objective market size and user innovation.

4. Simulation Analysis

In this paper, Vensim PLE software is adopted for model simulation analysis. Set INITIAL TIME to 0, FINAL TIME to 30, TIME STEP to 0.25, Units for TIME to Month. In the Vensim PLE simulation environment, the changes of diffusion, innovation user community diffusion and external environment diffusion affected by the leading user over time are shown in figure 1, 2 and 3.

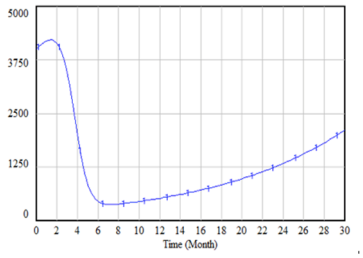

Fig. 1 diffusion trend diagram affected by leading users

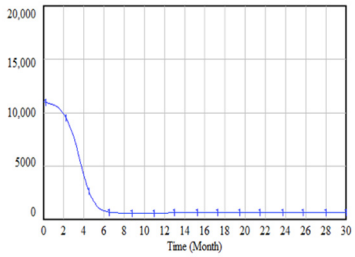

Fig. 2 trend diagram of external environment diffusion change

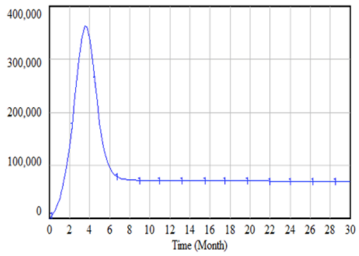

Fig. 3 diffusion trend of innovation user community

As can be seen from figure 1, 2 and 3, in the initial stage, external environment diffusion has the greatest influence on the diffusion of user innovation. As the diffusion progresses, the influence on the diffusion of user innovation gradually decreases and finally tends to a small stable state. In the initial stage, the diffusion of the innovation user community is 0, and then the diffusion effect increases sharply. After reaching a peak, the diffusion effect gradually decreases, and finally tends to a large stable state. After a period of fluctuation in the initial stage of diffusion, the influence of the leading user on diffusion gradually increases in the later stage.

The variation trend of loss rate - adoption rates is shown in figure 4. Potential adopters - the trend of cumulative adopters is shown in figure 5.

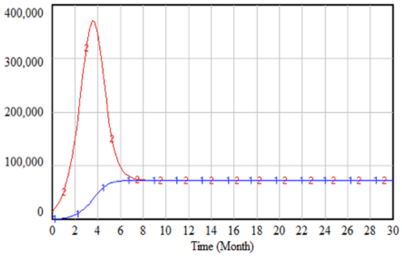

Fig. 4 trend chart of turnover rate - adoption rates

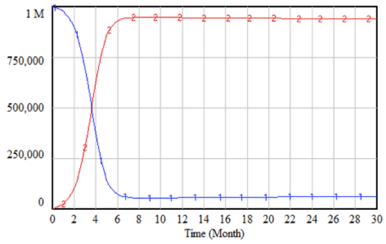

Fig. 5 trend chart of potential adopters - cumulative adopters

As can be seen from figure 4, adoption rates increase rapidly at the initial stage of diffusion, gradually decreases after reaching the peak, and finally stays stable after reaching the same value as the loss rate. At this time, the entire user innovation diffusion system also stays in a stable state. Figure 5 reflects that in the entire user innovation diffusion system, users mostly adopt user innovation results, and potential adopters eventually tend to a small stable state. This indicates that in the whole user innovation diffusion system, each diffusion subsystem has successfully completed the diffusion task, making the whole system achieve the optimal diffusion effect.

5. Conclusion

The results show that user innovation diffusion is a complex system including external environment, network environment and leading users. In this system, external environment diffusion plays an important role in the initial stage of the diffusion of users' innovation achievements, which is mainly realized through advertising and user word-of-mouth interaction. With the progress of diffusion, the diffusion effect of external environment decreases, and network diffusion gradually becomes the main channel of diffusion, while the innovative user community, as the platform for

communication between users, gradually becomes the main way of network diffusion. The innovative user community not only expands the communication channels between users, but also provides convenience for enterprises to manage user innovation. Enterprises should attach importance to the management of innovative user communities, timely feedback information, provide financial and technical support for user innovation, and promote the market transformation of user innovation. In the whole process of the diffusion of user innovation, leading users play a crucial role as the group leading the market trend and active innovation. In the later stage of innovation diffusion, the diffusion influenced by the leading users becomes the mainstream and continues to influence the innovation diffusion of users within a considerable time range.

The improvement of user innovation level and innovation incentive can promote the increase of leading users. At the national level, we should actively advocate user innovation and provide necessary policy and technical support for user innovation. At the enterprise level, enterprises should strengthen communication and cooperation with users, establish a sound identification system for leading users, provide leading users with a sound cooperative innovation platform, build a leading user incentive mechanism and other ways, accelerate the diffusion of user innovation, and promote the transformation of user innovation results.

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