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Self-service Product Innovation Based on Data Mining Technology

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Abstract

The core of service product innovation is to understand the demands of users. Self-service technology has changed the contact mode between users and the service, thus the traditional way to acquire information of users' demands could no longer meet the requirement of self-service product innovation. The advantages of data mining technology on analyzing and forecasting information can help reveal implication relations between users and products. It can also obtain the potential and valuable information of users' needs and increase the success rate of product innovation. This study proposed a new self-service product innovation model, and it analyzed and explored the approaches using data mining technology in the process of self-service product innovation to effectively import users' needs and organize product function design.

Key Words: *Self-service; Product Innovation; Data Mining; Innovation Management*

1. Introduction

With the development of information technique, self-service technology applications have become increasingly prevalent. Self-service technology (SST) is a technology enabling users to produce a service independent from direct service employee involvement (Meuter, Ostrom, Roundtree and Bitner, 2000) [1]. There are many different types of self-service technologies such as Internet-based applications including internet banks, interactive kiosks including ATM and airline check-in terminals. Recently, more and more innovative self-service technologies are introduced through a variety of industries replacing traditional face-to-face services, therefore, users are able to directly participate in the production and transfer of service and fast and conveniently acquire the needed service.

In the past, the study of innovation in services has emerged as an important research field (Menor and Roth, 2007) [2], and the main focus of innovation research was primarily concerned with innovations related to products (Miles, 2000) [3]. Self-service technology changes the contact mode between users and services, thus traditional service innovation process has been greatly changed. As more and more data are available for self-services, data mining has become an important tool for exploring the uncovered knowledge or intelligence underlying the dataset (Hand *et al.*, 2001) [4]. Damanpour and Gopalakrishnan (2001) [5] investigated the occurrence of product and process innovation in the banking industry. Applications of data mining have emerged in different business areas. Since self-service technology can accurately collect the data of using behavior and has more direct sources of information, this study proposed a new analysis structure of self-service product innovation adopting data mining technique. The study took product innovation of self-service terminals in commercial bank of china as an example. The applicability of the model was verified, and suggests of self-service product innovation management was proposed, which provide new thoughts for future studies of service product innovation.

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2. Literature Review

2.1. Service Product Innovation

Gallouj and Weinstein (1997) [6] thought innovation in services as any change that affects more than more than one service characteristics. Such changes are based on a number of operations such as addition, subtraction, association, dissociation or formatting (Gallouj and Savona, 2011) [7]. With the advancement of service industrial in social economic, service innovation has become more and more important. Users' demands act as an important factor in service innovation. Michel *et al.*, (2008) [8] suggested that service innovation can be regarded as a change in the roles of the customer and the value-creation processes. Based on new technologies, service innovation could emerge from new service production process, or new roles users played in provided service such as self-service innovation.

Alam (2002) [9], Chang (2006) [10], *et al.*, considered that user participation enhanced the success rate of service innovation; Hipper (1986) [11] and Cooper (1987) [12] discussed how enterprises effectively improve the success rate of new product development through the cooperation with users. Zhang Yu (2005) [13] thought that users in the whole innovation stage acted as source characters of innovation. Dai Yanshou (2003) [14] proposed the relationship between service innovation and users; Xu Qingrui, *et al.*, (2003) [15] suggested that the service innovation process should include service product innovation from the view of service innovation characteristics. Lin Lei, Wu Guisheng, *et al.*, (2004) [16] argued that some forms of service innovation and manufacture innovation were similar and both include product innovation, organization innovation, market innovation and so on.

The related research results of service innovation all consider that the service innovation includes product innovation. According to Barras' reverse product cycle theory, the main stage of self-service technology innovation is the product innovation [17]. Users' demands are the fundamental sources of product innovation. Gruner, Homburg (2000) [18], Lundkvist and Yakhlef (2004) [19] argued that the process of communication and socially-rich interactions with customers is one of the determinants of product success. Moreover, user-oriented concept of product innovation shows there is limitation in the function, principle and technology innovations of products if they are considered only from the view of service providers.

The existing researches showed that product innovation process has already paid attention to users' demands as well as the connection of innovation activities. However, these researches do not mention the relationship between the product innovation process and the user information data mining, not even using the pattern of the self-service to elaborate product innovation process.

2.2. Data Mining Technology

Data mining techniques like clustering, decision trees and so on have been widely used for successfully segmenting and targeting customers through various industries. Data mining provides an effective approach to discover and understand patterns in customer behavior and thereby helps the decision maker to better group customers (Chang and Chen, 2006) [20]. Data mining interest and application are increasing because it enables businesses to extract hidden information from large amounts of data so that they can better understand their customers (Chopoorian *et al.*, 2001) [21]. Data mining, a process of decision supporting mainly based on technologies such as statistics, analyzes data and makes inductive reasoning with high automation. With the development of information technology, the service providers use data mining to obtain users' habits, interests and hobbies. It predicts the future behavior of the users to make decisions of product innovation facing large amount of user and trade information.

Data mining is a kind of advanced and intelligent data processing and analysis technology, including some classic methods such as correlation analysis, sequence analysis, classification analysis, clustering and analysis. It can be applied to the different fields and stages of

user-centered enterprises' decision analysis and product innovation. Correlation analysis is as follows: the correlations hidden in data can be found, *e.g.*, "90% users in a self-service will purchase product "A" and product "B" at the same time ". Sequence analysis is as follows: analyze causal relationship of data such as "the sequence frequency of the user buying product "A", then product "B" and finally product "C" in a row during a certain period of time ". Classification analysis is as follows: the characteristic of record is described according to mark classification records; and the users and the products are divided into different categories according to the settled rules, such as the user area and convenient product function. Cluster analysis is as follows: a reasonable division of record sets can be gained like "A" user belongs to price sensitive type, but "B" user belongs to the efficient, sensitive one" according to certain rules.

Data mining can deal with a large amount of data, obtain user's information and estimate the product efficiency. Moreover, it can also evaluate whether the service product is successful or not, provide differentiation product and understand user's behavior. It also helps know user's product hobbies, the conversion rate and the second-glance rate of service usage, users' purchase modes, user group features and the tendency of purchasing in different user groups to find the connection between users and products. Based on data mining, it is easy to find the products of high purchase rate and low purchase rate. And products can be designed and modified according to user transaction information. Furthermore, users will be classified by modes so that the rate of return on investment could be evaluated, and the reliable trading information could be obtained. Different users will be provided with different personalized services. And personalized products will be customized, and products commonly used by users will be combined and integrated according to different users' interests.

2.3. Self-service

Self-service refers to the form of service production completely being done by users, which converts the subject of service production from the provider to the user. It creates a faster and more convenient new interactive interface and changes the way of communication between providers and users in this way. Self-service transfers transactions with high frequencies and low value into distributions with greater conveniences. Self-service can save manpower, reduce operating costs, create better service experiences for customers and obtain high rates of investment return.

Self-service is a service product, and self-service technology is the carrier of self-service. Self-service technology allows users to be exposed inevitably by technological media in service delivery process. Therefore, the attitude of users towards technology will influence the adoption of self-service. Dabholka and Bagozzi (2002) [22] found the attitudes of users towards self-service technology would have impacts on use intentions and final use behavior. Perceived usefulness is an important impact factor on self-service technology adoption according to many researches (Wang *etc.*, 2003; Curran & Meuter, 2005; Amin, 2007) [23-25]. The research of Dabholkar made in 2003 found that perceived ease of use is a determining factor to affect consumers using self-service [26].

According to the research made by Dabholkar in 1996 [27], happiness experience in the use of technology makes users tend to use self-service technology. Dabholkar and Bagozzi (2002) [22] found that perceived enjoyment is an important impact factor on the intention of self-service technology use. Meuter, *et al.*, (2000) [1] found that the high technical level of anxiety will lead to less use of self-service technology. Cunningham, *et al.*, (2004) [28] found that the perceived risk and value would affect the use process of self-service. Security and privacy concerns are the main impediments for the user to decide to use the self-service (Sathye 1999; Howcroft, 2002; Gerrard, 2003; Zhao, 2008; Lee, 2009) [29, 33]. Good conditions of facilities affect the usefulness of self-service technology and help to eliminate users' risk perception.

According to the related studies of self-service technology, the impact factors on self-service include value costs, security risks, functions, technical performances and external environment.

3. Theory Model and Analysis Framework

3.1. Innovation Conception Model of Self-Service Products

It can be concluded from the mentioned literature review that users' demands are the basic sources of products innovation, and accurately understanding it could be the key of innovation success. Users generally benefit by communicating with service staff in the traditional way of service innovation, but self-service changes the contact mode between users and services. Services are generally completed by users in self-service, and the communication interface between service providers and users has been greatly changed. Traditional way of acquiring user's requirements could hardly meet the demands of self-service product innovation.

An important feature of self-service is that users participate in service production and transmission. It is mostly a kind of voluntary behavior and less influenced by service personnel. Self-service production is usually standardized. Large numbers of data would be generated in self-service productive process and using process from users including information of their behavior and the related data of product use. Mainly based on information technology media, self-service technology is of convenience to acquire users' information.

Based on the features of self-service products, this study adapted data mining technology for self-service products innovation process and proposed a self-service product innovation conceptual model shown in Figure 1 in terms of data mining technology.

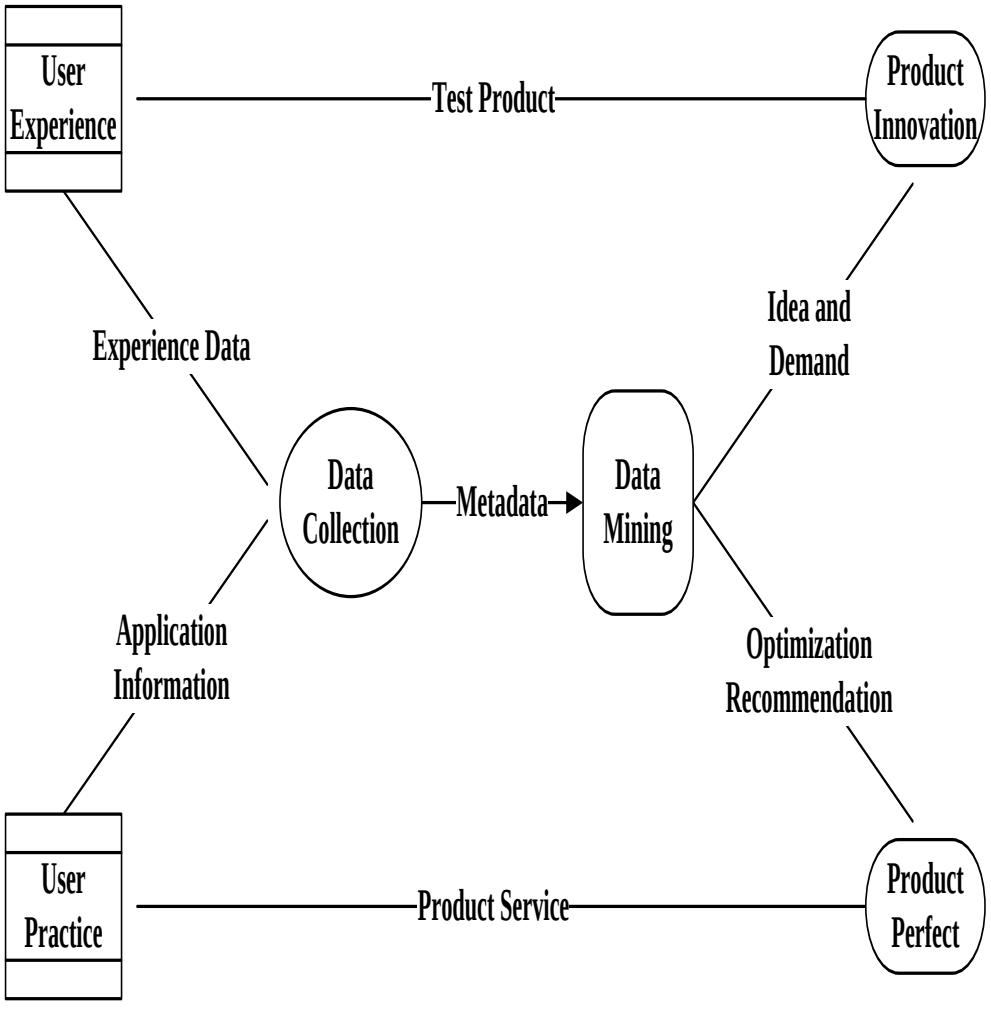

Figure 1. Innovation Conceptual Model of Self-service Product

Four stages can be included in the process of self-service product innovation.

Stage 1: Data Collecting and Database Building

Collect all kinds of users' information like trading, behavior and peculiarity in production, testing or transmission of self-service; data are extracted and loaded; user information database is built.

Stage 2: Data Mining and Users' Requirements Acquiring

Appropriate rules are set with data mining method, and users' favors are analyzed by building models. Product use condition is excavated, and users and products are classified; the relationships between user types and products are built based on correlation analysis; the laws of users' product use are found, and users' requirements are predicted with sequence analysis, which will finally form product originality or the proposal of improving existing products.

Stage 3: Service Innovation and Product Improvement

Innovative ideas or suggestions of perfecting products, transformed into the languages of product design, are imported; R&D teams are organized to complete products by innovating.

Stage 4: Test Promotion and Self-service

Develop new service products according to users' requirements, or bring service products to market after improvements; users produce, transfer and use services on self-service technology platform, generating data such as trading data. Then another service product innovation circle starts in the same way.

3.2. Analysis Framework of Self-Service Product Innovation Based on Data Mining Technology

Data mining process is the core process of self-service product innovation. Compared to traditional products innovation model, its main advantage lies in extracting users' personalization demand and converting it into the product creativity and service improvement suggestions. So the R&D team could develop service products suiting current market with the help of accurate understanding of users' demands through combining product features, framework and integration.

In traditional service innovation mode, the information of users' needs is collected and managed by service or professional personnel, and then decisions about the development of products could be made. In this process, requirements distortion is inevitable because of mistakes made by users' expressions or understandings of service personnel result in the products do not fully meet users' needs. But in the innovation mode based on data mining technology, service providers do not need to obtain users' requirements by guessing with this kind of contact, because users will expose their behavior and real needs about the service in self-service process. Meanwhile, advanced users can be classified through the analysis of user information. The advanced user requirements usually represent the requirement trend of the whole user group, which can provide more accurate and effective requirement prediction for innovation activity.

Structural data extracted by data mining technology can enhance the process from user demand expression to product innovation. It saves much time and enables service providers to promote products meeting the needs of users in the fastest way Therefore, the market can be occupied, and profits can be obtained. On the basis of the analysis above, self-service product innovation framework based on data mining technology was proposed, and it was shown in Figure 2.

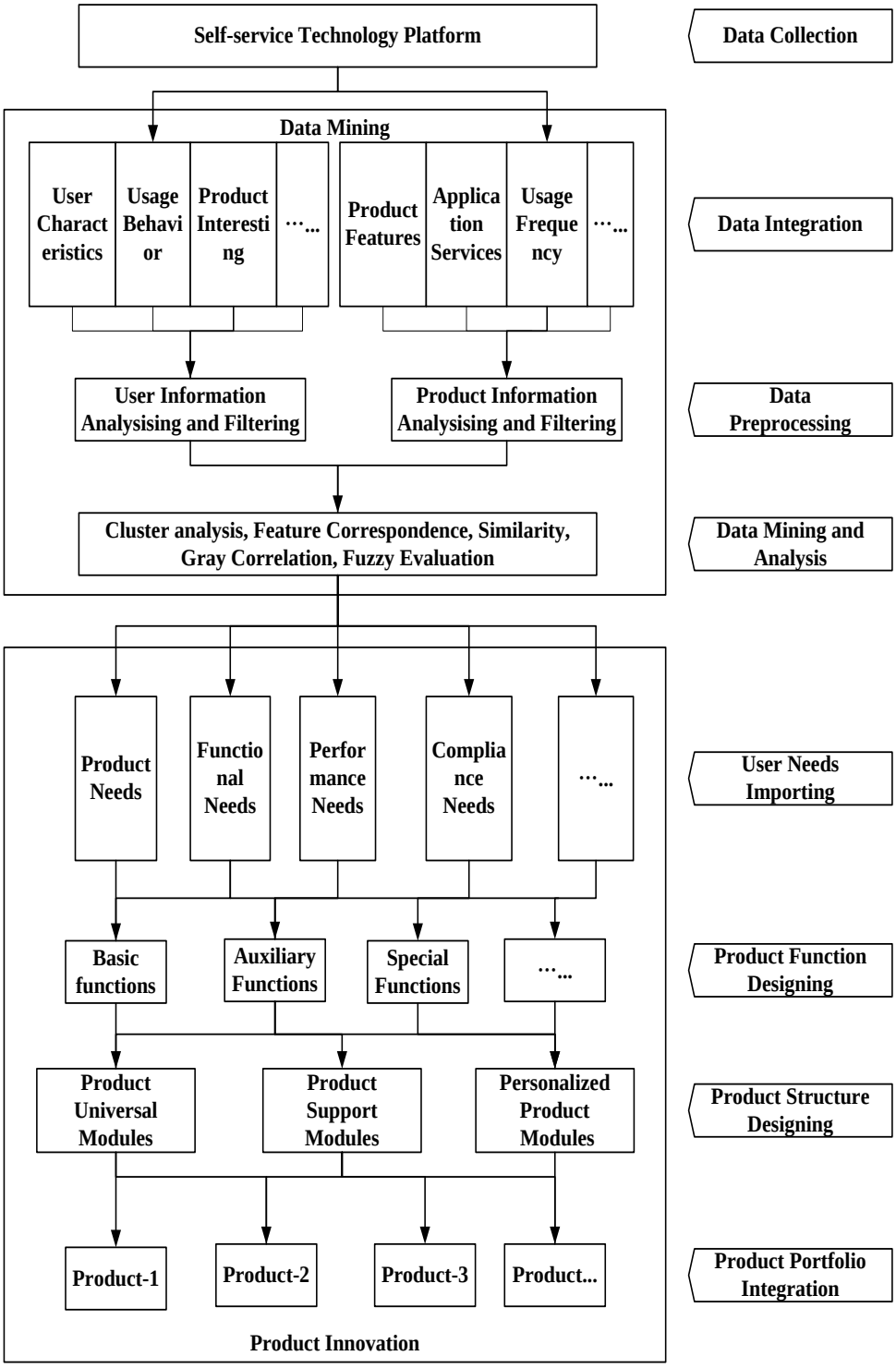

Figure 2. Self-service Product Innovation Framework Based on Data Mining Technology

The framework of self-service product innovation, based on data mining technology, mainly contains data collection, data integration, data preprocessing, data mining and analysis, users' requirements importing, product function designing, product structure design, product portfolio integration and so on.

Step 1: Data Collection and Integration

Data collection can be achieved with self-service technology platform with which service providers can widely collect and gather use log, operating records and characteristic information of users' contacts, *etc*., which can background product innovation process. For the purpose of innovation, service providers can set essential monitors collecting user characteristic or behavior information in the limitation of laws and regulations.

Multi-dimensional and multi-level analysis are carried out to find the trends in them, and the data needed by the analysis will be effectively integrated, then the data will be organized according to certain models. The integration of user data contains the characteristics of users and their trades, behaviors and favors. User characteristics mainly include their ages, education backgrounds, areas, genders and curiosities. Users' trades mainly include the service type of their daily purchase, their favor of products, trading time and tading places *etc*. Users' behaviors include their priorities of consuming products, actions after using a certain product, and adaptability of new products. Users' favors include favorite combination of certain products. Product data integration includes product characteristics, application service and the frequency of use, the freshness of products, product price, product complexity, product functions, and use times in a certain period of time or in a certain area and product-oriented user objects.

Step 2: Data Preprocessing and Data Mining Analysis

In order to facilitate the use of data mining methods and access to the information of user demand fast and conveniently, preprocessing of information about user and product needs to be firstly carried out after data sources and integration are identified. Therefore, clutter data which may affect product innovation decision-making will be deleted, and the quality of the data can be improved. Preprocessing usually contains data cleaning, integration, transformation and reduction. The core of data mining technology is the application of analytical methods of mining. When information preprocessed is brought into the mining analysis process, structural information, such as the user level, attributes, risk-loving, habits, loyalty, persistence, changes, user group, the value of product, product characteristics, transaction channels, trading locations and associated product functions, can be teased out by methods of association, sequential patterns, classification, clustering and fuzzy analysis. If varieties of analysis methods are used together, the analysis accuracy will be greater.

Step 3: User Demand Importing and Product Designing

Users' demands can be transformed into the functional requirements of design perspective after being acquired to guide subsequent product design work. The results of data mining analysis are as the input of product innovation decision form users' demands on product function, compatibility and performance. The R & D team is organized to refine users' various requirements and convert them into the ideas of design and improvement of product features. The framework of the product feature is established, and the causal relationships and hierarchical relationships among products functions are rationalized using functional decomposition method starting from the basic functions, supportive functions and auxiliary functions. Therefore, fully understanding the mechanism of product and the product defects needing to be improved can be achieved, and the product function design could be implemented.

Step 4: Product Portfolio Integration

Product is the realization of functions. A product usually contains more than one function. The general function and sub-function realized by product can be determined after the demand analysis and product function design, which will be mapped to the corresponding product modules. For example, the basic functions are mapped to product universal module; special functions corresponding to the individual needs of users can be met by personalized

product modules, so that the duplication of design could be avoided. Based on the realization of meeting most user requirements, the innovation should be focused on the diversity requirements of product, and the product structural design can be eventually completed. According to the relationship between the type of users and products gained using data mining analysis, corresponding final product is integrated, and the entire product innovation process is completed.

4. Case Study and Analysis

The self-service terminal is a non-cash self-service technology platform launched by the commercial banks in order to extend services, strengthen network coverage and shunt counter pressure. Some standard, simple, repetitive service operations are moved to self-service terminals. Self-service terminal provides inquiries, transfers, intermediate business, payment services and other services and mainly distributes in bank branches, shopping malls, residential areas, schools, public service halls and so on.

A national state-owned commercial bank (named A here) of China set about 20,000 self-service terminals on the purpose of alleviating outlets queuing pressure. They developed a large number of self-service functions and provided a wide array of services through self-service terminals, expecting that users can be transferred away from the increasingly-busy counters. However, the self-service terminals didn't show good shunting effects, and many service products could hardly be recognized by users; users still preferred to transact business on the counter. The business units of bank A headquarters and branch institution organized several studies and interviews, hoping to find a solution. They took measures such as improving the self-service process, privileging some businesses, strengthening publicity and launching more services products, but the results are unsatisfactory. According to statistics, the trading volume of each self-service terminal was less than 70 per day before 2009.

In recent years, the pressure of Bank A's counters is rapidly increasing due to the great business development of precious metals, securities and other financial industries. Business leading management department has been banded with product innovation and information technology departments. Data mining technology is used to analyze the historical data of self-service terminal users, and product application situation to obtain accurate user requirements and conduct the design of products since 2009.

When using self-service terminals, users need to use a bank card or account to log in, providing basic registration information such as users' identity card numbers, account outlets, contact numbers, addresses, etc. Self-service terminal transaction log records user's trading time, terminal equipment, business transacted and operation actions. The information provides the underlying data source for data mining, understanding users' requirements and product innovation. And the data are structured to make the process of collection comparatively convenient.

Bank A utilized data mining technology to carry out the comprehensive analysis of historical data of self-service terminal transactions. Users and products were classified based on business rules and user characteristics. Implicit information is repeatedly excavated from the views of users, products and their relationships, and the situations of product usage and product sales were shown with methods such as clustering, classification. The analysis shows that users' requirements are of locality, timeliness, functionality and other features: the remittance frequency of users from Jiangsu, Zhejiang, Guangdong areas is about three times of that in western areas; the use conditions of intermediary business in Beijing and Shenzhen are quite satisfactory, and query business rates in western regions are generally above 70%. Users of self-service terminal are generally under the age of 40. Users generally take inquiry actions after remittance. The use frequency of money transferring and funds trading functions in bank outlets equipments was about 5 times of those in other places. For terminals distributed in residential area, the product functions, such as information query and payment of water bill, phone bill and taxes, are satisfactory. For terminals distributed in schools, the

top functions are recharging and withdrawing. Around the 10th of each month, the query business grows by more than 30%. Before Chinese New Year or National Day holiday, frequencies of remittance transactions are more than 2 times of the usual ones. New product use the ratio of users who often browse product information is 1.8 times of that of other types of users. During particular product promotions, the growth rate of elderly users was obviously higher than that of young users, *etc*.

4.1. Innovation Mode of Self-service Terminal Product

Innovation model of self-service terminal product was built based on the adoption of the influencing factors and service product innovation process under self-service product innovation framework using data mining technology. It is shown in Figure 3.

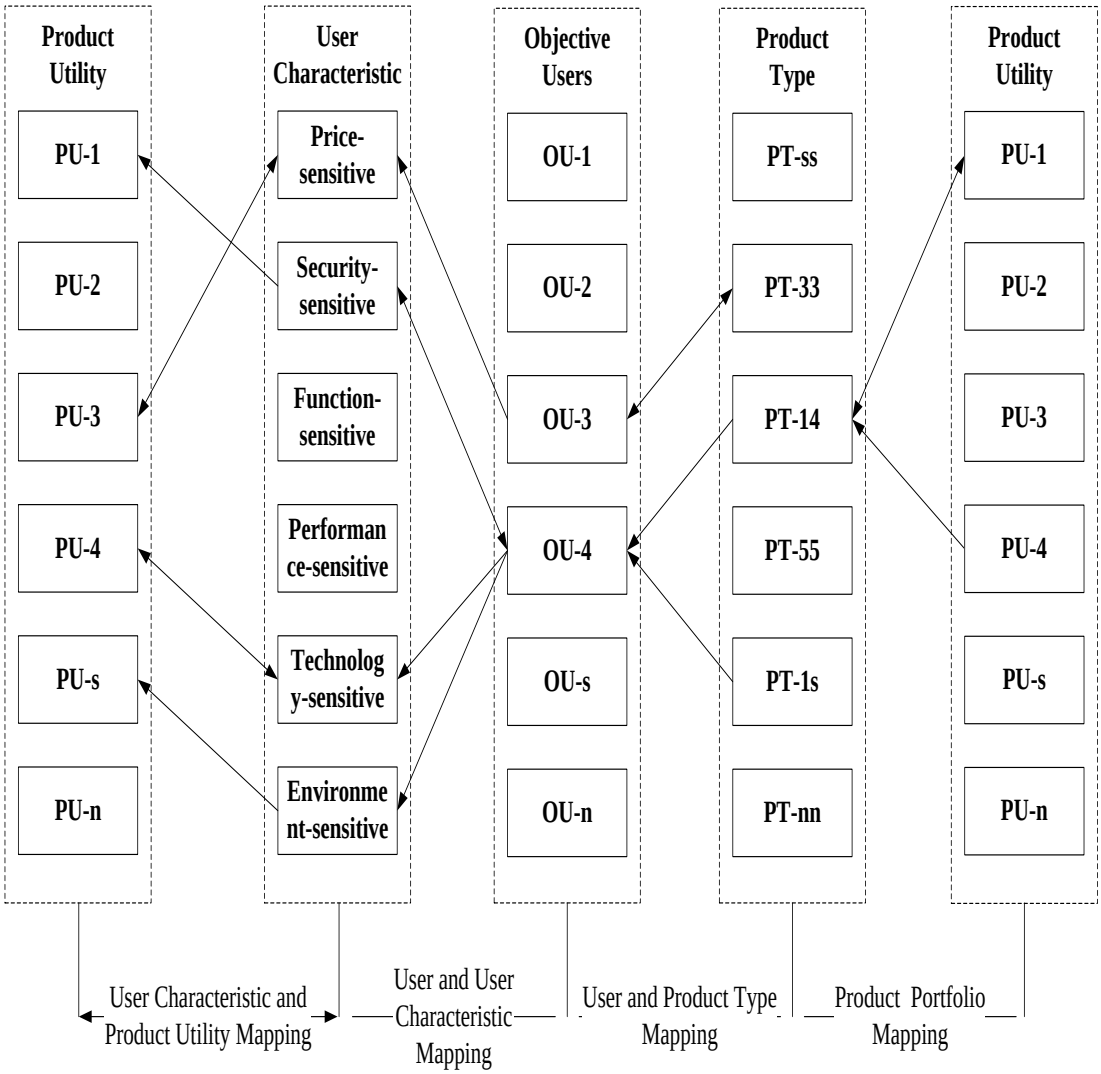

Figure 3. Product Innovation Model of Self-service Terminal

4.2. Analyses of Users' Characteristics and Requirements

Based on data mining of historical data, Bank A classified users into six types price-sensitiveness, security-sensitiveness, function-sensitiveness, performance-sensitiveness, technology-sensitiveness and environment-sensitiveness, clustering analysis methods. Price-sensitive users care about the cost of service products; times of self-service products being used by this type of users will be significantly enhanced if there are service promotions. Security-sensitive users concern about the safety of products and require products to be safe

and reliable. They seldom conduct account transactions like remittance or fund transactions in places other than bank branches. The function-sensitive users, usually selecting specific functions at high frequencies, care more about the practicality of products and less about product promotion. Performance-sensitive users prefer products with simple functional interface, pursuit high service performance, expect one-stop service and usually have antipathy against complex security control in self-service process. The technology-sensitive users concern about the advancement of the technology in service and like to try new products. Environment-sensitive users purchase services only in certain terminals and like products with similar interface style and design. After their characteristics are identified, users are mapped to different classes by bank A, respectively. Some of them probably belong to one class, and some of them probably belong to several classes at the same time. Thus, the user groups are built.

4.3. Design and Integration of Product Functions

Product is the combination of functional modules. Product innovation department of bank A divided their products into different functional modules, using functional decomposition method. For example, queries are decomposed into the queries of bills, balance and details; transfers are decomposed into remittance, repayment and inter-bank transfer; payments are decomposed into water, electric, gas, telephone, taxes and so on; intermediate business are decomposed into fund, insurance and precious metals, *etc*.; all these functions were subdivided as detailed as possible, therefore, they can correspond to specific user characteristics. The new product functions are firstly classified and mapped to a certain user characteristics corresponding to the similar features, and then the relevance of user characteristics and product functions is gradually established. Financial products with low costs and more discounts are developed aiming at price-sensitive users; products paid with no card are developed aiming at performance-sensitive users. Users' characteristics and product functions are in a many-to-many relationship. If a certain type of users' characteristics corresponds to less product functions, product innovation sector will develop the corresponding functions for the users according to their behavior in other distributions and product orientations. For example, the non-card micro-payment product is introduced to technology-sensitive users. If the consumption condition of a product is satisfactory, more similar product functions will be developed according to the corresponding specific users' characteristics. For example, the intermediate business products sold well in some advanced areas, the functions on self-service terminals such as payment of gas, water, and mobile phone bill were introduced timely by bank A.

4.4. User-Oriented Product Innovation

Innovation is a process from product design to new markets development and final profits acquisition. The last part of self-service terminal product innovation is to analyze user characteristics of target users, understand corresponding product functions and develop final product. It is to meet the needs of target users, expand market range and obtain profits and product innovation success. Product package which is functionally practical and easy to be operated was introduced to function-sensitive and performance-sensitive users by bank A. It effectively improved the user experience and increased the sales. Existing product functions are promptly improved based on users' behavior characteristics. For example, for behavior characteristic that users like to check their balances after transfer or remittance, balance inquiry and check sheet printing functions will be stated after successful transfer; fee needed to pay and the discount rate are shown before transfer determination for price-sensitive users; on-line bill payment, self-service card issuing and other products were introduced to users of developed east areas; more basic functions such as inquiry, check sheet printing and information introductions in the self-service terminal were introduced to users from middle or western areas.

Since self-service products innovation model is based on data mining technology, bank A achieved a deep understanding of users requirements, developed user-oriented products, enhanced the speed of products innovation and improved the effect of user experience using data mining technology. In 2010 and 2011, the average daily turnover of self-service terminals in bank A had been increased by nearly 30% compared to that in 2009, and great economic effect was achieved.

5. Conclusions

5.1. Research Contributions

Understanding users' demands is the key element of service products innovation. This research firstly introduced the data mining technology into the self-service products innovation process, which studied the approaches to accurately import the demands of users, organize product functions and conduct structural design. In the study, it is found that the data mining technology performs well in product innovation of man-machine interactive service mode. With data mining technology, valuable potential information was extracted to reveal user-product implicit relationships, which is conducive to the accurate understanding of user requirements and improving the success rate of product innovation.

This study introduced the data mining technology into self-service products innovation process and proposed a new self-service product innovation model based on data mining technology. It overcame the defect that service providers could not accurately understand users' demands because they were usually beyond service personnel's reach. The model shortens the process from acquiring users' requirements to the R & D team, avoids information distortion caused by the process of information transfer from service personnel to R & D department, and provides products innovation with real users' requirements. It also enriched and extended the service product innovation theory.

This study solved the problem of acquiring the sources of users' requirements in self-service product innovation, established the framework of service product innovation based on users' requirements and elaborated the mechanism and principle of product innovation framework. Finally, it took self-service terminals in a bank as an example to verify the usefulness of innovation framework, which extended the research area of service product innovation. It also provided a theoretical reference for the success rate improvement of product innovation as well as a practical guide for self-service development and applications in the existing socio-economic environment in China. Different from the theory of traditional service product innovation, this study researched the relationship between users' needs and the product function design from the perspective of the combination of technology use and product innovation processes and made service product innovation truly user-oriented and user-centered. The issues mentioned above are the very key issues ignored by previous studies.

5.2. Future Research Prospect

It is inevitable that there are deficiencies in this study like any others, but future research may contribute to the solution of these defects so that the study will be of greater general significance. This study researched from data mining to border mechanism framework of product innovation, but it made no further analysis on internal R & D activities of service providers such as internal innovation organization and transfers in interior in the actual service product innovation process. And this study did not answer problems such as the rule setting in the application of data mining technology and data mining model establishment. Meanwhile, understanding user demands through service personnel's surveys or interviews is an essential complement way of simply using data mining technology, which is also worthy of further study.

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