

Research on Current Execution of Customer Support Knowledge Management System of Medical Appliances Industry

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Abstract

Customer Support Knowledge of Customer Support Organization is one of the important assets of enterprises and "Customer Support Knowledge Management" is also the critical aspect of Business Knowledge Management; however, the attributes of Customer Support Knowledge are complicated, diverse, renewed rapidly and difficult to be managed. Thus, in order to design a successful Customer Support Knowledge Management System, apart from the consideration of "human" and "information technology" aspects, the concerns of attributes and Customer Support Knowledge and industry characteristics should be involved for meeting the requirements of Customer Support Organization and allowing the organization to acquire the competitive advantage of "Differentiation Service". This research used the "Customer Support Knowledge Management System" in a high-tech industry as an example and treated the end users of medical instruments in different types of hospitals in Taiwan which have received the support service of our company in recent six months as the population. The end users were mostly the nursing executives or ultrasonic wave technical personnel in intensive care unit and they had similar educational background and incomes and adopted the medical instruments such as physical supervision system, ultrasonic wave system, heart start or ECG machine produced by our company; the research method was to randomly treat the investigation results of the telephone customers' satisfaction from respective 30 end users in the population three months before and after this system execution as the samples and use hypotheses to validate if the end users' customer satisfaction significantly improved in terms of "Remote Support," "On-site Support," "Service Turn Around time," "Technical Competence" and "Service Manner" in order to understand the influence and managerial significance of execution of "Customer Support Knowledge Management System" on Customer Support Organization.

Key Words: Knowledge Management, Customer Support Knowledge, Customer Support Knowledge Management System, Medical Treatment Instrument

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1. Introduction

The most important asset in the organization is the knowledge of people and organization. In this changeable digital era, how to upgrade the value of organizational knowledge through efficient Knowledge Management is one of the key issues valued by the business; in other words, Knowledge Management has become the key for the individuals and business to stand out and maintain competitive advantages. When executing Knowledge Management, the importance of information technology should not be emphasized too much; "people" are the keys for information and knowledge creation and share; Davenport and Prusak (1997) indicated that some organizations wrongly thought that technology can replace the skills and judgmental capacity accumulated by manpower experience and he proved that the assumption that technology can replace human beings' knowledge or create equal substitute was incorrect. "Customer Support Knowledge" in Customer Support Organization is one of the critical assets in business. Customer Support Knowledge Management is also the important part of Business Knowledge Management; the attributes of Customer Support Knowledge are complicated, diverse, renewed rapidly and difficult to be managed. Thus, in order to design a successful Customer Support Knowledge Management System, apart from the consideration of "human" and "information technology" aspects, the concerns of "attributes of Customer Support Knowledge" and "industry characteristics" should be involved for meeting the requirements of Customer Support Organization, reaching the goal to efficiently manage "Customer Support Knowledge" and upgrade the organizational competitiveness.

Since high-tech industry products change rapidly and there is service-oriented Differentiation Strategy (Porter, 1990), Customer Support Knowledge Management is becoming more important for the organization. Davenport and Klahr (1998) indicated that because of the attributes of Customer Support Knowledge, its managerial method is different from other forms of Knowledge Management; besides, the content of Customer Support Knowledge includes different dimensions and it might involve wider scale including customers and the knowledge of the products they install, products and the applied knowledge, questions and knowledge to respond to the customers and customers' or analysts' knowledge to ask for the help from the experts. Under many support conditions, the analysts must first diagnose the customers' problems and then provide the solutions. Besides, most of the cases require two different kinds of knowledge. In this era in which the products are more commercialized, almost all of the enterprises can provide the products with similar functions. Only "service" can highlight the differentiation of the products; customer support is the concrete expression to deliver service differentiation. The study of Davenport and Klahr (1998) reveals that some enterprises in America reached the benefits in terms of Customer Support Knowledge included the following: (1) improving the quality to provide the solutions for the customers; (2) providing consistent correct answers for the same type of questions; (3) increasing First-Call

Resolutions; (4) reducing each Cost Per Call; (5) reducing the times to call Support Desk; (6) reducing Field Service Costs; (7) supporting the first line personnel transferred to low degree of technique and customer orientation; (8) providing substantial on-duty training facilities to allow the new employees to possess productivity in short time; (9) enhancing the Staff Satisfaction; (10) enhancing the Customer Satisfaction and “Customer Loyalty” and contribute to the possibly increased sales. Thus, if the business does not value Customer Support Knowledge Management, it cannot use differentiation service to acquire the above benefits.

In medical industry, medical service quality is one of the important “Competitive Advantages” for the hospital. In terms of software, it is related to medical personnel’s professional skills and service attitude. In terms of hardware, it is related to the facilities in the hospital and the functions of Medical Treatment Instrument. Thus, in order to fulfill maximum function of Medical Treatment Instrument, a complete “Customer Support” system of Medical Treatment Instrument is necessary. This research attempted to reorganize the literatures related to Customer Support Knowledge and Knowledge Management which established a “Customer Support Knowledge Managerial Model”; the research further introduced this model to Customer Support organizations of high-tech Medical Treatment Instrument industry and developed a “Customer Support Knowledge Management System of Medical Treatment Instrument” which included three sub-systems: Customer Support Knowledge transfer model of Medical Treatment Instrument, Customer Support service delivery model of Medical Treatment Instrument and Customer Support Knowledge managerial website of Medical Treatment Instrument. Finally, through the empirical cases of Customer Support Knowledge Management System of Medical Treatment Instrument, the researcher explored if the execution of Customer Support Knowledge Management System allowed the Customer Support organizations of high-tech industry to reach some benefits mentioned by Davenport & Klahr (1998) such as the significant refinement of customer satisfaction in terms of Remote Support, On-Site Support, Service Turn Around Time, Technical Competence and Service Manner.

2. Literature Review

As to the literature review, this research will review and reorganize the related literatures of domestic and foreign scholars and experts’ studies of Knowledge Management, organizational culture, information technology, success and elements of Knowledge Management project, characteristics of medical appliances industry and Customer Support Knowledge Management.

2.1 Knowledge Management

O'Dell and Grayson (1998) indicated that so-called Knowledge Management meant to provide correct knowledge to the members in need at the proper time in order to help the members adopt correct actions to strengthen the continuous process of organizational performance; the process included knowledge, confirmation, collection, classification and storage, share and saving, utilization, refinement to elimination. Papows (1999) proposed the reasons of necessary Knowledge Management execution for the following 7 items: (1) globalization: the organizations worldwide possess a very important competitive advantage; that is, to efficiently share experience and resources; (2) speed: business cycle is reduced. In order to reach efficient business operation, the information and knowledge needed should be acquired rapidly; (3) service orientation: in order to accomplish immediate response, all of the necessary information and related operational methods should allow the staff to receive and save on line at any time and they should be internalized into acts; (4) dispersion of working personnel: under the circumstance in which the employees' flow is high, a set of system is often needed in order to keep and reuse the employees' knowledge; (5) closer business relationship: global information network is also the resources to learn new knowledge. Each organization should integrate it into the daily learning process; (6) technique: advanced message system, group software and global network are integrated and provide the technical base of the Knowledge Management in the whole company; (7) competition: all-dimensional market-oriented system allows the organization to use its knowledge capital as the force to systematically upgrade organizational competitive advantage; (8) the main goal is to trigger the creation, share, repetitive use of knowledge in order to accomplish organizational learning and continue organizational life.

Nonaka *et al.* (2000) proposed Knowledge Management in broad sense which included four models: (1) purpose and subject; (2) knowledge creation process; (3) flexible use of knowledge asset; (4) value. Zack (1999) proposed Knowledge Refinery which involved five stages: (1) Acquisition: the organization creates assets and knowledge or acquires knowledge from various internal or external sources; (2) Refinement: before settling the knowledge acquired in the database, there should be a value-increased process (refinement) such as clarification, mark, index arrangement, classification, summary, standardization, integration and re-classification; (3) Storage and Retrieval: connecting the previous stage of constructing database and later stage of knowledge distribution; (4) Distribution: this stage includes all kinds of system and method by which the organization allows all to use the database; (5) Presentation: the situations in which the organization uses knowledge has great impact on the value of knowledge. The business must flexibly arrange, choose and integrate the content of knowledge. After acquisition, refinement and storage, knowledge platform is created and constantly renewed; at the retrieval, distribution and presentation stages, people acquire dif-

ferent perspectives from the knowledge. Sarvary (1999) thought that Knowledge Management includes three processes: (1) Organizational Learning: the process in which the company acquires information and/or knowledge; (2) Knowledge Production: the process to transform the information without processing and integrate it into knowledge. The knowledge can solve the business problems; (3) Knowledge Distribution: the process to allow the members in the organization to acquire and use company group knowledge.

Zack (1999) pointed out that the function of Subject Master Expert is like editing which ensures the quality of knowledge content; Subject Master Expert also resembles database manager who meticulously edits the abstract and index to ensure the quality of context which is beneficial for knowledge collection and knowledge value upgrading. In Customer Support Knowledge Management System, Subject Master Experts are usually the professional engineers who master techniques of Case-Based Reasoning and edit knowledge as new "case" into Case-Based Reasoning knowledge data base according to presentation format of Case-Based Reasoning for the use of consulting engineers.

2.2 Organizational Culture and Knowledge Management

Dash (1998) studied 500 organizations which executed Knowledge Management. The result showed that 80% of the targets indicated that "the culture existing in the organization" is the most significant obstacle for Knowledge Management; the study of Hibbard and Carrillo (1998) also found out that the most difficult problem the execution of Knowledge Management encountered was the refinement of organizational culture. Nonaka and Takeuchi (1995) thought that the studies of organizational culture recognized the importance of knowledge; however, they did not value knowledge enough. The reasons were in that: (1) most of the studies did not provide sufficient position for human creativity; (2) most of the time, people were treated as the knowledge dealers instead of creators; (3) as to the relationship with external environment, the organization was positioned in passive state and organizational refinement and creative competence were neglected (Nonaka and Takeuchi, 1995); the knowledge share of employees in the enterprise would be the challenge for the whole organizational culture since during the process of knowledge share, work process and structure would change or re-design. The most significant obstacle of Knowledge Management is that the culture formed in the original organization is not easy to be refined. Based on community presentation concept, Levy-Bruhl elaborated the production of organizational culture which was the shared characteristic and presentation passed by all members in social community by generations. The members in the community would generate different emotions according to different situations (Chuang *et al.*, 1991). If the tacit knowledge and explicit knowledge in organizational culture can be delivered to the ideology of everyone in the organization through symbols, finally, the members' ideology will gradually create new organizational cul-

ture and the promotion of Knowledge Management idea will be fairly easy (Liu, 2000).

Schein (1992) assumed that organizational culture was the shared space among the members in the organization. During the process of organizational learning, "share" in organizational culture was the part which can be explicit the most. Learning culture was thus created. It certainly created new force in organizational culture. The learning units included individuals and work teams. In the interactive communities among organizations, learning culture is the process of continuous learning which emphasizes time sequence, shared communication channel and organizational culture. Johanessen *et al.* (1999) found out that in the culture created by Knowledge-based organization, the employees set up their targets and generated team mechanism to stimulate each other; what learning culture stressed was continuous learning which certainly put the idea of Knowledge Management on the instruction principle of sustainable operation and allowed Knowledge Management to constantly renew managerial concept through continuous learning that could avoid the restriction of managerial mechanism (Liu, 2000).

World Executive's Digest pointed out that Community of Practice meant to establish some teams systematically. The employees are divided into groups to exchange opinions, share ideas and improve works; some companies also allow the customers to participate in the discussion and exchange their views. It is also a kind of community of practice. In brief, it means a group of people in the enterprise look for opportunity to be together and share their experience. Since it is not a formal organization, the participants are not limited. They might be engineers, strategic marketing advisers or even the business manager who is in charge of large scale customers. Knowledge Management adviser Etienne C. Wenger pointed out in Harvard Business Review that the establishment and maintenance of community of practice rely on long-term cultivation and we cannot expect the results in short term.

2.3 Information Technology Knowledge Management

Arthur Andersen provided the important element formula of Knowledge Management: $K = (P + I)^S$. K represents Organizational Knowledge, P is People, I is Information, $+$ is Technology and S represents Share. We can recognize that the operation of organizational knowledge is to combine personnel and information through technology and use shared organizational culture to accelerate the accumulation and establishment of knowledge (Daveport and Prusak, 1997). Therefore, there is close relationship between Knowledge Management and information technology. Information technology possesses the advantages of rapid speed and large capacity and it has been the best assistance for managerial field. We can access to the relationship between information technology and Knowledge Management from three perspectives: functions, purposes and content.

2.3.1 From the Perspective of Functions :

- (1) Knowledge Management emphasizes the transformation of tacit and explicit knowledge and exchange management of data and information. As to the managerial technique of the above two, traditionally, the knowledge is tacit in written documents, reports and certain page in official document or in the working personnel's instinct and experience. Thus, knowledge cannot be efficiently used and controlled.
- (2) Computer operational system in the past was based on the design of PC used by an individual. People were highly satisfied with computer processing with plenty of data such as keeping account and saving documents. However, in recent years, computer operational environment has gradually developed into network model such as centralized, cooperative and dispersed network which allow the computer network to be transformed into new information operational Management System of computer parts and file share (Fengshingtze and Chang, 1999).
- (3) Information technology values the application of "information management". The purpose is how to efficiently collect, record, save and check the data or information generated in the organization which is beneficial for the internal personnel's receiving the saving (Hsieh and Wu, 1998). Explicit knowledge can thus proceed with efficient management and circulation.
- (4) The instrument and technique of information technology are extremely mature. Through computer technology which develops proper software such as Management Information System (MIS), Electronic Data Processing (EDP) and Expert System (ES) (Hsieh and Wu, 1998), during the process in which the organization reaches the goal, Knowledge Management can thus support or create new competitive advantage.

2.3.2 In Terms of Content :

When Knowledge Management introduces information technology, managerial level, organizational structure and organizational culture in the organization will more or less be affected directly or indirectly which will certainly and considerably change the organizational pattern.

- (1) Basically, Knowledge Management is applied to organizational pattern in open system and it is easy to be influenced by external environment such as economic, social and cultural aspects.
- (2) During the process in which information is transformed in to knowledge, information technology plays an important role. Without good instrument, even the best knowledge can only be used by few people instead of everyone. Thus, while we are marching to new economic era, we must efficiently control the development of information technology to create maximum value of Knowledge Management.

The tools and techniques of information technology can completely fulfill the functions of Knowledge Management. Curretnly, there is the tendency that Knowledge Management be-

comes more dependent on computer network. International information connection also provides the service through computer cooperation and dispersed network platform. Dash (1998) believed that information technique was the least of three elements of Knowledge Management; however, if we cannot control the mutual support relationship between knowledge and information technology in the organization, it will still influence the organization considerably (Liu, 2000).

2.4 Customer Support Knowledge Management

Davenport and Klahr (1998) indicated that "Customer Support" was always involved with data and information management, such as the information needed to be acquired and analyzed: the customers' names and address, specific products needed to be supported, the acts adopted (such as personnel dispatch and authority code to deliver the products for maintenance) and even the time spent on maintenance. The knowledge is saved in the documents and these documents are even assumed as in electronic format. However, it is still very time consuming for the people to look for the knowledge while the the customers are waiting on the phone. The only knowledge which can be acquired exists in the expert's mind. Thus, in order to solve many customer problems, many experts should be hired. However, in many technology-intensive industries, it is possible for the companies to hire enough experts with the growth of product knowledge and customers' requirements. The support demand costs a lot in terms of personnel (salary and training) and infrastructure (such as computer network, customer database and office facilities). Traditionally, customer service is a kind of "support" instead of with the function of "profit creation." Thus, in order to acquire sufficient support capacity to satisfy the customers, there is the enormous pressure to reduce these costs.

Through Support Knowledge Management, many companies have reached the measurable profits, acquisition, distribution and application of the knowledge in order to reduce the turn around time. They thus can solve the customers' problems without assigning on-site maintenance personnel; they can use less experts (and expensive) support personnel and reduce the needs of support personnel completely through customers' Self-Service. For example, after Hewlett-Packard hired support analysts with lower technical level, the average maintenance time was reduced by 2/3 (from 15 minutes to 5 minutes). London Electricity reduced 40% of the frequency of calls. In Dun & Bradstreet Software, in the first several days of the new support personnel's arriving, 70% of the customer problems could be solved. NCR could reduce 10% assignment of on-site maintenance engineers. Broderbund allowed the customers to use their knowledge database directly through internet. Thus, the virtually increased support meant to add 10 personnel. It seems that, more obviously, Broderbund customers were no longer restricted to the service during working time; instead, they had technical service of 24-hour and 7 days per week. Likewise, support manager of

Cisco Systems estimated that providing service to the customers through internet allowed them to save support wages cost by 5 million US dollars every year. These various benefits of Customer Support Knowledge management which have been proved are the indicators for imitation of other organizations and other departments in the organization (Davenport and Klahr, 1998). Davenport and Klahr (1998) also mentioned that the multiple company support association of two high-tech industries: Customer Support Consortium and Desktop Management Task Force have started to develop knowledge presentation and share standard. Davenport and Klahr (1998) emphasized that regardless of structured knowledge before using or immediately offering of structure through searching or explanation, they were the critical issues of Customer Support Knowledge Management Technology.

In order to acquire more precise answers in faster and more accurate methods, the technologies which can provide more structured knowledge content gradually appear. These methods are related to "structured" support knowledge before being adopted. Although there are some companies sometimes feel disappointed at the further requirements needed to construct knowledge database, they have no choice toward the present immediate knowledge acquisitions. These knowledge-oriented technologies include Rule-Based Expert Systems, Probability Networks, Rule Induction, Decision Trees and Case-Based Reasoning.

Davenport and Prusak (1997) indicated that since it has been difficult to calculate the *financial return of knowledge, the more common measurement standard must be used*. Besides, since the observation time toward these managerial plans were limited, it needs further consideration with respect to the situation if present evaluation elements are suitable for future circumstances. However, the standard to measure the outcomes of these Knowledge Management projects are almost the same as the standard to measure other kinds to business reform plans. The following are the common standards used to measure if the Knowledge Management projects are successful: (1) the growth of resources related to the plans includes employees and budget; (2) growth of knowledge content and use rate (such as the amount of documents in database, times of users' acquisition and the numbers of people participate in the database of discussion pattern); (3) except for some people's effort, if the plan can still remain; in other words, the project is not belong to an individual; it is the shared mission of all staff in the organization; (4) if all staff in the organization can accept the concepts of "knowledge" and "Knowledge Management"; (5) the possibility of financial return such as the profit returns of Knowledge Management or the whole organization. We only need to generally understand the relationship between Knowledge Management and financial return and do not have to particularly stress it.

2.5 Characteristics of Medical Appliances Industry

Medical appliances industry is very different from traditional industries. Its characteristics

are generally described as follows (Li, 1999a; Li, 1999b; Chang, 1998): (1) it is the indicator of technology leading and it reflects national technology research standard and is related to national income: the high the national income is, people's medical care is more valued and the needs of medical appliances is more upgraded; (2) R&D competence is the competitive main force, the capital involved is plenty and the return is slow: the main key of product development is product design capacity (in other words, it must satisfy the doctors' use habit and medical diagnosis) and integration of each industry technical system; (3) it integrates technology and other high-tech industries as well as basic researches: medical appliances development is usually based on the combination of physiology, pathology, material theory, mechanical engineering electric machinery and optics. From basic theories to application techniques, they are necessary and closely connected; (4) technology-intensive level is high: the production technique needed by medical appliances industry mainly refers to the application of other industry mature techniques (for instance, ECG machine is based on the application of electronic technique on Medical Treatment Instrument and the technique of medical laser diode mainly derives from optics industry). With regard to sophisticated medical appliances, in particular, it is more necessary for the cooperation of basic medical theories and other top application techniques; (5) strict requirements of preciseness, security quality and reliability: the use of medical appliances products involves in human safety. Apart from higher degree of function, reliability and stability requirements, there must be strict control measures of security and efficacy; (6) there must be clinical test before commercialization, certification and approval, capital and time consuming and increased costs: the production and manufacturing are under severe quality control. Most of the medical product R&D requires the cost with high degree of techniques, strict examination and clinical test in order to guarantee the users (medical personnel and technicians) and direct consumers (patients). Thus, the duration from R&D to products to market is usually longer; (7) specifications and types are various, few-quantities and diverse production, high degree of return rate and unit price is high: there are various types of medical appliances including diagnosis and treatment instruments of different departments in Chinese and Western medicine. There are totally over ten thousand kinds and mostly are few-quantities and diverse productions which are difficult to reach economic scale; (8) it is not influenced by economy and prosperity. Life cycle of product is long: medical appliances are mainly applied to the field of medical care. People's needs on medical aspects are not easy to be influenced by other industries and overall economy; (9) top level and large scale expensive instrument market is in Oligopoly Model: although top level and large scale expensive Medical Treatment Instrument treats the world as the market and grows rapidly, R&D requires higher costs and the quantities are few. Oligopoly market is easy to be formed; (10) product marketing channel is unique and the hospitals are the end purchasers: the influences of professional doc-

tors' use experience, preference of brand, medical specialty and purchasing policy of medical units. There are usually specific marketing channels to sell the products and the product marketing channels are also the main competitive items of the companies; (11) governmental policies reveal great impact: national health policy, reward investment plan and industry developing policies have great impact on medical appliances industry. Using the implementation of national insurance as an example, it popularizes medical service and rapidly increases the needs of medical appliances; however, insurance payment policy will affect the decision making of purchasing medical appliances; (12) it is difficult for colleague organizations to operate: there are various types of medical appliances products which include the technical applications such as electronics, machinery, electric machinery, optics, material and physiology. The industry trade association includes various heterogeneous industries from the production of operational blade and tweezers to nuclear magnetic resonance diagnosis device composed of several thousand parts; from ice pillow and dressing to pacemaker connected with life security. The manufacturing or managerial methods of these instruments are various and thus it is difficult for the colleague organization to operate.

3. Customer Support Knowledge Management System Model

3.1 Customer Support Knowledge Transfer Model

The rapid renewal characteristic of Customer Support Knowledge results in the situation that the engineers cannot master different types of facilities of Customer Support Knowledge in short time on their own (Davenport and Klahr, 1998). Besides, due to the engineers' different educational backgrounds and specialties and limited time, the engineers must rapidly learn Customer Support Knowledge through organizational learning and use the most efficient method to support the customers. Customer Support organizations are based on certain products and choose suitable engineers to cultivate them as the peaking engineers of the said products. Through various knowledge transfer activities such as community of practice (World Executive's Digest, 2001), study forum, experience share and on-site learning, the peaking engineer allows each engineer to quickly learn the Customer Support Knowledge of the product.

Customer Support organization is based on certain customer and forms different Peaking Engineers into an Account Support Team to support the customer's different instruments and authorize a peaking engineer to be in charge of Account Management activities such as Service Delivery, Resource Management, Support Business Promotion and customer satisfaction and hold various knowledge transfer activities such as community of practice (World Executive's Digest, 2001), Study Forum, experience share and on-site learning for the Account Manager of certain customer. Each peaking engineer not only is familiar with his own speci-

alized product, but also can rapidly learn Front-line Support knowledge of different products from other peaking engineers. Besides, they can support the customers' different types of instruments on site and efficiently operate support manpower.

3.2 Customer Support Knowledge Management System Model

In order to ensure customer service quality, common Customer Support organizations not only possess professional Customer Support engineer, but also have to have a set of standardized service delivery process (as Figure 1). This process describes "service delivery" process focusing on response center in details such as customer contact, Customer Support administration, Customer Support engineers' offering of remote or on-site support, satisfying the customers' needs, resource management, logistics resources and customer response system, etc. This research attempts to involve "question confirmation" and "answer confirmation" of the above Customer Support service delivery model into the roles of Subject Master Expert (Zack, 1999) and CBR (Case-Based Reasoning) (Davenport and Klahr, 1998) technology in order to accelerate knowledge transfer and answer confirmation as Figure 2. The role playings in the above Customer Support Knowledge Management System model are as follows:

1. Each product peaking engineer undertakes the position of Subject Master Expert and uses the above Customer Support Knowledge transfer model to rapidly transfer knowledge and experience to the engineers.
2. Engineers share their work learning, knowledge and experience to the interactive Customer Support and hidden knowledge database (Zack, 1999).
3. Subject Master Expert manages the editing and quality control of the non-structural Customer Support tacit knowledge and then saves it to the integrated Customer Support explicit knowledge database (Zack, 1999). They can also save it to CBR knowledge database according to the standard of CBR presentation for the engineers or consulting engineers to use the knowledge repetitively (Davenport and Klahr, 1998).
4. According to the customer's description of the problems, the consulting engineers collect and acquire the similar cases from CBR knowledge database to rapidly solve the customers' problems. They can also screen certain CBR case such as FAQ (Frequently Asked Question) and save it to "customer knowledge database" to allow the customers to solve their own problems at any time without the restriction of time and space.

4. Empirical Cases of Customer Support Knowledge Management System

4.1 Background of Medical Treatment Instrument Industry

Medical Treatment Instrument is a kind of medical appliance which combines the basic

theories and application techniques of medicine, physiology, material theory, mechanical engineering and electronic engineering. It is actually the industry involving various high-tech synthetic applications which can be directly or indirectly used on the patients for examination or treatment. Any carelessness might easily lead to the harm to human bodies; thus, regardless of R&D and production of Medical Treatment Instrument and related medical products, they require extremely professional knowledge and techniques. They also comply with various strict medical regulations such as the standards of AAMI (Association for the Advancement of Medical Instrumentation) and FDA (Food and Drug Administration) and receive the import approvals from the health units in each country in order to enter the market. After entering the market, they will be strictly managed and supervised by Department of Health of our country (Department of Health, 2000a); once the patients are harmed seriously because of using Medical Treatment Instrument or there is "Recall" situation, the notice should be provided immediately and the modification measure should be accomplished within due date and reported to the related units for further examination (Department of Health, 2000b).

The market scale of Medical Treatment Instrument is relatively smaller and more specific than that of ordinary instruments. The former requires extremely professional knowledge and techniques when producing. It complies with the stricter standard than that of ordinary instrument. After entering the market, it must undertake higher degree of medical risk. Thus, the costs and prices of Medical Treatment Instruments are relatively higher than those of ordinary

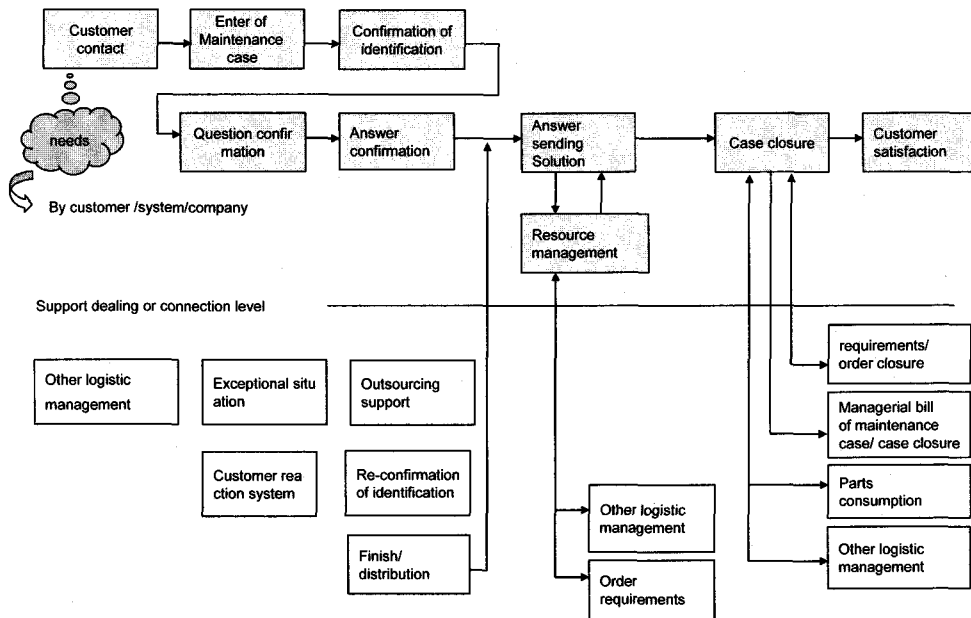


Figure 1. Service delivery process(Source: e-Loyalty Company)

instruments. Besides, the characteristics of Medical Treatment Instrument are different from that of ordinary instruments (Li, 1999a; Li, 1999b; Chang, 1998). The former requires the service provided by professional Customer Support organization in order to satisfy customer needs and the customers. Thus, the companies of Medical Treatment Instrument invest plenty of manpower, materials and capital on R&D, production, marketing and customer service of high-tech medical products and expect to use "Differentiation Strategy" to lead the market and acquire higher profits (Porter, 1990).

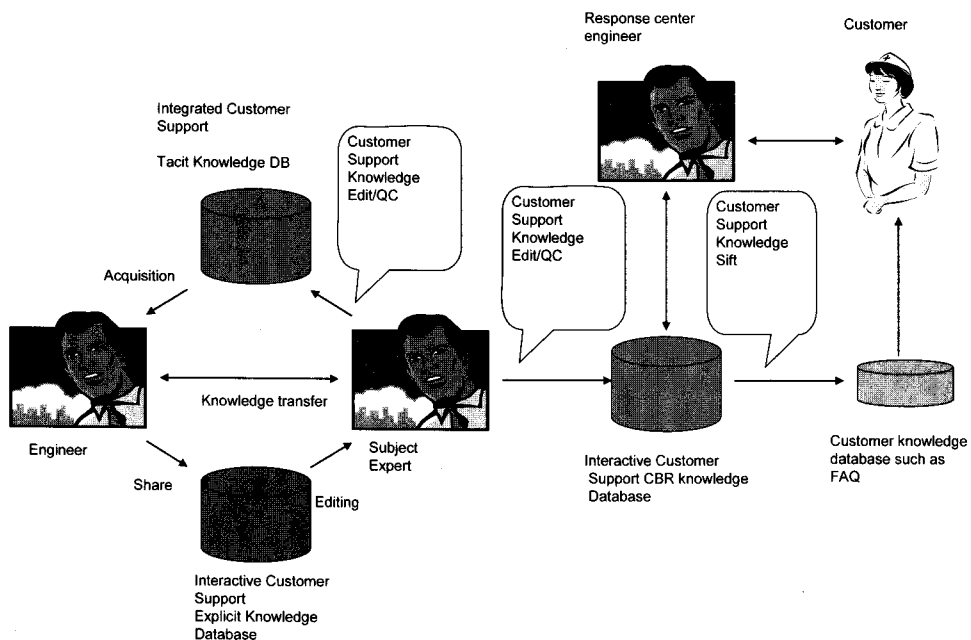


Figure 2. Customer support knowledge management system model

4.2 Target Missions of Medical Treatment Instrument Customer Support department

The characteristics of Medical Treatment Instrument are different from those of ordinary instruments (Li, 1999a; Li, 1999b; Chang, 1998). The users of Medical Treatment Instrument are mostly the medical personnel with specific medical professional knowledge. Therefore, Customer Support of Medical Treatment Instrument is also different from the support of ordinary instruments; in other words, it needs a professional Medical Treatment Instrument Customer Support department and team to provide the service. A professional Medical Treatment Instrument Customer Support department usually has four major missions. These missions are mutually dependent and closely connected, including the cultivation of support engineers, service delivery, customer operation, Customer Support business, etc. If these missions can be reached, product sale accomplishment can continuously and stably grow. The

activities of Medical Treatment Instrument Customer Support involve the later stage of life cycle of Medical Treatment Instrument. In a high-quality Medical Treatment Instrument service delivery, engineers should not only possess the basic competence to provide the following Customer Support activities, but also rapidly solve the customers' problems and provide them constant training and good service manner.

According to different customer combinations, Customer Support department plans different customer operational strategies and fulfills synergy (Wayland & Cole, 1997). It assigns exclusive Customer Support engineer particularly for "individual" and "group" critical customers, forms customers' exclusive operational team and establishes complete Customer Support files; Customer Support files include operational strategic goals, service support plan, installation list, important customer files, customer lists, visiting plans, maintenance service records, cost analysis, CBI (Critical Business Issues), KSF (Key Successful Factors), etc. Through regular and irregular customer satisfaction survey and visit, it accesses to the customers' reaction at any time, controls customers' satisfaction and immediately adopts efficient acts to maintain high degree of customer satisfaction and different customer combination. Besides, when managing customers, the department must have definite goals and strategies, proper flexibility, sincerity, integrity, Quick Response, Credit, Accountability, Focus, professional techniques, care about customers at any time, satisfying the customers' favor, balancing the profits of customers and the company, etc. Most of the Medical Treatment Instrument Customer Support departments should not treat the pursuit of high profits as the goal. It is sufficient for them to maintain customer satisfaction, normal operation of department or small scale of growth; although there are some Customer Support departments subordinate to sales department, most of the large scale oversea Medical Treatment Instrument factories such as Philips, Siemens and GE have independently operated Medical Treatment Instrument Customer Support department. In order to allow the successful operation of Medical Treatment Instrument Customer Support department in order to cultivate sufficient professional technical talents and reach organizational goal, the financial resources must be sufficient. The major financial sources are usually from internal Medical Treatment Instrument installation, educational training and warranty fee transfer, maintenance of external customer Medical Treatment Instrument and professional consulting. The main fund expenses are personnel salary, personnel training, holding activities, storage and control and marketing expenses, etc.

4.3 Medical Treatment Instrument Customer Support Knowledge Management System

Response Center is the first channel for the customers to look for support. The Customer Support personnel in Response Center such as Call Taker, Support Administrative and Response Center Engineer can immediately solve most of the customers' problems by providing Remote Support through telephone or network and dispatch Customer Support en-

engineers to offer Field Support if necessary to satisfy the customers' needs and the customers. Thus, customer response center plays critical role in Customer Support service delivery. The design of Customer Support Knowledge transfer model also affects the efficiency of Customer Support engineer Customer Support Knowledge transfer; thus, this research treated high-tech Medical Treatment Instrument industry as the background and integrated various Knowledge Management related organizations, technology and activities such as knowledge, community of practice, Subject Master Expert, organizational culture, customer relationship management, Customer Support Knowledge management technology, Customer Support service deliver into "Medical Treatment Instrument Customer Support Knowledge Management System" and presented it by three sub-systems: "Medical Treatment Instrument Customer Support Knowledge transfer model", "Medical Treatment Instrument Customer Support service delivery model" and "Medical Treatment Instrument Customer Support Knowledge Management Website" as Figure 3.

1. Medical Treatment Instrument Customer Support Knowledge transfer model based on system products: Medical treatment, electronics and information technology change rapidly and there is plenty of Medical Treatment Instrument related knowledge and the renewed speed is extremely fast. As Pavia, the vice chairman of McManis Associates, said: "with the speed of current innovation, in ten years, FDA will approve nearly 100,000 items of medical instrument development or enhancement" (Egger, 2000); therefore, it is actually not easy for Medical Treatment Instrument Customer Support engineers to catch up with the rapid change of system product support knowledge. In order to accelerate the support of system products to knowledge transfer, Customer Support organizations follow engineers' specialties and the installation of system products and this research re-arranges the duties of product expert engineers: participating in domestic and oversea major system product training, executing transfer training of system product techniques, cultivating system product engineers, system product second-line support, supporting newly installed system products, managing Knowledge Management forum of Management System product and regularly holding system product knowledge transfer meeting.

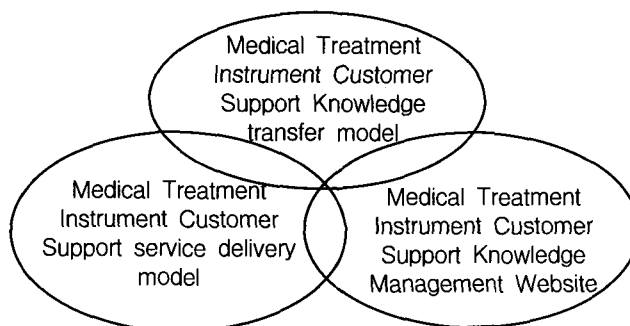


Figure 3. Medical treatment instrument customer support knowledge management system

2. **Customer-based Medical Treatment Instrument Customer Support Knowledge transfer model:** The medical departments in large scale hospitals such as medical center or teaching hospitals usually possess different types of sophisticated Medical Treatment Instruments. Customer-based support knowledge transfer model will treat this kind of hospitals as the units and different peaking engineers will form a Customer Support team to support different types of sophisticated Medical Treatment Instruments in the hospital. A peaking engineer will also be authorized as the “customer manager” in the hospital to be in charge of “customer operation” activities such as service delivery, support business promotion, resource management, customers’ satisfaction and hold various knowledge transfer activities such as community of practice (World Executive’s Digest, 2001), study forum, experience share and on-site training. Thus, each engineer can not only be familiar with his own specialized product, but also rapidly learn “first-line support” knowledge of different products from other peaking engineers. That is to say, they can provide on-site support according to different types of Medical Treatment Instruments and efficiently operate support manpower.

Customer Support service delivery model of Medical Treatment Instrument integrates the roles of Subject Master Expert (Zack, 1999) and CBR technology into Customer Support service delivery model generally based on customer response center and distinguishes remote and on-site support as Figure 4. The role playings of Customer Support service delivery model of Medical Treatment Instrument are as follows:

- (1) Call Takers or Support Administratives receive the calls from customers or on-site engineers to confirm the customers’ identification, register maintenance case and adopt related support administration.
- (2) According to problem descriptions, Consulting engineers use CBR database to acquire similar cases or use network to directly connect Medical Treatment Instrument for remote diagnosis to rapidly solve the customers’ problems. The more customers’ problems solved, the more costs of engineer on-site support are reduced.
- (3) When consulting engineers cannot rapidly solve customers’ problems, they must assign the engineers for on-site support.
- (4) Peaking engineers usually undertake the positions of Subject Master Experts who are in charge of the standard of CBR presentation (Davenport and Klahr, 1998), editing new maintenance cases or transfer tacit knowledge from tacit knowledge database to explicit knowledge database.

Medical Treatment Instrument Customer Support Knowledge is complicated and diverse. In order to keep the knowledge and allow the engineers to successfully share and rapidly acquire the knowledge needed, this system sets up a Customer Support Knowledge Management website. The organizational roles and duties of the website, developing tools and knowl-

edge framework are described as follows:

3. Organizational roles and duties of Medical Treatment Instrument Customer Support Knowledge Management website: A successful Medical Treatment Instrument Customer Support Knowledge Management website should not only possess suitable information technology framework, but also have complete informal organizational framework. For Customer Support Knowledge Management website, two important roles are: (1) knowledge chief (Ma, 2000a/2000b): responsible for knowledge strategy execution, resource offering, Knowledge Management technique and organizational framework design, regularly holding Knowledge Management meetings. (2) Subject Master Expert (Zack, 1999): in charge of editing, quality control and managing tacit and explicit knowledge zones and CBR editing. Other roles and duties of the organization are shown in Table 1.
4. Developing tools of Medical Treatment Instrument Customer Support Knowledge Management website: This Knowledge Management website is based on mission organization. The core members of Knowledge Management are non-professional Information Technology personnel. Thus, the selection of developing tools is mainly based on the

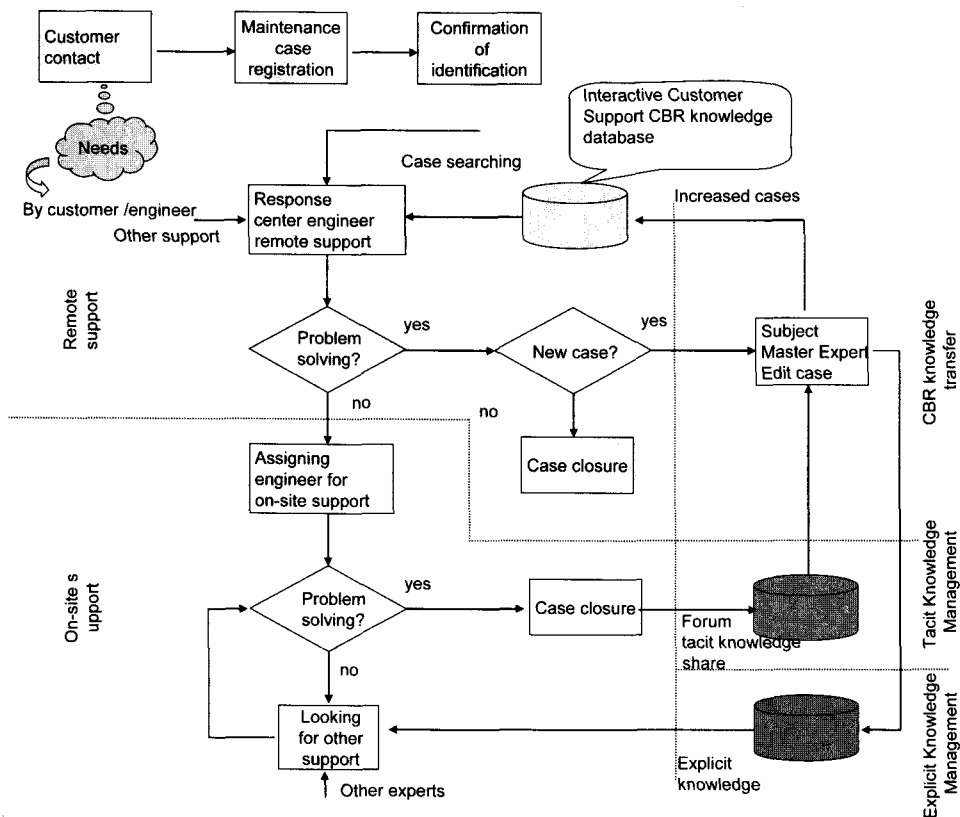


Figure 4. Customer support service delivery model of medical treatment instrument

ones which are currently easy to be acquired, operated and designed (Hsieh, 2000). The developing tools and framework of Medical Treatment Instrument Customer Support Knowledge Management website are shown in Figure 5.

Table 1. Organizational roles and duties of medical treatment instrument customer support knowledge management website

Roles	Duties
General manager	Knowledge strategy planning.
Knowledge chief	Knowledge strategy execution, resource offering, technical and organizational framework design of Knowledge Management, regular holding Knowledge Management meetings.
Knowledge manager	Managing Subject Master Expert group division according to skill database, design and stimulation, promoting and evaluating plans, webpage framework design.
Technology manager	Technical framework design of Knowledge Management website.
Learning manager	Training core and all Customer Support members, controlling tacit knowledge zone and the integration of response center of Knowledge Management.
Marketing manager	Promoting Knowledge Management website.
Subject Master Expert	Editing, quality controlling tacit knowledge as explicit knowledge or CBR cases.
Business assistant	Knowledge renewal of Knowledge Management website.

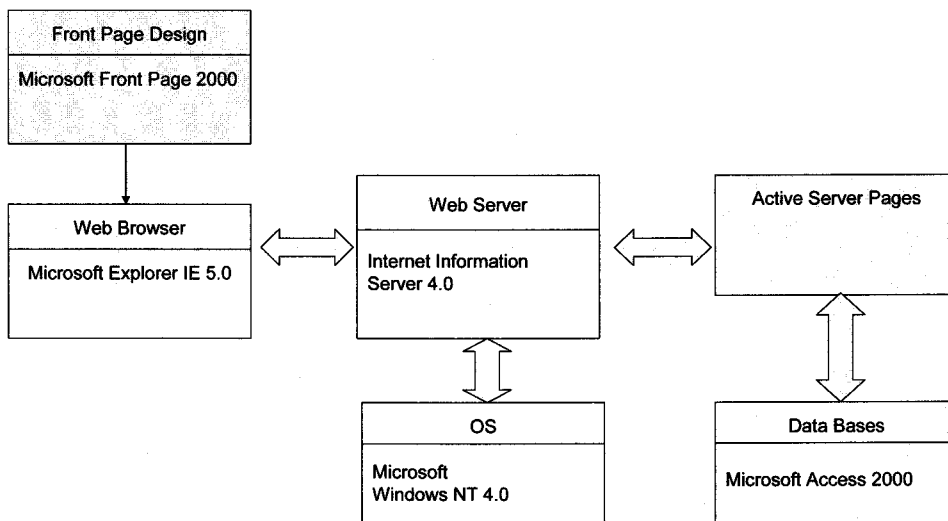


Figure 5. Developing tools and framework of medical treatment instrument customer support knowledge management website

5. Knowledge framework of Medical Treatment Instrument Customer Support Knowledge Management Website: the knowledge framework of Medical Treatment Instrument Customer Support Knowledge Management Website is shown in Figure 6. The following is the brief introduction: (1) "Bulletin board" and "forum" are "tacit knowledge zone" and the rest are in "explicit knowledge zone." Through editing and quality control, Subject Master Expert transfers tacit knowledge into explicit knowledge or CBR cases to support engineers' repetitive use; (2) According to different products, different product peaking engineers are assigned as Subject Master Experts who are in charge of tacit knowledge editing and quality control; (3) Regularly announcing the quality and quantity of knowledge share, affirming and encouraging personnel with prominent performance in public and establishing the culture of organizational knowledge share.

4.4 Evaluation of Customer Knowledge Management System effect

Through the establishment of Customer Support Knowledge Management website and learning of Knowledge Management related knowledge, both Knowledge Management project organizational core members and other Customer Support members have more profound understanding toward their own work content (Drucker, 1999) and Knowledge Management. Project organizational core technical members learn more experience with respect to website establishment and management. Knowledge chief also often shares his Knowledge Management project execution experience with the customers in large scale customer conference and directly contributes to the customer satisfaction. The implementation of Customer Support Knowledge Knowledge Transfer Model is based on various organizational learnings such as Study Forum, Skill Transfer Workshop and on-site learnig to share knowledge and experience and allow support personnel's professional Technical Competence to grow rapidly in order to upgrade the efficiency of Customer Support.

The re-design of Customer Service Delivery Model is based on traditional Customer Service Delivery Model focusing on customer response center and combines quality and editing funcitnos of "Subject Master Expert" and "CBR" technogloy which can provide immediate "remote" support response to complete Customer service delivery model. In order to understand the influence of execution of "Customer Support Knowledge Management System" on Customer Support organizations, this research treated the medical instrument end users in various types of hospitals of Taiwan which have received the support service of our company in recent six months as population. The end users were mostly the nursing executives or ultrasonic wave technical personnel in intensive care unit and they had similar educational background and incomes and adopted the medical instruments such as physical supervision system, ultrasonic wave system, heart start or ECG machine produced by our company. The research method was to randomly treat the investigation results of the telephone customers'

satisfaction from respective 30 end users in the population three months before and after this system execution as the samples and use SPSS for Windows 10.0 as hypotheses test to validate if the end users' customer satisfaction significantly improved in terms of "Remote Support," "On-site Support," "Service Turn Around time," "Technical Competence" and "Service Manner." The research variable 1 (μ_1) was the sample average before the execution of this research. Variable 2 (μ_2) refers to the sample average after the execution of this system. Null hypothesis $H_0: \mu_1 \leq \mu_2$, alternative hypothesis $H_1: \mu_1 > \mu_2$. As to the scores of μ_1 and μ_2 , 5 point refers to the most satisfying one and one point means the most unsatisfying one.

Hypothesis 1: After implementing customer knowledge Management System, customers' satisfaction toward "Remote Support" improves significantly. $H_0: \mu_1 \leq \mu_2$, $H_1: \mu_1 > \mu_2$. The research result revealed that $\mu_1 = 4.48$, $\mu_2 = 4.55$, t statistics of $\mu_1 = -0.5016$, $\alpha = 0.1$, freedom = 29, $p(T \leq t)$ one-tailed = 0.3098. Since $p(T \leq t)$ one-tailed $> \alpha$, $0.3098 > 0.1$; thus, H_0 was accepted. In other words, after implementing customer knowledge Management System, customers' satisfaction toward "Remote Support" did not improve significantly.

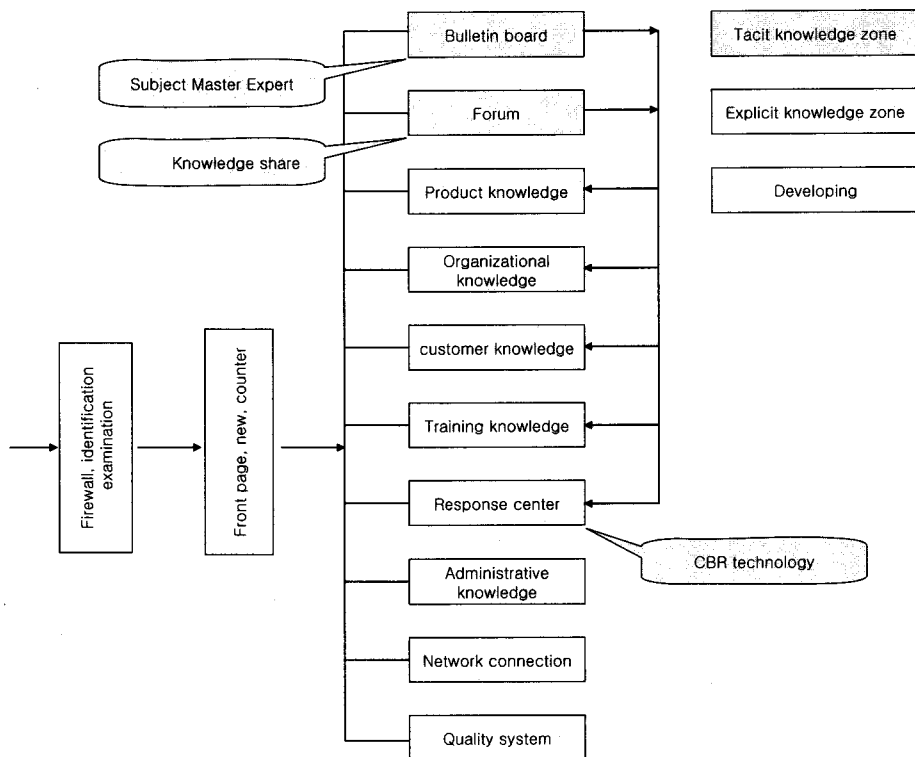


Figure 6. Knowledge framework of medical treatment instrument customer support knowledge management website

Hypothesis 2: After customer knowledge Management System, customers' satisfaction toward "On-site Support" improves significantly. $H_0: \mu_1 \leq \mu_2$, $H_1: \mu_1 > \mu_2$. The research result revealed that $\mu_1 = 4.58$, $\mu_2 = 4.76$, t statistics of $\mu_1 = -1.3629$, $\alpha = 0.1$, freedom = 29, $p(T \leq t)$ one-tailed = 0.0916. Since $p(T \leq t)$ one tailed $< \alpha$, $0.0916 < 0.1$; Thus, H_0 was denied. In other words, after implementing customer knowledge Management System, customers' satisfaction toward "On-site Support" improved significantly.

Hypothesis 3: After implementing customer knowledge Management System, customers' satisfaction toward "Service Turn Around time" improves significantly. $H_0: \mu_1 \leq \mu_2$, $H_1: \mu_1 > \mu_2$. The research result revealed that $\mu_1 = 4.35$, $\mu_2 = 4.5$, t statistics of $\mu_1 = -1.2235$, $\alpha = 0.1$, freedom = 29, $p(T \leq t)$ one tailed = 0.1154. Since $p(T \leq t)$ one tailed $> \alpha$, $0.1154 > 0.1$. However, the difference was extremely insignificant; there was no complete conditions to accept or deny H_0 . In other words, after implementing customer knowledge Management System, customers' satisfaction toward "Service Turn Around time" was not significant.

Hypothesis 4: After implementing customer knowledge Management System, customers' satisfaction toward "Technical Competence" improves significantly, $H_0: \mu_1 \leq \mu_2$, $H_1: \mu_1 > \mu_2$. The research result revealed that $\mu_1 = 4.5$, $\mu_2 = 4.76$, t statistics of $\mu_1 = -1.9746$, $\alpha = 0.1$, freedom = 29, $p(T \leq t)$ one tailed = 0.0289. Since $p(T \leq t)$ one tailed $< \alpha$, $0.0289 < 0.1$; thus, H_0 was denied. In other words, after implementing customer knowledge Management System, customers' satisfaction toward "Technical Competence" improved significantly.

Hypothesis 5: After implementing customer knowledge Management System, customers' satisfaction toward "Support Manner" improves significantly, $H_0: \mu_1 \leq \mu_2$, $H_1: \mu_1 > \mu_2$. The research result revealed that $\mu_1 = 4.65$, $\mu_2 = 4.8$, t statistics of $\mu_1 = -1.4298$, $\alpha = 0.1$, freedom = 29, $p(T \leq t)$ one-tailed = 0.0817. Since $p(T \leq t)$ one tailed $< \alpha$, $0.0817 < 0.1$; thus, H_0 was denied. In other words, after implementing customer knowledge Management System, customers' satisfaction toward "Support Manner" improved significantly.

5. Conclusions

The result of hypotheses examination revealed that after the execution of Customer Support Knowledge Management System, Customer Support organizations' customer satisfaction toward "On-site Support," "Technical Competence" and "Support Manner" improved significantly; in other words, Customer Support organizations' implementation of product or customer-based "Customer Support Knowledge Transfer" model, combination of "Subject Master Expert" and "Customer Support service delivery" model of "CBR" technology and establishment and use of Knowledge Management related activities of "Customer Support Knowledge Management Website" could rapidly upgrade engineers' professional Technical Com-

petence in short term and allow the engineers to provide quick and high-quality maintenance support service. Thus, the engineers could face and operate the customers in "calm and relaxed" manner. Thus, according to the hypotheses examination results, customers' satisfaction toward "On-site Support," "Technical Competence" and "Support Manner" was more significant. On the other hand, the hypotheses examination results revealed that the customers' satisfaction toward Remote Support and Service Turn Around time did not improve significantly. As to satisfaction toward Remote Support, the reason might be in that customer response center was often based on non-face-to-face method of Remote Support through telephone and fax. Thus, in short term, it could not immediately contribute to the upgrading of customers' satisfaction. It might take longer time to find out the significant influence. As to Service Turn Around time, the reason might be in that the engineers could not distinguish or record the time of support and customer operation in details. Thus, the satisfaction difference of Service Turn Around time was less significant.

The scale of Knowledge Management is wide. In this research, we can find out that Customer Support Knowledge Management actually includes many tangible and intangible activities activities we have been managing in daily lives such as educational training plan and courses, study forum, self-learning, on-the-job learning, e-mail exchange, network in business, internet, document management, tools and facilities, work process, organizational knowledge culture, professional Technical Competence, face-to-face talk, training, outsourcing support, expert network, etc. However, Customer Support Knowledge Management System only re-examines and integrates these original Knowledge Management activities. Since the observation time was not long, the effect of Customer Support Knowledge Management System execution did not reveal complete and significant refinement as expected. If we can spend more time, have careful consideration and adjust the methods of Customer Support Knowledge Management according to the environmental changes, the complete and significant refinement of plcustomer satisfaction will be just round the corner.

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