Innovation of Telehomecare Service industry: A Patent-based Assessment

Ming-Yu Wang[1], Jie-Heng Lin[2], Min-Chun Chiang[1]
[1]Department of Bio-industry and Agribusiness Administration, National Chiayi University, Chiayi, Taiwan
[2] Department of Technology and Innovation Management, National Taiwan University, Taipei, Taiwan.

Abstract--**With the advancement in information and telecommunication technologies, Telehomecare can surmount obstacles in space and time and exchange clinical information between patients and experts, which fulfill the patients' needs of the aged society. Servitisation not only represents the developments of new products or technologies, but also includes the innovative activities in improving current products and services which can respond to market demands. Patent databases contain abundant information on technologies, in which the category of "business method" contains patents in innovating business models. Therefore this study examines the telehomecare service patents which embedded in business method and telehomecare device technologies. This study presents the innovation outcomes and assesses the technological gaps in telehomecare service industry. The results offer suggestions and guidelines for firms to deal with strategy planning in patent portfolio, collaborator searching and technological developments.**

I. INTRODUCTION

A. Research Motives

The service industry has become a major source driving economic and productivity growth. In the Economic Cooperation Organization, service industry is the main source of job opportunity creation [25]. In many developed countries, there is almost no difference between manufacturing and service industries, while the differences between commodity production and service activities become increasingly ambiguous [19]. Service can play a supporting role in sales, and facilitate the demand for tangible products, thus, driving the manufacturing industry to grow and become the key of a competitive force [22]. Tidd, Bessant, and Pavitt [29] suggested that innovation refers to the re-design or improvement by an enterprise of a provided product, where services and methods enable the enterprise to survive and grow; and the enterprise obtains competitive advantage through product innovation, process innovation, and service innovation. Moreover, service innovation increases the quality and variety of services, and may therefore open up new markets [3].

An aging society has derived the demand for the long-term care of the elderly population; and the technical approach developed by the telehomecare (THC) industry is to fully meet the potential market demand based on new technology. According to the definition by the UN World Health Organization, a society is referred to as an aging society when the elderly population aged over 65 accounts for 7% of the country's total population. Under this standard, many countries have entered into an aging society. Taking Taiwan for example, according to the population age distribution in the annual statistical report of the Ministry of the Interior, the population aged over 65 in Taiwan officially passed 1.49 million people at the end of 1993, accounting for 7.1% of the total population. Therefore, Taiwan became a nation of aging society. According to the population estimation of the Executive Yuan in 2012, Taiwan's population structure will enter into an aging society in 2018. Taiwan's population structure ages so rapidly that the strong demand for the long-term care of the elderly population is derived [20]. There is a wide range of home-care instruments and equipment, and, due to the advances in communication technology, great progress has been made in THC equipment, gradually transferring medical care patterns from the hospital-based care of the past to home-based care.

Service innovation represents the development of new products or new technology, as well as containing all innovation activities specific to the market to improve existing products, services, and delivery, from the perspectives of organizational management and positioning. This study regards that an aging society has derived the demand for the long-term care of the elderly population; and the technical approach developed by the THC industry intends to meet market demand by providing new services based on new technology. Its service pattern of utilizing information technology to transmit the physiological parameters and medical information also accord with the definitions of service innovation, such as improving existing products, services, and delivery patterns, and generating interaction between customers and producers in the process. Therefore, this research takes the THC industry as the research target to analyze its related patents.

II. LITERATURE REVIEW

A. Service Innovation

Innovation is a kind of capability and resource of continuous improvement that can be utilized by enterprises to find and take advantage of various opportunities to develop new products to meet market demand [27]. Complete knowledge accumulation has an important role in innovation [30]. Most early innovation research mainly focused on product innovation in the production process [4]; and the vast majority of innovation research places emphasis on the technical innovation of the manufacturing industry, as it has long been the main economic activity [9], for example, in Baumol's [2] opinion, the service industry lacks innovation, as compared with the manufacturing industry. However, the

research of Panesar and Markeset [26] pointed out that the focus of innovation management varies along with the evolution of time, transferring from the early industrial innovative behavior and entrepreneurial spirit to contemporary service innovation.

According to Tidd, Bessant, and Pavitt [29] innovation refers to the re-design or improvement by an enterprise of the provided product, service, and methods to enable the enterprise to survive or grow; and the enterprise obtains competitive advantage through product innovation, process innovation, and service innovation. Moreover, service innovation increases the quality and variety of service, and may therefore open up new markets [3]. Den Hertog [8] defined service innovation as new ideas, new customer interaction, new value system/business partner, new revenue models, and one or a combination of new experiences or schemes in a new organization. With the impact of the service industry on economic growth, service innovation attracts more and more attention, with various literatures exploring published service innovation.

Coombs and Miles [7] divided literature on service innovation into three categories. The first category is the technologist or assimilation approach, the second category is the service-based or differentiation approach, and the third category the integrative or synthesizing approach. Since there is no formal R&D process in service, it is difficult to measure service output. Therefore, Lancaster [18] proposed that the service characteristics of products, whether tangible or intangible, could be both described as the embodiment goods or services. What consumers seek is not the product itself, but the service characteristics it offers. Gallouj and Savona [10] expressed that the integrative or synthesizing approach has developed a universal architecture applicable to both commodity innovation in the manufacturing industry and service innovation in the service industry. This architecture is able to avoid the underestimation of non-technical innovation made by the assimilation approach, and explores the technical characteristics in connection with service characteristics, as discussed by the differentiation approach. The architecture concept is based on the fact of no significant difference between commodity innovation and service innovation, the service concept provided by the service industry is similar to commodity development in the manufacturing industry [23], almost no difference between the manufacturing industry and service industry in many developed countries, and the difference between commodity production and service activities become increasingly ambiguous [19]. The most important structure of the integrative or synthesizing approach is the architecture proposed by Gallouj and Weinstein [12], which can explain the relations among the ultimate service characteristics, service provider's competences, service provider's technical characteristics, and user's competences. The research following that of Gallouj and Weinstein [12] mostly emphasizes the impact of the user's competences on the service provider's competences and service provider's technical characteristics. For example, in their research, Gallouj and Savona [11] further reduced user's competence down to user's competence and user's technical characteristics; however, few literatures re-explore the relation between the service provider's competence and service provider's technical characteristics, or their evolution under the integrative or synthesizing approach architecture of service innovation.

A business model provides data and other evidence to prove how an enterprise creates value for customers, how to realize delivery, and provides an overview of the revenues, costs, and value-related profits provided by an enterprise. In order to obtain profit from innovation, an entrepreneur must make innovations in products, as well as understand their own needs, customers' needs, and technical trajectories in the design of a business model [28]. An innovative business model can help a business to maintain its competitive advantage. A business model is important to managers, entrepreneurs, and academic research, for the following reasons: first, a business model represents the source of underutilized future value; second, it is difficult for a competitor to imitate a single commodity or process in a business model; and finally, a business model is a potential and powerful competitive tool [1]. Therefore, exploring the individual company's service innovation activities and development through a business model can result in a holistic understanding of service innovation. Kindstrom [16] first explored the service innovation of 7 enterprises' business models by way of research interviews.

Gebauer, Krempl, Fleisch, and Friedli [13] suggested that, compared with commodity innovation, service innovation is more easily imitated. Accordingly, this study regards that, even a service industry without formal R&D activities must utilize patents to protect their products, services, and business models of the service industry. Since a patent is a kind of property right granted by the government to a patentee, or their assignee and successor, it not only has a technical nature and legal force, but also the public uses of earning profit, maintaining competitive advantage, monitoring technical development, and protecting corporate interests and exclusive rights [6]. Many companies develop business model patents, thereby protecting the enterprise's technology-based business model of service. A business model patent contains a large number of service and technical information; therefore, it can be used as an analysis data source of the technology-based service. Additionally, a business model patent can describe the new technology details of a technology-based service. Many implications not yet addressed in previous research could be obtained from such analysis [15].

Patent analysis includes considerations concerning overall development and operating strategies, through which it is able to determine competitors' patent applications and research directions, understand market trends and customers'

needs, and analyze the new technology's features and commercialization possibilities [5]. Patent literature analyzes dozens of research projects, which can be divided into two categories; the first category includes structured data, such as patent number and date of application, in a uniform format; the second category consists of the unstructured data, such as the abstract and claims. A map representing both types of information is called a patent map [21]. According to the definition of the National Applied Research Laboratories [24], a patent map is a graphic presentation form of the reorganized patent information, and is intended to allow users to obtain the rich content of patent information through simple and clear graphics. A patent map can help users grasp the complex relationships between patents, understand the R&D status of a specific technology and company, and even know the competitive situation of the entire industry and the country. This study uses PatentGuider2008 to draw the patent management map, and Thomson Innovation to draw a technology-function matrix and technology-distribution aerial view of the patent technology map.

B. Telehomecare industry

THC is defined by Koch [17] as "to provide patients with two-way interactive audiovisual medical service in their residence, with a self-management group of chronic diseases, transmitting specific disease symptoms through the Internet, modem, or telephone, and being a powerful comprehensive patient/family health education program". THC uses communication technology to transmit physiological parameters and medical information, and provides a convenient two-way interactive mode with medical professionals through network transmission, thus, reducing both parties' travel issues, providing patients with home health care and management, and increasing patient activity freedom and disease self-management capabilities [14]. The THC system can facilitate the mobility and living quality of the cared-for at home, and transmit the physiological information of the cared-for through the telephone or network to overcome the barriers of space and time, thus, saving costs in long-term care service, reducing costs of national health care, and effectively enhancing the security of home care and home mobility.

III. RESEARCH PROCESS

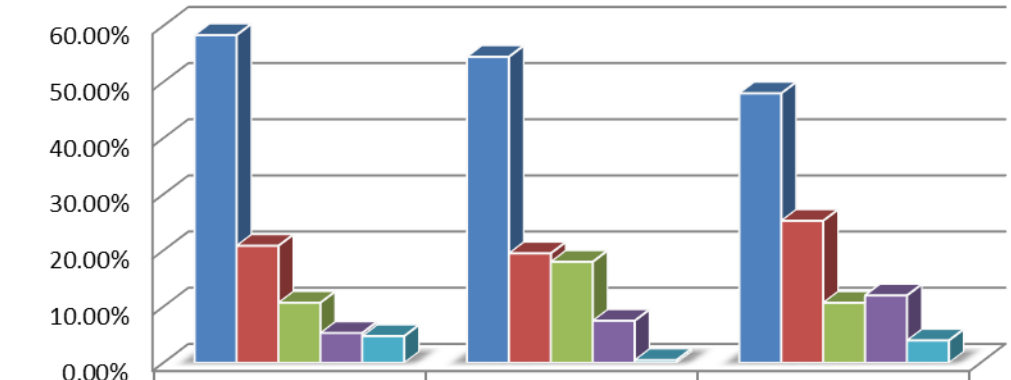
This research is conducted mainly by the following steps. First, books about THC in ITIS (Industry & Technology Intelligence Service Program) publications were consulted to determine patent-retrieval keywords in the technical aspects of THC; and determined that the scope of this technology was too ambiguous for the easy retrieval of simple patent keywords. Thus, all approved patents of the top five companies in the THC industry in the USPTO, as listed in the ITIS report, were searched by the text mining method in order to explore the words used by the three fields of these patents' titles, the abstracts and patent claims, and the frequency of these words; and the results showed no words of particularly high frequency, meaning the THC keywords used by each company were not unified; however, almost all the patents' International Patent Classification (IPC) numbers were found to be a combination of A61B, G06F, and G06Q. Therefore, it was decided to take A61B, G06F, and G06Q as the retrieval queries of this research. Then, the patents met the aforementioned retrieval queries were downloaded in the USPTO database of issued patents, with 2,074 patents obtained. As the patents issued 20 years ago have lost legal protection, this research narrowed the patent period to between July 1, 1993 and July 30, 2012. Finally, 1419 out of 2074 patents were selected as the basis for patent analysis in this research. Next, the remaining patent abstracts and claims were manually screened and read in order to screen out the patents related to this research, with 840 research-related patents screened out. The 840 relevant patents were manually classified into technology and function categories, and a technology-function matrix was created. The patent maps and statistical charts were made by using Thomson Innovation and Patent Guider, and finally, analysis was conducted on the patent management and patent technology maps to obtain the patent analysis results.

IV. ANALYSIS RESULTS

A. Analysis of Patent Management Map

The statistical analysis of patents can help to understand the developmental direction of products, R&D market trends, future trends of companies, and other important related information. Therefore, national and citation analyses of a company can be made from the patent data. In this research, the U.S. database of approved patents is used as the retrieval database of telemedicine patents; and the analysis software of "Thomson Innovation" and Copartner Technology Corp.'s "PatentGuider2008" is used for patent analysis.

In this research, the top three countries, in terms of patent numbers, are selected to make the comparison. As shown in Figure 1, almost all technology trends of the three countries concentrate in A61B005 and G06F019. The U.S. is far ahead of other countries in the numbers of IPC items, among which A61B005 leads with 102 pieces (58.36%) of the total number in the U.S., followed by G06F019 accounting for 20.85%. These two categories account for most of the patent output. The second country is Japan, accounting for 54.5% in A61B005 and 19.5% in G06F019, similar to those of the U.S. The third country is Germany, accounting for 48% in A61B005 and 25.3% in G06F019, with similar cases. The numbers of IPC of these two categories in other countries' patents are also in the majority. It can be concluded that most patents concerning the THC integration system concentrate in the two categories of A61B005 and G06F019.



	U. S.	Japen	Germany
A61B005	58. 36%	54. 50%	48%
G06F019	20. 85%	19. 50%	25. 30%
G06F017	10. 71%	18%	10. 70%
G06F003	5. 32%	7. 50%	12%
G06Q050	4. 76%	0. 50%	4%

Figure 1: Distribution of Main IPCs of Top Three Countries

B. Technology-function matrix

The technology-function matrix analyzes both the technical approaches applied in patents and the variety of functions achieved by them. A form of different technologies and attainable functions is constructed to be filled in with a corresponding number of patents, from which enterprises can develop R&D directions, by avoiding competitor patent intensive areas, and determining any blank-patent areas for research and development [6]. After the technologies and function are defined, cross-classification table is conducted on the 840 screened patents; the technology-function matrix diagram is constructed by filling in the patents one by one; and the results expressed in percentage are presented, using the levels to facilitate the observations of the distribution status.

In Table 1, the areas having a patent count greater than 20 are screened out, as shown in the yellow section; the percentages are ranked in order; and discussion is made on the main patentees specific to competing companies in the technology, and its function sub-areas. As shown in the table, in the technical area of the THC system, the distribution profile of the technology and function sub-areas of the main competitors is, as follows: in the technologies, according to physiological data analysis and function and physiological diagnosis, development has been made by many companies; in the technology aspect, Company D's technology is mainly positioned at achieving function in "storage management" in technical applications, where the three technologies of "wireless communication receiving", "data processing", and "physiological data analysis" are applied; Company K's technology is positioned at the "data processing" technology application in data collection and transmission; in the function aspect, Company I makes more development in the functions of storage management, and Company B makes more development in the physiological detection and diagnosis of the cardiovascular system.

In this research, the top ten cited numbers are entered into the technology-function matrix for comparison, where the distributed locations of this group of pioneer patents can be clearly viewed, as shown in Table 2

TABLE 1: DISTRIBUTION DIAGRAM OF MAIN PATENTEES OF TELEMEDICINE COMPONENTS

Technology-function Matrix			Function					
			Data collection and transmission			Data analysis and processing		
			Physiological detection	Data transmission	Storage management	Data processing	Image presentation	Physiological diagnosis
Technology	Data collection and transmission	Detection of cardiovascular system	Company B Company K Company A					Company K Company B Company T
		Image presentation technology	Company K Company M Company A			Company K Company A Company C Company E Company G	Company C Company E Company A	Company K Company U
		Wireless communication receiving technology			Company D Company F Company I			Company D Company B Company F
		Pulmonary function testing						
		Data processing	Company K Company D Company A		Company D Company C Company I	Company K Company C Company G		Company K Company D Company C
		Diagnostic technology of physiological functions	Company N Company D Company O					Company D Company V Company L
	Data analysis and processing	Physiological data analysis	Company B Company F Company D Company L	Company I	Company I Company D Company B	Company J Company G Company F		Company B Company D Company F
		Image analysis	Company P Company B Company Q Company R					
		Data signal analysis			Company A Company C Company S	Company A Company F Company C		

	Code	Company Title		Code	Company Title
1	A	Siemens Aktiengesellschaft	12	L	Eastman Kodak Company
2	B	Boston Scientific Corp.	13	M	Sony Corp.
3	C	General Electric Company	14	N	Abbott Laboratories
4	D	Bosch (Robert) GmbH	15	O	Roche Holding Ltd.
5	E	Koninklijke Philips Electronics N.V	16	P	Harbinger Medical Inc.
6	F	*Frist Opinion Corp.	17	Q	Cambridge Heart Inc.
7	G	Masimo Crop.	18	R	University Of Virginia (and Patent(s) foundation(s))
8	H	Hewlett-Packard Co.	19	S	OneMedNet Corp.
9	I	Medtronic Inc.	20	T	Omron Corp.
10	J	MedApps Inc.	21	U	University of Washington
11	K	Heartflow Inc	22	V	Brain Functions Laboratory Inc.

* Acquired by Healthways Inc. on August 1, 2007.

.

TABLE 2: ANALYSIS OF PATENT TECHNOLOGY AND FUNCTION - CITED NUMBER

Technology-function Matrix			Function								
			Data collection and transmission			Data analysis and processing			Self-management	Intervention	Machinery and equipment
			Physiological detection	Data transmission	Storage management	Data processing	Image presentation	Physiological diagnosis			
Technology	Data collection and transmission	Detection of cardiovascular system		● red						● red	
		Image presentation technology	● green								
		Wireless communication receiving technology		● red	● green			● red	● red	● red	
		Pulmonary function testing									
		Data processing	● red		● yellow	● red		● yellow			
		Diagnostic technology of physiological functions	● red		● yellow	● red		● yellow			● green
	Data analysis and processing	Physiological data analysis	● yellow				● yellow	● red	● red	● yellow	
		Image analysis	● green								
		Data signal analysis									
	Intervention	Cardiovascular system									
		Respiratory system									
	Machinery and equipment	X-ray									
		Nuclear magnetic resonance apparatus									
		Cardiovascular system									
		Other									

● red: Cited number 472-603 ● yellow: Cited number 455-468 ● green: Cited number 387-433

C. Analysis of Patent Technology Map

After the patent abstracts and claims are read manually, the period is narrowed to between July 1, 1993 and July 30, 2012. After 840 research-related patents are screened out, the publication numbers of the 840 relevant patents are retrieved using "Thomson Innovation" software, and the patent clustering contour maps are drawn using the retrieval results, where the higher the density of patent count the closer the color is to grey white.

1) Main Technology Clusters

In the patent clustering contour maps, the higher the density of patent count the closer the color is to grey white. In the three main THC patented technology clusters, the green cluster is health information obtained through the transmission of the collected physiological information; the yellow cluster is electronic body signal collection and conversion; and the light blue cluster is heart and nerve signal output and imaging technology. Apart from the said three main clusters on the map, there are sub-clusters with a small patent count at the top and the bottom left corner of the map, such as patient state analysis, remote monitoring, patient diagnostic system, three-dimensional modeling, user imaging interface, and heart rate related technology, with the separate cluster displayed on the right being patents concerning the intervention aspect, as shown in Figure 2.

2) Analysis of Top Ten Patentees in Patent Count

After technology clustering, the patentees are combined through manual review. The distribution of the top ten patentees, in patent count after the combination, is as shown in Figure 3. It can be seen from the figure that the competition in imaging technology and signal filtering technology is very intense throughout the industry. The red dots in the figure represent the distribution of 46 patents of Siemens', where the No.1 patentee in the patent count focuses on imaging technology and generating health information modules. The green dots represent the distribution of 42 patents of Boston Corp.', where the No.2 patentee in the patent count focuses on patent state analysis, access to relevant records, and patient location confirmation and intervention. The peach dots represent the distribution of 20 patents of the First Opinion Corp' (Acquired by Healthways Inc. on August 1, 2007) as the No.6 patentee. It is known from First Opinion Corp's patent distribution that the company's technical development mainly focuses on the voice interaction network and patient diagnostic system.

3) Spatiotemporal slice analysis

From the view of the spatiotemporal slice, as based upon inspecting a year's worth of spatiotemporal slices, 1998 was a year of dramatic changes in technology trends. Since it is exactly six years from 1993 to 1998, the six years are taken as the benchmark of staging. Moreover, the technology trend changes for the 6 years can be seen from the figure. Figure 4 shows a spatiotemporal slice of the period from July 1, 1993 to December 31, 1998, for a total of 290 patents. This spatiotemporal slice indicates that the focus is more on electrical body signal collection and conversion, neural networks, and imaging technology, all in the early stage of technical development.

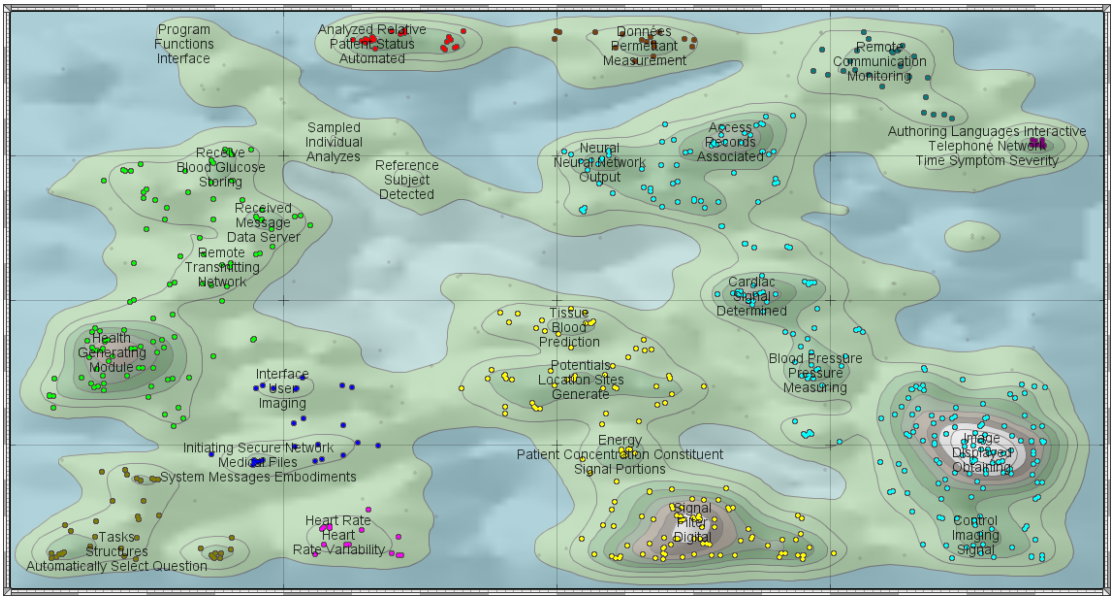


Figure 2: Patent Technology Clusters

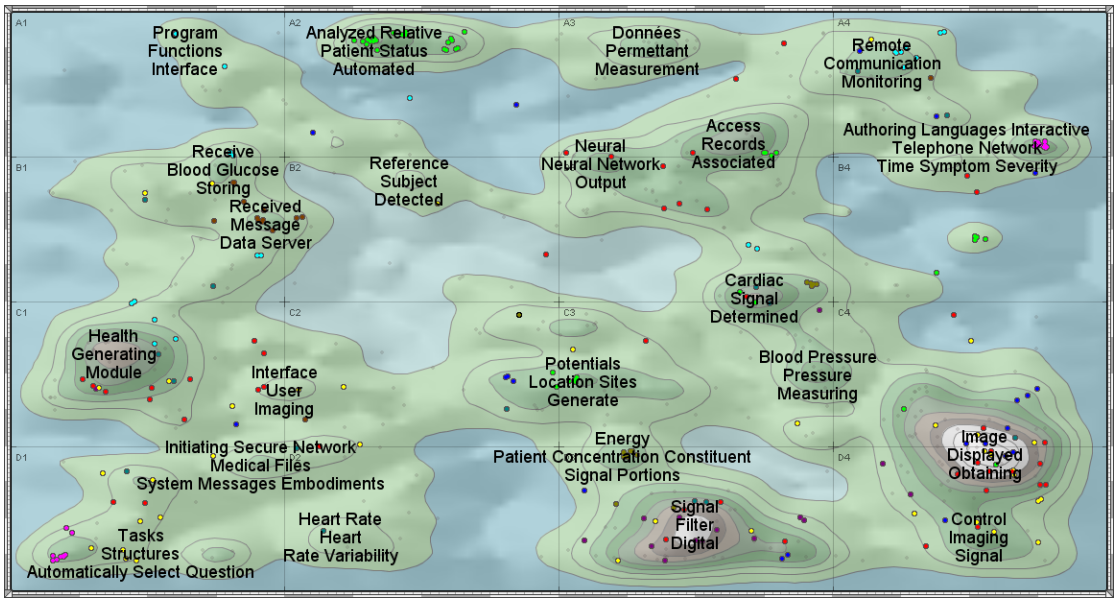


Figure 3: Patent Distribution of Top Ten Patentees in Patent Count

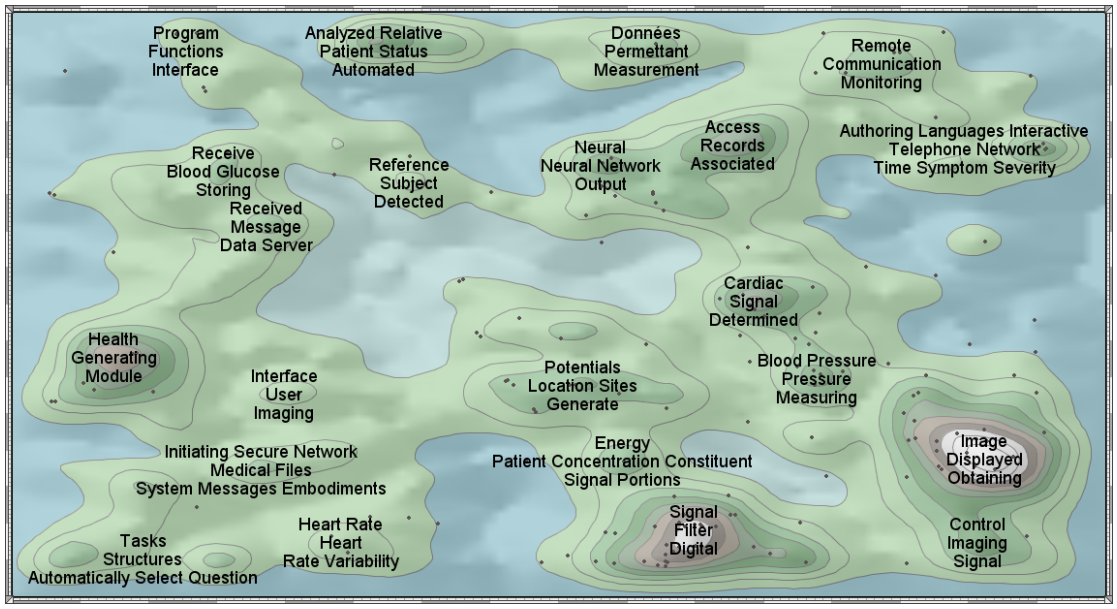


Figure 4: Spatiotemporal Slice, July 1, 1993 to December 31, 1998

Figure 5 shows a spatiotemporal slice of the period from January 1, 1999 to December 31, 2004, for a total of 389 patents. This period is characteristic of very vigorous technological development of technical developments not focused on the electronic body signal collection or conversion, but on neural networks and imaging technology only; and the technical development of this period is more comprehensive.

Figure 6 shows a spatiotemporal slice of the period from January 1, 2011 to July 31, 2012, for a total of 21 patents. The technical development in this period focuses almost entirely on the establishment of the three-dimensional model.

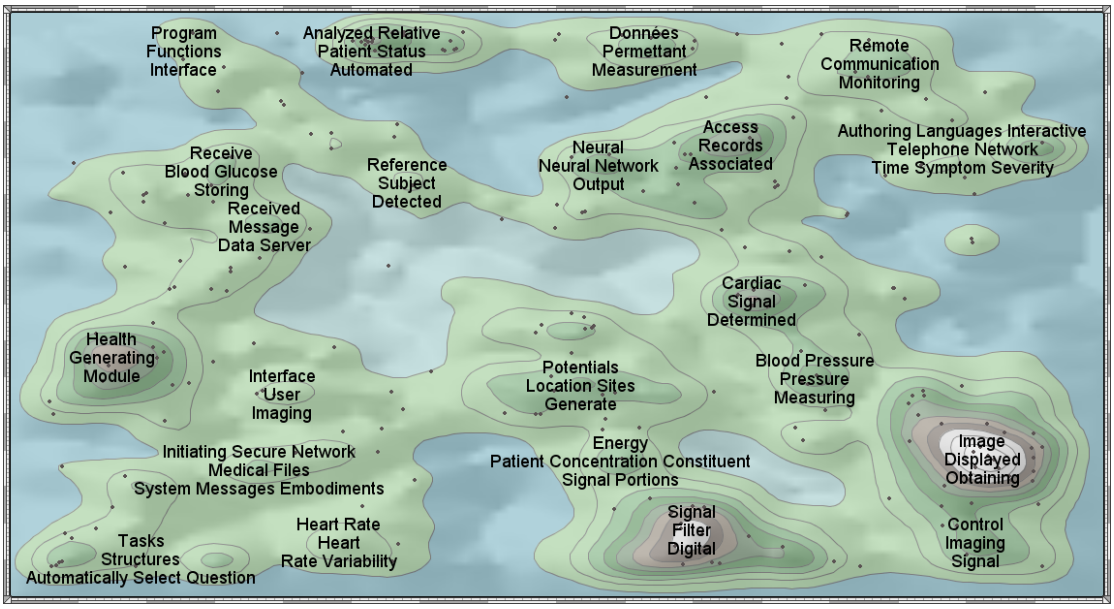


Figure 5: Spatiotemporal Slice, January 1, 1999 to December 31, 2004

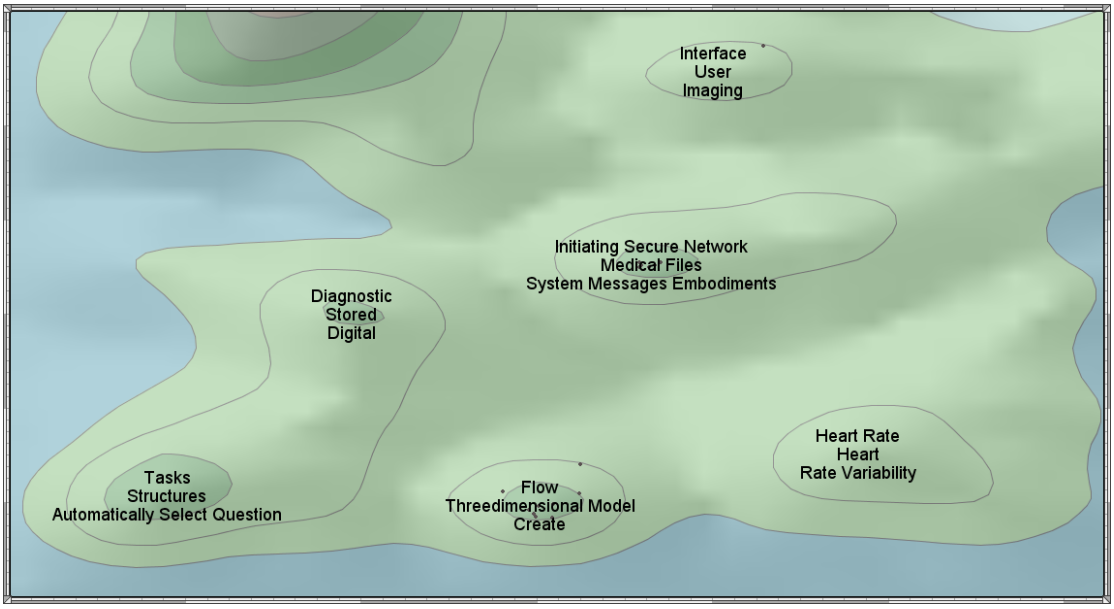


Figure 6: Spatiotemporal Slice, January 1, 2011 to July 31, 2012

V. CONCLUSIONS AND SUGGESTIONS

A. Conclusions

In this research, THC patent analysis is made through Copartner Technology Corp.'s "PatentGuider2008", and the analysis software of "Thomson Innovation". From the trend change patent count, it is known that the number of patent publications has increase yearly since 2006, indicating that many companies have completed the layout of technologies regarding THC. Therefore, enterprises in the telecare industry of Taiwan will face greater obstacles in patent applications in the future, and must actively develop a technology strategy and direction.

THC patent technologies rest in the hands of large American and international companies. The U.S. ranks number one in terms of the count of certified and published patents, and has 621 patents accounting for 74% of the total patents, and 340 patentees, which is significantly ahead of other countries, and indicates that the U.S. remains the leader in the field of THC. Enterprises in the THC industry of Taiwan intends to keep up with the U.S. in product and technology development in the future. At the corporate level, the top five companies in the count of certified home care patents are the German Siemens Company, American Boston

Scientific Company, American GE Company, German Bosch Company, and the Netherlands Philips Electronics Company. Among which, although Bosch and Philips Electronics have only 23 and 21 patents, respectively, they both have a very high number of citation by others, indicating that the two companies have very core technologies, and are the basis for subsequent patent innovations. Although Siemens has the largest number of patents, its numbers of self-citation and citation by others are not prominent. The patent technology-function matrix diagram shows that the top three patent-intensive areas include the detection of the cardiovascular system, physiological detection, data signal analysis, storage management, physiological data analysis, and physiological diagnosis, in which diagnostic testing, analysis, and diagnosis in physiological data analysis, have the highest number, showing that patent technology and function is more mature in the technical development of the three main technology-intensive areas.

B. Recommendations on Patent Portfolio Strategy

1) Referring THC pioneer patent

Since THC technologies are advanced in the U.S., where many related patents are in place, it is recommended that enterprises in the telecare industry create extensions or innovations by taking the very technically mature pioneer patents as the development basis, such as remote health monitoring and maintenance system in the patent number of US6168563, where the technologies are mostly wireless electrochemistry and multi-functional diagnostics and have achieved high efficiency, such as complete health management, computer-aided medical diagnosis, and multifunction physiological diagnosis. The patentee of US6168563 is the Bosch Company; it is suggested to cooperate with the company to make all-out efforts jointly for domestic and foreign THC. From the patented technology map, it can be seen that the patent distribution of imaging and signal filtering technologies present highly competitive status in the industry. It is suggested in this research that, enterprises in the home care industry no longer need to develop the layout for this technology. The patentee with the largest number of patents is Siemens, and the patentee with the second largest number of patents is Boston Corp. First Opinion Corp, the patentee with the sixth largest number of patents, has very concentrated technology distribution in the technology map. The patent distribution of the top ten patentees in the patent count is more dispersed, and thus, they are able to provide different references for enterprises in selecting business partners, such as Siemens, Boston Corp., and First Opinion Corp., which have more specialized technologies, or other top ten patentees in the patent count with very wide technical layouts can be selected.

2) Use of surrounding-style patent portfolio by followers of the U.S. market

Since the large American and international companies have already developed a THC layout with certain breadth and depth, it is recommended that followers in the telecare industry can adopt the surrounding-style patent layout to surround competitors' important patents with several small patents. Though probably not high in their own values, such small patents, through combinations, can block the effective commercial use of competitors' important patents, and then they conduct cross-licensing with the competitors through the surrounding small patents as a springboard into the U.S. market. Since patent number US6168563 has the largest number of citations, a surrounding-style patent layout can be developed specific to this patent.

3) Innovation from a technical gap

THC patent technology and function mainly cover the detection of the cardiovascular system, physiological detection, data signal analysis, storage management, physiological data analysis, and physiological diagnosis. With the patent development in these areas being very mature, enterprises in the telecare industry in Taiwan can develop their R&D directions to avoid competitors' patent-intensive areas. The areas of self-management and intervention currently belong to relatively blank areas, and are very good technical gap options that can be chosen for development. From the spatiotemporal slices of the technology maps in the most recent three years, it can be seen that the technology development trends of the home care industry have developed from focusing on electronic body signal collection and conversion and neural network and imaging technology of the early technical development period to technology distribution of the transmission of collected physiological information to technical development focused on three-dimensional model establishment.

Along with the advancement of medical technologies, THC technologies have become increasingly excellent, with new types of products and services being invented in succession. It is believed that, in the near future, these new types of care models will be commonly used in daily life, and even medical grade technologies not currently included in the home care area will be brought into general households, allowing the public to receive high-quality medical care and health education knowledge in general environments. Finally, this research intends that analysis of THC-related patent technologies can provide policy reference for the aging population discussions of various governments, help industrial circles to have a deeper understanding of the overall technology of the THC industry, and provide reference for the telemedicine industry in developing patent layout, determining technology gaps, and seeking cooperative partners for research and development opportunities in the future.

REFERENCES

[1] Amit, R., & Zott C. (2012). Creating value through business model innovation. *Sloan Management Review*, 53 (3), 41-49.

[2] Baumol, W.J. (1967). Macroeconomics of unbalanced growth: the anatomy of urban crisis, *The American Economic Review*, 57(3),

415-426.
[3] Berry, L.L., Shankar, V., Parish, J.T., Cadwallader, S., & Dotzel, T. (2006). Creating new markets through service innovation. *Sloan Management Review*, 47(2), 56-63.
[4] Brown, S.L., & Eisenhardt, K.M. (1995). Product development: past research, present findings, and future directions. *Academy of Management Review*, 20, 343-78.
[5] Chen, D.Z., Huang, M.H. (2002). *Patent information and Patent Retrieval*. Taipei City: Mandarin Library & Information Service Co.
[6] Chen, D.Z., Huang, M.H. (2009). *Patent information retrieval, analysis and strategy.* Taipei City: Hwa Tai Culture.
[7] Coombs, R., Miles, I. (2000). Innovation, measurement and services: the new problematique. In Metcalfe, J.S., Miles, I. (Eds.), *Innovation Systems in the Services Economy: Measurement and Case Study Analysis* (pp. 85-103). Boston: Kluwer Academic Publishers.
[8] Den Hertog, P. (2000). Knowledge-intensive business services as co-producers of innovation. *International Journal of Innovation Management*, 4(4), 491-528.
[9] Drejer, I. (2004). Identifying innovation in surveys of services: a Schumpeterian perspective. *Research Policy*, 33, 551-562.
[10] Gallouj. F., & Savona M. (2009). Innovation in services : a review of the debate and a research agenda . *Journal of Evolutionary Economics*, 19(2), 149-172.
[11] Gallouj, F., & Savona, M. (2010). Towards a theory of innovation in services. A state of the art. In F. Gallouj & F. Djellal (Eds.), *Handbook of Innovation and Services: A Multi-disciplinary Perspective* (pp. 27-48). United Kingdom, UK: Edward Elgar.
[12] Gallouj, F., Weinstein, O. (1997), Innovation in services, *Research Policy*, 26 (4/5), 537-556.
[13] Gebauer, H., Krempl, R., Fleisch, E., & Friedli, T. (2008). Innovation of productrelated services. *Managing Service Quality*, 18(4), 387-404.
[14] Hsu, C.H., Tang, Y.J. (2008). Current and future status of THC. *Taiwan Geriatrics & Gerontology*, 3(4), 34-47.
[15] Kim, S.H., & Im, K.H. (2011). Business model characterization by analyzing business model components of patent data. Applied Mathematics & Information Sciences, 6(1), 303-309.
[16] Kindstrom, D. (2010). Towards a service-based business model - Key aspects for future competitive advantage. *European Management Journal*, 28(6), 470-490.
[17] Koch, S. (2006). Home telehealth - current state and future trends. *International Journal of Medical Informatics*, 75(8), 565-576.
[18] Lancaster, K.J. (1966). A new approach to consumer theory, *Journal of Political Economy*, 74(1), 132-157.
[19] Lay, G. (2002). *Serviceprovider industry: industrial migration from manufacturing to selling products and services: trends and impacts*. Germany: Fraunhofer Institute Systems and Innovation Research, Karlsruhe.
[20] Liu, L.F. (2007). Job satisfaction of certified nursing assistants and its influence on the general satisfaction of nursing home residents: an exploratory study in southern taiwan. *Geriatric Nursing*, 28(1), 54-62.
[21] Liu, S.J. (2003). Patent map - a route to a strategic intelligence of industrial competitiveness. *In Proceedings of the first Asia-Pacific conference on patent maps*, Taipei, 2-13.
[22] Mathe, H., & Shapiro, R.D. (1993). *Integrating service strategy in the manufacturing company*. London, New York: Chapman & Hall.
[23] McAdam, R., McConvery, T., & Armstrong, G. (2004). Barriers to innovation within small firms in a peripheral location, *International Journal of Entrepreneurial Behaviour & Research*, 10, 206-21.
[24] National Applied Research Laboratories (2013) (http://cdnet.stpi.narl.org.tw/techroom/pclass/pclass_A034.htm)
[25] Organisation for Economic Co-operation and Development (2005). *Oslo manual: guidelines for collecting and interpreting innovation, 3rd ed*. Paris: OECD Publications.
[26] Panesar, S.S., & Markeset, T. (2008). Development of a framework for industrial service innovation management and coordination. *Journal of Quality in Maintenance Engineering*, 14(2), 177-193.
[27] Szeto, E. (2000). Innovation capacity: working towards a mechanism for improving innovation within an inter-organizational network. *The TQM Magazine*, 12(2), 149-158.
[28] Teece, D.J. (2010). Technological innovation and the theory of the firm: towards a theory of the innovating firm, In Bronwyn H.H., & Nathan R. (Eds), *Handbook of the Economics of Innovation, Chapter 16* (pp. 681-709). Amsterdam, Holland: North-Holland.
[29] Tidd, J., Bessant, J., & Pavitt , K. (2001). *Managing innovation：integrating technological, market and organizational change, 2nd*. Chichester: John Wiley & Sons.
[30] Varis, M., & Littunen, H. (2010). Types of innovation, sources of information and performance in entrepreneurial SMEs. European Journal of Innovation Management, 13(2), 128-154.