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Mechanisms of developing innovative IT-enabled services: A case study of Taiwanese healthcare service

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ABSTRACT

The medical, healthcare and care-giving services are of great concern in aging societies. This study proposes mechanisms for developing innovative information technology-enabled (IT-enabled) services. The Taiwanese government has adopted these mechanisms for stimulating service innovation in the healthcare industry. Action research is conducted to explore how the Taiwanese government learned from a hospital project and applied this experience to develop innovative IT-enabled services in the healthcare industry. This study also identifies issues that arise when innovative IT-enabled hospital services are implemented and viable solutions are offered to effectively address those issues. Useful lessons were learned from the key mechanisms employed by the Taiwanese government to promote service innovation. This study elucidates the mechanisms of innovative service development, ultimately increasing the knowledge of service innovation.

1. Research background

The service sector significantly contributes to the most emerging and industrialized economies worldwide. Comparative economic studies have indicated that the service sector is the driving force of economic growth in all developed economies (Rust and Miu, 2006). By 2004, the service sector in the United States accounted for 68.7% of its GDP, while the contribution of manufacturing declined to 29.6%. Due to the Baumol effect and other factors, service sector growth has been limited despite its economic importance (Tien and Berg, 2003). In 2005, to promote service innovation and stimulate economic growth, the Taiwanese government held the National Service Industry Development Conference, at which the government stated its goals and strategies for developing the Taiwanese service sector. Development strategies were proposed for 12 service categories. Among these categories, the medical, healthcare and care-giving services categories are of greatest concern in Taiwan's aging society.

Aging populations increase the burden on national healthcare programs. Many experts believe the only solution for satisfying projected demand for healthcare services is to implement technologies that enhance service efficiency and cost effectiveness. Based on a 2005 study by Japan's Ministry of Economy, Trade, and Industry, the healthcare services market for the elderly is projected to reach US $37.38 trillion, which is much larger than that in 2001. As in other industrialized economies, Taiwan has an aging population. According to the estimates by Taiwan's Ministry of Economic Affairs (MOEA), the business opportunities associated with the aging population are expected to grow from US $24.6 billion in 2001 to US $108.9 billion in 2025, a growth of 340%. To accommodate expansion of the aging service industry, the MOEA is promoting the Information Technology-enabled (IT-enabled) Services for Ubiquitous Care Projects (ITeS U-care Projects) to address the needs of Taiwan's aging population. This project is designed to encourage healthcare companies to participate in the development of new and innovative healthcare services to win the business emerging from the aging population.

2. Study objectives and methods

Systematic studies of service innovation reflect an important global trend (Spohrer and Maglio, 2005). The application of appropriate system engineering can significantly improve service productivity (Tien and Berg, 2003). However, new service development has not been adequately elucidated in either practice or research (Bullinger et al., 2003). Many researchers have postulated that successful delivery of services requires systematic planning (Bullinger et al., 2003).

Service design research started attracting attention in 1980, in which the research focus in studies of service design and development was mainly on process design in relation to efficiency management and quality design in service management (Menora et al., 2002). However, due to rapid advances in

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information and communication technologies (ICT), design in service innovation is not merely a part of service management, but is involved in the design of business models and competition. Information Technology-enabled services that use an ICT platform as the service core are the focus of this study. In such services, technology is not simply a service tool (Chao et al., 2007), but the core of services. For example, in the case of this study, services provided by a hospital to outpatients are designed completely on the Internet. Via the ICT platform, hospitals can obtain the latest real-time physiological signal of outpatients. Thus, outpatients at home can receive monitoring service through the Internet information system for daily service delivery.

This study analyzes the role of Taiwan's MOEA in addressing service innovation issues and proposes mechanisms for developing innovative IT-enabled services. This mechanism can be utilized to solve the problem of how to develop and design IT-enabled services. This work intends to elucidate the mechanisms of innovative service development, ultimately increasing the related knowledge of empirical studies of service innovation. Hopefully, results of this study can help enterprises systematically develop new services and enhance their likelihood of success.

This study focuses on the following objectives:

(1) proposing service development mechanisms for healthcare services;
(2) identifying the mechanisms of service innovation in a case study and in the Taiwan MOEA;
(3) discussing the issues involved in establishing innovative IT-enabled services in a hospital.

This study adopts action research as the research method (Baskerville and Wood-Harper, 1998; Mcniff, 2001).

The remainder of this paper is organized as follows. First, this study explores in-depth the nature of service innovation. Next, the issues involved in creating new healthcare services are discussed. Third, as a case study, the process of service development by a hospital and governmental promotion of healthcare service innovation in Taiwan are examined. Fourth, an approach for systematically designing IT-enabled services is proposed, and the Theoria Resheneyva Isobretatelskehuh Zadach (TRIZ) method is employed to solve service design problems. This study focuses on discussing an integrated method for designing and developing IT-enabled services. The detailed design methods in each process are not included in the scope of this study. The final section summarizes implications for the development of innovative services based on the case study and discusses directions for further research.

3. Service innovation

The importance of service innovation has forced research institutions and industrial companies to address such issues as service engineering, service management and service science from a service-innovation perspective (Gallouj and Weinstein, 1997). According to many studies, services can be characterized as intangible, simultaneous and heterogeneous (Hidaka, 2006). The emerging IT services have four unique aspects: they are information-driven, customer-centric, e-oriented and productivity-focused (Tien and Berg, 2003). Hertog and Bilderbeek (1999) proposed a four-dimensional model of service innovation to explain and analyze service innovations. The four proposed dimensions were new service concept, new client interface, technological adoption and new service-delivery system. According to Spohrer, the Chief Officer at IBM, knowledge sources driving service innovations are technology innovation, business innovation, demand innovation and social-organization innovation (Spohrer and Maglio, 2005). Notably, IBM is one of the few manufacturing companies to transform itself successfully from a manufacturer to a service provider. By capitalizing on its professional consultancy experience, IBM changed from a computer hardware manufacturer to a service-oriented company that integrates advanced technological, engineering and organizational expertise to provide comprehensive enterprises solutions with integrated services. Thus, service innovation requires multi-disciplinary cooperation.

The success of service innovation lies in clearly understanding the consumer demand (Chesbrough and Spohrer, 2006). Companies that can identify customer needs and align these needs with their core competencies are most profitable and champion innovation (Fulledr and Matzler, 2007). However, customers may have problems articulating their needs; that is, they cannot imagine what they have not experienced and what they do not know (Ulwick, 2002). Generally, the challenges in service innovation are how to capture constantly changing priorities of consumers, design new services that incorporate new technologies, and create new business models that generate new service value.

Designing innovative services requires careful consideration of the overall experience of users, including experience using new services (Buchenau and Suri, 2000). Studies have noted that design and behavioral science paradigms are required to ensure the relevance and effectiveness of Information System (IS) research (March and Smith, 1995; Hevner et al., 2004). Designers must emphasize "exploring by doing" and be willing to experiment with different designs. Moreover, service innovation requires cooperation of experts from different fields such as interactive, industrial and environmental designs. Professionals such as human factor specialists and mechanical or electrical engineers are also needed. A useful approach for service innovation is "experience prototyping" (Buchenau and Suri, 2000). In this approach, during the initial process when developing an innovative service, one must find the key service user and use a prototype to assess the user's feelings toward the new service to ensure successful service innovation.

However, service innovation in the healthcare industry is extremely complex and warrants further discussion.

4. Creating new healthcare IT-enabled services in Taiwan

In practice, healthcare service providers have attempted to enhance service quality and effectively control clinical results and decision-making. Investment in IT can positively affect delivery of healthcare services and improve productivity (Foley, 2006). As healthcare IT has improved, new models for electronic delivery of healthcare services have been created (Tan, 2005; Kalyanpur et al., 2007). However, unlike other service sectors, the healthcare sector is very complex, as it has many stakeholders, such as patients and their families, physicians, pharmacists, and nurses. In many cases, patients must accept available medical services due to their health and economic conditions. Unlike other services (for example, restaurant service) patients cannot choose services at will. Conversely, management in the medical sector must comply with extensive regulations and laws associated with human factors and processes (Asthana et al., 2006). However, healthcare should be considered an issue of public welfare rather than one of the purely private commerce. Patient needs, especially those of economically disabled people, should be given attention. The challenges associated with service innovation in the healthcare sector are to provide new, extensive, custom-made, ubiquitous and seamless services to an increased number of patients at any time and at lower cost than before. Government involvement and support are necessary for healthcare service innovation.

IT-enabled healthcare service based on new technological infrastructure is an innovative concept in integrated healthcare services. Many of the challenges have now emerged due to the technological feasibility made possible by new IT platforms on which new service relationships are constructed (Blomberg and Evenson, 2006). An integrated healthcare system would include institutions and organizations such as nursing homes, daycare centers, healthcare institutions, transportation companies and social-service institutions, and require the cooperation of a wide range of actors, including social-service workers, healthcare professionals, and patients and their relatives. Via computer networks, collaboration between healthcare institutions may evolve toward a long-term relationship, and the involved actors (stakeholders) may become members of virtual communities. However, several barriers in the healthcare services industry may impede widespread adoption of Internet-based care services and medical service delivery.

4.1. Action research

To identify the problems service stakeholders encounter in the operation and management of IT-enabled healthcare services, members of the Institute for Information Industry and *K Hospital* (anonymous) formed a research team. Although the Institute for Information Industry is a non-governmental organization, the Institute must fulfill some governmental missions as it is sponsored by the Taiwanese government. One author of this study was on this team as a liaison for the Institute, a facilitator of all related meetings, an idea simulator of the project, and provided the methodology for service innovation. The project team members held several meetings to identify issues germane to IT-enabled homecare services from patients, doctors, and IT-solution providers.

4.2. Participant observation

In the process of meetings and interviews, the author noted that due to the poor experience of patients or their families with ICT use, they have difficulty in imagining the so-called IT-enabled healthcare services. As one patient stated, "If it is possible to receive healthcare services at home, it is novel and good. But we have no idea of how to do this; it would be very different from the way we used to see the doctor."

One author of this study interviewed some doctors. These doctors agreed that it is very important for outpatients to receive care at home; however, this would change the way doctors diagnose illness. Young doctors typically have little problem using computers for diagnosis as they were taught to use computers in school. However, such usage can be problematic for relatively older doctors, as they are often unfamiliar with computer applications and have difficulty learning new ITs.

Doctors or project planners who may be in charge of the new service operation would be concerned with the following issues—which for—profit business model is appropriate, how telemedicine is used to monitor outpatient status at home, whether ICT is sufficiently mature and how can technology platform collect patient data and assess patient physical status.

4.3. Action learning

Based on information collected through interviews and meetings, we conclude that patients, doctors, and IT-solution providers have some difficulties with IT-enabled healthcare services. These difficulties become the challenges for service designers during innovative service development. These challenges are discussed briefly as follows.

(1) *Patients*: Patients accustomed to seeing physicians in clinical or hospital settings must be persuaded to connect to a telemedicine solution to reach a doctor for a live interactive session at home. The immediate benefits in terms of cost and time when patients are diagnosed in their homes may be apparent; however, psychological factors must be addressed as this experience differs from consulting a physician in person.
(2) *Physicians*: Generally, physicians are accustomed to working in enclosed environments such as clinics, examination rooms and departments. However, in remote patient care, physicians must become familiar with video conferencing and other advanced communication technologies. This necessitates adequate training to use new technologies effectively. The paradigm shift in understanding and becoming accustomed to new technologies poses a challenge to these professionals. Additionally, user-friendly and easily adopted solutions are critical to motivating physicians to utilize these technologies.
(3) *Technology*: A key issue in innovative healthcare services is identifying the needs of patients, physicians and other stakeholders, and defining a solution that can be "productized" to meet those needs. The next issue is to determine whether a solution has an adequate market; that is, whether there is a sufficient number of end-users to embrace the solution. Moving forward, a significant challenge is to constantly upgrade technology to meet ever-changing customer requirements and industry standards. This entails the evolution of technology such that it meets changing patient/physician needs and makes technology increasingly user-friendly and easy to operate. A prerequisite for IT-enabled service solutions is the ability to integrate with existing healthcare systems. More importantly, the security and privacy of patient data must be ensured. Other challenges include providing access to information captured by sensors to be securely transmitted to medical personnel regardless of their locations.

In conclusion, service innovation must consider multi-dimensional and cross-sector integration, seizing on consumer demands and overall experience of users. Moreover, innovative healthcare service design must address different demands and issues associated with patients, physicians and technology. Therefore, this study employed a demonstrative project to illustrate healthcare service innovation. This study explored this case to identify service innovation mechanisms and proposed solutions that address these issues.

5. Case study of *K hospital* service innovation

5.1. Project background

To seize potential business opportunities in an aging society, *K Hospital* implemented a new business model for ubiquitous healthcare services. In 2005, *K Hospital* funding was approved by the MOEA. The key objectives of the *K Hospital* project were to identify the needs of patients and identify future services required. This project, which was conducted from April 1 to December 31, 2005, had the following objectives: (1) define service specifications for community care for stroke patients; (2) outline system functions that support community healthcare services; and (3) develop teamwork within a care service alliance.

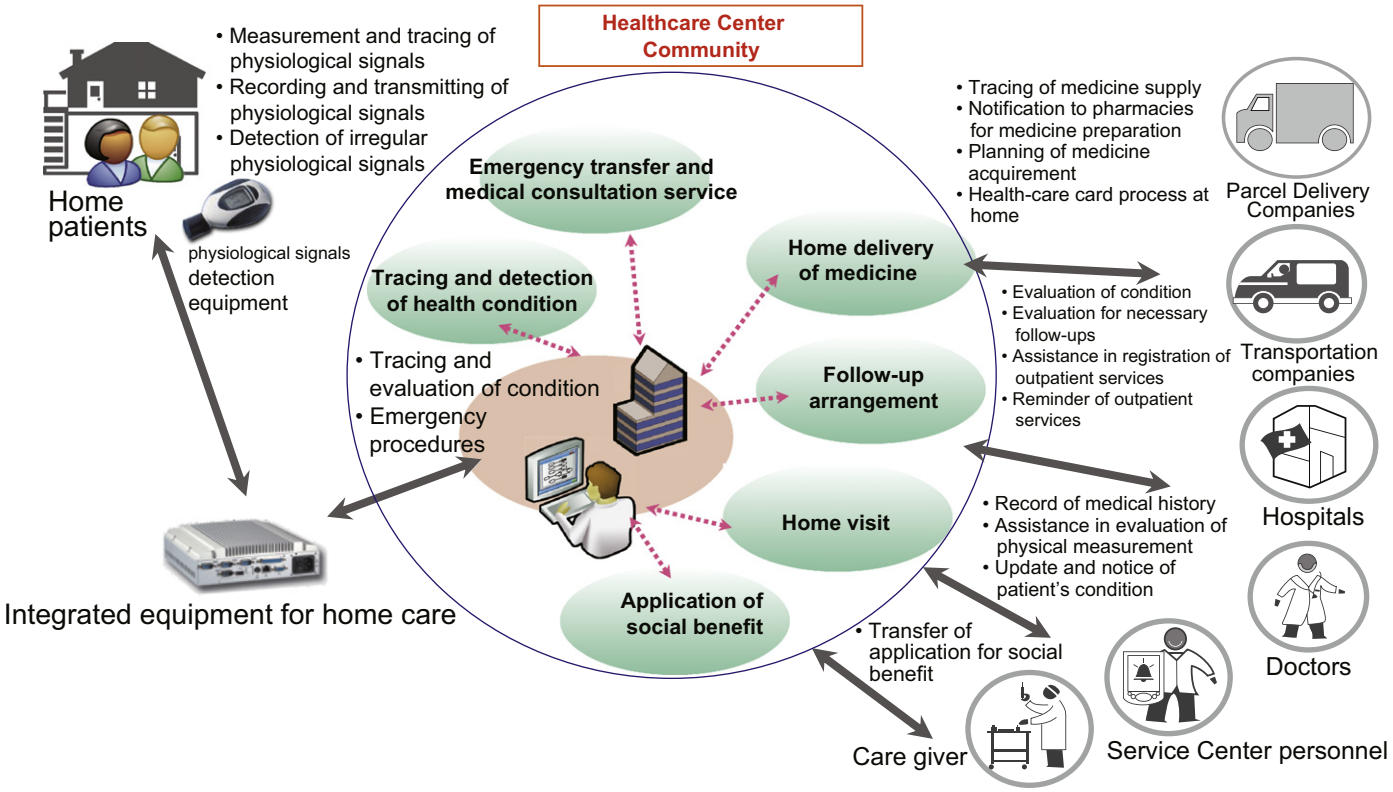

Fig. 1. Service mode for community healthcare network.

The target customers were patients who had suffered stroke within the previous year. Services were designed to provide continuous care, 24 hours a day, 7 days a week. The services included six services—monitoring physiological signals, follow-up diagnosis, home visits, home delivery of medicine, applying for social benefits/emergency transfers, and healthcare consultation.

The *K Hospital* group deemed community care centers responsible for service operation. Upon discharge from a hospital, patients can use the Home Healthcare System to monitor physiological signals and transfer this data via the Internet to the healthcare center for analysis. After activating the six services as above mentioned, the healthcare center can work with hospitals, other clinics, transportation companies, and care personnel to deliver the necessary medical services to stroke patients. Fig. 1 presents the innovative service model.

When patients were discharged from a hospital, *K Hospital* combined the delivery of services from healthcare professionals, hospitals, basic healthcare facilities (clinics), social care assistants and transportation companies. To support these new services, *K Hospital* re-constructed the service-delivery mechanism and procedures needed by patients. Such services emphasized the establishment of an IT-based healthcare service network, which was used to develop services to provide ubiquitous and seamless care. The hospital partnered with information system development companies and service providers to form an R&D alliance for co-designing delivery mechanisms and workflows that support these services. Furthermore, the project developed a pilot system to verify technical capability and prove that a proposed information system could meet the technical requirements of the services.

5.2. Action research

In the service-development process, a service designer must design service-delivery systems for new healthcare services. In the *K Hospital* case, the service design team met for discussions and meetings that focused on different service functions. In meetings, experts in the service-delivery process submitted work items in detail. Experts also determined how detailed work items could be combined to deliver a complete service. One author of this study participated in all meetings.

The service functions a hospital intends to provide to the stroke patients at home differ from those provided in a hospital. The major difference is that the service location is the home. All service providers must cooperate to determine who provides services to patients in their homes, how to deliver services to patients, and how to connect services between the home and hospital smoothly.

We observed that the formation of a network of competence for a new healthcare service, especially cooperation between teams, could be helpful.

5.3. Participant observation

Some typical issues in healthcare innovation service design were identified in various meetings. Those issues must be considered in the service design process. The following takes home delivery of medicine as an example service for illustration.

One pharmacist stated, "There might be problem in breaching current regulations since the Bureau of Health stipulates that continuous prescriptions for chronic illnesses must not be mailed to patients. Thus, mailing prescriptions to patients at home is not feasible."

A neurosurgeon argued, "In the perspective of business development, the new service of automatic delivery of medicines to patients at home may cause a boycott by the Pharmacist Association. Patients are now required to go to a pharmacy for medicine; if this service offers delivery of medicine to the home, it will deprive pharmacies of a business opportunity. Thus, this new service may engender protest from the Pharmacist Association."

Table 1
The who-does-what matrix for home delivery of medicine.

Role	Title	Know-how	Task
Project Leader	Director of Neurosurgery, CIO	The initial determination of the requirements of the entire service, including regulations	To give presents an initial outline of the service process
Pharmacist	Pharmacist of *K Hospital*	The process for picking up prescribed medicines; pick-up regulations	Set goals and an action plan for the new service
Related cooperate companies	Contracted Pharmacy	External process for picking up prescribed medicine pick-up; know-how	Set goals and action plan for the new service
Information System Engineer	Engineer in charge of the health insurance system	The know-how associated with the health insurance system	Tune up the system to fit the upload time of hospital data
HIS Engineer	Hospital Information System Engineer	Process of picking up prescribed medicine, including payment and know-how	New system specification (in the original HIS system)
Service operator	Social development center	Service operation process and know-how	New service operational planning
System developer	External information system developer	New system environment support	New system development specifications
Community care	Community healthcare staff	Basic medical and medicine knowledge	Local (nearby) care for patients to respond quickly

The pharmacy of *K Hospital* also argued "If a patient wants to pick up the controlled drugs with the prescription, he/she needs to show his/her national ID card for identification and sign-up for approval. In addition, some medicine needs a particular way of preservation. For example, insulin requires to be kept in the temperature of 2–8 °C. After it is picked up from the pharmacy and before it is delivered to the patient's home, the refrigerator facility is required to preserve the validation of the insulin."

A hospital information system engineer also expressed his concerns as follows. "The medicine prescription record should be kept in the hospital information system. Currently, after patients pick up the medicine from the hospital pharmacy, they go to the cashier counter for payment and show their health insurance cards. The card payment is linked by Virtual Private Network (VPN) to the governmental Bureau of Health. There would be some problems if patient would receive medicines at home."

The technology solution providers expressed that if access to and retrieval of data from health insurance cards were available for the home, a special mechanism for assessing health insurance cards must be designed. Technologically, how to build a health insurance VPN connection in the household environment to (1) verify the certification of the card-reader facility, and (2) certify personal identity. At the same time, it must cooperate with the health insurance facility verification mechanism, and it must be equipped with mobility and an uninterrupted power system.

Patients also expressed their opinions: "It would be unsafe if some strangers come to our houses to take our health insurance cards and money firstly, go to hospital to pick up medicine and pay the fee, and then bring back the medicine. How can we trust them?"

A proper mechanism is needed that ensures that these issues extracted from observations can be solved.

The service providers include local service providers (e.g., transportation companies), regional hospitals, clinics and IT companies. Based on the discussions in meetings, the know-how for the service was distributed among the different competence experts—doctors, nurses, and social workers. The business planner stated, "Because experts are all very busy, some working steps must be designed for teams to discuss issues and work together, so that experts can contribute their professional knowledge in meetings." The planner interviewed experts individually. Later, all experts were called for a meeting to improve communication.

5.4. Action learning

Lee and Chen (2007) suggested that cross-functional teams could achieve effective new product development performance. In the *K Hospital* case, it is found that bringing different experts together has a dramatic effect on the process of developing a new service. This allows experts in the healthcare domain to work with people from different domains to solve complex problems.

The project planner in the hospital stated, "In the past, those training doctors and nurses only focused on their own specific area of professional specialization. However, designers of a new service must discuss, and coordinate with each other to generate the best service for consumers and the business model."

To lead an expert meeting effectively, some pre-designed mechanism must be provided. The home delivery of medicine service is taken as an example. The project planner should analyze (Table 1) the service in terms of the roles and know-how of different experts, such that these experts can complete their tasks.

After long runs of discussions, negotiations, and brainstorming, a possible solution has been suggested. A new unit, community healthcare center, was involved. In Taiwan, there are widespread community centers in living areas. In the case of *K Hospital*, the coordination of a community center *S* was achieved. The community center *S* was staffed with nurses with basic medical knowledge and equipped with a healthcare system. The nurses could perform patients' home visits if needed. This healthcare system would regularly check the medicines' in-take records of the nearby patients. When the medicine quantity reaches down to certain levels, it would notify the staff at community healthcare center. The staff would double-check with the patient about the home delivery service, and then notify the pharmacy of *K Hospital*. When the medicine is ready, the pharmacy would connect to the community healthcare center with a medicine-ready message. A delivery person with pharmacist license would carry a laptop and IC insurance card reader to the patients' home for the card reading and payment. A message would be sent back to the community healthcare center for record. The delivery person should at the same day go back to the hospital and connect with Bureau of Health by VPN to upload the necessary records. The detailed procedure is shown in Fig. 2.

Because operational goals between organizations differ, a special cooperation agreement is needed to facilitate smooth progress of services. The project combined the care service system formed by local service providers, regional hospitals and clinics and IT companies. All companies signed alliance cooperation

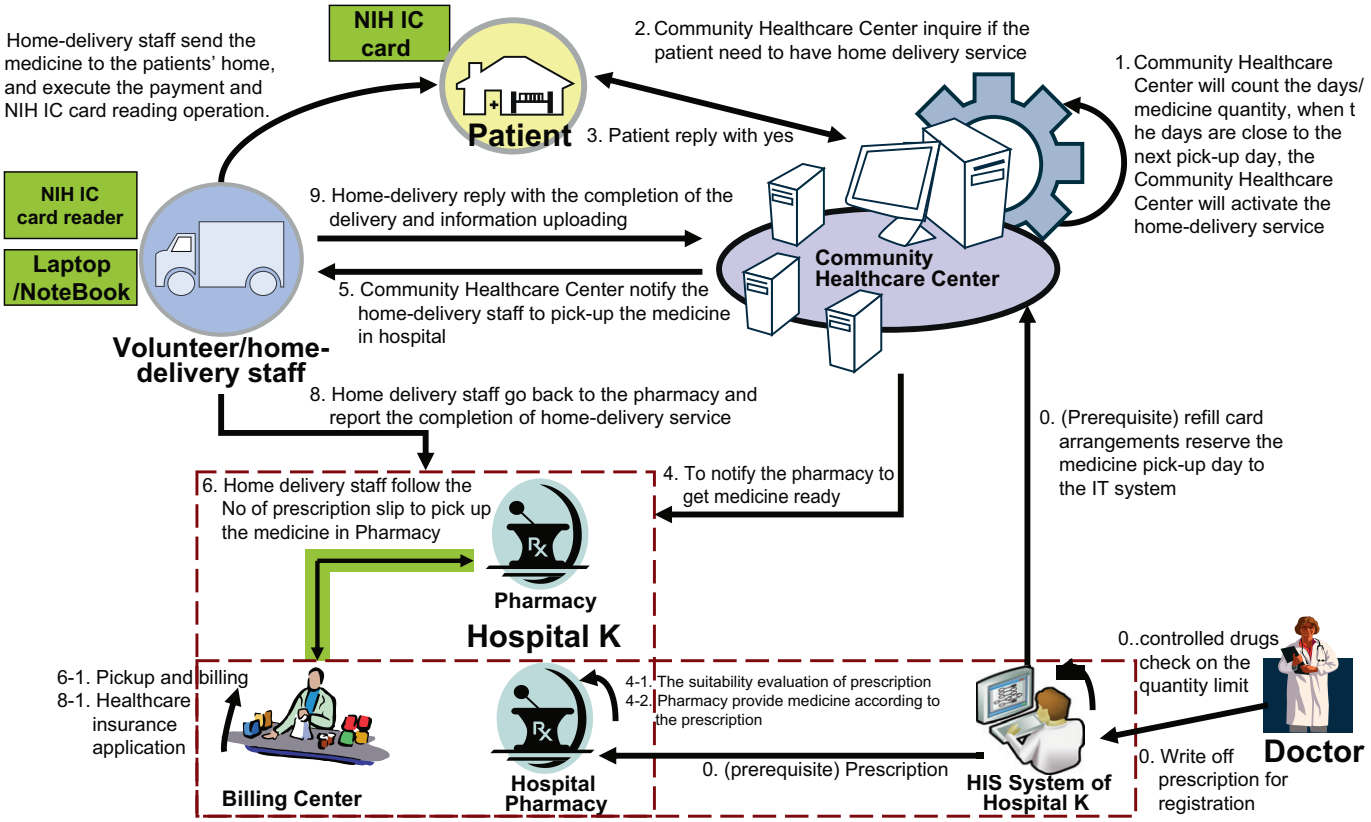

Fig. 2. Process of home delivery of medicine service.

contracts so they could co-develop the business model and establish long-term relationships.

6. Taiwanese government's approach

In the past, Taiwan's MOEA subsidized several companies developing information systems for specific services. However, development of innovative services in the healthcare industry was slow. After subsidizing the *K Hospital* project in 2005, the MOEA learned that lack of comprehensive system planning, pilot service testing and a stakeholders-oriented service design limits the development of innovative healthcare services.

In the *K Hospital* case, team members determined that the key issue in developing innovative healthcare services is how to handle the complexity of various dimensions and scales. The project team believed the first priority should be to conduct research to systematically analyze and design new services and perform consumer studies. Therefore, the *K Hospital* group proposed a "planning project" instead of a "system development project" for the new service model and applied for government funding. The MOEA learned from the research conducted by the *K Hospital* project that successful healthcare services innovation depends on how well service providers understand the needs of consumers (stakeholders) and design models that can be expanded to a full healthcare service system. Moreover, the ability of service providers to utilize ICT when innovating new services and creation of a profitable business model are also keys to success. Another key factor is the formation of a business alliance network.

To encourage companies to develop innovative services needed for an aging society in the near future, the government initiated the ITeS U-Care Project in 2006. The project encourages major projects with cross-sector alliances that focus on R&D innovation in medical services and business models. This initiative was intended to drive the development of innovative healthcare services and emerging industries in healthcare-related areas. The ITeS U-Care Project funded the development of three different senior healthcare service systems—community healthcare service systems for institutional care, home care service and emergency care service.

By the end of 2006, 12 projects applied for funding by the ITeS U-Care Project. The total five-year project budget was roughly US $23 million, of which approximately US $13 million matches the funding invested by companies. The project office estimates that after the projects were completed, the output value of the healthcare-related service sector would exceed US $467 million. Developed countries, such as Germany, USA, and Japan, whose service industries have started using ICT platforms for providing cross-country services and IT-enabled service development, overcome the barriers of time and space and expanded the regional scale to an extent that traditional face-to-face services could not be achieved. Faced with competition from those countries, the MOEA hopes the ITeS Project will enhance the competitiveness of Taiwanese companies in the healthcare service business and help these companies become world leading service providers.

7. Proposed mechanisms of service innovation

An innovative healthcare service should involve new technologies, business models, demands and social organizations. In the case of *K Hospital*, when high-ranking executives wanted to provide IT-based services to patients in their homes, they were confronted with several important issues—changes to service models (from service in hospitals to service at home); lack of

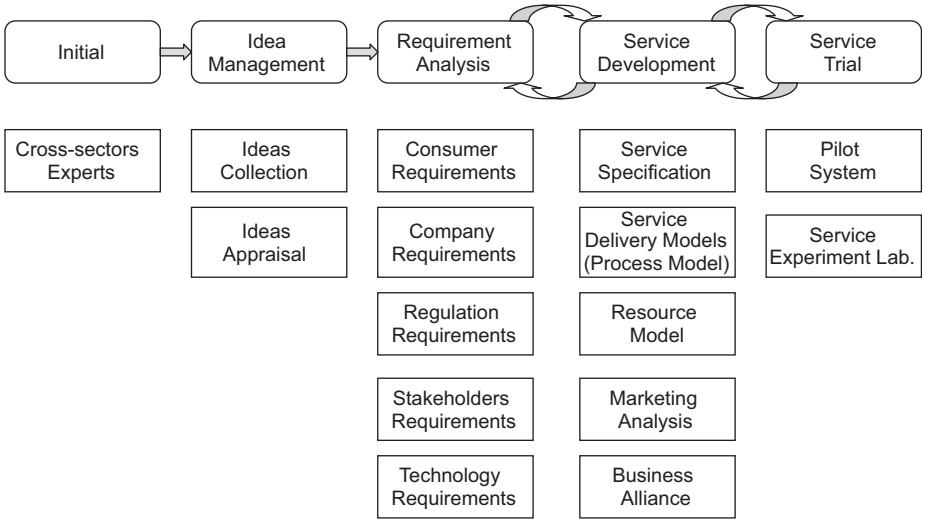

Fig. 3. Approach to new IT-enabled service design.

familiarity of users with services and tele-technology; lack of familiarity of service teams with ITs and service processes; and unclear service specifications. Therefore, executives systematically explored service scope, target groups (e.g., service consumers and providers), service specifications and service-delivery operations. We propose the following mechanisms to resolve these issues.

Service engineering is a systematic way to develop service in usage of models, methods and tools (Bullinger et al., 2003). Fig. 3 shows the five phases for developing new services—initial phase, idea management, requirement analysis, service development and service trial.

7.1. Initial phase

The development of innovative services is extremely complex. Thus, studies of consumer demand must be multi-dimensional. Therefore, establishing a multi-discipline team of experts is the first step in the service design process. Experts from multiple domains and disciplines are needed to plan and examine complex development processes involving consumer research, service design and construction of service trials. In the case of *K Hospital*, the hospital assembled a service development team comprised of psychologists, praxiology professors, neurosurgeons, family doctors, nurses, clinical doctors, information engineers and system development engineers to integrate cross-discipline knowledge into new services development.

7.2. Idea management stage

This stage, which includes idea collection and idea appraisal, requires comprehensive information collection regarding service features, business models, marketing types, innovative case survey results, market owners, related industries and companies, etc. In the case of *K Hospital*, these data provided input to expert team members for developing new service concepts. The subsequent appraisal sub-stage evaluated real-world environments, competitive advantages, organizational strategies, resource allocation and technology. Finally, service ideas receiving low appraisals were eliminated from consideration. This process was intended to characterize the status quo and prompt conceptualization of new service strategies.

In the process of new service idea development, the TRIZ method was a part of the service development toolset. Researchers have demonstrated that TRIZ is effective in solving technical problems when developing tangible products. Some researchers have utilized the TRIZ method for innovative problem-solving in new service development (Lin and Su, 2007; Chai et al., 2005). The following example demonstrates the application of TRIZ to the *K Hospital* case. The following problem was at issue. The hospital planned to offer blood pressure monitoring and providing emergency alerts to outpatients. Here, the accuracy of the household manometer is problematic. The accuracy of the household manometer, which is a simple device, increases over time. However, users do not know whether the manometer is accurate. An inaccurate manometer can generate an incorrect emergency alert. The objective is to minimize inaccurate manometer results.

- *Analysis*: The simplest analytical method in the TRIZ toolset is analysis of contradictions. The contradiction matrix consists of 39 engineering parameters and 40 inventive principles. Table 2 presents a small part of the original TRIZ contradiction matrix. In the current *K Hospital* case, emergency alert services for outpatients depend on two factors: convenience and the accuracy of blood pressure measurement. Of the 39 TRIZ parameters, the following parameters required improvement.
  - #28 Measurement accuracy (corresponding to reliability of the household manometer)
  - #33 Ease of operation (corresponding to measurement convenience)

  The TRIZ contradiction matrix was analyzed to identify the inventive principles in which worsening "Ease of operation" is associated with improving "Measurement accuracy." Table 3 shows the partial matrix with suggested inventive principles. These inventive principles are as follows:
  - Inventive principle #1: Segmentation
  - Inventive principle #13: Inversion (turning "the other way round" (Zhang et al., 2003))
  - Inventive principle #17: Moving to a New Dimension
  - Inventive principle #34: Discarding and Recovering
- *Solution*: Iterative analysis of each inventive principle and examples from related research were examined in consultation with teams of experts to identify the following ideal solution. The sub-principles of the four inventive principles were referenced to generate the following service operational concept: designing an Internet-ready home device capable of

Table 2
A brief part of the original TRIZ contradiction matrix.

Improving parameter	Worsening parameter				
	1. Weight of moving object	2. Weight of stationary object	3. Length of moving object	38. Extent of automation	39. Productivity
1. Weight of moving object	+	–	15,8, 29,34	26,35, 18,19	35,3, 24,37
2. Weight of stationary object	–	+	–	2,26, 35	1,28, 15,35
3. Length of moving object	8,15, 29,34	–	+	17,24, 26,16	14,4, 28,29
39. Productivity	35,26, 24,37	28,27, 15,3	18,4, 28,38	5,12, 35,26	+

Source: Adapted from The TRIZ Journal, July 1997 http://www.triz-journal.com/archives/1997/07/.

Table 3
Partial contradiction matrix of the *K Hospital* case.

Improving parameter	Worsening parameter Ease of operation
Measurement accuracy	#1, #13, #17, #34

receiving medical alerts. First, blood pressure is measured at home using a household manometer connected to the Internet. The household manometer records blood pressure and sends this data to hospital via the home box device. The hospital healthcare service provider then examines the measurement result and identifies any abnormal values. Finally, the home patient receives a "very good" message from the home box device when blood pressure is within the allowable ranges. Outpatients use the household manometer in the usual manner, except that it must be connected to the home box after acquiring a measurement. Home patients receive normal or abnormal messages via the Internet from the healthcare service provider. The accuracy of the manometer is extremely reliable.

7.3. Requirements analysis phase

This phase acquires the requirements for new services based on multiple perspectives. The scope of possible services is discussed first in the idea management phase and later in this phase, which identifies the requirements of consumers, companies, stakeholders and technology and appropriate regulations.

The key to a successful innovative service is to understand consumer requirements and consumer opinions of the new product. Therefore, a systematic consumer survey is needed. In the case of *K Hospital*, experts from multiple domains defined questions, analyzed critical factors and drafted a service workflow proposal that outlined procedures for consumer research. The next step was to transfer contents into questionnaires to survey consumers about quantity (questionnaires) and quality (personal interviews). The research methodology was modified to address differences between the target group and research items. The research report included user profiles, monthly investment in self-care, available service items, and priorities, experience and opinions regarding service flow. Fig. 4 presents this consumer research approach.

In the *K Hospital* case, to identify a range for acceptable pricing and appropriate service plan content based on this price range, consumer research was conducted via questionnaires and personal interviews. Questionnaires were distributed on July, 2005. Families of stroke patients were selected via purposive sampling. Interviews were conducted by trained interviewers. Of the 133 questionnaires distributed, 130 were retrieved from families of patients receiving treatment in hospital units such as the Rehabilitation Division, Neurology Clinic, Nursing Home and Home Therapy. Five caregivers of stroke patients were then interviewed to determine actual, real-world needs of patients. Additionally, since the new service would be paid in part through public health insurance and in part through private insurance, government officials and insurance representatives, physicians, and pharmacists were interviewed. This research was effective in clarifying the concerns of all stakeholders, responding to public demand for appropriate community care service, and helping to construct the planned information system and services.

In the healthcare service sector, surveying the germane regulations is one of the most important tasks when a new service is booming. In the *K Hospital* case, the hospital sought to establish home delivery of medical services. After survey, the hospital identified two regulations governing such services in Taiwan. One is that prescribed drugs cannot be delivered to patients by mail. The other is that a prescription can only be filled by a licensed pharmacist. To comply with these regulations, hospitals must design new methods of delivering medicine to outpatients. New service developers in the healthcare sector who fail to plan for these regulations may suffer huge losses.

Innovative new services can change the industry ecosystem and business relationships. Service systems are value-creation networks involving people, technologies and organizations (Maglio et al., 2006). Identifying stakeholders associated with new services at the beginning of service design is vital. The original idea of home delivery of medicine would likely meet resistance from pharmacist associations. Chronic patients are used to going to a pharmacy to get their medicine; thus, pharmacists have a stake in the status quo. Allowing patients to receive medicine at home would dramatically reduce the market share of pharmacists. If service providers do not clearly identify stakeholder requirements at the outset, new services may be abandoned under pressure from professional associations.

7.4. Service development stage

The service development phase begins after completing requirement analysis. The iterative interaction between these two phases must be understood when modifying service design. Plans for new services are based on analytical results from the requirements analysis phase, and include service specifications, a service-delivery model, resource model, marketing analysis and proposed business alliance. In the *K Hospital* case, discussions and brainstorming by multi-domain experts yielded service-related content such as analysis of current services and processes, analysis of the new service process, required personnel, execution time and workflow details, cost effectiveness of services, product pricing and analysis of other related factors and issues. Moreover,

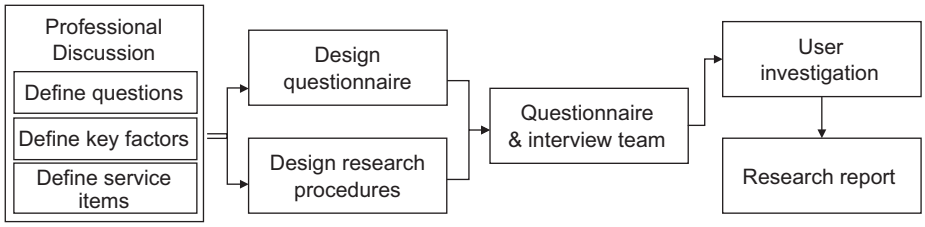

Fig. 4. Consumer research approach.

the team members chose partners based on service demands and formed alliances to include partner companies in the discussion of details for the process of executing the innovative service. These new members were to be involved in the design of service products and specifications.

Service specification and process modeling can be applied to describe a service. Service specifications delineate what a service does, and process modeling illustrates how intended outcomes of a service can be achieved (Bullinger et al., 2003). The service description differs from a product description in that the former involves multiple aspects, whereas the latter involves only single aspect. A physical product can be described by a single aspect such as appearance, functions or features. However, multiple attributes are included in a service description. Service is a process involving consumers in the production and delivery of services. The purpose is to solve problems or satisfying requirements through a service provider and service system. Therefore, describing a service requires identification of the following:

- *who* is offering the service: how many roles are involved throughout the service process, what are the work responsibilities of each role, and who is the service receiver
- *what* is the service content?
- what is the appropriate *time* to offer the service?
- *how* is the service delivered?
- *where* should the service be delivered?

Service description should be made according to the above multiple aspects. In the *K Hospital* case, the previous phase of requirement analysis for healthcare services indicated that the most vital services are as follows:

- monitoring physiological signals,
- follow-up diagnosis,
- home visits,
- home delivery of medicine,
- application for social benefits and emergency transfer, and
- healthcare consultation

The project leader assembled medical professionals, including nurses, healthcare managers, doctors, and pharmacists, and other personnel, such as taxi drivers, insurance representatives, and information system development engineers, to analyze service scenarios and design detailed operational processes for the above service models. The design of the community healthcare network system was based on individual service scenarios. For each scenario, consumers, users and related system providers were interviewed to determine their needs. Based on an analysis of interviews, functional modules were established for the healthcare system. The key technologies of the six major service functions were detection of physiological signals, electronic transfer of medical data, and exchange of electronic data among different members of the services alliance via an information system.

The resource model is designed for consumed or used up by service providers while providing services. Here, the focus is on planning for all resources needed to offer services. The resource model deals with human resources or human capital, natural resources (e.g., building materials and facilities), planning the deployment of operational resources (e.g., project management, quality control, capacity measures, financial feasibility, and production feasibility) and allocating resources for supporting IT.

Marketing analysis examines market feasibility of a service by evaluating target consumer profiles, market scale, market share, marketing strategy, policy and competitors. In the *K Hospital* case, the hospital surveyed consumer response to generate a cost structure. The service provider found that, among the six services, monitoring physiological signals, home visits, and home delivery of medicine were the most cost-effective services. Given these three services, costs were estimated to evaluate business model feasibility.

To solve the issues associated with delivering prescribed drugs to patients at home, the team developed the solution as described: drugs delivered by a licensed pharmacist who, at the same time, performs a home visit service.

Service providers can provide consumers with a one-stop shopping service by establishing strong business alliances. In the *K Hospital* case, the hospital determined the needs of consumers for several add-on services in addition to healthcares services identified in the requirement phase. Such services included housekeeping (e.g., housecleaning and laundry service), establishing a disability-free environment, transportation services (e.g., arranging transportation to and from a hospital), insurance services and leisure and travel services. Thus, the hospital enhanced its offer of value-added services by establishing business alliances with several organizations—a taxi association, insurance company, housekeeping company and a travel agency. This alliance is responsible for developing core- and value-added services for consumers. Providing services via business alliances reduces service cost and increases the value of core services. The boom in outsourcing services can assist in establishing effective business alliances (Karmarkar, 2004).

7.5. Service trial phase

Service trial, the final phase in service design, includes a pilot system and service experiment laboratory. The service development phase analyzes feedback from outcomes of the service trial phase to enhance service design. Innovative services are difficult to test in a laboratory. Many new services fail as they entered the market prior to adequate service testing. Therefore, new methods of service testing are required.

In the *K Hospital* case, before new services were officially launched, a pilot system was utilized to determine whether users accepted the new service. To ensure that the system addressed the key requirements for service scenarios, the project developed a pilot system with three functions—tracing and monitoring

physiological signals, home visits and home delivery of medicine. User experience was collected by allowing users to try the pilot service system. The pilot service system also demonstrated the completion and breakthrough of the key technologies—detection of physiological signals, electronic transfer of medical records, and exchange of electronic data among different members in the service alliances. After completing the pilot system, the team conducted a field test. Finally, the user opinions were fed back into the requirement analysis phase for service revisions and design. A new series of consumer studies may be needed.

8. Conclusions and research directions

The service sector in many emerging and industrialized economies is rapidly expanding worldwide. Service sector innovation has always been the driving force behind new directions in manufacturing and economic growth. This study analyzed service innovation issues arising from current trends in technology, business, demand and social organizations, the dimensions of service innovation, and consumer demands as the basis of service innovation. This study adopted the *K Hospital* project as a case study and the lessons learned by the MOEA as illustrative examples. This study proposed mechanisms for service innovation, including five phases—initial, idea management, requirement analysis, service development and service trial. The TRIZ method was applied for innovative problem solving. These approaches can be accessed by companies or researchers interested in developing innovative services.

Relevant literature generally uses three perspectives to describe service innovation (Tether, 2003). The conventional perspective is "technology dependence," suggesting that innovative services are mainly developed by suppliers. The second perspective, the interactive view, also called the Lille school, suggests that innovative services are developed jointly with customers. The third perspective, strategic positioning, suggests the service innovation is mainly developed internally as a competitive process. The perspective utilized in this study fits with that of the Lille school. Gallouj (2002) identified six innovation models—radical, incremental, *ad hoc*, ameliorative, recombinative, and objectifying. The case described here is closest to radical innovation—a brand new healthcare service was developed. Several vectors of the service form, such as provider competence, service characteristics, technology characteristics (new ICT applied), and customer competence (patients can be taken care of at home), have been changed.

The basic phase (the first layer in Fig. 3) of the proposed mechanism of service innovation may not differ from others suggested in the literature. However, this study identified the stages in detail (the second layer) in each phase. For, the lesson of the above *K Hospital* case, "cross-sectors expert", "stakeholder requirements," "customer research approach," "business alliance" and "service experiment lab." are important design stages. A survey of Taiwanese companies indicated that the issues of developing new services includes: lack of management mechanism for service innovation, the *ad hoc* methods for developing new services, lack of integration tool to support innovative service development, lack of suitable development mode and methods, etc. (Hsiao and Yang, 2008). The proposed mechanism of this study provides the necessary procedure for recruiting different domain experts, identifying user requirement, service trial, etc. Because this mechanism captures necessary sprits of service innovation, it can be applied to innovative service design in other industries. However, different industries have different environmental situations. For example, while applying to banking industries, the governmental financial regulations would put many restraints.

After examining the *K Hospital* case, this study applied *K Hospital* experiences to another case, *T Hospital* (anonymous), which takes care of asthma patients at home. Based on *K Hospital* experiences with the proposed mechanism, the service development period for *T Hospital* was shortened. One interesting comparison is the responsible organization in these two hospitals. In the case of *K Hospital*, the responsible organization was an original line department, a community healthcare center. No professionals were dedicated to the project. The organization level was not high. Thus, coordination took a long time. In the case of *T Hospital*, the responsible organization was a new virtual team. The coordination cost was still high. We suggest that a new organization should be established for service innovation development. Such a new organization should have the full support of top management and a high level of involvement from other upper level managers and dedicated professionals.

We recommend several future research directions. Because healthcare is a common service, this study focused on service innovation in the healthcare sector. Future studies may explore innovation mechanisms in other service sectors. Furthermore, integrating knowledge from different domains is required for effective IT-enabled services. Therefore, healthcare institutions may not effectively evaluate services at their initial phases. To address this typical obstacle in the development of emerging technologies in the service sector, follow-up studies are needed. The application of TRIZ to innovative service development is in its infancy, additional research is needed to map the parameters of contradiction matrices and inventive principles to service concepts.

To accommodate an aging society, countries worldwide are developing R&D projects for innovative services and products. Some examples are the Silver Economy Network of European Regions (SEN@ER), Vermont Blueprint for Health in the USA and Sukoyaka Family 21 in Japan. However, to our best knowledge, these projects have not fulfilled their detailed stages of service design, especially "stakeholder requirements," "business alliances" and "service experiment lab" during the phases of service innovation (Fig. 2). Most approaches are *ad hoc*. The experience of the Taiwan in promoting the ITeS U-Care Project can be used as a reference for other countries.

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