

Integrating PZB Model and TRIZ for Service Innovation of Tele-Healthcare

Chuang-Chun Chiou, Chien-Ju Liu, and Jenteng Tsai

Abstract—Due to the rise of aging population, effective utilization of healthcare resources has become an important issue. With the advance of ICT technology, the application of tele-healthcare service has received more attention than ever. The main purpose of this research is to investigate how to conduct innovative design for tele-healthcare service based on user's perspectives. First, the healthcare service blueprint was used to describe the processes of tele-healthcare service delivery, and then construct PZB service quality gap model based on the literature and practitioners' interviews. Next, TRIZ theory is applied to implement service innovation. We found the proposed service innovation procedures can effectively improve the quality of service design.

Keywords—Tele-homecare, Service blueprint, TRIZ, PZB model

I. INTRODUCTION

NOWADAYS the increase of aging population is a global phenomenon, consequently the increasing costs of healthcare and shortage of healthcare providers will be an inevitable challenge all over the world. For developed countries, the main aging burden resides in pension and health care costs. Similarly, the population aging will become a critical issue in the developing countries. For instance, China will have approximately 31 percent of its population aged over 60 in 2050, larger than the percentage found in the US. [Magnus, 1] Additionally, in Taiwan the rate of population aging is one of the highest in the world. The elderly are currently taken care by the family members or immigrant workers who may not have the basic training of nursing skills. With the advance of ICT technology, some health service can be enhanced by adopting the newly developed products. Such trend can facilitate the healthcare delivery to the elderly's homes or the places where the elderly reside.

Many initiatives have been launched in Taiwan to delivery health care service to the user in the distance. The government, Department of Health of the Executive Yuan, supported Tele-healthcare Service Development Project for hospitals including Wang Fang Hospital, Changhua Christian Hospital, Kaohsiung Medical University Hospital and Mennonite Christian Hospital four care teams. Each team member developed a tailored service model for specific need. Those practices are not well-developed.

Chuang-Chun Chiou is with Dayeh University, Changhua, Taiwan (phone:+886-4-8511888;fax:886-48511270; email:cjchiou@mail.dyu.edu.tw)

Chien-Ju Liu received her MS from Tunghai University, Taichung, Taiwan (phone: +886-4-23594319;fax:886-23594319;mail:dors@yahoo.com.tw)

Jenteng Tsai is with Tunghai University, Taichung, Taiwan (phone:+886-4-23594319;fax:886-23594319; email:tsajt@ie.thu.edu.tw)

There is plenty of room for improvement. Therefore, the main objective of this research is to conduct a systemic and effective innovation for tele-healthcare service. First, we use service blueprint to illustrate the tele-healthcare service delivery procedures, and then through the literature and practitioners' interviews to construct PZB quality gap model, and then combined TRIZ theory, analysis of an innovative program available to planner as a reference. Finally, the research found that the current practice of the tele-health care service needs to be modified. This research suggests and provides innovative thinking, continuous improvement procedures for tele-healthcare industry.

II. LITERATURE REVIEW

A. Tele-Healthcare

According to Health Resources and Services Administration (HRSA), Tele-health is defined as a professional service which delivers health-related services and information via information and telecommunications technologies. Tele-health could support the health professionals to conduct remote clinical service, out-patient distance education, public health, and health monitoring, which capture and transmit physical signals and biometric data. [Office of Health and the Information Highway, 2].

Maheu & Allen [3] described tele-healthcare service including health promotion, prevention, diagnosis, consultation, education, clinical treatment, and public health via transmitting the information and data. In addition to education for the patient and community, it also provides health data management, health care resources allocation and transfer. The technologies applied in tele-health include video conferencing, internet, image storage and transmission as well as telecommunication. Britton, Engelke, Rains & Mahmud [4], Koch [5] and Wenzek [6] from IBM thought tele-healthcare is to deliver health care service to the remote clients. It could be as simple as two health professionals discussing a case over the telephone, or as sophisticated as using videoconferencing between providers at facilities in two countries, or even as complex as robotic technology. Nevertheless, the current tele-health application is more focused on monitoring the clients via ICT technologies.

The technologies and products available for supporting tele-healthcare service are collecting data like Blood Pressure, Weight, Pulse Oxidometer, Blood Sugar values. Those data are monitored and trended for long term chronic care. Besides that,

With the availability of better and cheaper communication channels, direct two-way audio and video streaming between care givers and receivers.

Tele-home care is a special form of care service which is not only limited to medical treatment. It can be any form of service which is beneficial to users, users' relatives, care givers and medical professionals. The key motive of this kind of service is to enable the care receiver/ elderly to live at his/her most familiar environment and to maintain their esteem. Masatsugu Tsuji[7]

Research of tele-health care is still in its infancy. To promote the well-being of the clients, basically there are two directions to meet the clients' need, i.e., physical and psychological. With the advance of the ICT technology, there are so many opportunities to adopt the technology to directly satisfy the clients' physical needs. Consequently, the positive effects of application of new technology can benefit the clients psychologically. From technological perspectives, there are some important issues have been addressed such as developing health information management system, integrating ICT technology to medical treatment and healthcare service delivery, facilitating education and entertainment activities via new technology, etc.

Due to the increasing population of the elderly and the chronic disease patients as well as the rising medical costs, tele-health care is an effective way of delivering care service to the clients and assisting them live independently. Currently, Tele-health care provide three functions: (1) Safety and security monitoring system; (2) Biometric data monitoring; (3) consulting service via phone and video conferencing. Gasier and Barlow [8] studied the effects of tele-health care and found that it can significantly reduce the number of in-patients and medical expenditure. Furthermore, through biometric monitoring and video conferencing the clients can receive more appropriate service.

In Taiwan, three tele-health care service models have been developed. They are based on location of receiving service, which are classified as community, home and institution. Each service model can work independently. Once there is a need of transfer among them, the clients can be smoothly shifted from one model to another through resources adjustment on an integrated information platform. (ITRI)

Community-based model provides five service including a convenient health station, health education and consulting service, GPS, medicine usage direction, and transfer of resources. In addition, this type of service can be integrated with other resources like food delivery, house-cleaning, transportation, and rental of assistive equipment.

Home-based model provides five service including biometric data collection, distant health education, house visit, introduction of living resources, and emergency handling. This kind of service will be enhanced by integrated with other resources such as nursing care at home, professionals' visit and assistive equipment.

Institution-based model provides five service including video diagnosis, biometric data collection, relative video

conferencing, health education, and direction on medicine usage. Some medical resources such as specialist and cross-department doctors can enhance the service of Institution-based health care model.

B. Exploring the care receivers' needs

Customer need is not only the driving force of technical progress, but also the important basis of product innovation design. Customer need has become the starting point of designing service delivery. Facing the customer-driven market, service design must cover a larger scope of the value chain and provide high added value to the customers.

Researchers have made several attempts to explore the voices of customer requirements in relation to the product /service design process. Quality function deployment (QFD) is a commonly used method to explore the voice and customer's need and translate the voices into technical specification of the product/service design. However, QFD depends heavily on human subjective judgment during the extraction of customer requirements and determination of the important weights of customer requirements. In order to obtain systematic comparison between the factors that affecting the service design, Kwong and Bai [9] introduced a fuzzy number in the pairwise comparison of Analysis of Hierarchical Process (AHP). Li et al. combined rough set theory, Kano model, AHP, and the scale method, an integrated method is proposed to obtain the determinants of customer requirements and to determine the final importance of customer requirements.

PZB model [10]The SERVQUAL application must be periodical in order to filter trends and changes in the customer perception. The identified gaps must provide tools to offer innovation development and sustainable to each profile or market-share. The professional profile flexibility could be arranged in real time to establish a transparency relation among the client's desires and the delivered service.

C. Service design / Innovation

Zeithaml and Bitner [11] are clear relating services as acts, process and performances. Vargo [12] enhance Zeithaml & Bitner's original definition asserting that services are specific applied competences (knowledge, skills and experiences) in acts, performances and processes targeting benefits. Relevant literature generally uses three perspectives to describe service innovation (Tether, [13].Gallouj (2002)[14] identified six innovation models—radical, incremental, ad hoc, ameliorative, recombinative, and objectifying. Several vectors: provider competence, service characteristics, technology characteristics (new ICT applied), and customer competence(patients can be taken care of at home),have been changed. Service engineering is a systematic way to develop service in usage of models, methods and tools (Bullinger et al, 2003) [15]. Fig. 1 presents five phases for developing new services—initial phase, idea management, requirement analysis, service development and service trial. 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.

D. Service Blueprinting: A Practical Technique for Service Innovation

Service design methods should place greater emphasis on managing the service experience, enabling a flexible and modular design to accommodate the real-time co-creation of value through customer interactions with the firm across the different interfaces. Service blueprint was developed more than 20 years ago to clarify service concepts and systematize the process of service design. Service blueprint is a kind of process-oriented service design method. Service blueprinting (SB; Shostack 1984) [16] comes from service management and it uses case and activity diagrams (Booch, Rumbaugh, and Jacobson 1999)[17], which was developed in the field of software engineering. Recent works such as Stuart and Tax (1997) [18] and Berry et al. (2002) [19] proposed frameworks for service design and management that integrate service processes (functional clues), people (human clues), and physical facilities (mechanic clues), but the integration of technology into service design has not been fulfilled.

E. TRIZ

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. 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.

III. RESEARCH METHODOLOGIES

Propose a systematic and efficient framework toward innovative problem solving. Like many other methodologies, there are three basic stages in the problem solving process: “define the problem,” “generate solutions,” and “evaluate solutions.” Based on these, we extend this process to come up with seven steps.

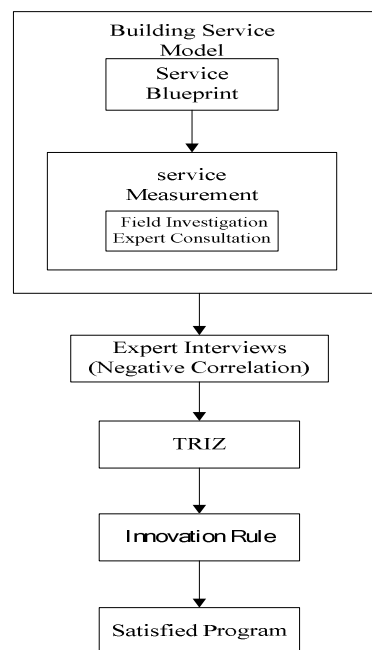


Fig. 1 The systematic procedures of service innovation

Step 1: Defining the main service contents in Tele-health care service

From the perspectives of marketing research, it is essential to identify the main service contents which represent the customer’s need. The service providers are keen on satisfying the customers’ need means that service can create value towards the customers. Therefore, the first step of service innovation is to identify the service contents clearly.

Step 2: Identifying the key interactive contact by service blueprint

Once the main service contents are defined, the service designer needs to examine the deeper interaction between the service receiver and service giver. Service blueprint is a useful tool that can be used to investigate the interfaces and activities where the customer’s needs are met.

Step 3: Analyzing and classifying the service measurement

In order to conduct a systematic and holistic analysis on service innovation, we can establish key constructs and the corresponding criteria for each construct.

Step 4: Generating the TRIZ parameters

Before the TRIZ inventive rules can be applied, for any specific service sector we need to build up service parameters table that is mapped from engineering one. In other word, the established service service parameters are based on the engineering parameters table.

Step 5: Examining the contradiction and finding the corresponding inventive rules

Following the previous steps, the main service contents, key interfaces between the service giver and receiver, and

parameters table are identified and available. Next, PZB model can be integrated with TRIZ method to examine the contradiction.

Step 6: Generating the feasible solutions

In this step, the contradiction and service gaps will be resolved by applying the contradiction matrix which provides standard TRIZ solutions and the corresponding rules. Hence, the innovation problem is translated into standard problem. Next, inventive rules are applied to find the standard solution. Finally, the standard solution is transformed to solve the original problem.

Step 7: Evaluating the service innovation

The final step is to evaluate the effectiveness in term of cost, time and manpower.

IV. SERVICE INNOVATIONS IN TELE-HEALTH/ CASE IMPLEMENTATION

Step 1: Defining the main service contents in Tele-health care service

According to the survey and the observation of the existing practices of tele-health care, there are three main service contents, i.e., (1) emergency service; (2) monitoring on daily activities; (3) monitoring on biometric data. They can provide support for the emergency and accidents handling as well as long term wellness monitoring. Such service can store the clients' health records and facilitate the health management.

The resources from a variety of industries can be integrated to build new service model of tele-health care. For example, the resources include the nursing expertise of hospital (Ar-Tun hospital, Min-Shen hospital), communication platform provided by communication company (Chunghua Telecom, emergency response service of security company (Chung-Hsin Security), mobility designed by construction company (Yuan-Shun Construction), and assistive facility made by equipment manufacturing company (Lifeline, Tunstall, Health Hero, Fujitsu, Card Guard).

Step 2: Identifying the key interactive contact by service Blueprint.

Next, service blueprint is used to examine the details and the interaction between the care receiver and the service system. In other words, the analysis goes deeper from the main service contents to specific contact points. We classify the activities by the contact processes which are taken place when the service is executed. The service blueprint is shown in Fig. 2.

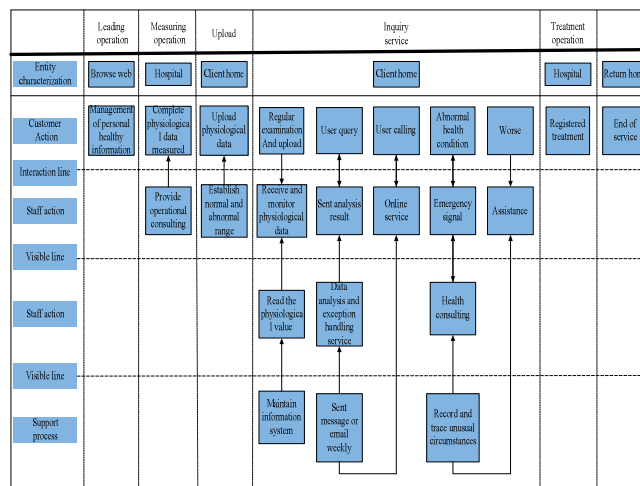


Fig. 2 Service blueprint

Step 3: Analyze and classify the service measurement

Tsai and Chung (2011) conducted a survey on tele-health care and face-face interviews in suburb area of central Taiwan and presented an explorative factor analysis. They propose an evaluation framework including three constructs and eight measures. Three constructs are described from three perspectives which are technology, social psychology, and management. Further, three constructs are deployed into eight measures which are system quality, privacy risk, trust, service quality, cost effectiveness, satisfaction level, usage intention, and health intension.

In this research we extended five new measures for both "system quality" and "service quality." They are monitor technology, measurement technology, communication technology, system platform, and personnel education and training are under the measure of "system quality." Further, medicine usage, medical treatment, health education, video consulting, and emergency response are deployed from the measure of "service quality." The new framework consists of three constructs and 16 measures.

Step 4: Generating the TRIZ parameters for health care service

As mentioned previously in the literature review, although TRIZ originally was applied in the field of solving engineering problems, it can also be used to cope with the problem in the field of service innovation. Follow the same logics in engineering problem solving, we need to identify the attributes that affects the customers' satisfaction level. For those attributes, there exist some contradiction and gaps need to be resolved. Before we use TRIZ contradiction matrix, we need to translate the engineering parameters into attributes of health care. Parts of the TRIZ parameters for health care service are demonstrated in Table I.

TABEL I

TRANSLATE ENGINEERING PARAMETERS INTO ATTRIBUTES OF HEALTH CARE

TRIZ parameters and description		Apply ICT and illustrate TRIZ parameters	
Parameter	Description	Parameter	Description
Speed	Object speed	Responsive	Service delivery speed and timeliness
Power	Attempt to change the object state interaction between sub-system	Supply capacity	When demand is change, the impact of capacity services will how to change
Pressure	Receive strength of sub-system	The variety of need with time change	The variety number of need
Shape	External shape	exterior	Sense characteristics
Sub-system stability	Maintain completely and healthy ability	Functional	The usability of care system and equipment

Step 5: Examining the contradiction and finding the corresponding inventive rules

In the previous step, service quality gaps have been measured by computing the difference between the expectations and perceptions by PZB model. In this study, a survey and expert interview are conducted.

Among three dimensions and 16 measures, the results show that there are significant differences in the dimension of social psychology. The most critical measure of social psychology is privacy risk which has three negative relationships with the other measures. They are communication technology, satisfaction level, and users' intention. These finding suggest that tele-health care service designers should be looking carefully at each of these negative relationships and re-examine the possibility of resolving these contradiction innovatively. That means the improvement efforts should be focused on those area.

Step 6: Generating the feasible solutions

In the process of new service development, the TRIZ method is a very useful tool. Researchers have demonstrated that TRIZ is effective in solving technical problems when developing tangible products. On the other hand, some researchers have utilized the TRIZ method for innovative problem-solving in new service development (Saliminanim and Nezafati, 2003[20]; Lin and Su, 2007 [21]; Zhang et al., [22,23]).

The following problem was at issue. Compatibility and communication between different equipment play an important role to tele-health care service. Therefore the reliability, safety, and security of the information platform can increase the customers' satisfaction.

Of the 39 TRIZ parameters, the following parameters require improvement. The parameters to be improved are the responsiveness (p9) and reliability (p27) of communication

technology. Meanwhile, the negative effects on the other parameters, i.e., information loss among platform (p24), should be avoided.

Referring to the contradiction matrix, we can found the following table which illustrates four inventive rules can be applied to generate ideas for improvement.

TABEL II
FOUR INVENTIVE RULES

Improve the parameters	Avoid getting worse parameter	#24 Lost information
	#9 Response efficiency	13, 26
	#27 Reliability	10, 28

These inventive principles are as follows:

#10 Prior counteraction (corresponding to Recognizing and making necessary social situations for future)

Solution: this inventive principle was referenced to generate the following service operational concept: (a) prepare the necessary compatible health management information platform that can enable the exchange of the medical, diagnosis, and financial data by using the common standard like, Health Level 7; (b) avoid of time waste during the movement via using wireless technology.

#13 Do it in reverse (corresponding to Considering Social process inversion)

Solution: this inventive principle was referenced to generate the following service operational concept: (a) Try to make the movable parts or external environment are fixed and make the fixed part can be movable. Originally, the clients should go to hospital to examine their basic biometric data. On the contrary, the data can be transmitted via wirelessly. That is the movable parts can be fixed; (b) upside down-encourage the users to voice their suggestion on achieving better service.

#26 Coping (corresponding to Recognizing similar systems and renewed program running)

Solution: this inventive principle was referenced to generate the following service operational concept: (a) Try to substitute the expensive and complex part with simple one. Continuous improvement on data transmission technology can increase the reliability. Transmission network can also be simplified; (b) Use optical to substitute the convention method. The accuracy of medicine distribution can be improved by using RFID technology.

#28 Replacement of mechanical system (corresponding to using more influence social process with less connection)

Solution: this inventive principle was referenced to generate the following service operational concept: (a) In-person service can be replaced by multimedia communication channels such as using audio, video, and other sensation ability. The related technology and products including DVD, video conferencing are already available; (b) Change the field from static to dynamic, from fixed to changeable, and from random to structured. One

practical application is to use fingerprint to substitute the log-on process. Meanwhile such move can increase security.

Step 7: Evaluating the solution

According to the analysis in Step 6, we focus on the improvement of responsiveness and reliability. We have applied four inventive rules (10, 13, 26, and 28) to increase the performance of responsiveness and reliability. To perform an examination of the feasible solutions is based on criteria such as cost, time, available human resources, technological level, etc. After the examination and presentation of the feasible solutions, the confirmed feasible solutions can then be implemented. Through a period of implementation, the results can be further evaluated with various specified performance criteria, and if the results indicate that the conflicts of the problem are not effectively resolved, it is suggested that the users of the method should repeat the evaluation to examine which step involved the problem.

V.CONCLUSION

The main contributions of this study are presenting three major service contents for Taiwanese telehealth care industry and using a systematic method to conduct service innovation, which integrates the concept of service gap and TRIZ theory. From the perspectives of building a new service model, we have explored the clients' needs and tried to create value for the stakeholders, not only the care receiver but also their relatives.

There are plenty of research opportunities in the areas of health care. Further research on establishing a platform that enables all cross-organization stakeholders can exchange information. That will enhance the customer relationship management. In addition, health care service is closely related to health insurance, social welfare, and medication system. The interaction between those areas is very complex. The interfaces need to be further clarified. Furthermore, how to conduct a systematic and holistic integration of different resources from the different departments is also an interesting topic.

ACKNOWLEDGEMENT

This research is partially support by National Science Council of Taiwan, R.O.C. (Grant No. NSC 100-2221-E-212 -017 -MY3.)

REFERENCES

- [1] G. Magnus, "The Age of Aging: How Demographics are Changing the Global Economy and Our World Canadian Studies," in *Population* 38, No. 1-2 :191-3 (Spring/Summer 2011).
- [2] Office of Health and the Information Highway, Available online at: http://www.fp.ucalgary.ca/telehealth/What_Is_Telehealth.htm. (accessed December 25, 2010).
- [3] M. M. Maheu, A. Allen, "E-Health & Telehealth Glossary," Available online at: <http://telehealth.net/glossary.html>. (accessed January 10, 2011).
- [4] B.P., Britton, M.K. Engelke, D. B. Rains, and K. Mahmud "Measuring Costs and Quality of TeleHomecare," *Home Health Care Management & Practice* June 12: 27-32 (2000).

- [5] S. Koch, "Home telehealth – Current state and future trends," *International Journal of Medical Informatics*, 1-12 (2005)
- [6] H. Wenzek, "Telehealthcare Will Soon Be Keeping All of Us Healthier," IBM, (2005).
- [7] M. Tsuji, "Business Briefing : Clobal HealthCare," *The Telehomecare/ Telehealth System in Japan*, 72-74 (2002).
- [8] M. Gasier, J. Barlow, Project form as a vehicle for delivering innovative, adaptable healthcare facilities. Examples form the UKs PFI hospitals programme. HaCIRIC, (2007).
- [9] C. K. Kwong, H. Bai. "A fuzzy AHP approach to the determination of importance weights of customer requirements in quality function deployment," *Journal of Intelligent Manufacturing*, vol. 13, no. 5, pp. 367-377 (2002).
- [10] A. Parasuraman, V. A. Zeithaml, and L. L. Berry, "A Conceptual Model of Service Quality and Its Implication for Further Research," *Journal of Marketing*, 49, 41-50 (1985).
- [11] V. A. Zeithaml, L. L. Berry, "Service Marketing: Integrating Customer Focus across the Firm," McGraw-Hill, New York, (2000).
- [12] L. V. Stephen & F. Robert "Lusch Service-dominant logic: continuing the evolution J of the Acad," *Mark. Sci.* , 36:1-10 (2008).
- [13] S. T. Bruce, "The sources and aims of innovation in services: Variety between and within sectors Economics," *Innovation and New Technology* Volume 12, Issue 6, (2003).
- [14] F. Gallouj, *Innovation in the service economy: the new wealth of nations*, (2002).
- [15] H.J. Bullinger, K. P. Fähnrich and T. Meiren "Service engineering—methodical development of new service products," *International Journal of Production Economics* Volume 85, Issue 3, 11 September, Pages 275-287 (2003).
- [16] G. L. Shostack, "Designing services that deliver," *Harvard Business Review*, 62(1), 133-139 (1984).
- [17] Booch, Grady, J. Rumbaugh, and I. Jacobson, *The Unified Modeling Language User Guide*, Addison-Wesley, Boston (1999).
- [18] F. I. Stuart, and S. Tax, "Toward an Integrative Approach to Designing Service Experiences: Lessons Learned from the Theatre," *Journal of Operations Management*, Vol.6 (22), pp.609-627 2004.
- [19] Berry, L. Leonard, P. C. Lewis, and H. H. Stephan, *Managing the Total Customer Experience Sloan Management Review*, 43 (3), 85-89 (2002).
- [20] M. H. Saliminamin, N. Nezafati, "A new method for creating non technological principles of TRIZ," *The TRIZ Journal*. October, (2003).
- [21] C. S. Lin, C. T. Su, "An Innovative Way to Create New Services: Applying the TRIZ Methodology," *Journal of Chinese Industrial Engineering*, Vol. 24No. 2P 142-152 (2007).
- [22] J. Zhang, K. H. Chai and K. C. Tan, "40 inventive principles with applications in service operations management," *The TRIZ Journal*, December, (2003).
- [23] J. Zhang, K. H. Chai and K.C. Tan, "Applying TRIZ to service conceptual design: an exploratory study," *Creativity and Innovation Management*, 14, 34-42, (2005).

Chuang-Chun Chiou is an Associate Professor of Department of Industrial Engineering and Technology Management at Dayeh University, Taiwan. He received his Ph.D. degree in Industrial Engineering and Enterprise Information from Tunghai University. His research interests include sustainable supply chain, coordination in supply chain, and service science. His research work has been published in journals including *European Journal of Operational Research*, *Annals of Operations Research*, *Journal of Chinese Institute of Industrial Engineering*, *Journal of Quality*, *Journal of Operations Research Society of Japan*, *International journal of Production Economics*, etc.