行政院國家科學委員會專題研究計畫 成果報告

iCare: 社群化智慧型居家照護--子計畫四：角色智慧群體決策之居家照護系統平台(3/3)
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行政院國家科學委員會補助專題研究計畫 ■成果報告

（計畫名稱）

iCare: 社群化智慧型居家照護-子計畫四：

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計畫參與人員：

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iCare Home Portal: An Extended Quality Aging e-Service Model

The quality of life of senior citizens around the world is a critical issue in today's society. According to World Health Organization (http://www.who.int/), there were 600 million people aged 60 and over in 2000; there will be 1.2 billion by 2025 and 2 billion by 2050. In addition to the thousands of unnecessary deaths, each year missed health care opportunities cost the nation more than 1 billion dollars in avoidable hospital bills, and nearly 41 million work days, resulting in the loss of 11.5 billion for American businesses,, as reported by U.S. Department of Health and Human Services (http://www.aoa.gov/). These make assisted living and home care become a fast growing health-care sector. A scrutiny of extant technologies for aging services (see **Sidebar 1**) reveals that they are invariably aiming at health care or electronic care (eCare) and overlooking social and behavioral aspects of aging service. eCare is an emerging health care field that utilizes Web technologies. Angood [2] identified three eCare trends that utilize the Internet: medical informatics (focused on information), telemedicine (focused on communication), and cybermedicine (focused on the Internet and global networking technologies). These eCare trends share a common belief in that maintaining an independent lifestyle is socially important to the quality of life of seniors and caregivers, which helps reduce potential health-care costs health-care costs associated with hospitalization or placement in a full-time care facility. Unfortunately, existing health care or eCare services for seniors are mostly oriented toward clinical gerontology or neuropsychology. They overlook certain quality dimensions such as community involvement, consumer participation, and continuous quality improvement. In this paper, we describe an intelligent care (iCare) system that makes an eCare system ambient enough to address social and behavioral aspects of aging service. The iCare system is characterized with an iCare ontology featuring ambient service accessibility, unbound information reachability, attentive personalized service provision, innovative life-style creation, precious digital memory and seemingless social connection. The objective of the system is to provide quality e-services to the elderly anywhere and anytime via iCare home portal.

The Need for Expanding eCare Model

According to American Association of Homes and Services for the Aging, care quality encompasses ten elements, we extract six of them that are related to iCare model (except commitment, Governance & Accountability, Human Resources Development, Research Findings and Education): (1) Leading-edge personal care and

services that can adapt to a changing society. (2) Community involvement that engages in social accountability, volunteer involvement and relationship building. (3) Consumer-friendly information that seniors, families and caregivers can access and understand easily. (4) Consumer participation that engages residents/clients, family members and other consumers in healthcare and healthcare services. (5) Continuous quality improvement that uses specific methods to enhance existing services (6) Public trust and consumer confidence that commit to a policy of outreach, openness and authenticity to increase public understanding of quality aging services and earn consumer trust. The aim of these quality elements is to engender good service consumption experience (i.e., a service process that results in a mental impression in consumers in terms of consumer cognitive, emotional and behavioral responses).

To meet the desired care quality goals, this study devises an iCare framework that extends eCare elements and technologies into a broader domain regarding the additional concerns of consumer participation and continuous quality improvement. Moreover, an iCare home portal aims to provide proactively appropriate quality iCare-aware e-services to the elderly is created and tailored to any home context. This portal provides implies opportunities for a whole set of new quality-aging e-services and is based on a novel notion of "warm-hearted" technologies that expand care services.

A Framework of iCare Home Portal

The issues associated with existing eCare technologies can be organized into three dimensions: environment, physical, and relationship dimensions. The *environment* dimension refers to software and hardware (wired and wireless) required for the deployment of the iCare infrastructure. The *physical* dimension concerns the issues of independence, safety, and quality life of aging people. The *relationship* dimension emphasizes on social network that features meaningful human interactions. The framework of iCare home portal expands these dimensions by adding decision as the fourth dimension (See Figure 1(a)). The *decision* dimension represents automated collective decisions for determining appropriate e-services tailored to personal situational context of elderly people and enabling effective delivery of quality e-services. These decisions can be automatically and intelligently rendered using a set of delegated agents representing myriad participants involved in caring for the elderly.

Both physical and relationship dimensions are fundamental to iCare, providing the context data required for reasoning during collective decisions in the decision dimension. The physical dimension concerns with formal caregiving in which formal caregivers (such as nurses or doctors) are involved. The aims of this

dimension are to promote healthy behavior for problems prevention, achieve early disease detection to establish disease signatures before symptoms become readily apparent, and improve treatment compliance to help people recover smoothly. The relationship dimension, conversely, concerns with only the informal caregivers (such as friends, neighbors, coworkers, family members, contents providers, *etc*.).

Theory underlying the iCare decision dimension

The novel value of iCare rests in its decision dimension, which represents virtual collective decisions (involving numerous participants) when determining which e-services (in terms of service concepts defined below) are appropriate and can be tailored to the context of the elderly. The underlying theory in the iCare decision dimension is the Stacey Model.

The Stacey Model (also called the Certainty-Agreement Model) was proposed by Ralph Stacey in 1996 [11]. The objective of the model was to select appropriate management actions within a complex adaptive system involving multiple participants based on the degrees of certainty and levels of agreement (Table 1). Many different disciplines in collective decision-making correspond to different zones of decision problems. In accordance with different degrees of certainty and agreement, the disciplines employed by iCare include garbage-can reasoning, brainstorming, and case-based reasoning.

For the simple zone of collective decision-making, decision problems are straightforward for planning and controlling (i.e., close to certainty and agreement) and the principle of case-based reasoning is adopted to resolve decision problems. In the chaos zone, decision problems are difficult to handle without conformity (far from certainty and agreement). The zone between the chaos and simple zones is called the "zone of complexity" and the principles of garbage-can reasoning and brainstorming are embraced.

The collective decision making will be triggered by iCare home portal automatically based on the information of the elderly single/multiple needs identified. Garbage-can reasoning is exerted in the presence of the elderly multiple needs given the resource constraints on the part of the multiple care givers (close or remote). For example, a collective decision derived from garbage-can reasoning would be rendered at a situation that the elderly person has to decide to eat dinner with a daughter visiting unexpectedly or play chess (e-service) with neighbors as planned (i.e., given the simultaneous presence of the family need and the social networking need at the same time slot for the elderly). Brainstorming is performed in the presence of the elderly single need desiring for interesting e-services. For instance, a collective decision derived from brainstorming would be rendered at a situation that the agents

for son, daughter, and family doctor aim to discover an innovative e-service (e.g., Chinese shadow boxing teaching e-service) collectively in order to attain the same outcomes of an outdoors exercise (i.e., given the presence of the healthy need at home for the elderly). In the iCare platform, each zone of collective decision is equipped with a self-learning mechanism capable of continuous improvement in decisions made).

In iCare, the decision dimension (i.e., virtually collective decision-making by consumers) is a significant feature as it captures collective consumer participation for the care goal (i.e., the appropriate contextual care service) and the subsequent status of goal-fitting (i.e., continuous care quality improvement). The Stacey Model is employed in this study as the theoretical foundation for resolving collective decision problems under the certainty and agreement dimensions.

iCare e-Services

Based on care-taking and care-giving functions and assuming the elderly people are not seriously ill, iCare e-services can be categorized into taking iCare and giving iCare e-Services as follows:

- Giving iCare e-Services: this is a set of e-services that engage an elderly person to contribute to individuals or communities, unfolding two sub-categories of e-services (individual-centric and community-centric).
- Taking iCare e-Services: this is a set of e-services that engage an elderly person to attain four kinds of resources (physical, mental, combined or informative):
  - Physical: e.g.., *telemedicine e-services* that provide remote medical assistance.
  - Mental: e.g., *Home-Movie e-Service* and *connection-oriented e-services* which aim to provide aids to a lonely aging person based on social connections.
  - Combined (mental plus physical): e.g., *therapy entertainment* that is presented to an elderly person (individual-centric) or group (community-centric).
  - Informative: e.g., provision of information (specialized, generic or only for personal information management) to an elderly person.

iCare e-Service Ontology

Figure 1(b) displays the ontology of iCare e-service consisting of four primary concepts (device, home-portal, participant and service). The concepts of Device and Participant represent different hardware (such as sensors, handheld devices, and objects) and roles (such as family, caregiver and friend) that are involved in providing

iCare services. The Home-Portal is a smart interface connecting the elderly with service providers and other participants. These concepts will are further discussed as follows.

- The Service concept is characterized with three high-level attributes (scope, source, and type).
  - Scope means the degree of heterogeneity and reachability that a service embodies (i.e., how specialized and widely an e-service takes on).
  - Source indicates the resource origins from which an e-service draws upon (e.g., human being or contents providers).
  - Type specifies the forms that an e-service is rendered. They could be data-oriented (e.g., text or multimedia), community-oriented (e.g., community channel for the elderly people), personal information (e.g., information management pertaining to the daily life of the aging people), and information category (e.g., special-topic information such as medical information or financial information).
- The Device concept refers to the set of devices (involved in the iCare e-services) that can be divided into two categories (electronic and non-electronic).
  - Electronic means electronic hardware involved in the iCare environment (i.e., sensors, handheld devices, *etc.*).
  - Non-Electronic indicates the non-electronic equipments around the surroundings (e.g., myriad kinds of objects).
- The Participant concept is characterized with four attributes (role, relationship, profile and preference).
  - Role indicates the character played by a participant involved in the iCare environment (e.g., the elderly person, caregiver, family member, remote caregiver, *etc.*).
  - Relationship means the relationship of a participant to the elderly person.
  - Profile specifies the demographic profile of a participant.
  - Preference specifies the preference of a participant (e.g., for the example of the elderly person, it includes the set of e-services the elderly person has consumed or his (her) habits and hobbies.

In Figure 1(b), a node refers to a concept described above, a dotted arrow line indicates the “is-a” relationship from a subclass concept to a class concept, and a solid arrow line denotes the “part-of” relationship from a part concept to an integral concept.

An example (home-movie e-service) is utilized to explain how an e-service is described using the concepts defined in the iCare service ontology. This service provides customized video comprising photos, pictures and videos (likely provided by

remote participants or media). The objective of this care e-service is to assist lonely aging people in feeling entertained by enjoying combined media provided by family members or friends. The characteristics of the home-movie service are as follows.

- Source: an appropriate social circle based on “relationship proximity” (high, medium, and low) of the elderly with respect to a given recognized “mood status” (e.g., happy or homesick) of the elderly.
- Type: a data-oriented form represented using the multimedia format.
- Scope: “profile-matched” heterogeneity and designated areas of reachability with respect to an elderly person’s preference.

Using the iCare service ontology, care e-services can be well delimited according to aspects in the expanded eCare model. Furthermore, this study can construct agents (that commit to this ontology) who engage in virtual collective decision making using the iCare decision dimension.

Implementation of iCare Home Protal

To demonstrate the features of the iCare Home Portal, we shall implement a prototype with the Service Oriented Architectural (SOA) strategy, as depicted in Figure 2. There are three possible types of collective decision blocks for service recommendation: Case-Based Reasoning Model (providing regular decision within single need), Brainstorming Model (providing innovative decision within single need), and Garage-Can Model (providing appropriate decision within multiple needs and resources constraints). We will demonstrate the Brainstorming Model.

Brainstorming is a collective decision-making application that involves numerous participant types (with moderate degrees of certainty and agreement) for determining appropriate e-services (in terms of the service concepts defined in the iCare service ontology) tailored to the context of the elderly. This type of collective decision-making is good for elderly people who are extraverted and favor innovative and interesting lifestyles.

Figure 3 demonstrates a snapshot of the iCare system running with brainstorming. At the left side, the user value vector is revealed to represent the elderly person’s view on the relative importance of the aspects of family, health, friend, time, and money (from 7 to -7). At the bottom of left side, the available resources (e.g., time and money) of the elderly (and the caregivers) are exhibited. The iCare system also shows the current collective decision model (e.g., e-brainstorming). The bottom of right side then shows the dynamic context information of the elderly person (e.g., time, place, temperature, and the members in the house). Finally, the detailed XML input/output information of services of the current decision model is listed at the right side.

In the iCare Home Portal, a specific mechanism of agent-based e-brainstorming

has been developed and integrated into the portal for representing certain participants who engage in an idea generation session for care service recommendations. To evaluate the agent-based e-brainstorming mechanism in iCare, the improvement in the number of ideas generated (i.e., group creativity) and the diversity of ideas generated must be justified for the purpose of innovative care service recommendations and continuous quality improvement. The experimental setting of the prototype is as follows. (1) a universe of 8 e-services (i.e., possible ideas of services delivered) for mental needs under consideration; (2) up to 10 possible roles (i.e., agents representing son, daughter, *etc.*) involved in e-brainstorming, each of which embodies its own knowledge domains; (3) a benchmark Greedy mechanism that randomly selects an e-service from existing knowledge of relevant domains for service recommendations; (4) two metrics, Average Service Types and Service Diversity Rate (see definition below), were used for inspection of the mechanism's performance. Figure 3 shows the portal with the e-brainstorming mechanism, while Table 2 presents the evaluation results.

Definition of Metrics

Average Service Types = $\sum_{i=1}^{N} t_i \Big/ N$

Service Diversity Rate = (Average Service Types / T) * 100 %

- N = Total number of experiment iterations
- t_i = Number of Service Types generated from the i *th* experiment
- T = Number of available e-services

Performance Benchmarks

This study benchmarks the Greedy model against the e-brainstorming model by comparing the number of types and their diversity of the generated e-services with different number of roles (3, 5, or 7) involved in the decision process for justifying the capability of group creativity in e-brainstorming. From Table 2(a), when the e-brainstorming mechanism does not account for agent knowledge learning capabilities (i.e., the capability for continuous quality improvement is disabled), various relatively good performance of the e-brainstorming mechanism is attained (w.r.t. different numbers of participants involved) in both Average Service Types (e.g., 3.7 > 2.77 when roles = 3) and Service Diversity Rate (46.25% > 34.58% when roles = 3) in comparison with the greedy approach. However, the results also reveal that the performance gap becomes small when the number of roles is increased.

With agents' capabilities to learn knowledge in e-brainstorming, the performance improvements are then increased (e.g., Table 2(b) shows the increased improvements

of the case with 3 participants). Number of Average Service Types increases according to the extended VIQ number (from 4.8 to 6.07 when VIQ is 1 and 3 respectively); meanwhile, the percentage of Service Diversity Rate also increases. Finally in Table 2(c), the mechanism's performance improvement in Service Diversity Rate is proportional to the number of participants involved (i.e., Roles) and the number of ideation rounds (i.e., Ideation Rounds). For example, Service Diversity Rates are 46.25%, 70%, and 83.33% when the numbers of roles are 3, 5, and 10 for 4 ideation rounds in e-brainstorming. In short, this application demonstrates how the iCare model (augmented with the decision dimension) engenders consumer participation (by virtual collective decision-making with the agents of the elderly's son, daughter, or family doctor) in recommending appropriate contextual e-services for the elderly. Furthermore, more participants and ideation rounds in the decision process result in higher Service Diversity Rate and number of Average Service Type. That is, the results exemplify that the iCare model assures not only more consumer participation/community involvement but also continuous quality improvement in e-services recommendation.

CONCLUSION

This study proposes an expanded iCare model for electronic elderly care. This model utilizes collective decision-making to underscore the desired care quality elements of consumer participation and continuous quality improvement, in addition to the fundamental aspects adopted from the environment, physical and relationship aspects. This study also envisions the possible forms of iCare e-services and the ontology required for empowering agents in fulfilling the collective decision process. Hopefully, our effort will lead to numerous new opportunities for developing innovative elderly care services.

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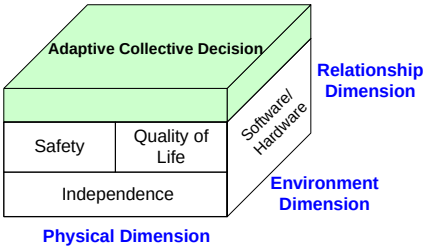
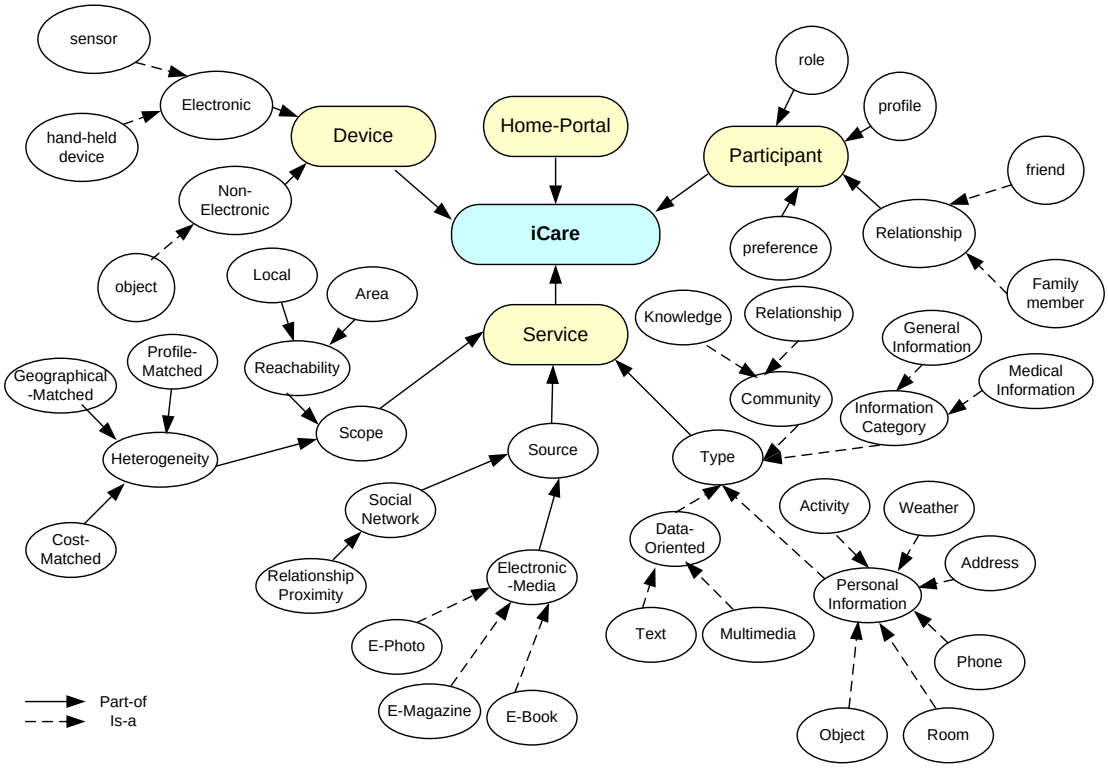


(a) A Framework of iCare Home Portal



(b) iCare Ontology

Figure 1. iCare framework and ontology

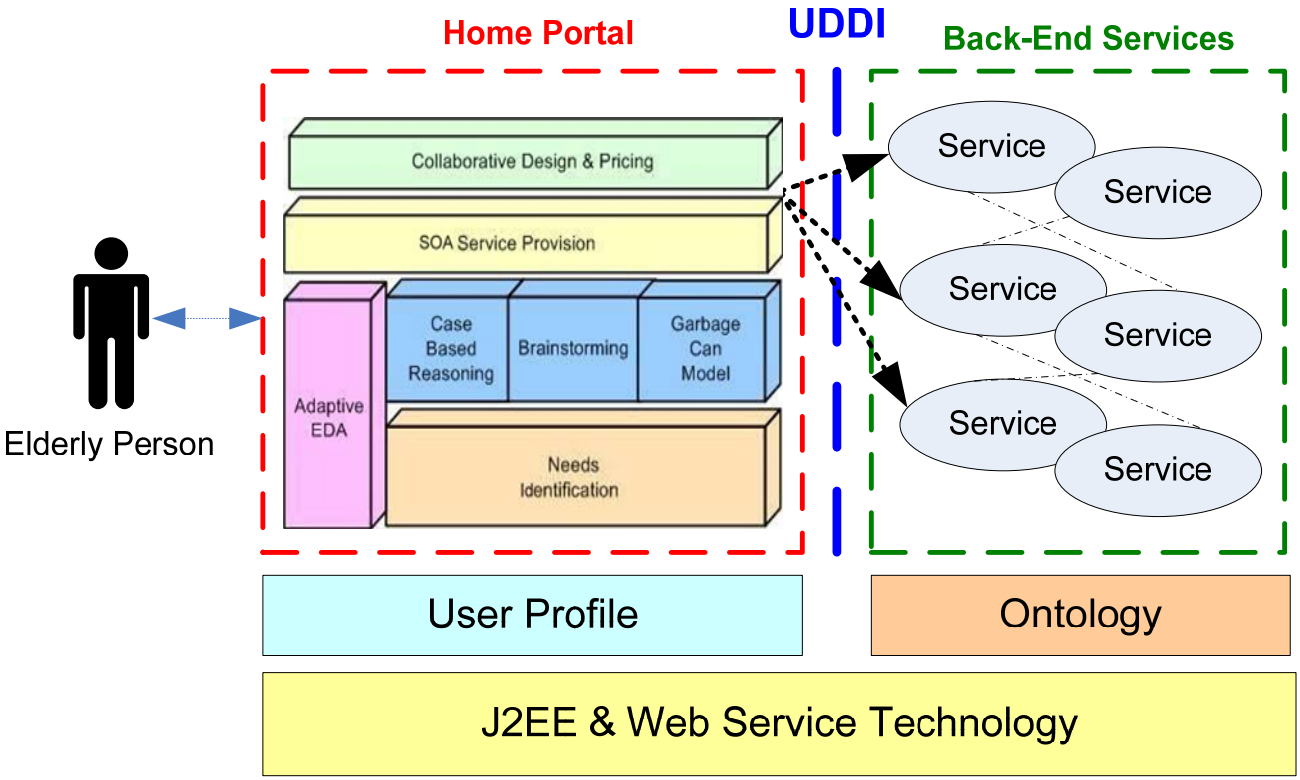


Figure 2. The system architecture of the iCare home portal

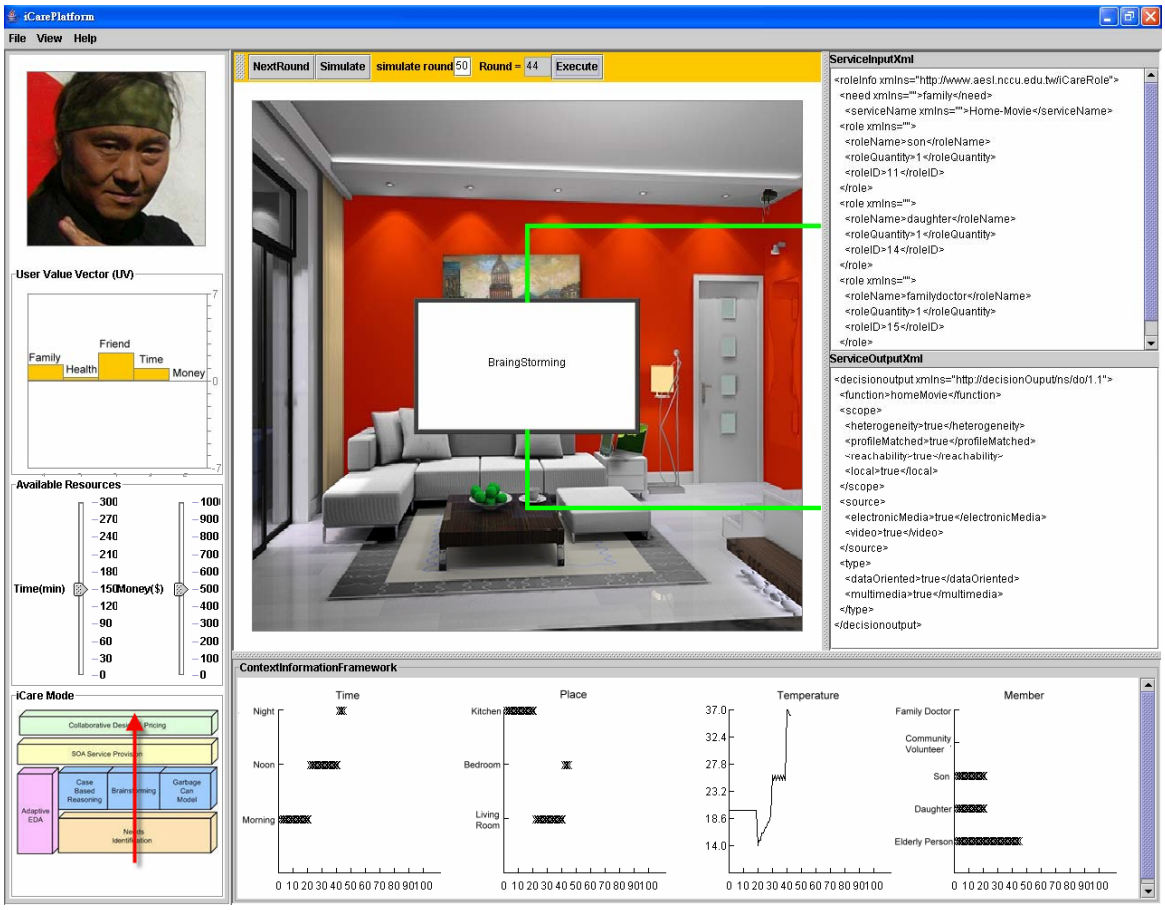


Figure 3. iCare Home Portal running with the e-brainstorming mechanism

Table 1. Stacy Model equipped with three different principles employed for iCare virtually collective decision making

		Certainty About Outcomes		
		High	**Medium**	**Low**
Agreement about Outcomes	**Low**	**Garbage-Can Principle** (present a decision mechanism with multiple needs and resources constraints) This model combines the Garbage Can Theory and intelligent agents so as to furnish a decision strategy deciding on an appropriate order in needs satisfaction considering the limited resources among participants.		iCare employs the web technology to help elderly person at home environment. The situation regarding high uncertainty is sparse. Therefore, the situation located in three cells won't be discussed.
	Medium	**Brainstorming Principle** (reach virtually collective decision in a brainstorming session with the collaboration of a set of learning agents) This model utilizes the method of Q-Learning grounded on three capabilities of human's association (e.g., similarity, contiguity, and contrast) and combines the brainstorming theory and intelligent agents for attaining a collection of automated decision agents.		
	High	**Case-Based Reasoning Principle** (improve the living quality for elderly people from the mental perspective) This model presents a Substitution-Based Case Adaptation CBR to analyze the causes of effecting the change of aging's mood status. Furthermore, inferring the reasons of changed mood in a sensor networking environment and furnish the aid proactively.		

Table 2. Performance of the e-Brainstorming Home Portal

(a) e-Brainstorming performance benchmarked against the greedy approach (if the agents are without the knowledge learning capabilities through ideation rounds)

Decision Model		Roles = 3	Roles = 5	Roles = 10
Greedy Model	$\sum_{i=1}^{N} t_i$	83	118	182
	Average Service Types	2.77	3.93	6.07
	Service Diversity Rate	34.58 %	49.17 %	75.83 %
e-Brainstorming	$\sum_{i=1}^{N} t_i$	111	148	200
	Average Service Types	3.7	4.93	6.67
	Service Diversity Rate	46.25 %	61.67 %	83.33 %

(b) e-Brainstorming performance with respective VIQ values (if each agent has knowledge learning capabilities through ideation rounds for the case of 3 Roles)

Metrics	without knowledge learning	VIQ = 1	VIQ = 2	VIQ = 3
$\sum_{i=1}^{N} t_i$	111	144	153	182
Average Service Types	3.7	4.8	5.1	6.07
Service Diversity Rate	46.25 %	60%	63.75%	75.8%

Note: VIQ represents a specified number of new idea instances added into the Idea Knowledge Base.

(c) Performance comparison in terms of Service Diversity Rate

Decision Model	Roles = 3	Roles = 5	Roles = 10
Greedy Model	34.58 %	49.17 %	75.83 %
e-Brainstorming – 1 Ideation Rounds (i.e., not yet brainstorming learning)	18.33 %	36.25 %	44.17 %
e-Brainstorming – 4 Ideation Rounds	46.25 %	70 %	83.33 %
e-Brainstorming –13 Ideation Rounds	70.83 %	96.25 %	100 %

Sidebar#1: Aging Service Technologies

Aging service technologies improve the lives and societies by caring for aging populations, helping the elderly become healthy, independent, and have vigorous lives. These technologies can be utilized to create caregiver networks, enabling people to age in the comfort of their homes. Examples of aging services technologies include relevant projects that utilize sensors and actuators to correlate with the aims of aging services technologies, such as monitoring occupants, communicating with occupants, and assisting occupants in their daily activities.

There are two principal categories of aging services technologies: care-oriented technologies and environment-oriented technologies. Care-oriented technologies support the professional needs and enhance quality of care and life in terms of cognitive perspective. For example, mobile technologies are utilized for cognitive assistance to Alzheimer's patients. Environment-oriented technologies assist elderly people in living safely and actively with quality.

Care-Oriented Technology

- Autominder is a cognitive orthotic system developed by NASA JSC that helps aging adults adapt to cognitive declination and continue with routine activities [8]. The autominder provides adaptive/personalized reminders for daily living activities and maintains an accurate model of a client's daily plans.
- The Assisted Cognition project was developed to enhance the quality of life for people suffering from Alzheimer's disease and similar cognitive disorders [5]. The systems developed can sense an individual's location and environment, learn daily behaviors and help patients via various interventions.
- The Nursebot project was developed at Carnegie Mellon University [9]. The project goal was the development of personal robotic aids that have five primary functions: cognitive prosthesis, safeguarding, systematic data collection, remote tele-medicine, and social interaction.
- The UbiMon Project investigated healthcare delivery by combining wearable and implantable sensors (i.e., a body sensor network system) [7]. The project aim was to monitor patients under natural physiological states to detect and prevent transient but possibly life-threatening abnormalities.
- The MiCare project is a patient-centric healthcare environment [12] that focuses on (1) seamless integration of care services and (2) context-aware authorization of healthcare records. The MiCare project seams the care services with multiple roles and manages healthcare records by authorization in different contexts.

Environment-Oriented Technology

- The Aware Home is an experimental residence that has two identical and independent living spaces [6]. In this project, occupants were constantly monitored and tracked while cautiously collected and stored personal information.
- The MIT's House_n is renowned as future home architecture [4]. The project constructed prototypes demonstrating how to create environments that help people live longer and healthier, reduce resource consumption and integrate learning into their everyday activities in the house.
- The Smart House is an alternative smart home environment in which computation is embedded into physical objects [3]. The project attempted to proactively change its environment to provide services that promote an independent lifestyle for the elderly.
- The Gloucester Smart House was developed using several integrated and stand-alone smart house systems to assist people with dementia [1]. The systems were built in the house to prevent flooding, detect a user getting up in the morning, provide messaging through voice units distributed throughout the house, and monitor cooker devices and turn them off when smoke or gas is detected.
- The uHouse is a comprehensive home health monitoring system developed in South Korea that monitors a patient's biosignals and activity [10]. The objective of the uHouse project was to develop a system that monitors a patient's biosignals continuously without using obtrusive devices.

Literature indicates that the two categories of aging services (i.e., Care-oriented and Environment-oriented) technologies are related to environmental and physical dimensions (for environment-oriented technology focusing on environmental assistances and care-oriented technology concentrating on mental assistance). That is, these systems are predominantly oriented to sensor technology in clinical gerontology or age-related motor/cognitive neuropsychology. Progressing beyond environmental and physical dimensions, iCare suggests a novel industry of quality e-services that emphasize community involvement, consumer participation and continuous quality improvement via the relationship and decision dimensions. Table A contrasts the components (hardware-based and hardware plus software based) of various projects under environment-oriented, care-oriented, and home plus care technologies. Three components specialized for iCare are specified: (1) proactive needs identification (proactiveness), (2) collective decision for service recommendation (community involvement/continuous quality improvement), and (3) collaborative service delivery and pricing (consumer participation).

Table A: Comparisons among Environment-Oriented Technology, Care-Oriented Technology, and iCare Technology

		Environment-Oriented Technology					Care-Oriented Technology					Home+Care Technology
Component		Aware Home [6]	House_n [4]	Smart House [3]	Gloucester Smart House [1]	uHouse [10]	Autominder [8]	Assisted Cognition [5]	Nursebot [9]	UbiMon [7]	MiCare [12]	iCare
Hardware -Based	**Nursing**					✓			✓		✓	✓[1]
	Daily Living Assistance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Sensor Monitoring	✓	✓		✓	✓		✓	✓	✓	✓	✓
Hardware + Software Based	**Social Network**	✓						✓	✓			✓
	Early Detection of Problems	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Proactive Needs Identification (proactiveness)											✓
	Collective Decision for Service Recommendation (community involvement/ continuous quality improvement)											✓
	Collaborative Service Delivery and Pricing (consumer participation)											✓

[1] iCare system could enable nursing service according to user's needs.

參加國際學術會議報告

The 9th IEEE International Conference on Electronic Commerce Technology (CEC 2007) and The 4rd IEEE International Conference on Enterprise Computing, E-Commerce and E-Services (EEE 2007) July 23-26, 2007, Tokyo, Japan

報告人：政大資管系教授 苑守慈

一、 參加會議經過：

CEC/EEE 2007 國際學術會議於 National Center for Science of Tokyo 舉行。此會議吸引來自世界各國約二、三百人參加。會議有三個 workshops 、一個 Web Service Challenge，三個 Keynotes、二個 Panels、四個 Industrial Sessions、及 二十個 Technical Sessions。Technical Sessions 分爲二大類：Commerce and trading technologies track、Enterprise Computing and Engineering Track。 筆者亦於會議中擔任大會主席（General Co-Chairs）
。

二、 參加會議心得：

此次國際學術會議邀請到許多世界知名學者及企業家擔任Keynotes Speakers及Panelists，例如 Dr. Yoshio Ishida of East Japan Railway Company Vice Chairman，Dr. Guenter Mueller of University of Freiburg, and Dr. James M. Tien of Rensselaer Polytechnic Institute. 等。茲將筆者有興趣之若干議題討論說明如下：

<u>Keynote 1: Service engineering for Innovation</u>

- Service cycle
  - sensing service customer factor
  - design and provide the tailored-made service
- e.g., on-demand fashion and health-ca
- Service engineering (four aspects):
  - Basic science (mechanics, static physics)
  - Method – structural analysis
  - Measuring (dimensions, forces)
  - Databases (mass, coefficient of friction)
  - Tool (CAE, CAD)
- Service Engineering = Assess the feasibility of design dimensions
  - Engineering for service production by
    - reasonable assessment of design target (customer satisfaction, service

value)
    - by engineering (basic science, measurement technologies – human sensing, method/models, statistics/human modeling, databases-evidence databases, tools-service simulator)
- Service engineering methods:
    - Make higher value or satisfaction for customers, by informatics/mechanical supporting or products
    - monitor technologies by quantitative scales, statistics and optimization technologies
    - Be an evidence database based on knowledge
    - Reduce unreasonable trial and errors
    - Example
        - Customer factors related to satisfaction are measured in shop
        - Recommend the suitable size and style according to customer's individual factors
        - Service cycle: service provision evaluation → human sensing → service planning
- Innovative service cycle (integration of multiple service cycles)

  e.g., 3d body shape data use of for multiple service cycles

  (e.g., shoe service and health-care service)
- Service innovation is evidence based or science based?
    1. Example: weather forecast
        - by statistics (memory based)
        - by simulation (models)
    2. Example: Shoes
        - Basic human models are required for measuring and storing service evidences

Keynote 2: Classification of Service Value Models

- Design of artifact to value creation by RACE (Research into artifacts, Center for Engineering – Tokyo University
- Four categories of services
    1. Providing service model
        - Provider and customer are defined independently of their value
        - Service environment is clear.
        - Closed system optimizations strategy is necessary
    2. Adaptive service model
        - Customer objective is defined completely.

- Service environment is changing and unpredictable. Service model is open system. Adaptive strategy is necessary.

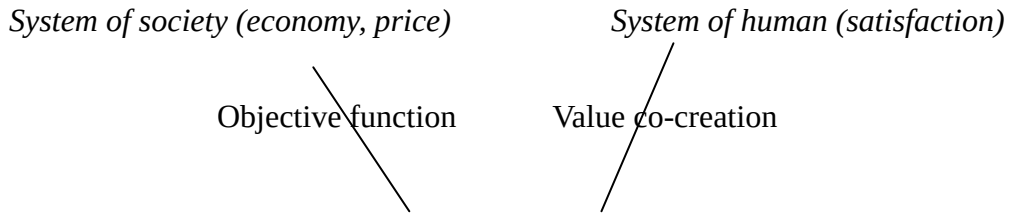
3. Co-creative service model.
   - Service customer objective is ambiguous so that the producer and customer are mutually inseparable.
   - Core theories of emergence (genetics,)

Co-Creation Model --- (artifact, human, environment)

Existing ---------- → creation

Analysis synthesis

Analysis → collection ➔ selection → organization → function expression → artifact → value creation



System of artifact (cost) – design manufacturing, utilization, product lifecycle, network

- Summary
  - Class 1- improvement of service efficiency:
    - From service to manufacturing (class 2 to 1)
  - Class 2 - extension of manufacturing (class 1 to 2)
  - Class 3 - co-creation of manufacturing and service (toward class 2)
  - Class 4 - service network (co-creative community, network externality)

SSME Invited Paper - CAD system of service (interaction of description, design creation, analysis/evaluation)

- Description of service + A receiver & his/ her value
- Serviset: function and attribute (lexica description, network with weights, function and attributes) →. Parameter model → graph (connecting each by each as a multivalent system)
- Evaluation: customer satisfaction = Kano Model + Prospect Theory
  - Satisfaction varies according to classes of functions and attributes (w.r.t. Kano)
  - Personal specification (w.r.t. Prospect)

SSME Panel

- Proposed issue framework
  - Science
    - Service creation (business model, user value, society/benefit, innovation, economics)
    - Service design (format, on-demand, co-production, push, pull, 2-way, network graph)
  - Engineering
    - Service management (tools, queuing theory, service calculus, real time, reasoning, reliability)
    - Service delivery (middleman, agents, optimization, efficiency, reliability)
- Panelist 1: (Tokyo U)
  - Science =Analysis of service engineering = synthesis of service
  - 4 classes (improvement of service efficiency, extension of manufacturing, co-creation of manufacturing and service, service network)
- Panelist 2: (Tokyo U)
  - Triangle-- modeling (service description, value description, customer description, etc), design, evaluation
- Panelist 3
  - Research group: customer–oriented business innovation by math/statistics/IT/management
  - Course in MBA: science of services – theory and practice
  - Future: Japan Government's award: Education of Service Innovation Program
- Panelist 4: (IBM)
  - Group's objective = innovation + informatics

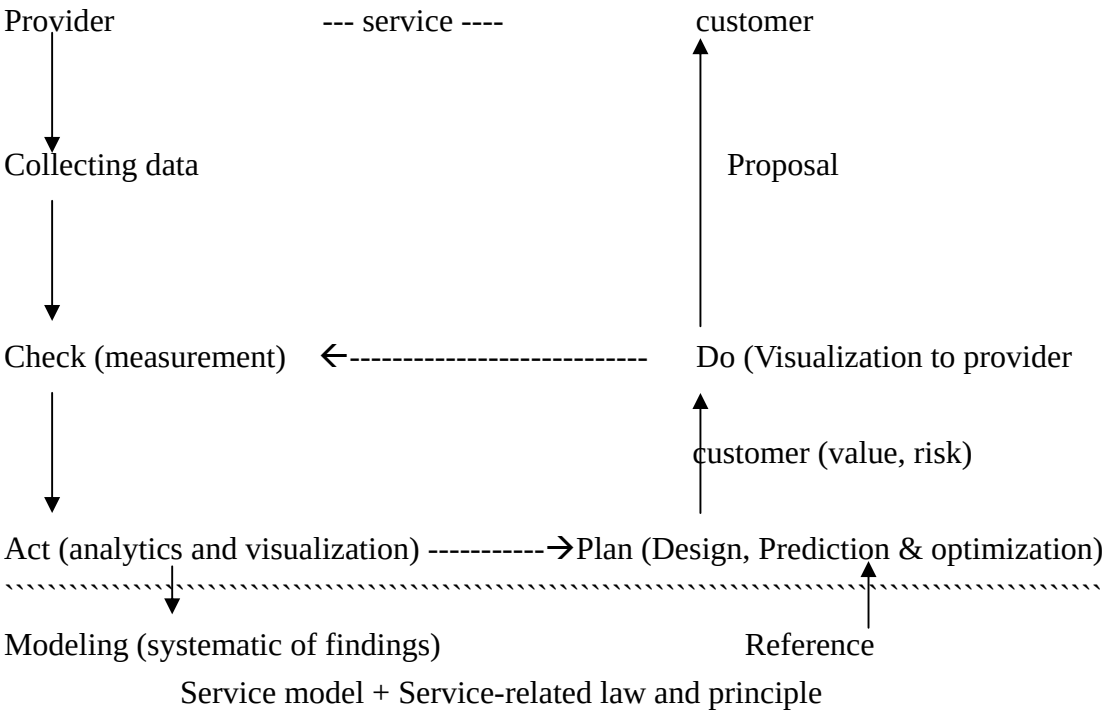
	Consider of use (No)	Consider of use (Yes)
Quest for understanding Of fundamentals (Yes)	Issue discovery Pure basic research (e.g., service design)	Issue driven Basic research (e.g., service design)
Quest for understanding Of fundamentals (No)	Best practices	Pure applied research (e.g., simulation)

Pink: scope of science

	Research (technology-oriented)	Research (market-oriented)
Maturity (high)		
Maturity (low)		

- Example: examples of low maturity + technology-oriented = service languages, service theory, modeling language, measurement, formula

- Panelist 5: (Fitushi)



- Panelist 6 (NEC)

	Science	engineering
Goal	Explain the real world	Make value for someone
application	Modeling	Modeling + design

Functions to be developed (methods/tools and renovate) + Mentality to be co-created for to successful innovation

三、建議事項：

筆者因明年將舉辦一個類似之國際學術會議，對於非常有名之名校學者、國際級

企業領袖之邀請有些困難。建議國科會建立一資料庫儲存與本國曾有合作關係之國際級學者專家，以輔助會議學者專家之搜尋與邀請。

四、攜回文件：

學術會議論文集。