International Journal of Computing Sciences Research (ISSN print: 2546-0552; ISSN online: 2546-115X)
Vol. 1, No. 3, pp. 17-37
doi: 10.25147/ijcsr.2017.001.1.14
https://stepacademic.net

Long Paper

Service-Oriented Architecture Application in Long-Term Care Institution: A Case Study on an Information System Project Based on the Whole Person Concept in Taiwan

Feng-I Chung
Department of Management Information System, National Chung Cheng University
albertchung@lib.ccu.edu.tw

Chia Lun Lo
Department of Health-Business Administration, Fooyin University
allenlo.tw@gmail.com
(Corresponding author)

Date received: September 9, 2017
Date received in revised form: November 27, 2017
Date accepted: December 12, 2017

Recommended citation:

Chung, F. I., & Lo, C. L. (2017). Service-oriented architecture application in long-term care institution: A case study on an information system project based on the whole person concept in Taiwan. *International Journal of Computing Sciences Research*, *1*(3), 17-37. doi: 10.25147/ijcsr.2017.001.1.14.

Abstract

Purpose – The caring approach for long-term care is different with the general care because it emphasizes comprehensive health care. If the system establishment lacks integrated concepts, the system will then be unsuitable. This study aims to develop an innovative system project based on the whole person concept and provides the experience for applying the concept of Service-Oriented Architecture (SOA) to integrate different operations of the system which called U-care project.

Method – This involves substituting the function module of the original system architecture with a service-based approach to provide a service interface. In addition, there must be a connection between the well-defined interface for the services and the formation of comprehensively integrated system architecture. Evaluations were

conducted both on the programmers of the U-care project and on end user experience form using the system.

Results – The results describe our resulting functional design of the system. The implanted experience based on SOA was also presented and the services were success practice in a long term care institution.

Conclusion – The contribution of this paper is the project functional design and practical feasibility. It also showed the SOA platform with a set of reusable domain function service is suitable for the long term care institution. It can support the actual improvement on the project development schedule and operational performance of personnel.

Recommendations – Further work on emphasizing the establishment of domain knowledge by developers when developing long-term care related software to reduce difficulties in communication with users, refining the process applied to the SOA is recommended to improve the efficiency of the project.

Research Implications – Service-oriented computing promotes the approach of assembling application components into a network of services that can be loosely coupled to create flexible, dynamic business processes and agile applications. Therefore, the architecture of service oriented uses services to support development teams can achieve rapid, low cost, interoperable, evolvable and massively distributed long term care system.

Keywords – long-term care institutions, service oriented architecture, long-term care information management system, cross-referencing, anomalous incidents

INTRODUCTION

As the national health level improves and medical technology advances, the average life expectancy of the global population is prolonged, causing a rapid rise in the elderly population. The UN defines the world population structure and categorizes countries with a population aged 65 years or older who account for 7% of the total population as an "aging society," 14% is known as an "aged society," while 20% or more is known as a "super aged society." Data from the UN Population Division show that the global population aged 65 years or older is projected to reach 25% by 2050, and one out of four persons will be 65 years or older (United Nations, Department of Economic and Social Affairs, Population Division, 2014). By 2025, it is estimated that the elderly population in Taiwan will reach super aged society status as defined by the UN and that the percentage of the elderly population will reach as high as 35.5% by 2050 (DESA, 2007). The speed of population aging in Taiwan has far surpassed most developed counties in Europe and the United States (as shown in Table 1).

Table 1. Population Projections for Persons Aged 65 Years or Older in Developed Countries (%)

Year / County	2005	2011	2050
Taiwan	9.7	10.7	35.5
U.S.	12.4	13.0	20.0
Canada	13.2	14.1	25.7
U.K.	15.8	16.6	23.3
Sweden	17.3	17.2	25.0
German	19.3	20.6	26.0
Japan	20.0	31.2	42.1

The advent of the super aged society not only changed the demographic structure in Taiwan, but the issues derived from it, such as medical care, economy, psychology, social welfare, and policies, are drawing increasing attention. In particular, the majority of diseases associated with older persons are chronic and diverse; and the subsequent medical expenses are enormous. In the example of the United States, the percentage of older persons in 2000 accounted for 12.3% of the total population; however, this group accounted for 26.2% of the total consumption of the total medical budget there. Hence, the planning speed of the national policies and establishment of care institutions must also keep pace with the population's aging.

The proportion of the disabled population within Taiwan is also quickly increasing as the population ages annually (see Table 2). The Taiwan's total population is projected to experience negative growth after 2026, revealing a potentially serious issue with a significantly reduced working population. Due to industrialization and urbanization, traditionally large families are also transforming into smaller families, and the intention and ability of the family to provide home care is declining annually. A large elderly population needs long-term care and the effects brought by an aging population should not be overlooked. The WHO suggests that the advent of an aging society will bring not only the pressure of demographic structure transformation but also increasingly heavy loads on long-term care finance and labor (World Health Organization, 2002). Hence, future elder care and foster care can no longer be undertaken by a single family. How to cope with the enormous elderly care demand has become a large challenge for the entire society.

To cope with the demand of the future long-term care population as well as implementing the "whole person care" frequently envisioned by the medical industry, the government of Taiwan has actively encouraged solutions in the past decade in an attempt to build the long-term care system. However, the effects fell behind expectations while the service resources and the growth of service requesters are still quite limited. In addition to the long-term care services that are divided into excessively

different administrative systems in Taiwan, often leading to poor promotional performance, the limited care personnel in institutions causes older persons to perceive poor care quality or low service efficiency. However, the complex care work of long-term care institutions does also trigger a number of factors in poor care quality or low service efficiency. These include the pressure of care work and the lack of real-time updated care-related knowledge and laws. Studies suggest that the high turnover rate in care personnel can significantly and severely affect costs for medical-related institutions (Yin & Yang, 2002).

Table 2. Taiwan's Institutional Long-Term Care Demand Projection

Year	2016	2021	2026	2031
Disability Population Projection	542,271	641,342	758,541	900,494
National Population Projection	23,296,248	23,634,537	23,930,657	23,832,371
Proportion accounted for National Population	2.3%	2.7%	3.4%	3.8%

Although some long-term care institutions have attempted to develop a long-term care information system for improving care work, regular paperwork increased personnel work efficiency and reduced work fatigue. However, the small operational scale of most long-term care institutions has prevented them spending too much money on development costs for large information systems. Moreover, the complex care works at long-term care institutions while subsystems with independent development of operational process could not assist each other in care. Most IT companies lack knowledge of the long-term care domain, and find it difficult to develop and maintain such complex systems.

Hence, the lack of system functions that meet actual long-term care demand prevents institutions from improving care quality through such systems. Since most of long term care institutions in Taiwan are small scale, which means the large IT project with long periods of development time can't afford by these instructions because it needs complex domain knowledge and time consuming to communicate with the end user. Therefore, it is needed to simplify the development and reduce the development costs. The developers need to collect the knowledge base to store similar service function components to reduce the development costs and develop high quality services (Stav, Walderhaug, Mikalsen, Hanke, & Benc, 2013).

This study develops a long-term care support system designed for domestic long-term care institutions. Due to its complexity, service-oriented architecture (SOA) has been used to eliminate large, cumbersome programs, using simplification and automation processes to save considerable costs. Such an approach not only can improve the operating efficiency of the long-term care information system, but also reduces the time and costs

for program maintenance (Dowling & Leech, 2007). The study further discusses the suitable placement position for different data in an attempt to achieve a user-friendly interface and quickly integrate related care information for establishing a whole-person long-term care system. Then a conclusion section follows, addressing some lesson learns of the research and managerial Implications are given.

RELATED WORKS

The aging of society has become a crucial issue, leading lots of pressure in small family and increasing the expense for elderly welfare. The increasing demand for the elderly care are also illustrates the shortage of care workers in the long term care institutions. It will leads to the lower efficiency in services and worse medical quality (Lo & Su, 2017). It is a good way to construct an information system with the concept of "holistic care" system. The holistic care concept was defined as independence, involvement, self-realization, care, and dignity. It is the fundamental framework of long term care information system (Hurlock-Chorostecki, 1999). However, the scale of the elderly care institution is usually rather small in Taiwan. Therefore, it is an important issue to find a good architectures software style to increase the investment efficiency and shorten the development time consumption for software developing team.

Structured programming has been proposed for discussion since 1980. Programming code for repeated use is regarded as media for implementing structured programming in addition to improving software performance and saving development costs. Post-1990s, structured programming was gradually replaced by object-oriented language due to the Internet boom. As the increasingly popular client/server and n-tier multi-layer architecture started to develop, the system is now no longer limited to operation on a single large server. Due to the increasing scale of the systems, people started to pay more attention to how to save development time in order to maintain such a large system through more convenient means. This led to the proposal of SOA. Post-2000, SOA became the standard, new-generation information system model (Erl, 2004). The SOA approach facilitates reuse of domain services between disparate systems and incorporation of domain knowledge into software artefacts, and its flexibility facilitates tailoring and personalization of the systems to the needs of individual users or user groups (Stav et al., 2013).

The smallest unit of SOA is known as a "service" (Cugola & DiNitto, 2008). A service cannot be regarded as software but rather is defined as an independent operation needed for completing commercial operations. Many services have been proposed to form the architecture, and such service forms solutions combining many different types and procedure services. The use of a service-oriented service means the integration of distinctive information technology environments and improvements in stability to increase repeated usability of resources in order to reduce operational and development costs (Uleman, 2006). SOA mainly involves three roles, namely Service Provider, Service Requester, and Service Broker (Brenner & Unmehhopa, 2007; Newcomer & Lomow, 2004). The architecture of the three roles is shown in Figure 1 and described as follows:

1. Service Provider: these are also service owners and execute the platform for a service. Service functions are provided for use by service requesters while service brokers use the specific details of the network services.
2. Service Requester: the work of a service requester is to issue requests for a service. When certain functions of service requesters can be satisfied, the service requesters will issue a request and expect the service providers to provide satisfying services.
3. Service Broker: here, the broker accepts the registration request from the service provider and processes query requests from the service requester. The service broker also authorizes the service provider to publish a service description. Service requesters may query proper items of service from the service broker in case they need services while attaining the service information from the broker.

Since the benefits of SOA are communicate based on key functions of the system. SOA can provides simpler component of the software for some complex business process which means SOA can improve software reusability and increase the satisfaction of the end user. The purpose of saving costs will also be achieved in the end of the IT project (Stav et al., 2013).

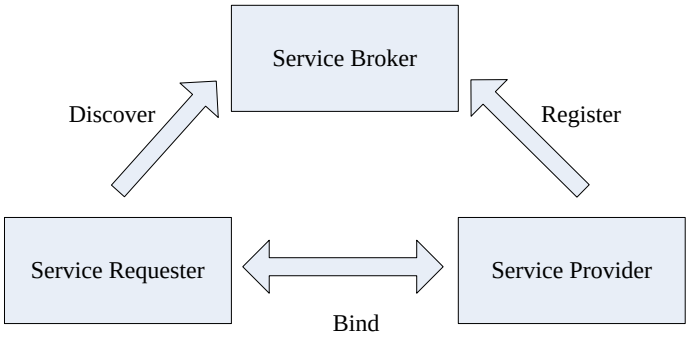

Figure 1. Service-Oriented Architecture

In recent years, SOA has been widely applied in the medical field's information systems (Li, Wang, Lu, Lin, & Yen, 2012; Babamir & Arafard, 2012; Steurbaut et al., 2012; Chen et al., 2012; Hsieh, Hsieh, Cheng, & Lai, 2012; De Capua, Meduri, & Morello, 2010; Park & Nam, 2012). In addition to improving actual development efficiency, users perceive satisfaction from the system use. Hence, the study proposes the concept of applying SOA architecture to institutional long-term care information systems. The care operation of each unit from the care process is regarded as an independent service provider, and when users bring up requests, the plan to meet user demand can be generated through the system proposed by this study. In order to deploy the SOA platform, the researchers would classify the relative function by the requirement of domain knowledge. All roles of services scenarios on the SOA platform were divided into several groups: One is residents, another is care staffs, care givers, and welfare workers, and the other is administrators. Following the figure 1, the architecture of the system classified into the (1) control center, (2) platform and applications, and (3) collaborative providers' systems. The control center

plays a crucial function for communication with all devices and the subsystems of our project. Therefore, several interfaces were layout for various external systems to support the business process coordination. The processes were usually focused on the workflow management within their organization.

METHODOLOGY

System Functions

The long-term care information system developed in this study is called the UCARE system, which refers to the ubiquitous care for assisting long-term care institutions. In consideration of the limited labor and funds of the institutions, the design needs to establish an integrated system using the most efficient method of development. At the same time, due to the continuity of long-term care work and the different operating units involved in the care work, it is necessary to take into account the data generated from different operations. Data inter-passing is necessary and the development requires designing relevant system functions through SOA perspectives. Moreover, the current conditions of institution residents need to be analyzed with an emphasis on how to maintain resident health through the intervention of the information system.

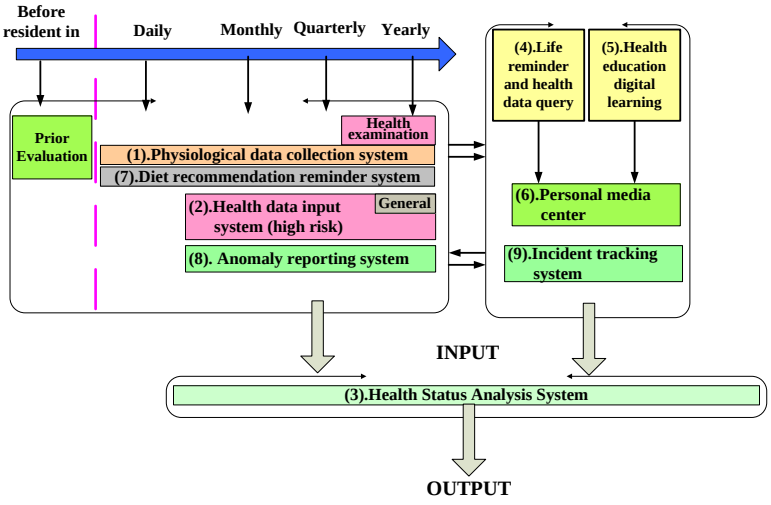

Figure 2. System Function Chart

The factors that affect health include physiology, psychology, diet, environment, and exercise. Physiology factors include drug habit, chronic disease control, unplanned medical care, health scale, and daily physiological measurements. The psychological factors include interpersonal interaction and mentality scale. Diet factors include nutrition scale assessment, nutrient control, and items of diet. Environment factors include health advocacy and health education video broadcasting. Exercise factors include the amount and number of exercises. Nine subsystems have been defined from the aforementioned factors. The system function is presented in Figure 2.

System Architecture

Service oriented Architecture (SOA) is an architectural style to use a clearly defined interface for divide an information system into a set of interconnected components which means developers can make use of them by some protocols (ex. HTTP). Among them, Web Services is now the standard of service oriented computing for implementing a dynamic and flexible business process. Based on XML, Web Service were founded upon three standards: the Simple Object Access Protocol (SOAP), which is a communication protocol describing the format of a message exchanged among Web Services operational participants; the Universal Description, Discovery, and Integration (UDDI), which is a standard providing business information description in relation to Web Service registration and searching by service providers and requesters; and the Web Service Description Language (WSDL), which is a service description language defining details of operational interfaces and message exchanges between Web services and business software application (Bultan, Su, & Fu, 2006; Lin, Chen, Guo, Chiang, & Chang, 2012). Web Service is now being used by most organizations to share information or functions across systems or platforms, especially using in the intranet as a transport medium for saving their development cost. To complete, organize, and collect the care content provided from different data sources in the system's care information database, researchers will need an environment that can be explored in different servers and establish connections as well as a format that allows for an exchange of data content. Therefore, this study selects Web Services to implement the hands-on practice and design from the SOA content.

With regards to the connection method between the heterogeneous platforms and UCARE server used by the caregiver, in addition to using standard web protocol (HTTP protocols) to engage in management interface, the syndication agreement of the network summary is used for health events in an attempt to implement the low transmission amount needed for wireless transmission on mobile platforms and facilitating applications on mobile devices. The architecture designed from SOA is shown in Figure 3.

OOAD (Object-Oriented Analysis and Design) technical approach and Unified Modeling Language (UML) were used to develop this system within one and half years. For the purpose of ubiquitous care, we constructed our system in a web-based environment. Microsoft .NET 3.5 and an IIS7.0 environment is used as the system development platform. ASPX and C# are used as the programming languages. All subsystems are interconnected and we adopted SOA as our system architecture. Such architecture consists of five parts, namely, the Service Broker Server, Health Event Server, Health Event Catalog Service Server, User Client, and Care Content Providing User Client. The functions and purposes are introduced below.

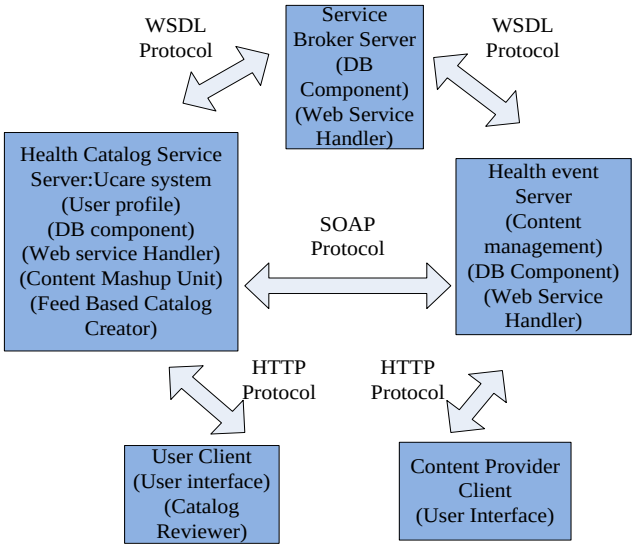

Figure 3. System Architecture and Basic Component Chart

Service Broker Server

This includes a UDDI-based service database and Web Services processing components. The function is responsible for providing service requesters and service servers with a contact channel from the SOA. Under such architecture, the health event server publishes service information through the WSDL format, whereas the service broker server stores such content-providing server information in the UDDI server database. Supported by WSDL and UDDI standards, the health event server inquires from the service broker server through the SOAP format if the services of other servers can be acquired to facilitate the connection.

Health Event Server

This plays the role of service provider in a SOA. The service of providing content includes the storage of databases for health event content and the component of management health events. After establishing database and services, the server submits the registration to the service broker server through the WSDL format to notify the service broker server through the provision of the service format and information.

Pure health event content provides a simpler server structure, meaning that the needed components can only be used to access the database and process the Web Services requirement, in addition to establishing a connection with the data exchange. In practice, there are single servers that concurrently play the role of the health catalogue service server.

Health Event Catalog Service Server

This is the most complex part of such architecture, containing the most functions and components. The main system function of this server storage also provides users with customized health event catalog architecture. Due to the need to process user information, the user interface, components, and the database for storing user information need to be administered to store the different user data and their health event requirement. One user can possess the requirement for multiple health catalogs. The server itself also needs one content database to provide content regarding the health event catalog. The content of such databases can be collected from the content of other health event catalogs. The server acts as a service requester in SOA that proposes queries to the service broker in addition to connecting to other service servers in an attempt to acquire content. The content can be provided by the server, implying that the same server hardware can concurrently own two roles, namely the health catalogue service server and health catalogue content server. Due to the design of multiple data sources, a specific component is required to organize the content data acquired from different resources. Therefore, repeated data are removed and the comparison data are updated to store the organized data into the database for access.

User Client

This refers to the user environment of general users, and its form can be a desktop computer, laptop computer, Kiosk, or mobile phone, PDA, and even any web feed-supported reading devices that could be connected to the Internet. Users provide server connections with the long-term care system service through user interfaces to configure the styles and conditions for customized health events. The user interface most commonly used is presented through dynamic web technology, and executed and configured through supporting browsers.

Care Content-Providing User Client

The role of care content-providing user client is the simplest form that aims to provide care content updates and is operated through a standard personal computer connecting to the Internet. To establish dynamic websites on the care content-providing user client, the content server terminal only requires a browser for operating data management. Alternatively, a Win-form program can be developed to connect with the care content-providing user client for data changes. This method is more difficult to provide cross-platform services compared with the dynamic websites. Nonetheless, Win-form program can provide operations that are more convenient and faster processing for large or specific data.

RESULTS

System Description

The nine subsystems listed by the study include functions summarized as follows:

(1) Physiological Data Collection Subsystem

The purposes of this system establishment are to convert physiological measurement data into information, and to integrate with existing health care instruments of institutions to undergo monitoring of resident health conditions so the residents can measure resident cards through the automatic sensor at the health center and public area. The system will automatically compare the physiological data that have been measured and collected in the database each time. In the event of the figures showing an anomaly or having not been measured, the system will initiate an alert for the caregiver and the residents to provide reminders and care recommendations. Caregivers can also check the residents' physiological data for anomalous information daily and use such information as a reminder to establish and generate the reminder list.

(2) Health Data Input Subsystems

The purpose of the system establishment is to put the interview scale into electronic form and to coordinate with peripheral sensor equipments or televisions and computers with different interfaces in an attempt to complete the scale data input and simplify the input/output procedures of the scale data. The system also combines with other subsystems (collection of physiological data and medication records) to automatically collect the health information on the elderly population so the older persons will conveniently and freely record the physical function, mentality, social functions, and other physical and psychological conditions on the scale without interference to their everyday lives. The health conditions are traced over the long run to analyze effectively the root cause, prevent problems in advance, and post-supplement for diagnosis and treatment later.

(3) Personal Multimedia Center

The subsystem aims to establish simple and yet multi-functional personal information data in the residents' room as an experiment to eliminate the elderly residents' fear and repellence of high-tech equipment through an operating interface, such as TV display and remote control, which are familiar to people today. Residents are provided with an enjoyable and painless operating environment to enjoy TV, DVDs, music, and photo albums as well as other rich multimedia entertainment functions while switching to connect with the platform that displays the health information or various life-related messages and recommendations as transmitted from other subsystems. Such systems can facilitate the institutions with undertaking personalized health education information

via the said platform so the residents can obtain relevant information via the most intuitive means.

(4) Reminders in Life and Health Data Query Subsystem

The subsystem establishes a reminder message processing mechanism that provides a consistent communication interface integrated with the events sent out by other subsystems into one reminder event list. This then sends reminder messages to the residents via text message. Meanwhile, some events (such as visitors, outgoing, and medical visits) can be pre-obtained during the care process. The caregivers are also permitted to establish foreseeable events from the maintenance interface. Such information can be integrated into common event categories to facilitate future caregivers with reminding residents through recordings. Residents can also play the recording from the personal multimedia center platform in the room. Additionally, residents may conduct health information queries from the multimedia center inside their rooms.

(5) Health Education and Digital Learning Subsystem

The subsystem is developed to provide institution administrators with configuration of health education theme categories to classify the teaching material content. The association with the system resident chronic diseases through ICD9 disease coding can also be configured in an attempt to choose the appropriate health education video for residents to view. The residents will follow the medical instructions and enhance their own self-caring capacity when they can view personalized health education information from the multimedia center inside their room in a relaxed mode.

(6) Dieting Recommendation and Reminder Subsystem

The subsystem is established to allow for extended menu and recipe design functions that go beyond the existing meal ordering system in the market, which lacks professional recommendations and care for the dieting nutrition that are needed in personalized services.

(7) Anomaly Reporting Subsystem and Event Follow-up Subsystem

The main development goal of the anomaly reporting subsystem and event follow-up subsystem is to build the system into the personal handheld device platform and the staffs' existing web platforms. The staff can immediately report the anomalous records from the handheld device to the platform upon discovering the red alert for residents' psychological or physical health or any observation of anomaly events. The proper personnel will be notified immediately for handling the issue. The residents can also log in from the computers in the public area of the institutions to report the caregivers of the institutions and allow for quick processing.

(8) Health Condition Analysis Subsystem

Finally, for residents sent to the care institutions because their family could not take care of them, the family mostly cares to control quickly the health and comfort of the older persons staying at the institutions. Because of this, the health condition analysis subsystem is designed to allow family to control the health state of the older persons within the shortest time. Therefore, the residents' personal health files need to be collected and integrated in a real-time process, starting from the checking in of the elderly to the gradual and faithful recording of the physical, psychological, and mental health state of the elderly. The elderly personal health files are established through the collection and organization of physique, interview, medical visits, and dieting information in order to present the overall health performance of the older persons. The older persons' health conditions are also effectively traced through long-term records summaries, and analysis prevents issues in advance and post-supplements for diagnosis and treatment later. Hence, the main operations of the subsystem are divided into the personalized configuration of health analysis standards and the briefing operation process. This subsystem can provide medical care staff with residents' long-term health analysis data and establish a health analysis chart to cooperate with the briefing operation process, so that the family of the elderly can immediately control the long-term health trends of the residents during their visits.

The nine subsystems are developed through the SOA architecture. The study divides the long-term care system into three main aspects of scope. The first is the back-end configuration for definition of long-term care knowledge. Due to the different physiques of each long-term care resident, the system emphasizes the customized care method and therefore the care personnel must define the physical thresholds of each resident through the maintenance functions provided by the system. The administrators may also duplicate the existing physical thresholds configured by the system to customize modifications in the event that residents of similar categories check in, thereby accumulating the care knowledge attributed to long-term care institutions and preparing for the decision-making supporting system for the senior management to be derived from long-term care institutions.

The health event process service established through SOA and the unit service for SOA process service calling will complete one or several SOA-related process unit services, such as physiological measurement reminders, health education readings, dieting recommendations, and anomaly event follow-up reminders. This is the second aspect. The third is the front-end of the long-term care system. After the residents or caregivers input daily physiological measurement, events, dieting records, and high-risk measurements through the system interface, the system will compare through personalized physiological signs and transmit proper health event recommendation values from knowledge definitions to the personal computers of the care personnel or the multimedia center platforms inside the resident rooms according to the different

situations of the residents. These will be used as recommendations for care behaviors in the follow-up process.

Data Architecture Description

The Web Services were developed to support the functions sharing operations with the UCARE system. The system is distributed to a considerable number of subsystems through different operating processes in order to administer the processing rules. It is inevitable that many similar processes use identical data and rules. Hence, the system defines the corresponding modes and rules for each subsystem when analyzing the data rules and process rules. In the event the rules contain high consistency, they are listed as members of the service. The following three rules are described as follows.

The main tasks of the data rules aims to find out the storage position of data, data storage method, classification of data properties, and data processing method. The storage position of data is distributed in the memory, file folders and historical database, and backup device. Data storage method can be divided into memory, data files, and database, while the memory mainly contains data with the largest storage and access, the size of which can be estimated and data less frequently moved. For example, basic personal data files require authentication by many subsystems and can be taken into consideration for listing as members of service events. Data files are mainly stored with less frequently moved or less frequently accessed files (i.e., the various health threshold configuration files and the corresponding basic information files). The database is stored with data after changes, temporary cell tables of statistics reports, and the overall event summary data, including online data and personalized configuration files, pre-computed and completed statistics results service files, and report data as well as the log files configured for security reasons.

The process rules mainly define the method of data processing; in other words, to find the services that can be listed as health events. Such services are then divided into emergency processing, general processing, and batched processing according to the level of urgency. Emergency processing is mainly used in the processing of health state anomalies matched with an emergency nature. General processing is mostly used in tossing data back to a service event after daily health measurement in order to compare the results of personalized health threshold database. Batched processing refers to processing regular or fixed-frequency services (i.e., account processing and calculation of resident dieting nutrition). Moreover, the process rules also define service of other demands, including commercial logistics, data synchronization, message processing, error processing, work schedule, and memory management as well as many event services. The following Figure 4 and Figure 5 illustrate the anomaly event service and health education recommendation service, using sequence diagram to convince the procedures and proceeding methods to be called upon for service.

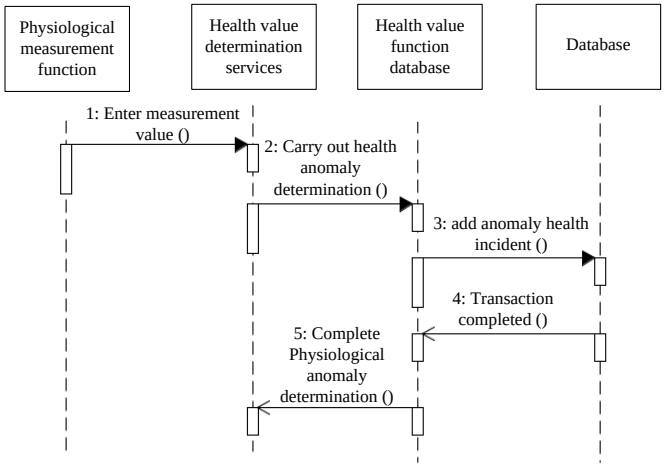

Figure 4. System Sequence Diagram: Anomaly

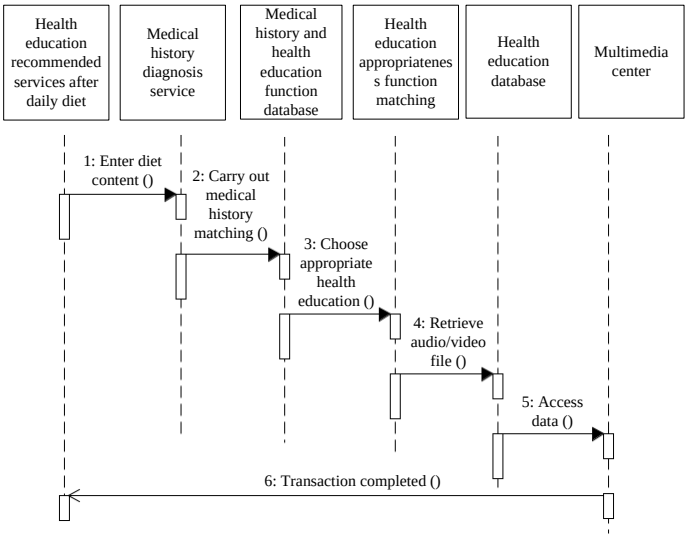

Figure 5. System Sequence Diagram: Health Education Recommendation Service

System Assessment and Analysis Result

The study intends to assess whether if the care system of UCARE foster and care institutions developed through SOA can truly meet user demand. The measurement of users' satisfaction after information introduction has become one of the considerably developed issues in the IS field. Several theoretical models with reliability and validity can be provided to explain why users adopt IT. In particular, DeLone and Mclean (1992) proposed IS Success Model in 1992 as the most famous system introduction assessment theory, which proposes that there are six constitutes affecting IS success, namely system quality, information quality, use, user satisfaction, personal influence, and organizational influence. In 2003, the model emphasized the concept of personal and organizational influence on updated effectiveness explaining that information quality and system quality will increase service quality, enhancing user intent and user satisfaction while the user intent and user satisfaction contribute to the organizational benefits. The medical care

industry is one service industry, particularly in foster institutions where residents can take care of their own living while maintaining autonomous, in addition to choosing whether to stay at the institution. Hence, whether if system introduction can enhance perceived satisfaction, is more appropriate and commonly used as a means of assessing success for system introduction.

In the experimental institution chosen for this study, the objects comprise care personnel and administrator of the institution, and the developers of the UCARE project development group. First, taking into consideration the limitation in business and time for the institutions, only 20 staffs have been selected to carry out the system assessment results after the actual use of the system. The care personnel consisted of women aged between 24 and 40 years old with a degree in college or higher. Meanwhile, to understand the level of objective improvement after system intervention, we choose seven operations including health care consulting and guidance physiological measurement, living and health scale assessment, emergency medical service, medicine delivery service, flu vaccination, and dieting guidance, as the bench assessment operations. They were asked to set up the My Survey online satisfaction questionnaire system, fill in the questionnaire and submit their opinion. The questionnaire is based on the information system success model and construct covered service quality, system quality, information quality, user acceptance of the inter face, satisfaction with the sub-system, and influences on the organization and individuals.

Every construct was designed as 3 to 5 structural questions. The items in the measurement tool were five point scale where 1= strongly disagree and 5 = strongly agree. Cronbach's Alpha of the satisfaction scale used in this study was over 0.7 which means the measurement tools are good reliability and validity. The results from satisfaction were quite satisfied (75.3%) with service quality of the subsystem functions, and they said the projects are completed faster than they expected. In addition to the end user, we were also interviewed with the programmers in the UCARE project and asked them to share their opinion about the architecture. All of the evaluation result is positive and they all agree of the interface can shorten their developed time. Therefore, the researchers can improve the communication barriers with users, which means cognitive differences or the gap could be shorten between the developers and the end users.

Besides, the researchers also collected the actual time taken by the staff on paperwork before the system's introduction and then verified the same operational time spent on the system in post-introduction. The comparison of the two shows us understanding of whether system intervention can improve work efficiency, save paperwork time, and care for residents in reality, in order to improve care quality.

In sum, employees of introducing institutions earn the highest scores in influencing system introduction to organization and personal operations, followed by information quality and functions while the lowest score is the perception to user interface. This could

have resulted from the unfamiliarity to interface at its early introduction. The influence from the actual comparison of before and after introduction to care operation is shown in Table 3, and the results indicate efficacy in improving personnel work efficiency that can improve HR-related costs.

Table 3. Operating time differences between, before, and after the introduction of system

Operational items	Before intervention (min)	After intervention (min)	Decrement (rate of decrease)	Cost reduction of labor
Dietary recommendations	120.0	28.0	-92.0(-76.67%)	360.64
Emergency medical services	100.5	73.7	-26.8(-26.67%)	105.21
Healthcare inquiries and counseling	55.5	11.5	-44.0(-79.28%)	172.48
Influenza vaccination	89.4	57.0	-32.4(-36.24%)	127.00
Life and health metrics and evaluations	113.5	63.7	-49.8(-43.88%)	195.37
Physiological measurements	84.5	10.3	-74.2(-87.81%)	291.06
Prescription delivery services	95.0	80.0	-15.0(-15.79%)	58.80
Total	**658.4**	**324.2**	**-334.2 (-50.76%)**	**1,310.56**

CONCLUSIONS

Despite social advancement in today's society, the concept of sending older persons to foster homes (long-term care institutions) is still considered a non-filial act deeply rooted in the Chinese population. When the service quality of long-term care institutions fails, the descendants of the residents bear even greater pressure. Faced with the advent of an aging society and trends towards small families, it becomes inevitable for foster institutions to take care of older persons rather than their families. Nonetheless, the unintentional human error in care personnel, lack of heritage mechanisms for specific care experience, and spending too much time in collecting health information and preparation of paperwork nursing care records found in the institutions, or the direct application of nursing system from acute medical institutions is insufficient to cope with long-term care; such issues mentioned will prevent the long-term care institutions from effectively improve care standards. Hence, the study integrates SOA to design an integrated institutional long-term care information management system. In particular, SOA not only saves time in data collection and costs for data integration but also drastically reduces programming codes and enhances programming application, in addition to saving operating time for long-term operations that require cross-referencing of data.

Hence, the study discovered the following qualities of the SOA-based institutional long-term care information system. (1) Help the care personnel with collecting the various physiological and psychological care data of residents by automatically integrating them into the care list to spend the majority of the time and effort in the caring process and

paying attention to the communication with residents, thereby improving care quality. (2) Automatic determinations of anomalous events: the main purpose is to remind caregivers with precautions so that no omission or negligence is found in executing care procedures. (3) Establish a care knowledge base and knowledge sharing platform: the health knowledge encountered during cumulative care process allows new care personnel to follow personalized care techniques and knowledge base while the long-term institutions will not lose valuable knowledge property due to the high turnover rate in care personnel, thereby assuring care quality while new care personnel be can immediately familiarized with the care business of residents, maintaining the due care quality. (4) Can integrate care data under heterogeneous systems or different subsystems. (5) The system can propose adjustments and recommendations for care methods according to the care knowledge base (such as recommendations for seeking medical help, dieting adjustment, or conduct health education).

MANAGERIAL IMPLICATIONS

It is necessary to explore an architectural styles to support trans-institutional information sharing (Haux, 2004), in the elderly care domain because the services for the elderly and disabled do not exist in isolation (Stav et al., 2013). There are a large set of independently developed systems and services in existing environments in the elderly care domain. These systems and services should be able to communicate with each other not only be exchanging data but also understanding each other's data to increase the standard care issues (Stav et al., 2013). SOA platform with a set of reusable domain services is a suitable foundation for more rapid development and assist living systems covering reoccurring needs among the users in the elderly care institution. Therefore, SOA may be useful to the designers and developers in this domain.

To sum up, this study presented an innovation system called U-care and shows the ideal of utilizing a service-oriented architecture in developing the service interface for the long term care system. The target beneficiaries and the managerial implications of the research are list below.

First of all, the institutional long-term care system architecture proposed by the study can substantially reduce care time while timely providing residents with health information to remind care personnel of precautions, thereby reducing health failure resulting from human error. For long-term care institutions, the system can establish a care knowledge base for different residents, accumulating older persons' care information, knowledge, and experience, which does not reduce failure in cumulative care experience assets due to high turnover rate but also involves sharing the care knowledge of different cases in institutions, reducing the familiarizing time of care personnel. Hence, the use of the system can implement care experience into specific heritage and storage.

Secondly, service-oriented computing promotes the approach of assembling application components into a network of services that can be loosely coupled to create flexible, dynamic business processes and agile applications. Therefore, the architecture of service oriented uses services to support development teams can achieve rapid, low cost, interoperable, evolvable and massively distributed long term care system. The use of the SOA not only assists system administrators and domain experts with establishing internal control mechanisms but also integrates care knowledge and comments with relevant specifications into the system through the strong scalability of the aforementioned SOA. Most importantly, due to the care work itself, at long-term care medical institutions, it acts as the core value and the computer grade of user client usually remains low. The system is built on three-layer architecture and such systems do not need re-installation or deployment of system to user clients. The convenience of use is enhanced while relevant maintenance costs are reduced for users. The function architecture is designed on the SOA and, therefore, the determination of the logistic layer is processed by the server to reduce the loading on workstation.

Finally, the study proposes relevant recommendations for healthcare software development companies. Due to the complex long-term care operations, the companies are recommended to emphasize the establishment of domain knowledge by developers when developing long-term care related software in the future to reduce difficulties in communication with users. Additionally, the care operations are recommended for automatic processing to reduce the cumbersome operating procedures for the care personnel. Users mostly need systems that can assist them to save routine operating time in order to implement friendly face-to-face care. The long-term care institutions have lower levels of funding for purchasing information systems and usually follow a gradual procurement process. Hence, the system is required to strengthen operations in different operating systems while the operations can integrate heterogeneous systems. Such antecedent influence factors can affect the acceptance and usage of that software by the care personnel. Follow-up studies are suggested to emphasize the home activity items, which the study has not discussed. Testing and assessment can be conducted though a positioning system and to verify for anomalous events, such as falls, through the SOA-based services. Such improvements can create a more effective long-term care system with more complete functions, so that the system functions can better meet the demand in the long-term care field.

ACKNOWLEDGEMENT

The authors would like to thank the Ministry of Science and Technology of the Republic of China, Taiwan, for supporting this research (Contract No. MOST 106-2410-H-242-001-)

REFERENCES

Babamir, S. M., & Arabfard, M. (2012). Improving service accessibility in service-oriented HIS. *Journal of Medical Systems*, 36(6), 4021 -4030. doi: 10.1007/s10916-012-9874-7.

Bultan, T., Su, J., & Fu, X. (2006). Analyzing conversation of Web services. *IEEE Internet Computing, 10*(1), 18-25. doi: 10.1109/MIC.2006.1.

Brenner M. R., & Unmehhopa M. R. (2007). Service-oriented architecture and web services penetration in next-generation networks. *Bell Labs Technical Journal*, 12(2), 147-160. doi: 10.1002/bltj.20243

Chen, C.-H., Hsieh, S.-H., Su, Y.-S., Hsu, K.-P., Lee, H.-H., & Lai, F. (2012). Design and Implementation of web-based discharge summary note based on service-oriented architecture. *Journal of Medical Systems*, 36(1), 335-345. doi: 10.1007/s10916-010-9479-y.

Cugola, C., & DiNitto, E. (2008). On adopting Content-Based Routing in service-oriented architectures. *Information and Software Technology, 50*(1-2), 22-35. doi: 10.1016/j.infsof.2007.10.004.

De Capua, C., Meduri, A. & Morello, R. (2010). A smart ECG measurement system based on web-service-oriented architecture for telemedicine applications. *IEEE Transactions on Instrumentation and Measurement*, 59(10), 2530-2538. doi: 10.1109/TIM.2010.2057652.

DeLone, H. W., McLean, E.R. (1992). Information System Success: The Quest for the Dependent Variable. *Information System Success*, 3(1), 60-95. doi: doi.org/10.1287/isre.3.1.60.

DESA (Department of Economic and Social Affairs of the United Nations Secretariat) (2007). *World population prospects the 2006 revision*. Retrieved from http://www.un.org/esa/population/publications/wpp2006/WPP2006_Highlights_rev.pdf

World Health Organization. (2002). Active ageing: A policy framework. *The Aging Male*, 5(1), 1-37. doi: 10.1080/tam.5.1.1.37.

Dowling, C., & Leech, S. (2007). Audit support systems and decision aids: Current practice and opportunities for future research. *International Journal of Accounting Information Systems*, *8*(1), 92-116. doi: 10.1016/j.accinf.2007.04.001.

Erl, T. (2004). *Service-oriented architecture: A field guide to integrating XML and web service*. New Jersey, USA: Prentice Hall.

Haux, R., (2004). Health information systems-past, present, future. *International Journal of Medical Informatics*, 75(3-4), 268-281. doi: 10.1016/j.ijmedinf.2005.08.002

Hsieh, S.-H., Hsieh, S.-L., Cheng, P.-H., & Lai, F. (2012). E-health and healthcare enterprise information system leveraging service-oriented architecture. *Telemedicine and E-health*, *18*(3), 205-212. doi: 10.1089/tmj.2011.0100.

Hurlock-Chorostecki, C. (1999). Holistic care in the critical care setting: Application of a concept through Watson's and Orem's theories of nursing. *Canadian Association of Critical Care Nurse*, *10*(4), 20-25.

Li, S.-H., Wang, C.-Y., Lu, W.-H., Lin, Y.-Y., & Yen, D. C. (2012). Design and Implementation of a telecare information platform. *Journal of Medical Systems*, 36(3), 1629-1650.

doi:10.1007/s10916-010-9625-6.
Lin, Y. H., Chen, R. R., Guo, H. M., Chiang, S. C., & Chang, H. K., (2012). Sharing personal health information Via Service-Oriented Computing: A case of long-term care. *Journal of Medical Systems, 36*(6), 3563-3571. doi:10.1007/s10916-012-9832-4.
Lo, C.-L., & Su, Z. Y. (2017). Developing multiple evaluation frameworks in an older adults care information system Project: A case study from Taiwan. *Journal of Aging and Long Term Care*, *1*(1), 34-48. doi: 10.5505/jaltc.2017.65375.
Newcomer, E., & Lomow, G. (2004). *Understanding SOA with web services*. Indianapolis, IN: Addison Wesley.
Park, E., & Nam, H. S. (2012). Interoperable real-time medical systems for assured healthcare services. *IEICE Transactions on Communications*, *95*(10), 3100-3102. doi: 10.1587/transcom.E95.B.3100.
Steurbaut, K., Colpaert, K., Van Hoecke, S., Steurbaut, S., Danneels, C., Decruyenaere, J., & De Turck, F. (2012) Design and evaluation of a service oriented architecture for paperless ICU tarification. *Journal of Medical Systems*, *36*(3), 1403-1416. doi: 10.1007/s10916-010-9602-0.
Uleman, R. (2006). Service oriented architecture unveiled. *Geospatial Solutions*, 16(6), 30-33. doi: 10.1109/SOSE.2006.27.
United Nations, Department of Economic and Social Affairs, Population Division. (2014). *File 8: Average annual rate of change of the total population by major area, region and country, 1950-2050 (per cent).* Retrieved from https://esa.un.org/unpd/wup/cd-rom/WUP2014_XLS_CD_FILES/WUP2014-F08-Total_Growth_Rate.xls
Stav, E., Walderhaug, S., Mikalsen, M., Hanke, S., & Benc, I. (2013). Development and evaluation of SOA-based AAL services in real life environments: A case study and lessons learned. *International journal of medical informatics*, *82*(11), e269–e293. doi:10.1016/j.ijmedinf.2011.03.007.
Yin, J.-C., & Yang, K.-P. (2002). Nursing turnover in Taiwan: a meta-analysis of related factors. *International Journal of Nursing studies*, *39*(6), 573-581. doi: 10.1016/S0020-7489(01)00018-9.