

## Database System Development for Care of the Elders in Community

Jurai JARAEPRAPAL<sup>1</sup>, Puangrat JINPON<sup>2,\*</sup>

<sup>1</sup>*School of Nursing, Walailak University, 222 Thaiburi, Thasala, Nakhon Si Thammarat, 80161, Thailand*

<sup>2</sup>*Information Technology and Educational Media Center, Southern College of Technology, Thungsong, Nakhon Si Thammarat, 80110, Thailand*

(\*Corresponding author's e-mail: [jpuangrat@gmail.com](mailto:jpuangrat@gmail.com))

*Received: xxx, Revised: xxx, Accepted: xxx*

### Abstract

This participatory action research aimed to develop a database system for care of the elders in community, Pakpoo sub-district, Nakhon Si Thammarat. The key informant were composed of public health officers, community leaders, representative of Local Administrative Organization, elders and their families, lecturers and nursing students of Walailak University. Research instruments included interview questions, elderly health assessment form, developed elderly health database system as an experimental tool and usability evaluation form. Data collection by survey, interview, group discussion, and observation. Quantitative data analysis by frequency distribution and percentage, the validity and reliability of questionnaire were confirmed with the experts Cronbach's alpha. The qualitative data reveal content analysis. The results have shown that the database system consist of; the elders health assessment comprised general information, prior illness and treatment, functional, mental health risk, risk for fall, and environment, the required features to support of achievement goal for well-being, consistent with their life style, social capital, and local wisdom. In addition, it could be reduced early risk factors to protect of chronic illness, injury, and decline in physical and psychosocial. The reporting requirement comprised of frequency distribution in capital, problems and need. Perception of the system and its effectiveness were evaluated using a questionnaire after participants had had an approximately one month period of experience of using the system. The responses to the questionnaire were positive about the system features and system process. Using the database system, executives and health officers and elders have been improved it based on feedback continuum.

**Keywords:** Clinical decision support, older adult, database health system, data visualization, clinical informatics

### Introduction

The global trend of elders is on the rise, going up from 10% in 2000 to 15% in 2025. In Thailand, the number of the elderly which had remained steady at 9.4 percent in 2000 drastically grew to 20 % in 2025 [1], indicating arrival of the elderly society in 2024–2025 [2,3]. Old people affected the society in two aspects; 1) As a benefit to society due to their ideal role in giving advice to younger generations, taking care of grandchildren in the family as well as passing on empirical knowledge to both interested individuals and the society, etc., 2) Old age naturally comes with increased dependency on the society. Deteriorated bodies could possibly cause health problems or even disabilities. As a result, financially and socially relying on others for basic needs is common. It was estimated that the number of the elderly unable to help themselves would increase from 94,200 in 2010 to 739,600 in 2040 [4]. The government had to allocate healthcare management service budget to the elderly care portion 2.5 times more than that given to working age [5]. Therefore, the government stressed the importance of elderly care system by the community [6,7] because

those close to the elderly can provide relevant care to them best and helped cut down some unnecessary service costs as well [8,9].

From community phenomena and literary reviews, it has also found that both health and social services for the elderly are not universally available. The main cause is that older people have difficulty accessing the service, due to limited travel to the service unit. Therefore, improving proactive health care services is a challenge for careers [10]. The factor that causes the health team not to be able to provide health services is the lack of systematic information about the elderly, such as information of the elders potential, problems and needs [3]. There are no specific data sets of the elderly, therefore, no information to communicated, associated care with other relevant organizations, for example, used for sub-district level planning development for care of the elders. Most of the care is available at the hospital, such as health screening, caring for chronic illness, lack of proactive activity to empower older people in the community. As a result, the elderly waste time and lack of opportunity to receive a variety care.

Currently, there is a growing use of the elderly care database [6,8], as a result of: enabling the elderly to receive effective care, such as using information to design health care and supporting the older people access health information and uses for their self-care [6], help vulnerable frail older adults get more effective care [8], and help older adults with dementia receive effective care[11]. Increased service system efficiency, due to the use of contextual information to solve differential problems of the elderly [12], it present outcome evaluation for policy making to decreased budget planning, and it as a tools for coordinated between health care team and the other related organization those in charge the care of the elders. This situation allows the Bureau of Promotion and Protection of the Elderly to set a policy that Elderly care workers in the community should develop an elderly database for continuing care; planning , implementation, monitoring of elderly care for efficiency improving of the elders care results [13].

Although database systems are recognized as an important tool in increasing service quality and continue to develop, but existing of this knowledge is still limited, that composed of no data set and specific databases yet for elderly care planning, which differ from other age groups to take care of their physically, mentally, socially and intellectually, there are no data available for using the elderly health promotion plan to slow down aging and to have a long life with quality, Finally, most of the knowledge is in the field of information but the event that occurs in the profession of nursing, which is the specialty, other occupations fail to understand the nursing event leads to the analysis of information systems that non-responsive databases to support professional work in the nursing process.

School of Nursing, Walailak University is a nursing institution that plays a major role in producing new knowledge to serve society and to be aware of those problems, then the participatory action research was used for study the “Database System Development Supporting Older Adults Care”. This study aimed to developed a database health system for older adult care in community, the information from database supporting policy decision making for health care team and related organization to caring consistent with the contextual of the elders, such as planning, implementation, monitoring, and evaluation and study the result of using a developed database system and improved to meet the needs of users.

The results of this study supporting health team in data storage, used to develop a service that can improve the elders health status in the community, focus on health promotion and prevention of early health problems and illness caused by aging and chronic diseases, slow down aging in physical and psychosocial functioning for the goal of maintaining health status, the elders can live a long life, full potential and healthy balance in accordance with the way of life in family context society and local culture are finally.

## **Materials and methods**

### **Participants and sampling**

This research studied the population living in Pak Poon sub-district, Muang, Nakhon Si Thammarat, Thailand. The key informants of this study consisted of the health team involved in the health care for the elderly, the elderly and the families as follows; 1) research teams were 5 nursing instructors and 43 nursing student from the school of nursing of Walailak University 2) Those involved in the provision of elderly services in the community include: 2.1) the 4 person of the management team of Pak Poon Sub-district Administration Organization consists of the prime minister and the deputy, head of the health and

environment division, Director of Banpu Health Promotion Hospital, 2.2) the 3 health and nursing staff of the Elderly Care and Services Division of the Pak Poon Public Health Service, 2.3) the 5 of caregivers from the public sector include elder care volunteers, volunteer care for the disabled, 3) The 908 of the elderly, the size of them was determined by the Yamane schedule, with a comparable population of 3,482 elderly people in the district, and get 843 elderly people (95% confidence interval, 3% random variation), and proportional stratified random sampling by determining the size of the elderly population of each village to the total number of elderly people present.

### **Research Methods**

This study adopted participatory action research (PAR) as its main methodology, because we studying about the need of data set and database system that supporting health care team using for care of the elders in community. It was developed based on the needs of the users and to be tested and developed to meet their needs. PAR approaches have demonstrated to be a helpful tool provided a process for the health care team in community to come together address their own needs about dataset and database system for development [14]. We used a 4-step action research cycle though Kemmis and McTaggart framework [15]: Planning, Action, Observation and Reflection in 3 phases of research: phase 1 development of study design and data collection, phase 2 development and implement the database system for care of the elders in community, phase 3 evaluation of database system and end of research.

#### **Phase 1 development of study design and data collection**

This phase composed of 4 steps: 1) the research team was established from the university researchers and community based research teams those who were involved with caring for the elderly in the community, 2) the study purpose and the benefits expected were explained to them, 3) the research team who worked on academic was trained on community storage skills for data collection assistants, and 4) studying the need of data set and database system for elderly care from all sectors, preparing the data into the database development cycle in the next period (February 2011-May 2011).

#### **Phase 2 development and implement the database system for care of the elders in community**

Researchers observed the health team activities in developing database systems and reflecting the activity information for those involved on the process of developing, improving, and planning new operations. This phase composed of 6 steps: 1) database initial study; studying the database need from all related sectors to define the aims, problems, scope and rules of the database system to be developed, 2) database design from data gathering in the first step, 3) implementation and loading; creating the database for entry the actual data, 4) testing and evaluation; testing the database system by the health team to trial, suggested to find various errors and capabilities evaluation for using as a guideline to improve the database system to meet the needs of users properly, 5) operation database system after has been developed successfully, 6) Maintenance and Evaluations; this process occurs during used the actual database system, then modifying in case it is added, or change the needs of the user affected the database system, and maintenance for effective working. (July 2011-March 2014)

#### **Phase 3 evaluation of database system and end of research**

This phase was the summary of database development process, researchers and health teams attended the conference for final evaluation and learning of the whole process to find a conclusion factors that make the development successful, and the factors that hinder the development, proposed the finding for making public policy, and reflected the results of the research given to the community. (April 2014 - September 2014)

### **Research tools**

The quantitative and qualitative tools were used in this research. The quantitative tools composed of two questionnaires, the elderly health assessment and the usability evaluation assessment. The content and constructive validity of the questionnaire were confirmed with 3 experts in public health for the elderly health assessment and 3 experts in database management for the usability evaluation assessment. Internal consistency was tested using Cronbach's alpha to evaluate the degree of measurement error within each subscale. Acceptable values were greater than 0.700. The reliability of the questionnaire were confirmed

with Cronbach's alpha of 0.87 for the elderly health assessment and 0.85 for the usability evaluation assessment.

The qualitative tools and trustworthiness building as follow; 1) before the study started, 5 researchers and research volunteers were developed their potential by educating and practice the research skills, 2) semi-structured questionnaire for interview and group discussion, the health care team needs of data-set and database system for caring the elderly, were developed and confirmed with the brainstorming of 5 experts after tried out and adapted to suit the area, 3) the data triangulation in health care team and the elders were confirmed with recording, trial, and improving valid data by the observation of health care team behavioral in the process of data-set and database system development.

The database system were used as the experimental tools to support the health team for care of the elders in community.

### **Data Collection**

This study collected data by group discussion, brainstorming, in-depth interview, and observation in the study process every step, record in field note form, and the elderly health survey in Pakpooon sub-district.

### **Database system architecture**

The database system has been developed using web-based technology, Business Intelligence (BI) concepts, and open source computing environments [16-18], that is, MySQL, PHP, Highcharts JS, and Google Maps. The Apache web server 2.2.8 and MySQL 5.0.51b are used as web server software and a database management system, respectively. Highcharts JS is used to develop visualization and data analysis tools, which displays a diversity of charts on web pages [19-21]. Highcharts JS adds interactive calculations and impressive visualizations to websites by integrating objects embedded with PHP scripts and HTML tags [37]. Google Maps is used to visualize interesting factors and to plan routes [22].

### **Database system development process**

According to a database life cycle (DBLC) [23], the participant observation between the researchers and the health team was used in this study. These set of processes were used to reflect the activity information, improve the processes, and revise the plan to accomplish the purpose. DBLC involved in six steps: database initial study, database design, implementation and loading, operation, testing and evaluation, and maintenance and evaluation, which can be described as follow:

1. Database initial study: these step was used to collect and analyze the system requirement from the health team, users of the system, to be support decision making to plan and evaluate the older adult taking care. Two results were estimated in these step: the objective of the system using and the system report. Two objectives were determined from the health team in utilizing information: the first, these information were used to enhance the older adult happiness based on their lifestyle, health and social resources, and the local wisdom of the older adults in community. After implementing the activities, the initial risk factors were reduced because of health prevention, such as chronic disease, injure, and deterioration in the physical and psychosocial functioning in the older adults. Four reports were required: 1) report in easy format, such as graph and comparison in on page, 2) personal information frequency report, such as religion, education, caregiver, and health history, 3) diseases found in the older adults order by disease and community, and 4) the distributed of diseases found plot in Google Maps and point travel detail.

2. Database design: data requirement from the first step were utilized to determine in designing database then creating database design tools to communicate between designers and programmers, such as ER diagram and data dictionary.

3. Implementation and loading: the database system was produced and the data was input into the database system. The system performance, security and standard setup were evaluated by users.

4. Operation: the database system was used by the health team as follow: 1) the questionnaires with the geographic coordinate (GPS) of house were collected, 2) the data from questionnaires with the geographic coordinate (GPS) of house were input into the system, and 3) the system generated the reports for appropriate planning in individual context.

5. Testing and evaluation: the effectiveness and user perception of the system were evaluated by the health team. Their comments were used to enhance the performance of the system to meet the user needs in various fields correctly and completely. The end user manual was developed to guide users in system using.

6. Maintenance and evaluation: while using the database system, this should be analyzed and changed in some functions or processes to be an efficiency tool, because of changing in the requirements, or the implementation environment, bug fixing or porting of the system to new environments.

#### **Statistical analysis**

We developed automatic calculation tools using statistical analysis concepts, such as frequency distribution and percentages (%) for nominal data. Ordinal data were described with mean values and standard deviations (SD) using SPSS. The qualitative data used content analysis along with the data collection process, and post-retrospective data analysis to generate conclusions from the research.

#### **Usability evaluation**

The effectiveness and user perception of the database system were evaluated through use of 16 questionnaires under four main headings: user-program interaction, database system's features, system performance and security, and Satisfaction with the service quality of the system. We selected 57 users, covering all user groups. The selected user groups were made up of one health center staff members, 2 management teams of Pak Poon Sub-district Administration Organization, 8 health care volunteer, and 3 nurse lectures and 43 nurse students of Walailak University. Designated lecturers and students in nurse had been using the database system for one month prior to the evaluation process in case of their duties were collected and input data into the system. For health center staff members, management teams, and health care volunteer, we organized meetings, demonstrated the database system, and allowed them to use it for one hour prior to the evaluation process in case of their duties were a viewer for decision making. The participants were given a questionnaire during the meetings, they were asked to fill out the questionnaire, indicating their level of agreement with statements, using a five-point Likert scale. The participants' anonymous responses were collected. As different of experience in using the systems, we separated the analyzed results into two parts, the manipulated data users and the viewer for decision making.

#### **Ethics statement**

This study was approved by the Ethical Clearance Committee on Human Rights Related to Researches Involving Human Subjects, Walailak University (Number 51/034: 25/11/2008).

### **Results**

#### **System description**

The system was designed to be used by three user groups: 1) system administrators, actioned as managed users and solved the wrong data entry by users, 2) data entry users, actioned as input data into the system, and the general users, actioned as reported all data based on their privileges. Users can access the database system by logging into the system, though users who do not log in still have not access to any information and reports. For security reasons, the login system requires a username and password, only obtainable from the system administrator. The Facebook Page, FAP\_aging at URL: <https://www.facebook.com/fapaging>, was used to coordinate, advise, and solve problems for users. Since March 2014, a prototype database system has been available online at URL: <http://fapaging.welfarepakpoon.org> (Figure 1a). At present, the database system contains data from 908 older adults, in twelve communities. Following the login, the user can choose two main functions: older adult data entry and user management.

#### **The data entry**

The data entry requirement for decision making to take care the elders is composed of two parts: the elders and the caregiver information. The elder information consist of eight information: 1) personal

information, such as name and surname, gender, age, address, ID card number, marital status, educational, and the care giver, 2) past history, such as surgery history and health check up, 3) drug history, 4) physical examination, 5) functional assessment, such as the Barthel ADL and the Chula ADL index assessment, 6) risk assessment and common problem, such as quality of life to be happiness, risk factor for fall and fear of fall, excretion, and malnutrition, 7) cognitive assessment, such as Chula mental test (CMT) and Thai geriatric depression scale (TGDS), and 8) environmental assessment at home. The caregiver information consist of caregiver's type, the relationship with the elder, and caregiver's personal information, such as education and income. In summarized, the data entry of the database system is composed of four parts: users and privileges, questionnaires, the data from questionnaires, and the reports for decision making support in taking care.



**Figure 1** Home page of the database system provided the access way and the user listed in Facebook account with their thumbnail profile picture.

### Visualization and analytical tools

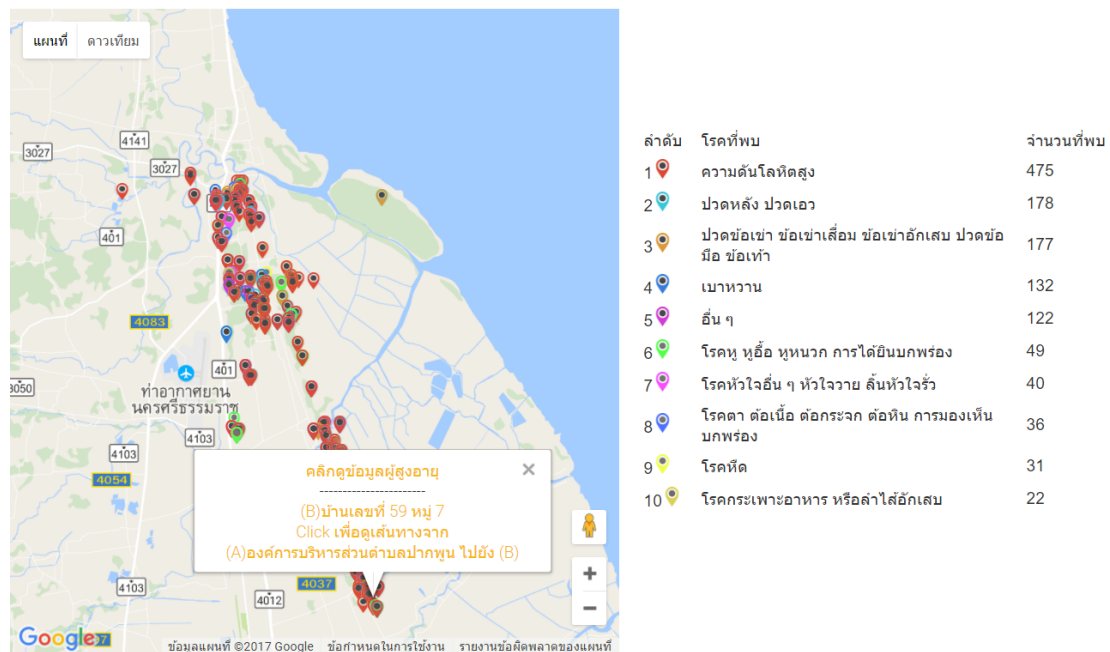
The data visualization tools provide graphical analytic reports for each community. A visual and real-time representation of important aggregated data related to health information, including the health criteria, are presented on the dashboard. The visualization tools provided demographical and statistical reports for each community that summarized data determined to be essential for health promotion use. These tools were presented on dashboard in real-time, with aggregated data related to population and the elder health information, to automatically calculate health status, and the elder's house position on Google Maps. The database system generated visual demographical reports in stacked bar and pie chart formats (Figure 2a). This tool was designed to present data in bar and pie chart and data table formats to allow surveillance, and to obtain epidemiology data from top ten statistical analyses of data on the prevalence of diseases faced in communities (Figure 2b). GIS data from the database system was used to visualize the distributed locations of the prevalence of diseases. Instead of presenting the raw data through tables or lists, we uploaded our presentation as a group of colorful balloons via Google maps (Figure 3). Streets, places, and images

surrounding the selected location could also be viewed in these maps. Moreover, the health status of the older adult in detail could be viewed by mouse click on the balloon.



**Figure 2** Reports of the database system. (a) pie and stacked bar charts visualized religious belief for each community in 12 communities (light blue interpreted Buddhism, dark blue interpreted Christianity, and light green interpreted Islam), and (b) 7 chronic diseases have found in six months prior from 12 communities (1. Coronary disease, heart disease and myocardial infarction; 2. Other heart disease, heart attack, and heart valve disease; 3. Hypertension; 4. Asthma; 5. Lung diseases, 6. Tuberculosis; and 7. Cerebrovascular disease).

## โรคที่พบ 10 อันดับแรก



**Figure 3** The distributed locations of the prevalence of top ten diseases found in the elders in communities. There were 1) Hypertension, 2) Back pain, 3) Arthritis, 4) Diabetes, 5) Others, 6) Ear problems, 7) Other heart disease, heart attack, and heart valve disease, 8) Eye diseases, 9) Asthma, and 10) Gastrointestinal diseases.

#### Evaluation of the database system effectiveness and user perception

The usability system evaluation results of nursing team from Walailak University and those involved in the provision of elderly services in the community as follow; the overall average user satisfaction with the database system was 3.84 and 3.82, respectively. In terms of average value for each main heading of the questionnaire, comprising four main headings, user ratings were highest in the system can supporting operation (4.05 and 4.04). The users also showed that they were concerned about the transaction classification clearly (3.65 and 3.63). Considering each main heading, in terms of the user-program interaction, users were satisfied that the database system easy to access and run at an appropriate speed (3.75 and 3.74). For the database system's features, users were satisfied that the system could provide GIS report for support in decision making (3.96 and 3.94). When asked about the performance and security, they were satisfied with the system has an efficient and secure data storage, (3.86 and 3.84). Finally, in the service quality of the system, they reported that the overall of efficiency of the system (4.05 and 4.04) were satisfied. No different value found in user satisfaction with the database system between groups of users.

#### Discussion

This study developed database health system for older adult care based on database life cycle, it consisted of database initial study, database design, implementation and loading, test and evaluation, operation, and maintenance and evaluation [23]. The finding presented the database users satisfied in the the most average is satisfaction of quality in service of the system because it can help facilitate about their work. Our results indicate that the elder database health system supported and helped the health care teams to managed care for older adult in the community, because it helps health care teams worked quickly on care and reduced their workload in searching and put together all of the elders data, and suggested the health promoting hospital should updated new data at least once a month [24]. Especially, it can supported efficient



older adult care, managed the efficient service system and coordinated the health network for care, due to it contains information about the integrate data of health status and social status, that technologies supporting integrated-care delivery through better assessment, planning, organization, and monitoring [25], and the integrated information visualization could potentially increase the understanding of community well-being status and ultimately enhance decision-making and strengthen communities [22]. The information pulling from database developed was the success factors for older adult care, because it used for intent work of health network, beneficial management, cooperative partners, and good leader [26]. In addition, the study of database for care patient was studied about internet referral database system, the result shown effects of development database can help health care teams to refer the patients and reduce the period of care [27]. Moreover, there was also a studied about health-related knowledge after used online medical database of older adults, after the older adults used the database, it can improve the knowledge for older adults care [28]. Based on this research, it is proposed to those who responsible elderly care in community; The Health Promotion Hospital and Sub-district Administration Organization should develop and implement a database that is consistent with the context of their area, in order to increasing quality and efficiency of care, because it supported classified group of elderly and seek appropriate caring for them that supporting the continuum care. For example, the use of information to design health care improves patient participation in self-care [6], helps vulnerable frail older adults get more effective care [11], such as the electronic case record of elderly wristband warning falls accident help health care team arrive at the located rapidly and help immediately [29], and home-based M-health (mobile health) system to assist elderly outpatients to improve the medication safety and prevent medication errors [30], and used it as a screening tool which identifies an elderly population at high risk for hospital and emergency room [31]. Therefore, the efficient health database system can help the health care teams to develop care for older adults in community.

## Conclusions

We have developed the tools for supporting health care team to care the elders in Pakpoo community; 1) the elder assessment form for collecting data, and 2) the database system supporting the process of entry a lot of data and retrieval information from the system that can be used to effectively plan the care of the elderly. It has been stated that the developed health database system can help facilitate better performance, because it helps in analyzing, interpreting, and reporting for quick decision-making. We developed and tested database system until the health team satisfied. However, each community is different and cultural diversity. Therefore, it proposed that the health care team in community ought to develop the database system for care of the elders that appropriate their context.

## Acknowledgements

We thank the staff from Pakpoo sub-district administration organization and Bansalabangpoo health promotion hospital for their collaboration with this project. Financial support was obtained from Research and Development Institute.

## References

- [1] Population of Thailand in the future, Available at: <http://www.ipsr.mahidol.ac.th> (in Thai), accessed July 2014.
- [2] The world's population and the population of Thailand, BE 2543 to 2568, Available at: <http://service.nso.go.th>, accessed August 2013.
- [3] Foundation of Thai gerontology research and development institute (TGRI). *Annual report: the elderly, Thailand 2010* (in Thai). Bangkok QPL Limited, Bangkok, 2012.
- [4] P Pramote. *Elderly situation, trends and the impact of the ASEAN engagement of Thailand in year 2015 (in Thai)*. n.p., Bangkok, 2012.
- [5] P Hirdes. Addressing the health needs of frail elderly people: Ontario's experience with an integrated health information system. *Age Ageing* 2006; **35**(4), 329-31.

- [6] S Koch and M Hägglund. Health informatics and the delivery of care to older people. *Maturitas* 2009; **63**(3), 195-9.
- [7] M Kaye. Health literacy and informatics in the geriatric population: The challenges and opportunities. *OJNI* 2009; **13**(3), 1-19.
- [8] S Koch. Healthy ageing supported by technology: a cross-disciplinary research challenge. *Inform. Health. Soc. Ca.* 2010; **35**(3-4), 81-91.
- [9] M Marschollek, K Wolf, R Haux, S Mix, B Effertz and E Steinhagen-Thiessen. ICT-based health information services for elderly people: past experiences, current trends, and future strategies. *Med. Inform. Internet.* 2007; **32**(4), 251-61.
- [10] L Dumrikarnleard, editors. *Circumstances and care needs of the elderly in the community (in Thai)*. n.p., Bangkok, 2012.
- [11] SA Zwijsen, AR Niemeijer and CM Hertogh. Ethics of using assistive technology in the care for community-dwelling elderly people: an overview of the literature. *Aging. Ment. Health.* 2011; **15**(4), 419-27.
- [12] U Jaraeprapal and S Aekwarangkoon. Geographic Information System development for Community Health Promotion. *Thai J. Nurse C.* 2008; **23**(3), 49-60.
- [13] Bureau of Promotion and Protection of the Elderly of Thailand. *Law related to the elderly And local government organizations*. The Office of Elderly Promotion and Protection, Bangkok, 2011.
- [14] R Arellano, FE Balcázar, F Alvara do and S Suárez. A Participatory Action Research Intervention in a Rural Community of Mexico Concerns Report Method. *Univ. Psychol.* 2015; **15**(2), 1197-208.
- [15] S Kemmis and RM Taggart. *Participatory Action Research*. In N.K. Denzin & Y.S. Lincoln (Eds). "The Sage handbook of qualitative research. (3rd ed.pp.559-603). Sage, Thousand Oaks, 2005.
- [16] P Diviacco. An open source, web based, simple solution for seismic data dissemination and collaborative research. *Comput. Geosci.* 2005; **31**(5), 599-605.
- [17] X Ma, Y Li, M Bourgeois, M Caffee, D Elmore, D Granger, et al. Web CN: A web-based computation tool for in situ-produced cosmogenic nuclides. *Nucl. Instrum. Methods.* 2007; **259**(1), 646-52.
- [18] B Delipetrev, A Jonoski and DP Solomatine. Development of a web application for water resources based on open source software. *Comput. Geosci.* 2014; **62**(1), 35-42.
- [19] MS Hutton, S Azevedo, R Beeler, R Bettenhausen, E Bond, A Casey, et al. Experiment archive, analysis, and visualisation at the National Ignition Facility. *Fusion Eng. Des.* 2012; **87**(12), 2087-91.
- [20] T Lotz, J Nieschulze, J Bendix, M Dobbermann and B König-Ries. Diverse or uniform? Intercomparison of two major German project databases for interdisciplinary collaborative functional biodiversity research. *Ecol. Inform.* 2012; **8**(1), 10-19.
- [21] J Soh, X Dong, SM Caffrey, G Voordouw and CW Sensen. Phoenix 2: A locally installable large-scale 16S rRNA gene sequence analysis pipeline with Web interface. *J. Biotechnol.* 2013; **167**(4), 393-403.
- [22] P Jinpon, M Jaroensutasinee and K Jaroensutasinee. Integrated information visualization to support decision-making in order to strengthen communities: Design and usability evaluation. *Inform. Health Soc. Ca.* 2016, DOI: 10.1080/17538157.2016.1255626.
- [23] P Rob and C Coronel. *Database Systems: Design, Implementation & Management, Seventh Edition* 2007, Thomson Course Technology. Available at: <http://www.pravinshetty.com/Db/wk2/SG/FIT1004SG2.pdf>, accessed July 2014.
- [24] P Srisilapanan and et.al. *Development of Elder Health Information System: A Case Study of Lumphun Province.* 2010.
- [25] N Dubuc, ND Colli, L Bonin, C Corbin, I Labrecque, J Guilbault, et al. Development of a Computerized Integrated-Care-Pathway System to Support People-Centred and Integrated Care: Usefulness of the Participatory Design Method. *Int. J. Interg. Care* 2016; **16**(6), 91.
- [26] P Opanant, P Pa-in and S Punyawong. Development of care system for dependent older persons in community. *J. Nurs. Sci. Health* 2015; **38**(2).
- [27] T Thammakoon, K Kaewoun, N Raungsakun and N Suchart. Internet Referral Database System Development, Phitsanulok Province. *Buddhachinaraj Med. J.* 2009; 26(1).

- [28] O Freund, I Reychav, R McHaney, E Goland and J Azuri. The ability of older adults to use customized online medical databases to improve their health-related knowledge. *Int. J. Med. Inform.* 2017; **102**, 1-11.
- [29] J Piotrowicz, A Soll, U Kielar, A Zwiefka, A Guligowska, M Pigłowska, et.al. ICT and Environmental Support for Patient with Frailty Syndrome: Carewell Project, Focus Project, and Sunfrail Project. *Medical Science Pulse* 2017; **11**(1), 37-43.
- [30] M Tsenga and Hui Wub. A cloud medication safety support system using QR code and Web services for elderly outpatients. *Technol. Health Care* 2014; **22**(1), 99-113.
- [31] SJ Crane, EE Tung, GJ Hanson, S Cha, R Chaudhry and PY Takahashi. Use of an electronic administrative database to identify older community dwelling adults at high-risk for hospitalization or emergency department visits: The elders risk assessment index. *BMC Health Serv. Res.* 2010; **10**, 338.