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# Critical Factors in the Application of Artificial Intelligence to Establish Health Care Systems for Seniors

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## Abstract

The advance of medical technology and the enhancement of national life expectancy in past years result in increasing solitary elders and weakening care function of family due to aging, low birth rate, and family structure change. Aiming at the elderly, the provision of telehealth care service has become primary. The development of personal health management systems for seniors is also gradually emphasized. The combination of health care with web-based artificial intelligence and information technology could effectively enhance the quality of telecare and save medical resources for reasonable distribution and full application to enhance the effective self-health management of seniors, reduce the outpatient visits, and save the outpatient time as well as avoid the expenditure for medical resources. Aiming at seniors and people who have to take care of seniors in Shanghai for the questionnaire survey, total 500 copies of questionnaire are distributed, and 357 valid copies are retrieved, with the retrieval rate 71%. The research results are concluded as below: (1). "Information quality" is the most emphasized dimension, followed by "management service" and "system quality"; (2). Top 5 indicators, among 14 evaluation indicators, are sequenced timeliness, notification of abnormality, reaction time, correctness, and monitoring operation. Finally, suggestions are proposed according to the results, expecting to enhance the selfhealth management ability of seniors and have them acquire sound health care.

*Keywords*: artificial intelligence, senior, health care system, critical factor, social economy, social support.

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## Introduction

Domestic population structure is inevitably transforming toward low birth rate and aging, and the requirements for the elderly health and safety care are rapidly increasing. Aiming at the elderly, the provision of telehealth care service therefore has become a primary issue. From the aspect of social economy, it becomes the trend that the increasing elderly population and medical expenses for chronic diseases require the application of medical technology to home care service for reducing medical costs. In spite of the advance of medical technology and the promotion of national life expectancy, the problems of aging, low birth rate, and family structure change have resulted in increasing solitary elders and weakening care function of family. The promotion of long-term health care policies becomes more important. However, merely the promotion of seniors' self-health management ability could effectively reduce medical costs and the care burden of the society and family; besides, it should be carefully faced for the continuous development of the society. The daily life of seniors and the care requirements for chronic diseases become primary issues. The development of personal health management systems for seniors is also gradually emphasized. The combination of health care with web-based artificial intelligence and information technology could effectively enhance the quality of telecare to reduce medical resources for reasonable distribution and full application. Telecare would assist in enhancing seniors' health and saving human resources and equipment costs. In this case, health management systems for seniors by introducing applied care information system through web-based artificial intelligence and information technology is developed for collecting the daily evaluation data and the measurement data of seniors. The system contains health information monitoring system, cloud service technology, and health management service to establish the cloud health management service system applicable to seniors. Seniors and the family members could easily grasp the real-time health information (e.g. the monitoring results of blood sugar, blood pressure, blood oxygen, and heartbeat) through the Internet. Besides, the system would automatically remind family members of understanding the latest health information of seniors for proper self-health management and preventive service. It would enhance the effective self-health management of seniors, reduce the outpatient visits, and save the outpatient time to avoid expenditure for medical resources. For this reason, critical factors in the application of artificial intelligence to establish the health care system for seniors is preceded the empirical research, expecting to enhance seniors' self-health management ability and allow seniors acquiring sound health care.

#### Literature review

### Artificial intelligence

Wu & Jung (2016) referred it to collecting and assembling affairs, engaging in selection, and further understanding and knowing affairs. A computer with the ability of knowing, understanding, perceiving, learning, selecting, and judging affairs, as human beings, was called artificial intelligence. Lai (2016) simply defined artificial intelligence as a computer system presenting human knowledge and behavior and being able to solve problems through learning, reasoning, and judgment, memorize knowledge, and understand human natural language. Ng (2016) described the generation of artificial intelligence (AI) that people decomposed the process of reasoning, problem solving, learning, judgment, and thinking decisions induced by the stimulation of and reaction to problems and affairs into some basic steps and modularized or formulated such problem solving processes through programming for a computer, with structural method, being able to design or cope with other more complicated problems. Chua & Banerjee (2018) considered that artificial intelligence attempted to constantly giving machines with human wisdom for simulating or replacing human wisdom. In this case, artificial intelligence would be the mechanization and materialization of human wisdom and further extend the effect intensity and sphere of activity of human wisdom to have a computer be able to think and judge as human brains and present learning and problem solving ability. From the overall research on artificial intelligence, Lang et al. (2016) pointed out the broad application of artificial intelligence, including expert system, natural language processing, robotics, machine vision, automatic programming, machine learning, problem solving, game playing, machine translation, speech recognition, and intelligent agent.

#### Health care

Ding *et al.* (2017) regarded it as the provision of integrated health and supportive service in the places of residence of patients. It aimed to prevent, delay, or replace temporary or long-term use of institutional care. Hamblin (2017) pointed out health service as the body of the entire health service, providing professional service patterns to the places of residence of patients and the family members. Rycroft-Malone *et al.* (2016) indicated that the purpose was to enhance, maintain, or recover patients' health, or reduce the diseases and disabilities of patients and the family members down to the minimum so as to achieve the independent life as much as possible. Bor *et al.* (2017) regarded health care as the provision of professional health nursing service and life care at home, allowing the cared receiving care in the familiar living environment to show positive value of patients' quality of life and reduce the waste of medical resources. Onishi (2016) stated that home health care institutions often took the responsibility for

health care of subjects who did not need hospitalization but still require health care and nursing. Giles-Corti et al. (2016) pointed out three levels of home care service, including 1.acquisition of physiological information, containing correct delivery and complete storage/application/monitoring, 2.contact and coordination of care service, including emergency help at home, sending warning signals for abnormality, and notification of return, and 3.assistance in self-health management, covering assisting the cared in grasping the daily physiological information changes, well doing self-management and tracking, and making early prevention (Wu & Jung, 2016). Cimperman et al. (2016) indicated that most home care systems required the cared measuring physiological signals of blood pressure, blood sugar, blood oxygen, and heartbeat every day and uploading to the central server of service providers for the family members or caregivers viewing such data on the Internet at any time in order to understand the health state of the cared as well as physicians reading the long-term health monitoring data for more accurate evaluation. Marzouk et al. (2017) stated that the system would immediately remind the family members or caregivers with messages or e-mail of abnormal conditions when the measured physiological information exceeding the normal range. A system being connected with social support systems or commercialized could even provide the cared with the requirements for calling ambulance, meal delivery, purchase, and social activity. Klaassen et al. (2016) therefore explained that the ideal home care service should cover individual care, wound nursing, physical therapy, occupational therapy, speech therapy, social work, nutritional health counseling, medical appliances rental, home care service, housework service, day care service, provision of temporary rest for family members (break service), meal (drink) delivery service, transportation, as well as emergency care and rescue systems. Sitzman & Watson (2018) mentioned that service coverage was deep and broad; under the considerations of effective utilization of resources and cost control, the link and cooperation among systems required the integration of technologies.

#### Health care system model

Chua & Banerjee (2018) modified the original information system success model by organizing 285 papers discussing the performance of information systems within a decade after the information system success model being proposed. In addition to the original system quality and information quality, the modified information system success model was added service quality. Lang *et al.* (2016) regarded the different weights of dimensions in the information system success model that system quality and information quality might be important for measuring a single system. In this case, service quality might be a primary variable when measuring information system departments. Diamantidis (2017) indicated that system quality and information and use, and user satisfaction would influence use intention. According to the information system success model, Goold *et al.* (2016) also pointed out the factors of system quality, information quality, and service quality in user satisfaction and use.

Chen et al. (2017) roughly divided the service functions of telecare systems into personal emergency responses system (PERS), long-term wellness monitoring system with the provision of health data record and analysis tool, and personal health record (PHR) for emergency care or health care service. Souza-Junior et al. (2016) pointed out distributed telecare systems as long-term wellness monitoring systems and personal health record focusing on the establishment of long-term health condition data and the provision of more health information management and analysis functions. With the wireless function of Bluetooth, Hall & Greenberg (2016) achieved the real-time monitoring and database storage of physiological signals by transmitting the subjects' physiological signals on the oximeter, sphygmomanometer, and electrocardiograph from home computer systems to the monitoring end and the centralized health care platform through the Internet. Tawfik & Anya (2015) stated that the monitoring end could acquire the real-time physiological signals of the subjects and the centralized health care platform could save the complete measurement information of the subject for history inquiry in the future. With the convenience of PDA, Ellis et al. (2015) established an individual health management system, allowing users inquiring various food energy and nutrition contents, consumed calories in exercise, and medicine contents; it presented convenience, could enhance medical administration efficiency and quality, and transmit data to hospitals through the system (Willis & Leone-Sheehan, 2017).

## **Research design and method**

#### Fuzzy Delphi Method

Delphi, developed by the US RAND in 1950, is a group decision-making method to achieve the consensus of studied problems or programs through expert group questionnaire survey. Fuzzy Delphi Method (FDM), combining fuzzy set theory with Delphi, allows expert groups independently making judgment according to the professional thinking, shows the effect of brainstorming, does not need complicated statistics, and could break through the limits of time and space.

#### Establishment of evaluation indicator

Fuzzy Delphi Method (FDM) is utilized in this study for the expert questionnaire survey and the threshold selection of primary and secondary criteria. The expert group questionnaire survey in Fuzzy Delphi Method (FDM) could reduce the questionnaire survey times and the statistics time to enhance the correctness and allow the evaluation scale of expert group decision-making consensus being more flexible and efficient. Referring to the fuzzy linguistic variable diagram proposed by Buckley (1985), the expert questionnaire survey criteria are displayed with 9-scale; and, the geometric mean proposed by Klir & Yuan (1995) is applied to the integration and calculation of expert group decision-making consensus. With the modification of Delphi Method, the research criteria in this study cover the followings: (1) Information quality: timeliness, correctness, integrity, and security; (2) System quality: ease of use, reaction time, meeting requirements, access capability, and integration; (3) Management service: user management, system maintenance, monitoring operation, and notification of abnormality.

## Research object

Seniors and people who have to take care of seniors in Shanghai are regarded as the questionnaire analysis objects in this study. Total 500 copies of questionnaire are distributed, and 357 valid copies are retrieved, with the retrieval rate 71%.

## Results

After completing all hierarchical weights, the allocation is done according to the relative importance to present the importance of the hierarchical indicators in the entire evaluation system and to apply artificial intelligence to establish the overall weight of the health care system for seniors, *Table 1*.

dimension	Hierarchy 2	Hierarchy 2	indicator	Overall	Overall
	weight	sequence		weight	sequence
information quality	0.368	1	timeliness	0.117	1
			correctness	0.086	4
			usefulness	0.045	13
			integrity	0.071	7
			security	0.055	11
system quality	0.289	3	ease of use	0.063	9
			reaction time	0.094	3
			meeting	0.066	8
			requirements		
			access capability	0.033	14
			integration	0.075	6
management service	0.343	2	user management	0.049	12
			system	0.058	10
			maintenance		
			monitoring	0.082	5
			operation		
			notification of	0.106	2
			abnormality		

Table 1. Overall weight of health care system for seniors

## Conclusion

According to above questionnaire survey analyses, *Table 1*, the following conclusions are summarized. Among the evaluation dimensions in Hierarchy 2, "information quality", weighted 0.368, is the most emphasized, about 36.8% of overall weight, following by "management service" (weighted 0.343) and "system quality" (weighted 0.289). From the survey, information quality is the most emphasized dimension in the application of artificial intelligence to establish health care systems for seniors.

Among the evaluation indicators in Hierarchy 3, the evaluation indicators are sequenced as below: (1) The evaluation indicators in information quality are sequenced timeliness, correctness, usefulness, security, and integrity; (2) The evaluation indicators in system quality are ordered reaction time, integration, meeting requirements, ease of use, and access capability; (3) The evaluation indicators in management service are sequenced notification of abnormality, monitoring operation, system maintenance, and user management.

By organizing the questionnaire data for the critical success factors in the application of artificial intelligence to establish health care systems for seniors and the overall weight, top five indicators, among 14 evaluation indicators, are timeliness, notification of abnormality, reaction time, correctness, and monitoring operation.

#### Suggestion

According to above conclusions, the following suggestions are proposed in this study.

1. In consideration of increasing aging population and busy work of family, people could not perfectly take care of the seniors. The application of artificial intelligence to establish the health care system for seniors aims to have seniors use the system for personal health monitoring and management and allow the family members grasping the real-time and correct physiological health information of the seniors to achieve the popularity of health management. In this case, the notification of abnormality must be prompt and definite. It is therefore suggested to keep the fluent circulation of information among monitoring operation centers, seniors at home, and the family members 2. The government is suggested to continuously promote health value and importance to enhance seniors' emphasis and practice of healthy lifestyles as well as assist seniors in establishing health promotion model and health care system with artificial intelligence. The promotion of health could help seniors understand and concern about the physical and mental states as well as know the lifestyles and health behaviors, including regular exercise habits, good diet and behaviors, and proper pressure coping strategies.

3. Health centers to enhance seniors' health should be established to provide service contents, health management systems, and practice conditions; class lessons and physical fitness activity are covered, expecting to establish seniors' positive intention under health promotion lifestyles, assist them in establishing health behaviors with intervention strategies, provide individual and continuous medical suggestions, and increase the opportunities to maintain the health behaviors with the physiological health data, psychological health information, interpersonal relationship, and physical fitness activity to effectively promote the physical conditions and health habits of seniors.

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