

Article

Constructing Factors Related to Sociotechnical Analysis in Elderly House

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Abstract: As the senior population is increasing, elderly housing is an essential activity in society, prompting the demand for an array of new and extended services. Hence, building information systems, communication, workflow processes, and the end-user are regarded as parts of the information system. The process adopted here combines the FAHP model and ETHICS approach (which we call FETHICS) to deal with the sociotechnical analysis in the elderly house while we are constructing work systems. The purpose of this study is to use the socio-technical analysis of mental and human implementation to capture information content and systems. The results show that environment monitoring, on the job training, providing increased effective care work, and being able to respond to changes in the general environment represent the most important critical information about housing the elderly. Based on the factors identified, a hierarchy model of critical information regarding elderly housing is proposed. The results suggest the content of the elderly house for collecting a weight to each member within this group experience, while also indicating the configuration of the information service framework.

Keywords: sociotechnical analysis; elderly house; FAHP; ETHICS



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1. Introduction

Due to the large size of the aging population, it is necessary consider information analysis in long-term care industry. The senior population is increasing in society, prompting the demand for an array of new and extended services [1]. This includes housing that meets the needs of the elderly person and senior care facilities, diverse and user focused suite of care and support. In addition, eHealth (smart medicine) will become the main solving for caring the elderly [2]. It is also important that elderly people can live in a more suitable and satisfying home with ease. How to integrate hard and software to generate smart medicine service solutions will be critical to the elderly. To pursue information system, meet the elderly need to enhance the quality of life of elderly people while also ensuring they keep their independence, social and enjoy living at home. Therefore, to solve this problem, smart home systems and smart medicine are accepted, as the former develops its technological capabilities in artificial intelligence (AI) and big data applications to be applied to meet the needs elderly [3]; while the latter refers to environments equipped with Internet of Things (IoT) sensors to be applied around assistance to the elderly [4].

AI and IT in smart homes are being intensively studied, but a lack of communication with the end-user and the workflow process make their adoption rate low for the elderly people with regard to new technology. Few studies focus on the subjective opinion of the elder needs and evaluation of select information options. The purpose of this study is using socio-technical analysis in terms of mental and human implementation to capture information, content, and systems for elderly housing. Thus, a good human resources arrangement and appropriate selection of visibility information for the elderly house are

necessary to execute integrated into existing operations and to achieve more efficient integrate hard and software and generate smart medicine service solutions. The aim of the present paper is to evaluate different concrete critical information with utilizing fuzzy analytic hierarchy process (FAHP) model and ETHICS approach. For this, we form an expert group and evaluate all opinion of its weight. While using linguistic variables calculate the scores of each criterion and rank criteria opinion.

The study contributes to sociotechnical analysis in elderly house research in the following ways. First, the FAHP model and ETHICS approach we deployed to capture information, content and system addresses a significant methodological to constructing factors of elderly house requirements. Second, our study shows topics by evaluating weights related to the global weights for the sub-criteria in the system. Third, the identification of sub-factors supports a framework for analyzing the human implementation and represents a reliable target for future research into elderly house requirements in the future.

The paper is organized as follows: Section 2 presents the theoretical review, ETHICS used. Section 3 describes the analysis. Section 4 presents the results. Sections 5 and 6 discuss findings. Section 7 shows research limitations.

2. Theoretical Framework

2.1. Sociotechnical Analysis

There is an increasing application of information technology in health care related with a sociotechnical view [5]. Meanwhile, this explores not only the ways technology is used, but also the social and organizational contexts into which its embedded [6]. Many studies focused on the institutional planning of the elder house in long-term care facilities, service standards, and the exploration of institution building for nursing use [7,8]. However, there are few articles focusing on humanistic needs, such as job satisfaction and flexibility, and the influence that technology and systems would have upon us, especially in an elderly house. In the study, the change in the elder housing and the introduction of ETHICS in the field were examined in terms of the hierarchy model of critical information on transitions [9], one of the concepts where socio-technical transitions have been studied. Because the method focuses on the interdependence and mutual adjustments between technological, social, and mental dimensions [10–12], it is an overall concept in studying elder housing.

2.2. ETHICS

ETHICS (Effective Technical and Human Implementation of Computer based System) is an approach adopted when designing an information system. ETHICS is also a technical analysis covering organization, administrating, and working life quality factors. In the ETHICS approach, all attendants are involved, to contribute and to discuss, in the designing process [13]. ETHICS was applied socio-technical analysis to integrate the whole system and connect users in its implementation in the elderly house. In other words, the study adopts a socio-technical approach to conduct work effective for information systems and to provide satisfaction for the user [14].

3. Methods

The initial indicators structure employs the hierarchical framework diagram of the work, as shown in Figure 1. This study attempts to obtain the practice indicators and evaluation criteria for elderly house end-user [15]. To achieve this goal, this work selects 20 experts who offered their opinions on information system development adoption and combines qualitative and quantitative approaches to solve complication elderly house (EH) execution. This is achieved using the fuzzy analytic hierarchy process (FAHP) assessment aspects and by evaluating indicators of the managerial competences for elderly house (EH) information. The use of FAHP can effectively improve the real visibility information of EH work and reduce the gap created by expectations with actual experience.

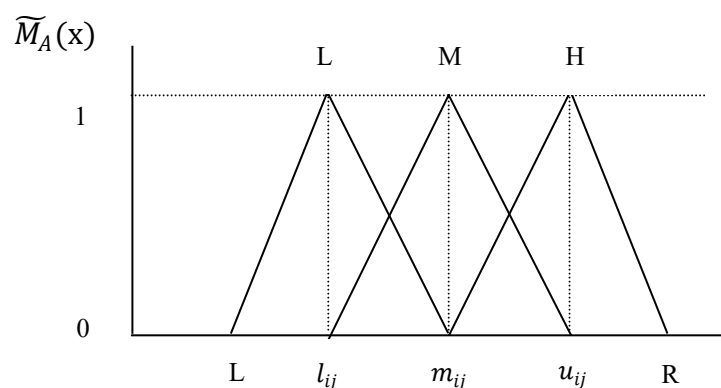


Figure 1. Membership functions of linguistic values for criteria rating.

3.1. FAHP

The Delphi technique is one group-decision method and is a structured process for collecting the opinions of selected specific participants in the fields. A combination of the Delphi technique with triangular fuzzy numbers was adopted in order to focus some of the ambiguity of opinions of the Delphi participating [16]. This technique was applied to confirm the practice indicators and evaluation criteria for EH because it solved not only the resulting disadvantages, but is also affected by outlier opinions from the conventional Delphi technique. The study adopts Fuzzy logic [17] to provide an effective way of dealing with problems, which understands the impact that technology and systems would have upon us especially in the long-term care industry.

3.2. FETHICS

FAHP is one applicable technique in multiple criteria decision making [18,19] and it is used to solve complicated problems in economics, social science, and management science, etc., fields which are necessary and interesting for people [19]. The process combines the FAHP model and ETHICS approach (which we call FETHICS) to determine the level of real visibility information for an EH work effectively is composed of the following steps:

Step 1: Identify all factors in calculating EH information.

Step 2: Structure the FETHICS model hierarchically based on the all factors identified as Step 1. FETHICS model is fulfill the all objective evaluated at the first level, factors are in the second level.

Step 3: Use pairwise comparison matrices to calculate the weights of the factors. This scale measuring the relative weights is used for solving fuzzy decision-making problems, as shown in Table 1 [20,21].

Table 1. Linguistic scales for difficulty and importance.

Linguistic Scale for Difficulty	Linguistic Scale for Importance	Triangular Fuzzy Scale	Triangular Fuzzy Reciprocal Scale
Just equal	Just equal	(1, 1, 1)	(1, 1, 1)
Weakly more difficult	Weakly more important	(1, 3/2, 2)	(1/2, 2/3, 1)
Strongly more difficult	Strongly more important	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
Very strongly more difficult	Very strongly more important	(2, 5/2, 3)	(1/3, 2/5, 1/2)

Step 4: Calculate weights for the sub-factors.

Sub-factor weights are calculated by multiplying local weight. Then, using the geometric average technique and adoption triangular fuzzy numbers define the fuzzy judgment matrix (Figure 1).

Triangular fuzzy numbers are represented by $\widetilde{M}_A(x)$, where ℓ , m , and u are parameters, shown as follows:

$$\mu_A(x) = \begin{cases} 0 & , \text{when } x < \ell \\ \frac{x-\ell}{m-\ell} & , \text{when } \ell \leq x < m \\ \frac{u-x}{u-m} & , \text{when } m \leq x < u \\ 0 & , \text{when } x \geq u \end{cases} \quad (1)$$

Adopt fuzzy mean and spread technique to transform fuzzy weight numbers to crisp versions, which are obtained by the following equation [22].

$$W_{\ell i} = \sum_{j=1}^z \ell_{ij} / z \quad (2)$$

$$W_{mi} = \sum_{j=1}^z m_{ij} / z \quad (3)$$

$$W_{ui} = \sum_{j=1}^z u_{ij} / z \quad (4)$$

$$W_i = [W_{\ell i} + W_{mi} + W_{ui}] / 3 \quad (5)$$

where i stands the fuzzy weight of the i -th criterion.

Step 5: Measure the sub-factors. Linguistic variables proposed are used to measure the sub-factors, and the average values related to these variables are shown in Table 2.

Table 2. Linguistic values and mean of fuzzy numbers.

Linguistic Value	The Mean of Fuzzy Numbers
Very high	1
High (H)	0.75
Medium (M)	0.5
Low (L)	0.25

Step 6: The EH calculation. Using sub-factors and the average values and linguistic values to calculate the EH. Then, keep going to compute EH is compared with the highest bound and lower bound according to a new design or the occurrence of correcting precautions. The weight value must be normalized to make the total weight value sum to 1. There are two main ways to standardize fuzzy numbers:

There are two main ways to standardize fuzzy weight number.

The proposal of Chang and Lee (1995) is shown in Equations (6)–(8) [18].

$$NW_{\ell i} = \frac{W_{\ell i}}{[(\sum_{i=1}^n W_{\ell i})(\sum_{i=1}^n W_{ui})]^{1/2}} \quad (6)$$

$$NW_{mi} = \frac{W_{mi}}{\sum_{i=1}^n W_{mi}} \quad (7)$$

$$NW_{ui} = \frac{W_{ui}}{[(\sum_{i=1}^n W_{\ell i})(\sum_{i=1}^n W_{ui})]^{1/2}} \quad (8)$$

Chen and Hwang (1992) proposed, as shown in Equations (9)–(11).

$$NW_{li} = \frac{W_{li}}{\sum_{i=1}^n W_{li}} \quad (9)$$

$$NW_{mi} = \frac{W_{mi}}{\sum_{i=1}^n W_{mi}} \quad (10)$$

$$NW_{ui} = \frac{W_{ui}}{\sum_{i=1}^n W_{ui}} \quad (11)$$

The weight value must be normalized to make the total weight value sum to 1. Whether we adopt the method of Chang and Lee (1995) or Chen and Hwang (1992) to transform fuzzy weight number, the fuzzy weight number must be normalized to make sure the sum of a total weight number equal 1 [18,23].

4. Results

In order to obtain sub-factor weights, the study adopts Delphi technique with triangular fuzzy numbers which we call FETHICS to integrate the advantages of each approach. Therefore, an expert team was formed from 20 experts in the field of long-term care and information industry, each from different fields.

4.1. The Questionnaires Collection

The questionnaires were distributed who, having over 15 years in the field of long-term care experience, information development and architectural space planning. Using our networking advantages and contacting individuals who operate and manage responsibilities, while collecting data. At first stage, experts were contacted by e-mail or phone. Once the candidates were identified, we sent questionnaires by e-mail.

In order to increase the response rate, emails, follow-up phone calls, or face-to-face interviews were used. Research assistants responded any questions as soon as possible when the participants had confused about the survey. Finally, 20 experts who offered unique suggestions with information system development and implementation for the senior housing Industry.

4.2. The Proposed Model

Step 1: Determine the critical information. The goal of main factor weights is located on the second level in Figure 2.

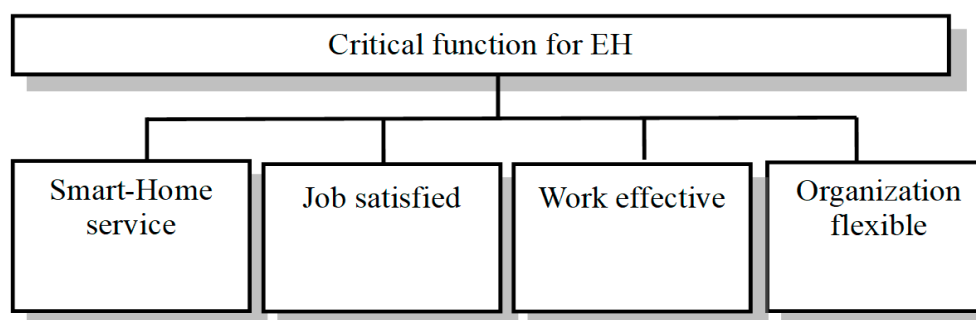


Figure 2. Critical function for EH.

Step 2: The factors and sub-factors are determined to measure the EH. The expert team determined 26 indicators to find the EH work systems. These 26 indicators are separated

into four sub-factor whose names smart-home service, job satisfied, work effectively, and organization flexible.

A. Smart-Home service

- A.1. Healthy Management
- A.2. Biophilic Design
- A.3. Information Management
- A.4. Environment Monitoring
- A.5. Amenity Improvement
- A.6. Community Management
- A.7. Risk Management

B. Job satisfied

- B.1. Consultative and participatory work environment
- B.2. On the job training, providing
- B.3. Transparent management
- B.4. Creative work environment
- B.5. Diverse and challenging jobs
- B.6. Job security
- B.7. Sharing work resource and environment
- B.8. Interchange of knowledge and skills to take caring with residents
- B.9. Encourage with the innovation of long-term care skill

C. Work effective

- C.1. Deliver real-time and accurate information within the organization
- C.2. Complete two-way communication channels
- C.3. Increase care work effective
- C.4. Providing more forward-looking products for care worker
- C.5. Providing a proactive care process
- C.6. Establish a reasonable performance evaluation system
- C.7. Establish a work tracking system

D. Organization flexible

- D.1. Ability to responds change in general environment
- D.2. Cooperating with third parties
- D.3. Cooperating with an information expert of third parties

Step 3: The initial 26 indicators are separated in four sub-factors, as shown in Table 3. The analytical results show smart service, job satisfied, work effectively, and organization flexible to be important information. For the identification for the critical information of EH, Environment monitoring (0.148) was considered to be the most important main critical information of smart-home service. On the job training, providing (0.117) was considered to be the most important main critical information of job satisfied. Increase care work effective (0.150) was considered to be the most important main critical information of work effective. Ability to respond to change in general environment (0.336) was considered to be the most important main critical information of organization flexible.

Table 3. Critical information for EH.

Main Critical Information	Sub-Critical Information	Average of Fuzzy Number	Ranking	Fuzzy Weight
Smart-Home service	Environment Monitoring	82.79	1	0.148
	Amenity Improvement	81.50	2	0.146
	Information Management	80.58	3	0.144
	Biophilic Design	80.18	4	0.143
	Risk Management	79.53	5	0.142
	Community Management	77.52	6	0.139
	Health Management	76.85	7	0.137
Job satisfied	On the job training, providing	78.75	1	0.117
	Job security	78.19	2	0.116
	Sharing work resource and environment	77.27	3	0.115
	Interchange of knowledge and skills to take caring with residents	75.96	4	0.113
	Encourage with the innovation of long-term care skill	75.29	5	0.112
	Diverse and challenging jobs	73.55	6	0.109
	Transparent Management	73.15	7	0.108
	Consultative and participatory work environment	72.39	8	0.107
	Creative work environment	69.82	9	0.104
Work effectively	Increase care work effective	82.43	1	0.150
	Providing more forward-looking products for care worker	82.28	2	0.149
	Providing a proactive care process	80.20	3	0.146
	Deliver Realtime and accurate information within the organization	78.24	4	0.142
	Complete two-way communication channels	78.01	5	0.142
	Establish a reasonable performance evaluation system	75.96	6	0.138
	Establish a work tracking system	73.79	7	0.134
Organization flexible	Ability to responds change in general environment	81.74	1	0.336
	Cooperating with third parties	81.00	2	0.333
	Cooperating with an information expert of third parties	80.69	3	0.331

5. Discussion

The purpose of this study is using socio-technical mental and human implementation to capture information content and systems, and the main findings were as follows: (1) Environment monitoring was considered to be the most important main critical information of smart-home service. (2) On the job training was considered to be the most important main critical information of job satisfied. (3) Increased effective care work was considered to be the most important main critical information of work effectively. (4) Ability to respond to a change in general environment was considered to be the most important main critical information of flexible organization.

Taken together, socio-technical aspects of both mental and human implementation represent the most important main critical information regarding the elderly house. Thus, the government has a responsibility to provide eHealth services for caring the elderly (the government must increase the fiscal investment to meet the elderly house demand on the supply side).

6. Conclusions

This study combines the FAHP model and ETHICS approach (which we call FETHICS) to analyze the elderly house while constructing work systems. The results indicate that the critical information for EH are ranked in the following elderly house information of importance: environment monitoring, on the job training, providing, increase care work effective and able to respond changes in technology, regulations, economics, residents, industries were the most important main critical information. Accordingly, the study showed that the socio-technical method is necessary in considering analysis of the elderly house, e.g., increased effective care work and adjust organizational flexibility. The proposed model for a hierarchy of the critical information is proposed to provide an objective and effective decision model for firms to develop strategic services for the elderly house with its eHealth providers. When the system is formally launched, it is expected to simplify procedures and meet the goals of facilitation as a paperless eHealth provider, so as to generate smart medicine services, allowing more efficient and integrated work in terms of hard and software solutions.

7. Limitations and Future Directions

The linguistic values and data were collected from 20 experts experienced in long-term care, management information, and architectural space planning, but other fields may be investigated by researchers in subsequent studies. However, its construct validity is limited by time, comparing baseline with the final measurement by researchers invested in communication and workflow processes.

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Institutional Review Board Statement: Ethical review and approval are not required for this study due to the nature of this article. Being that our analysis in information requirement from experts who have experience in long-term care, managed information and architectural space planning for constructing and knowledge of elderly housing.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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