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A Study on the Sustainable Development for Senior Learners

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Abstract: In an aging population with a changing demographic structure, the government aims to ensure that elderly people receive care. In the concept of lifelong learning, education opportunities are available to senior learners, not just children and young people. The sustainable development for senior learners becomes a very important issue because it promotes a variety of learning activities for senior learners. Many universities have started to offer education for senior learners in Taiwan. Positive experiences for senior learners in senior universities can be fostered by ensuring the sustainable development of senior education. In this paper, a study on sustainable development for senior learners is proposed. This study aims to explore potential tools or approaches in evaluating the sustainable development for senior learners for decision making. In this study, two approaches are applied to analyze the sustainable development for senior learners. The first is a statistical analysis, and the second is the random forest model. The methodology of statistical analysis focuses on three aspects such as social assistance, inspiration, and the learning fulfillment for senior learners in senior universities. The random forest model is used to generate decision rules to support decision making. The random forest in this study obtained 22 decision rules. The results suggest that the items in the questionnaire and the decision rules from random forest could provide useful information that allows decision-makers to analyze the sustainable development of senior learners.

Keywords: sustainable development; senior learners; statistical analysis; random forest; decision making

1. Introduction

The quality of life for the senior learner is not only reliant on health [1]. University provides variant ways of living for living better and is not only focused on teaching activity [2]. In ordinary universities, students must adapt to the environment and syllabus. For senior learners, the senior university must consider their work, hobbies, family life, and community life. Thereafter, the sustainable development for senior learners can ensure lifelong learning. Senior universities encourage elderly people to enjoy life and engage in learning opportunities so that education is available to all learners, not just children and young people. The government encourages senior universities to design and plan useful courses that meet the needs of senior learners in Taiwan. People over 55 years old in good physical condition and no academic qualifications can apply to attend the senior university. Senior learners not only appreciate the brand-new knowledge as well as activities, but also obtain the same services as regular students, such as using resources of the library, receiving medical care, and getting counseling [3,4]. In previous

studies, statistical analysis was used to study the social assistance, inspiration, and discovering the fulfillment of elderly learners [5]. Researchers also focused on teaching activities, learning styles or their effects on students [5–8]. Unfortunately, they did not study the positive experience of elderly learners. A positive experience is an important issue to foster sustainable development for senior learners by understanding their needs and receiving their feedback after they have engaged in learning. The decision tree classifier is a classification method so that decision rules can be generated to reveal the feedback of senior learners [1]. Because it requires the specific development and the analysis of feedback for senior universities, a study on the sustainable development for senior learners is proposed in this paper. This study aims to explore potential tools in evaluating sustainable development for senior learners. In this study, two approaches are applied to analyze sustainable development for senior learners in Taiwan. One is statistical analysis, and the other is the random forest model. Statistical analysis is a component of data analytics, and it is used in this study to answer questions through formal questionnaires [9]. Random forest is an ensemble learning method based on the decision tree classifier, and it generates decision rules that can support the information for decision making [10]. In Section 2, we first briefly discuss the decision tree classifier to arrive at our proposed approach and then present the proposed algorithm. Findings are described in Section 3. Discussions of the results are in Section 4. Limitations of the present study and suggestions for future research are described in Section 5. Section 6 provides our final thoughts.

2. Methodology

2.1. Method of Decision Tree Classifier

The decision tree classifier, a supervised learning method, is an attractive classifier because it performs data mining at a high speed. It is based on the strategy of divide-and-conquer to construct tree rules in a recursive manner [11]. A decision tree consists of a root node, internal nodes, branches, and leaves, starting from the root node and using information gain to divide the samples into subsets. A node specifies an attribute, and every internal node stands for an examination of the feature. Each branch represents the outcome of the examination and each leaf marks a choice of the value. The path from the root node to a leaf node stands for the decision rule.

To set $\{C_1, C_2, \cdots, C_k\}$ as the classes, a leaf node is identified as class C_i for the decision tree classifier T. The information gain is as follows [12]:

$$\begin{aligned}
Information\ Gain(X) &= Info(S) - Info_X(T)\\
Info(S) &= -\sum_{i=1}^{k} \frac{freq(C_i,S)}{|S|} \times \log_2\left(\frac{freq(C_i,S)}{|S|}\right)\\
Info_X(T) &= \sum_{j=1}^{n} \frac{|T_j|}{|T|} \times Info(T_j)
\end{aligned} \tag{1}$$

where $Info(S)$ is the needed amount of information to determine the class of samples in S, $Info_X(T)$ is the information value for attribute X to partition T, $|S|$ is the amount of samples in S, $freq(C_i,S)$ is the amount of samples in C_i, n is the amount of output samples, T_i is a subset of T as the ith output sample, and $|T_j|$ is the amount of samples in T_j. In this paper, the random forest based on decision tree classifier is used to generates decision rules that can support the information for decision making.

2.2. Sample, Demographics, and the Proposed Algorithm

Overall, 164 pre-test surveys are distributed, with 124 respondents. The pre-test questionnaires include 19 questions in the scale of social assistance, 12 questions in the scale of inspiration, and 16 questions in the scale of learning fulfillment. This paper proposes a study on sustainable development for senior learners using statistical analysis and random forest. The proposed algorithm includes two stages, as shown in Figure 1.
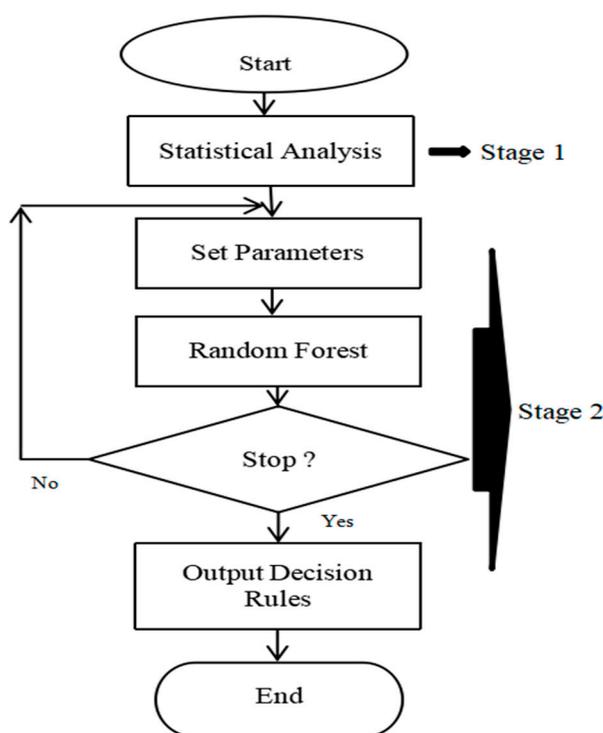
Figure 1. The flow of the proposed algorithm.

In the proposed algorithm, the goal of stage 1 is to analyze the factors of social assistance, inspiration, and also the learning fulfillment of senior students in senior universities. For stage 2, it aims to understand whether their feedback are different from variant backgrounds for senior learners.

In stage 1, SPSS is the utilized software to carry out task analysis in this research. For project analysis, Cronbach's α has to be above 0.7. The correlation between the project and the total score has to be above 0.3, and the criterion of internal consistency has to reach a significant level (0.05 or 0.01). The CR value of individual items should be at least 3 and have a significant difference ($\alpha = 0.05$ or 0.01). The total score of each sub-item for its subscale needs to be more than 30, and $p < 0.01$. The Kaiser-Meyer-Olkin (KMO) and Bartlett's test are applied to establish the appropriate variable analysis, then the factor analysis was performed to establish the construct validity of the scale [4,5]. For factor analysis, the standard is a factor load greater than 0.4, and then the internal consistency of each level of the scale after correction is observed. The principal component analysis (PCA) is utilized to find the components that analyze the maximum variance by the changed component. The principal components could be described as $C_i = \varphi_i X$ where C_i is the principal component, φ_i is the eigenvalue of the sample covariance matrix, $X = [x_1, x_2, \cdots, x_n]^T$ and x_i is an observed data vector. PCA could be rewritten as below [9]:

$$C = \Phi X \qquad (2)$$

where $C = [c_1, c_2, \cdots, c_n]^T$ is the principal component vector and $\Phi = [\varphi_1, \varphi_2, \cdots, \varphi_n]^T$. The factor analysis used is PCA for factor extraction, Direct Oblimin for oblique rotations, and retention of common factors with eigenvalues above than one [5]. After that, the formal questionnaires are reduced to include 17 questions in the scale of social assistance, 10 questions in the scale of inspiration, 13 questions in the scale of learning fulfillment, and the background variables of senior learners. In terms of background variables, such as gender, age, education level, living conditions, region, economic conditions, participation status, and the information sourced from the university are used in this study.

In stage 2, the random forest method is used to create decision rules to analyze whether the feelings of senior learners are variant from different backgrounds. First, we set parameters for random forest. The arbitrary forest is an ensemble knowing technique that constructs the best classifier using

the majority of the decision tree classifier. Each decision tree classifier is sampled independently with equal distribution in the forest [13]. The steps of random forest are stated as follows [10,14]:

Step 1. Select samples from the dataset.
Step 2. Create an unpruned decision tree classifier for each sample. At each node, the predicted variables are randomly sampled and the best split is selected from these variables.
Step 3. Decide on the new dataset by the majority votes for decision tree classifiers of the trees.
Step 4. Repeat the process of *Step 2* until the stop criterion is met.
Step 5. Finally, output the decision rules for the decision maker.

3. Finding

The respondents filled information on three aspects, social assistance, inspiration, and the learning fulfillment are listed in Table 1.

Table 1. The results for three aspects.

Aspects	KMO	Bartlett's Test χ^2	Item	The Top 3 Highest Average Score
Social assistance	0.86	1103.11	Tool assistance	4.18
			Emotional assistance	4.17
			University support	4.14
Inspiration	0.86	873.18	Psychological inspiration	4.28
			Physiological inspiration	4.22
			Social inspiration	4.10
The learning fulfillment	0.85	1220.55	Interpersonal interaction	4.28
			Growth after attending the course	4.22
			Environmental fulfillment	4.10

3.1. Social Assistance Analysis

Regarding social assistance, the average scores from high to low are assessed as tool assistance, emotional assistance, and university support, with scores of 4.18, 4.17, and 4.14, respectively. The results denote that the social assistance of senior learners originates from a combination of teaching tools and materials.

3.2. Inspiration Analysis

In terms of inspiration, the average scores from high to low are ranked as psychological inspiration, physiological inspiration, and social inspiration with scores of 4.28, 4.22, and 4.10, respectively. The results denote that the senior learners have a positive perspective towards inspiration. In addition, self-affirmation and living for oneself are important for senior learners.

3.3. Learning Fulfillment Analysis

In terms of learning fulfillment, the average scores from high to low are assessed as interpersonal interaction, growth after attending the course, and environmental fulfillment with scores 4.33, 4.23, and 4.18, respectively. The results denote that senior learners have a positive mindset towards learning fulfillment, and it is derived from mutual fulfillment and sharing of emotional barriers.

3.4. Random Forest Analysis

For random forest, the number of the decision tree classifier is set as 500. The decision tree is shown in Figures 2–4. In Figure 2, there are four decision rules for social assistance. In Figure 3, there are seven decision rules for inspiration. There are 11 decision rules for learning fulfillment as shown in Figure 4.
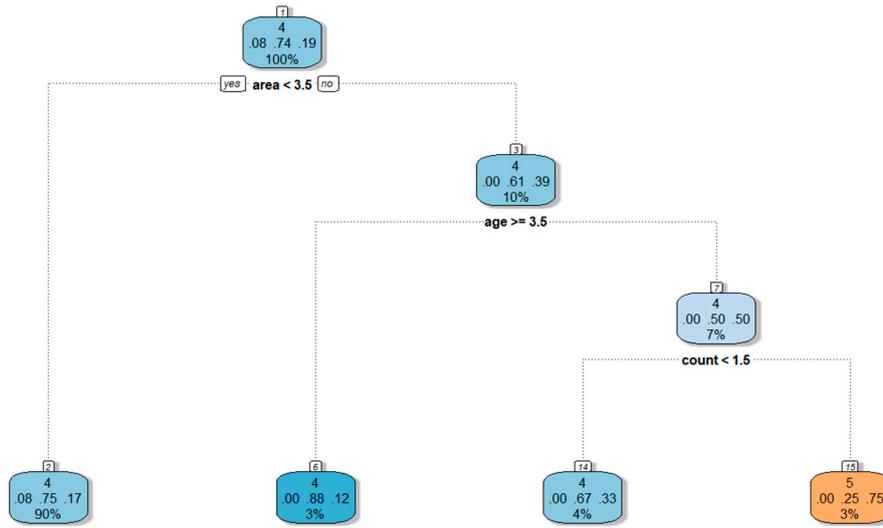
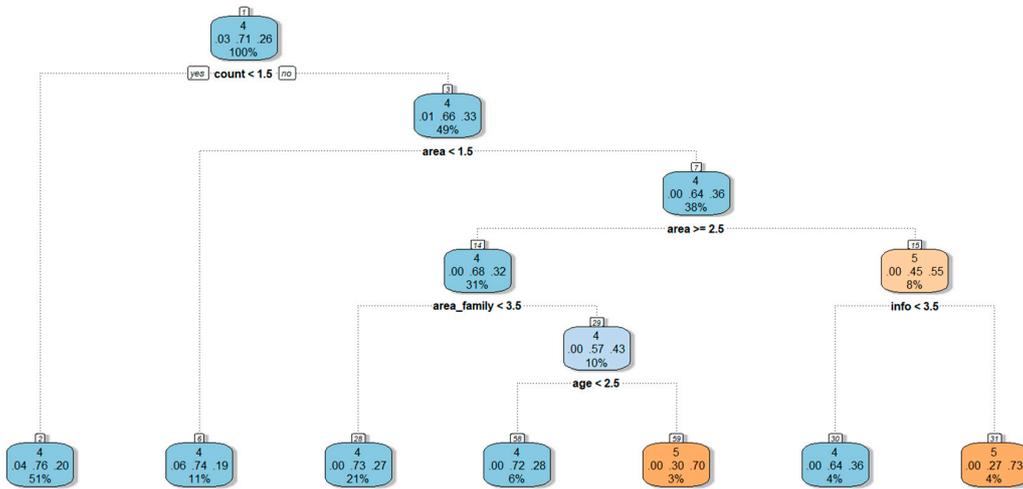**Figure 2.** The decision rules for social assistance.

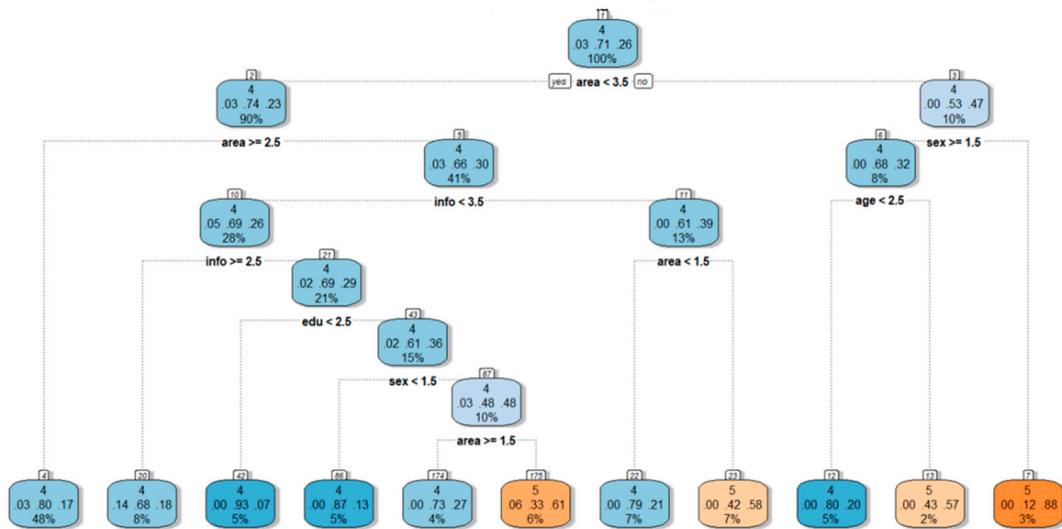**Figure 3.** The decision rules for inspiration.

Figure 4. The decision rules for learning fulfillment.

Here, the 22 decision rules are explained.

1. When the senior learners inhabit the "Northern region", "Central region", or "Southern region", the overall satisfaction with the fulfillment is 4 points, and the status is "satisfactory".
2. When the ages of senior learners are over 70 years and they live in the "Eastern region", the overall satisfaction with social assistance is 4 points, and the status is "satisfactory".
3. When senior learners are involved in their "first participation" at the university, 55–69 years old, and live in the "Eastern region", their overall social assistance satisfaction is 4 points, and the status is "satisfactory".
4. When senior learners have participated in the senior university more than twice, 55–69 years old, and live in the "Eastern region", they are "very satisfied" overall with their social assistance (a score of **5 points**).
5. When the senior learners "participate for the first time", the overall satisfaction with their inspiration is 4 points, and the status is "satisfactory".
6. When the senior learners live in the "Northern region" and have participated in the university more than two times, the overall satisfaction with their inspiration is 4 points, and the status is "satisfactory".
7. When senior learners are "living alone", "cohabiting with a spouse", or "cohabiting with a child", reside in the "southern region" or "eastern region", and have participated more than twice, the overall satisfaction of their inspiration for participation is 4 points, and the status is "satisfactory".
8. When the senior learners are aged between 55 and 64, "cohabitate with their spouses and children", live in the "Southern region" or "East region", and have participated more than twice, the overall satisfaction with their inspiration is 4 points, and the status is "satisfactory".
9. When the senior learners are over 65 years of age, "cohabitate with their spouses and children", live in the "Southern region" or "East region", and have participated more than twice, they are "very satisfied" with their inspiration (a score of **5 points**).
10. When senior learners' information source for the senior university is "network information", "friend recommendation", or "family recommendation", and senior learners live in the central region and have participated more than two times, the overall satisfaction with their inspiration is 4 points, and the status is "satisfactory".
11. When the senior learners' information source is "poster, flyer" or "other", and they live in the "central region" and have participated more than twice, they are "very satisfied" overall with their inspiration (a score of **5 points**).
12. When the senior learners live in the "Southern region", their overall satisfaction with learning fulfillment is 4 points, and the status is "satisfactory".
13. When the senior learners' information source is "family recommendation" and they live in the "Northern region" or "Central region", their overall satisfaction with learning fulfillment is 4 points, and the status is "satisfactory".
14. When the senior learners' education level is less than junior high, their information source is "Network information" or "friend recommendation", and they live in the "Northern region" or "Central region", their overall satisfaction with learning fulfillment is 4 points, and the status is "satisfactory".
15. When the senior learners are "male", have an education level above high school, reside in the "Northern region" or "Central region", and their information source is "Network information" or "friend recommendation", their overall satisfaction with learning fulfillment is 4 points, and the status is "satisfactory".
16. When the senior learners live in the "Central region", are "female", have an education level above high school, and the information source is "Network information" or "friend recommendation", their overall satisfaction with learning fulfillment is 4 points, and the status is "satisfactory".
17. When the senior learners live in the "Northern region", are "female", have an education level above the high school level, and the information source is "Network information" or "friend recommendation", they are "very satisfied" overall with learning fulfillment (a score of 5 **points**).

18.　　When the senior learners live in the "Northern region", and the source of information is "posters, leaflets" or "other", the overall satisfaction with their learning fulfillment is 4 points, and the status is "satisfactory".

19.　　When the senior learners live in the "Central region", and the information source is "posters, leaflets" or "other", the overall satisfaction with their learning fulfillment is **5 points**, and the status is for "very satisfied".

20.　　When the senior learners are aged 55–64 years old, are "female", and live in the "Eastern region", their overall satisfaction with learning fulfillment is 4 points, and the status is "satisfactory".

21.　　When the senior learners are over 65 years old, are "female", and live in the "Eastern region", their overall satisfaction with learning fulfillment is **5 points**, and the status is "very satisfied".

22.　　When the senior learners are "male" and live in the "Eastern region", their overall satisfaction with learning fulfillment is **5 points**, and the status is "very satisfied".

4. Discussions of the Results

In this paper, these discussions are derived from the results. For statistical analysis, it is used to produce questions for the formal questionnaire by performing project analysis and factor analysis. From social assistance, the scores are 4 points or above. The highest level of social assistance is the right to access the equipment and teaching resources. From the order of importance of inspiration, the inspiration of senior learners comes from their desire for mental and physical energy, which is more important than their desire for external support and recognition. From learning fulfillment, the highest level of fulfillment is interpersonal interaction, followed by growth after attending the course. It is noted that interpersonal interaction plays an important role for senior learners.

Random forest is used to analyze positive experience to understand senior learners' needs and receive their feedback after they have engaged in learning by the tree-like rules. From decision rule #4, #9, and #11, when senior learners have participated in the senior university more than twice, they are "very satisfied" overall with their social assistance or they are "very satisfied" overall with their inspiration (a score of 5 points). In terms of inspiration, elderly students participating in senior college for the second time have better scores than senior university learners participating for the first time. From rule #17, when the senior learners live in the "Northern region" and "Central region", the overall satisfaction with their learning fulfillment is 5 points, and the status is "very satisfied". Elderly students staying in the central regions are more pleased than those living in the northern regions. From rule #21 and #22, when the senior university students live in the "Eastern region", their overall satisfaction with learning fulfillment is 5 points, and the status is "very satisfied". Elderly students staying in the eastern region have higher learning fulfillment than those living in other regions.

For social assistance or inspiration, the government should encourage senior universities to invite senior learners to participate in the senior university more than twice. For learning fulfillment, the government should ask senior universities in the central and eastern regions to share their resources with other regions.

5. Limitations of Present Study and Suggestions for Future Research

The semester of each university is not fixed, and several contractors of senior universities have been filled in many times and declined, so there are already restrictions on the number of study samples. In the case of the subjects, the physiological conditions of the elderly are relatively poor. The respondents filled in the current information on social assistance, inspiration, and learning fulfillment, and only the actual received samples can be analyzed and studied. In order to attract more senior learners to participate in senior university and provide more useful information for decision-makers, more advanced methods should be performed in the future.

6. Conclusions

This study aims to explore potential tools or approaches in evaluating the sustainable development of senior learners for decision-makers. It first uses statistical analysis to study on three aspects for senior learners, senior learners, social assistance, inspiration, and learning fulfillment. Thereafter it uses the random forest model to produce tree-like rules to understand the needs of senior learners. For the sustainable development of senior universities, it is recommended that elderly students encourage those who do not participate in the curriculum of the senior university to participate. This will allow those who do not have information of entrance to join in the senior university. Since the curriculum of senior university is based upon the circumstances of each senior college, it is suggested that the whole regional universities should exchange syllabuses and share experiences to limit the void of urban as well as rural regions, so as to accomplish the goal of successful aging throughout Taiwan. According to analyze different background variables of senior learners, these 22 decision rules generated in this study could provide useful information for decision making. Decision rules #4, 9, 11, 17, 19, 21, and 22 all have 5 points, and the status is "very satisfied". These merits should be preserved for sustainable development for senior education. It implicates that the above information could provide a valuable reference for decision-makers to foster sustainable development for senior learners in Taiwan.

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