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Leisure and Happiness of the Elderly: A Machine Learning Approach

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Abstract: Leisure activities play an important role in improving happiness levels for the elderly. The purpose of this study is to explore leisure-related factors that affect the happiness of the elderly using machine learning algorithms. For this research, the 2019 National Leisure Activity Survey released by the Ministry of Culture, Sports and Tourism, Republic of Korea, was used to analyze the data of 1769 elders over the age of 65 among 10,060 men and women aged 15 years and older in 17 cities and provinces nationwide, and it went through the process of data preprocessing, data segmentation, prediction model construction and evaluation, and model tuning. According to the findings of the study, the main factors predicting the happiness index of the elderly were leisure life satisfaction, leisure time, whether to use public leisure facilities, leisure policy satisfaction, and leisure activity companionship. The overall findings of this study imply that exploring sustainable policy towards the achievement of sustainable happiness for the elderly is important. Based on these results, policy measures to improve the happiness level of the elderly were discussed.

Keywords: the elderly; leisure activities; quality of life; machine-learning; sustainable happiness

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1. Introduction

According to the UN's World Population Prospects 2022, the proportion of the world's population aged 65 and over is expected to reach 10% in 2022, and even 16% by 2050. In particular, Republic of Korea's aging population is even more prominent. In 2020, Korea's elderly population was 15.7%, and it is expected to exceed 25.5% in 2030, 34.4% in 2040, and 40% in 2050 [1]. Korea's aging population is progressing at a very rapid pace, and by 2050, the level of population aging is predicted to be the highest in the world [2]. In this regard, Republic of Korea needs to prepare appropriate countermeasures to the cases of super-aging.

As we enter an aging society, interests in how to help the elderly live healthier and happier lives are very high. How satisfied are the elderly living in modern times with their lives? According to the 2022 World Happiness Report [3] recently released by the United Nations, in most countries, such as the United States, the United Kingdom, and Germany, the happiness index shows a U-shaped curve that decreases towards middle age and then rises as one enters older age. However, South Korea was different from other countries. The happiness index declined in midlife and then did not rise again. This shows that the happiness level of the elderly in Korea is relatively low compared to that of the elderly in other countries. In this regard, efforts are urgently needed to improve the quality of life and raise the level of happiness of the elderly in Korea.

In order to increase the level of happiness of the elderly, it is first necessary to identify the factors that affect the happiness of the elderly. In a number of studies, it has been shown that demographic and sociological factors such as income, gender, age, and education

level [4–7]; physical factors such as objective and subjective health status and physical activity [8,9]; social factors such as social relationships, social status, and social support [10,11], as well as depression, anxiety, and self-efficacy; and psycho-emotional factors such as perception of aging [12–15] affect the happiness of the elderly.

Another concept that often appears as a factor that influences the happiness of the elderly is leisure. First, leisure activities themselves have a positive effect on the well-being of the elderly [16–18]. In addition, happiness levels vary depending on what kind of leisure activities are performed and with whom [19–21]. In addition, the frequency of leisure activities [22–24], leisure spaces and facilities [25,26], smartphones and internet use [27,28], and so-called leisure resources such as leisure time and expenses also affect happiness [29,30].

In addition to objective factors, subjective factors are also reported to influence the happiness of the elderly. In particular, it can be seen that happiness levels vary depending on the extent to which participation in leisure activities is restricted [31,32], and it can be found that satisfaction as a result of leisure activities also influences happiness [33,34].

A comprehensive review of the studies presented above shows that the happiness of the elderly is influenced by a variety of leisure factors. However, existing studies have the limitation of analyzing the relationship between leisure factors and happiness from a one-dimensional perspective. Of course, some studies have a multidimensional approach, but this also has the limitation of not being able to approach and analyze the leisure factors that affect happiness in a diverse and comprehensive way. Therefore, for a more in-depth discussion of leisure factors that predict happiness in the elderly, multidimensional studies that comprehensively consider various predictors are needed.

Therefore, this study seeks to examine the relationship between leisure and happiness among the elderly by comprehensively considering various predictive factors. In particular, machine learning techniques are applied in this study to improve the accuracy of prediction results. Machine learning is regarded as the core of predictive analysis, and it produces highly reliable prediction results while minimizing prediction errors [35]. In addition, it has the advantage of relatively little intervention from researchers and more accurate prediction and decision-making compared to traditional statistical techniques in that it predicts the outcome of new data by learning rules and patterns from existing data [36]. In this respect, building a model to predict the happiness of the elderly through machine learning is expected to have great value and implications in academic and practical terms.

In this regard, this study aims to explore leisure-related factors that affect the happiness of the elderly using machine learning algorithms. First, we will use various machine learning algorithms to build a model to predict the happiness of the elderly, compare each model, and adopt the model with the best predictive performance as the final model. In addition, we want to identify the relative importance of predictors in the final model to derive the main factors that affect the happiness of the elderly. Based on this analysis, we would like to explore sustainable policy measures to improve the happiness level of the elderly.

2. Literature Review

2.1. Concept of Happiness and Factors Affecting Happiness

Happiness is a very abstract term, even among various psychological terms. The concept of happiness is defined differently in each country depending on cultural and historical factors, and is also defined somewhat differently among scholars [37]. Diener (1984) [38] defined happiness as subjective well-being and argued that happiness is determined by subjective judgment about one's life. Subjective well-being can be said to be distinct from other happiness-related concepts in that it emphasizes momentary satisfaction rather than overall satisfaction with life. Meanwhile, some researchers explain happiness in relation to life satisfaction. In this regard, Veenhoven (2010) [39] defined happiness as overall satisfaction with one's entire life. Kalmijn and Arends (2010) [40] explained

happiness as subjective appreciation of one's life as a whole. As such, happiness includes various concepts ranging from momentary satisfaction with life to overall satisfaction.

Happiness is related to various factors. In particular, an individual's income has been the most actively discussed area in explaining happiness [41,42]. One study found that higher personal income was positively associated with happiness in Organization for Economic Co-operation and Development (OECD) countries [43]. Individual health and social relationships are also important [44–47]. Higher levels of self-rated health were associated with higher levels of happiness [48,49], and good relationships with family, friends, and neighbors had a positive effect on happiness [50,51]. In addition, education [52], labor [53], and politics [54] are related to happiness. Furthermore, leisure is an important factor that affects happiness [55,56].

2.2. Leisure and Happiness of the Elderly

Leisure activities play an important role in enhancing our quality of life. Particularly, for the elderly, leisure activities serve as a resource that helps them adapt well to their new life after retirement. Leisure activities have a positive impact on the physical, social, and psychological health of the elderly [57]. Leisure activities reduce depression and anxiety levels among the elderly [58], promote neighborhood and family relationships, and improve quality of life [59]. Participating in leisure activities, especially for the elderly who suffer from loneliness, significantly contributes to their psychological health, which is effective in preventing and treating individual diseases [60]. In addition, leisure activities have a positive effect on the happiness of the elderly [61]. In this way, leisure plays a key role in improving the quality of life of seniors and improving their level of happiness. However, the relationship between leisure and happiness in the elderly may vary depending on the type of leisure activity, companion, frequency, time, space, and so on.

2.3. Leisure Factors Affecting the Happiness of the Elderly

Leisure factors affecting the happiness of the elderly can be broadly divided into objective factors and subjective factors. Objective factors include leisure activity type and companionship, frequency, cost, time, space, whether public leisure facilities are used, and time spent on smart devices.

Regarding the types of leisure activities, the elderly are more likely to be happier when they engage in active leisure activities such as physical activity, tourism, and cultural and artistic activities, rather than passive leisure activities such as watching TV and surfing the Internet [17,20,21,62–64]. The elderly who enjoy social leisure activities such as volunteering, clubs, and religious activities are said to have higher levels of happiness [19,65–70]. In addition, there are also studies that have emphasized the importance of passive leisure activities such as napping, watching TV, and reading, along with active leisure activities [71].

The companion factor of leisure activities is also related to the happiness of the elderly. It has been shown that the elderly who have many companions to spend their leisure time with have higher levels of happiness [72]. In addition, it is analyzed that the elderly who engage in leisure activities with family and friends are relatively happier than those who engage in leisure activities alone [19,73,74].

The elderly who participate in leisure activities more frequently have lower levels of depression and higher levels of happiness than those who do not [22–24]. On the other hand, there are studies that show that the happiness level of the elderly decreases as the frequency of participation in leisure activities increase [75], and some studies have shown that the frequency of participation in leisure activities itself does not determine the happiness level of the elderly [76].

Leisure resource factors such as leisure time and expenses also affect happiness in older adults. Much leisure time tends to reduce happiness levels [29,77]. This may be linked to results showing that economically active older adults have higher levels of life satisfaction and happiness compared to those who do not do so [26,66,78–80]. Some studies have

shown that participation in economic activities does not significantly affect the happiness levels of the elderly [81–83]. Along with leisure time, leisure costs are an important factor affecting happiness. A number of studies have shown that the elderly who spend more on leisure consumption have higher levels of happiness [29,30,77,84].

Leisure space and facilities are also important factors. The elderly with higher participation in outdoor leisure activities are more likely to have higher life satisfaction than those with higher participation in indoor leisure activities [85], and the elderly with low participation in outdoor leisure activities are more likely to experience a sharp decline in physical function [86]. Increased outdoor leisure facilities in the community are associated with a reduced risk of depression in the elderly [87]. In addition, elderly people who use public leisure facilities have higher life satisfaction than seniors who use private leisure facilities [25], and the number of elderly care facilities and the happiness of the elderly are closely related [88]. On the other hand, there are also studies that show that the type of leisure facility does not significantly affect the happiness level of the elderly [77,89].

The use of smart devices also affects the happiness of the elderly. The elderly who use and are accustomed to smartphone use have higher levels of happiness compared to those who do not [28,90], and social media use and satisfaction improve happiness levels in the elderly [27,75,91,92]. Some studies have shown that the use of smart devices is not necessarily positive for the lives of the elderly [93–97].

In addition to objective factors, subjective factors are also reported to influence the happiness of the elderly. In particular, leisure constraints that limit leisure activities are closely related to happiness levels [32]. Leisure constraints reduce productive and active leisure activities in the elderly, and thus it is analyzed that elderly people who are highly restricted in their leisure activities have higher levels of depression and a low sense of self-integration [31,98].

Leisure satisfaction, the result of leisure activities, is a major predictor of happiness [99–101], and, in particular, the influence of leisure satisfaction on happiness may be greater in older adults [34]. A number of studies have shown that leisure satisfaction lowers levels of depression and improves well-being in the elderly [33,88,101].

3. Research Methods

3.1. Research Model

The objective of this study is to investigate leisure-related factors affecting the happiness of the elderly based on machine learning. Through the review of prior research, a research model was constructed, as shown in Figure 1.

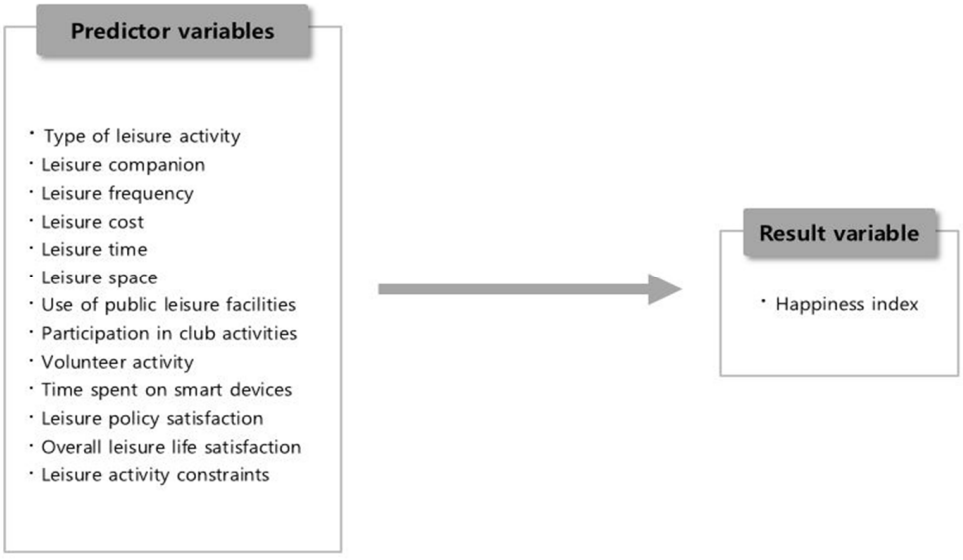

Figure 1. Research model.

3.2. Data Analysis and Target Population

In this study, the National Leisure Activity Survey, a national statistic, was used as analysis data. The National Leisure Activity Survey is a state-approved statistic that 'aims to analyze the actual state of leisure activities of the people to understand changes in lifestyle and quality of life, and to use them as basic data for the formulation of related policies' [102,103]. Currently, the data of the 2021 National Leisure Activity Survey have also been released; however, considering that the survey period is during the COVID-19 period (it is believed that COVID-19 may have had a significant impact on the survey results), the 2019 National Leisure Activity Survey data were selected for analysis. The population of the 2019 National Leisure Activity Survey is 10,060 men and women aged 15 years and older in 17 cities and provinces nationwide. In this study, 1769 elderly people over the age of 65 were selected as the final study population. Specific information about the analysis data is as follows:

Survey structure

- Survey agency: Ministry of Culture, Sports and Tourism
- Survey subject: Population over 15 years old nationwide
- Number of valid respondents: 10,060
- Survey period: 9 September 2019–14 November 2019
- Survey method: Household visit interviews in which a professional surveyor visits a sample of households and fills in the responses to the questionnaire
- Legal basis: Statistics of approval designated by the National Statistics Agency (approval number: No. 113014)

Sampling design

- Target population: Population over 15 years old nationwide
- Survey population: Members of households over the age of 15 who reside in all households in Korea at the time of the survey
- Sampling frame: Use of data from the National Statistics Office's '2017 Census' survey
- Stratification: A total of 17 cities and provinces are stratified into urban cities and rural areas which divided into dong (i.e., towns) and eup/myeon (i.e., villages), reflecting the characteristics of urban and rural areas.
- Sampling method: Stratified Multi-Stage Cluster Sampling
- Sample allocation and extraction method: Random extraction after allocation by square root proportional distribution in consideration of the number of households in the trial by the precision and adequacy of the sample, etc.

Weighting

Final weight: Design weight × non-response adjustment factor × (1/in-household extraction rate) × population information adjustment factor.

3.3. Analytic Variables

3.3.1. Result Variable

The variable set as the result variable is the 'happiness index'. The happiness index uses the following questionnaire: 'How happy do you think you are right now?' The questionnaire is structured to respond on a 10-point scale (1 = 'very unhappy', 10 = 'very happy'), and higher response values indicate a higher level of happiness.

3.3.2. Predictor Variables

The variables set as predictors are 'the type of leisure activity in which the most participated, companionship, frequency, cost (based on one time), leisure cost (monthly average), leisure time, most used leisure space, use of public leisure facilities, participation in club activities, volunteer activity, time spent on smart devices, leisure policy satisfaction, overall leisure life satisfaction, and leisure activity constraints'.

The type of leisure activity in which the most participated, companionship, frequency, space (place), use of public leisure facilities, participation in club activities, and volunteer activity were set as categorical variables, and leisure cost (one-time basis, monthly average), leisure time, time spent on smart devices, leisure policy satisfaction, overall leisure life satisfaction, and leisure activity constraints were set as continuous variables. Specific information about the predictors is shown in Table 1.

Table 1. List of predictor variables included in the analysis.

Variable	Variable Type	Item	Value
q2_1_n2_2	categorical variable	Type of leisure activity in which the most participated in the past year	1 = Cultural and artistic activity 2 = Sports activity 3 = Tourism 4 = Hobbies 5 = Rest activity 6 = Social and other activities
q2_2_1_1	categorical variable	Companionship (leisure activity companion)	1 = Alone (without a companion) 2 = Together (with a companion)
q2_3_1_1	categorical variable	Frequency in leisure activities	1 = Everyday 2 = Not everyday
q2_5_1	continuous variable	Leisure cost (one-time basis)	Response value (won)
q9	continuous variable	Leisure cost (monthly average)	Response value (won)
q13	continuous variable	Average leisure time per day	Response value (hour)
q16_1	categorical variable	The most used leisure space outside of the home	1 = Indoor space 2 = Outdoor space
q19	categorical variable	Use of public leisure facilities	1 = Yes 2 = No
q22	categorical variable	Participation in club activities	1 = Yes 2 = No
q23	categorical variable	Volunteer activity	1 = Yes 2 = No
q24	continuous variable	Time spent on smart devices during leisure time	Response value (hour)
q27	continuous variable	Leisure policy satisfaction	7-point scale 1 = Very dissatisfied 7 = Very satisfied
q30	continuous variable	Overall leisure life satisfaction	7-point scale 1 = Very dissatisfied 7 = Very satisfied
q35	continuous variable	Leisure activity constraints (degree)	7-point scale 1 = No constraints at all 7 = Very constrained

3.4. Analysis Method

The data analysis method went through the processes of data preprocessing, data partitioning, building and evaluating predictive models, and hyperparameter optimization. The specific analysis process is shown in Figure 2.

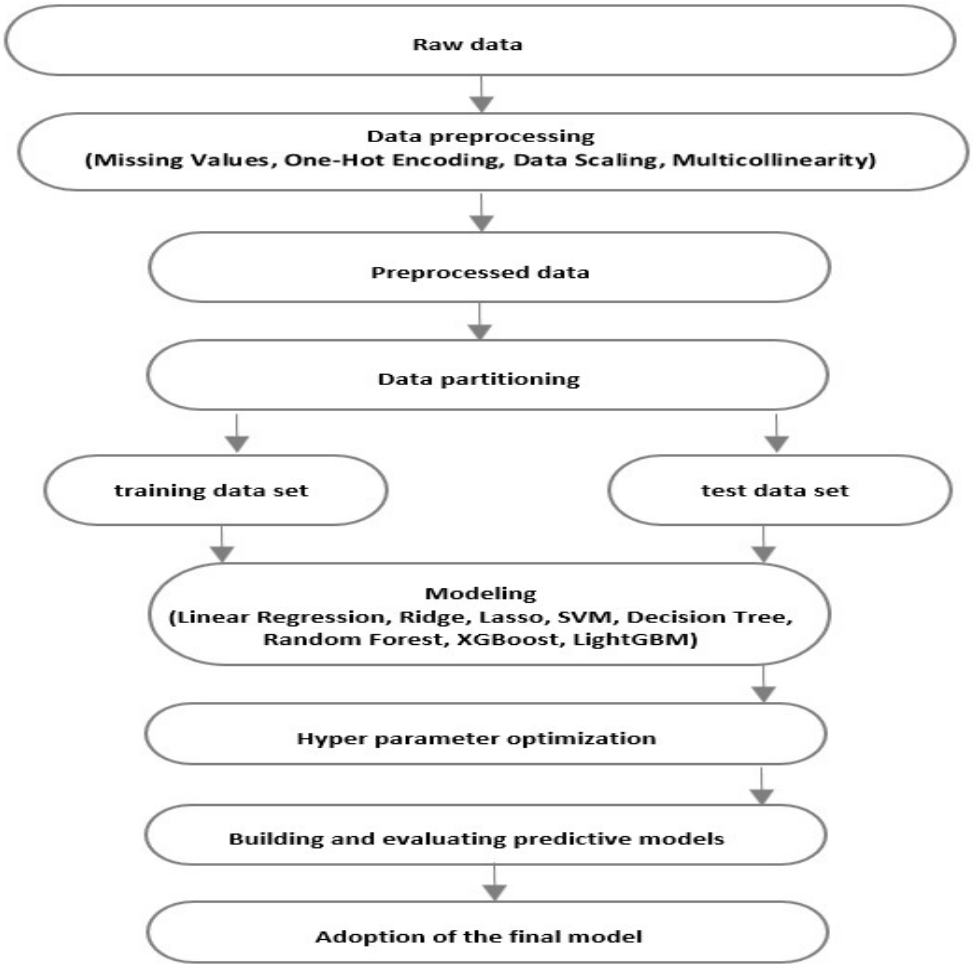

Figure 2. Analysis process.

3.4.1. Data Preprocessing

One-Hot Encoding

As a preprocessing procedure for data analysis, categorical data were converted to one-hot encoding. Then, considering the multicollinearity problem among the transformed variables, one dummy variable was removed. The list of removed variables (baseline variables) is shown in Table 2.

Table 2. List of baseline variables.

Variable	Baseline Variables
q2_1_n2_2	Rest activity
q2_2_1_1	Alone
q2_3_1_1	Everyday
q16_1	Indoor space
q19	Yes
q22	Yes
q23	Yes

Data Scaling

In order to match the range of different data values to a certain level, the data values were standardized to an average of 0 and a variance of 1.

Multicollinearity

As a method for identifying multicollinearity problems, the VIF (Variance Inflation Factor) was identified. The multicollinearity criterion was a VIF of 10 or higher. As a result of calculating the VIF, it was found that there was no multicollinearity problem, with a minimum of 1.04 to a maximum of 1.59.

Data Partitioning

In order to generalize the predictive model, the analysis was conducted by dividing the entire data into a training data set and a test data set. The data split ratio was applied as 70% for training data and 30% for evaluation data.

Building and Evaluating Predictive Models

In this study, based on eight supervised learning algorithms (Linear Regression, Ridge, Lasso, SVM, Decision Tree, Random Forest, XGBoost, and LightGBM), a model was built to predict the happiness index of the elderly, and the performance of each model was compared. The performance evaluation of the model used the typical performance indicators of the regression model: R^2 (r-squared) and root mean square error (RMSE). R^2 refers to a coefficient that measures the extent to which the regression line estimated in regression analysis explains the actual sample. In other words, it refers to an indicator that shows how well the predictive (independent) variable explains the resulting (dependent) variable. The range is between 0 and 1, and a value of 1 means that the regression line perfectly matches the data. Conversely, if the coefficient of determination is 0, it means that the regression line does not explain the distribution of the data at all. RMSE is a generalized measure of standard deviation and represents the average difference between the value predicted by the prediction model and the actual value. Therefore, the lower the value of root mean square error, the better the prediction model.

Hyperparameter Optimization

Hyperparameters were optimized to improve the performance of previously built predictive models. As a method for optimizing hyperparameters, grid search was used. Grid search refers to a method of specifying certain values for each hyperparameter and learning data for all combinations of specified values to search for a combination of hyperparameters that represent optimal performance indicators. In this study, the hyperparameters were optimized for each algorithm, and the model with the best performance was adopted as the final model. The final model was then used to determine the relative importance of the predictors.

Analysis Tools

Python 3.7 and jupyter notebooks were used to perform machine learning.

4. Research Results

4.1. Model Performance Evaluation

The performance of the machine learning model was evaluated by applying the predictive model built from the training data set to the test data set. The prediction results for each algorithm are presented in Table 3. In the case of RMSE, it ranged between 1.200–1.638, followed by SVM, Ridge, Linear Regression, Random Forest, LightGBM, XGBoost, Lasso, and Decision Tree. In the case of R^2, it was distributed between −0.278–0.314, followed by Decision Tree, Lasso, XGBoost, LightGBM, Random Forest, Linear Regression, Ridge, and SVM. After applying eight algorithms, the SVM algorithm performed best (RMSE = 1.200, R^2 = 0.314). Figures 3 and 4 visualize the model performance evaluation.

Table 3. Model Performance Evaluation.

Model	RMSE	R^2
Linear Regression	1.202	0.311
Ridge	1.201	0.312
Lasso	1.449	0.000
SVM	1.200	0.314
Decision Tree	1.638	−0.278
Random Forest	1.217	0.294
XGBoost	1.351	0.130
LightGBM	1.278	0.222

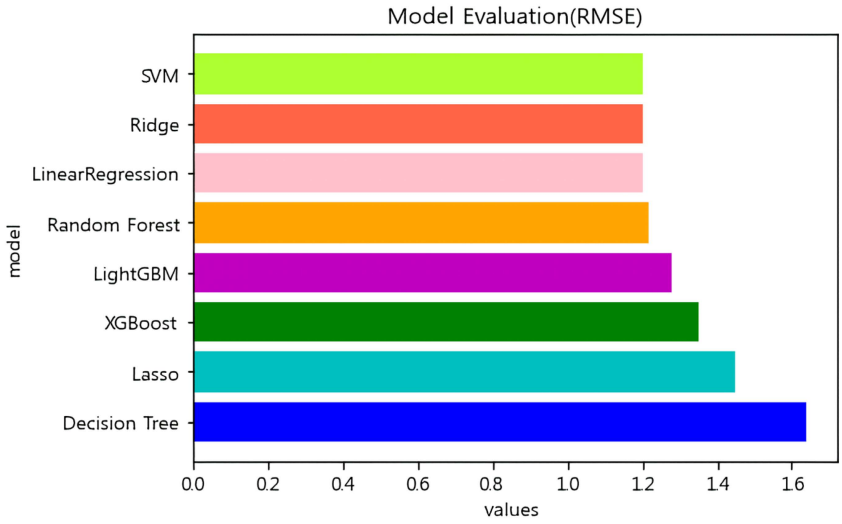

Figure 3. Model Performance Evaluation (RMSE).

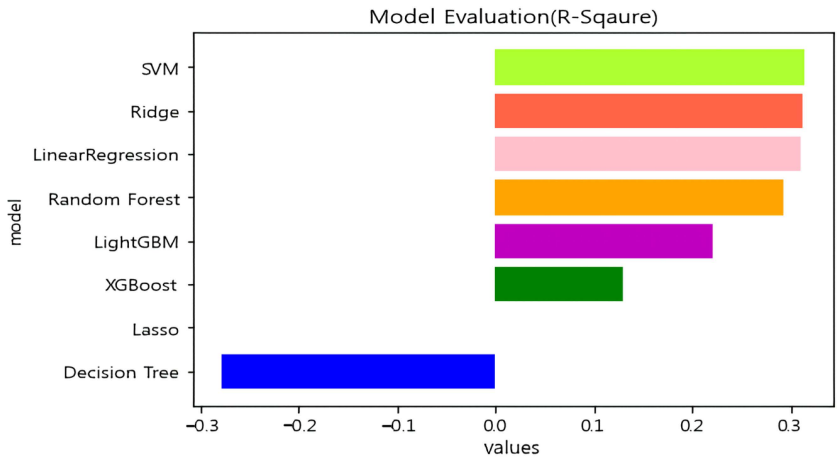

Figure 4. Model Performance Evaluation (R-Square).

4.2. Hyperparameter Optimization

In order to improve the accuracy of the machine learning model, the optimal hyperparameters for each algorithm were searched and applied. After hyperparameter optimization, the results for model performance are shown in Table 4 and Figures 5 and 6. In the case of RMSE in Table 4, it was distributed between 1.195–1.225, followed by Lasso, XGBoost, LightGBM, SVM, Ridge, Linear Regression, Random Forest, and Decision Tree. R^2 ranged between 0.284–0.319, followed by Decision Tree, Random Forest, Linear Regres-

sion, Ridge, SVM, LightGBM, XGBoost, and Lasso. After optimizing the hyperparameters, the Lasso algorithm performed best (RMSE = 1.195, R^2 = 0.319). Therefore, in this study, the Lasso model with the best predictive performance was adopted as the final model.

Table 4. Hyperparameter optimization.

Model	Hyperparameter Optimzation	RMSE	R^2
Linear Regression	-	1.202	0.311
Ridge	alpha = 50	1.198	0.316
Lasso	alpha = 0.01	1.195	0.319
SVM	kernel = 'linear', C = 0.1, gamma = 0.001	1.198	0.316
Decision Tree	max_depth = 3, min_samples_leaf = 45	1.225	0.284
Random Forest	n_estimators = 170	1.207	0.305
XGBoost	colsample_bylevel = 0.5, colsample_bytree = 0.6, gamma = 0.1, learning_rate = 0.01, max_depth = 3, min_child_weight = 5, n_estimators = 500, reg_lambda = 0.1, subsample = 0.8	1.195	0.319
LightGBM	colsample_bytree = 0.3, learning_rate = 0.03, max_depth = 3, n_estimators = 300, num_leaves = 5, reg_alpha = 0.007, reg_lambda = 0.2	1.197	0.317

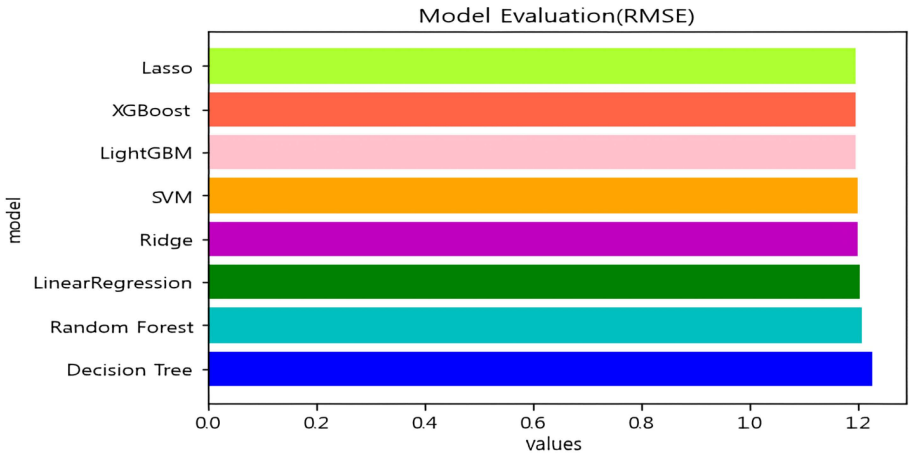

Figure 5. Model Evaluation After Optimizing the Hyperparameters (RMSE).

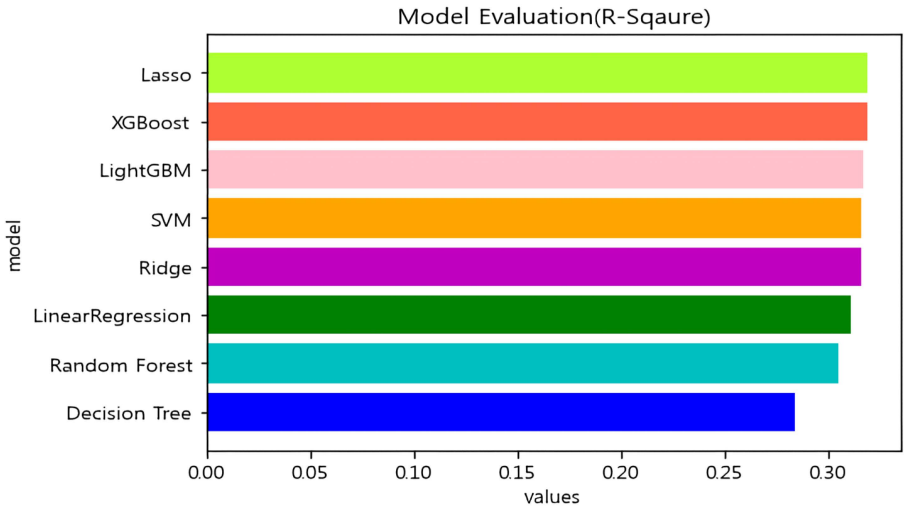

Figure 6. Model Evaluation After Optimizing the Hyperparameters (R-Square).

4.3. Importance of Predictor Variables

The Lasso algorithm analyzed the relative importance of variables that predict the happiness index of the elderly. Out of a total of fourteen variables added to the model, the top five variables with relatively high predictive power were extracted, as shown in Figure 7. The important predictors were leisure life satisfaction (q30), leisure time (q13), whether to use public leisure facilities (q19), leisure policy satisfaction (q27), and leisure activity companions (q2_2_1_1). Looking specifically at these, it has been shown that the higher the satisfaction with leisure life, the less leisure time, the more public leisure facilities that are used, the higher the satisfaction with leisure policies, and the more leisure activities with others, the higher the happiness index is.

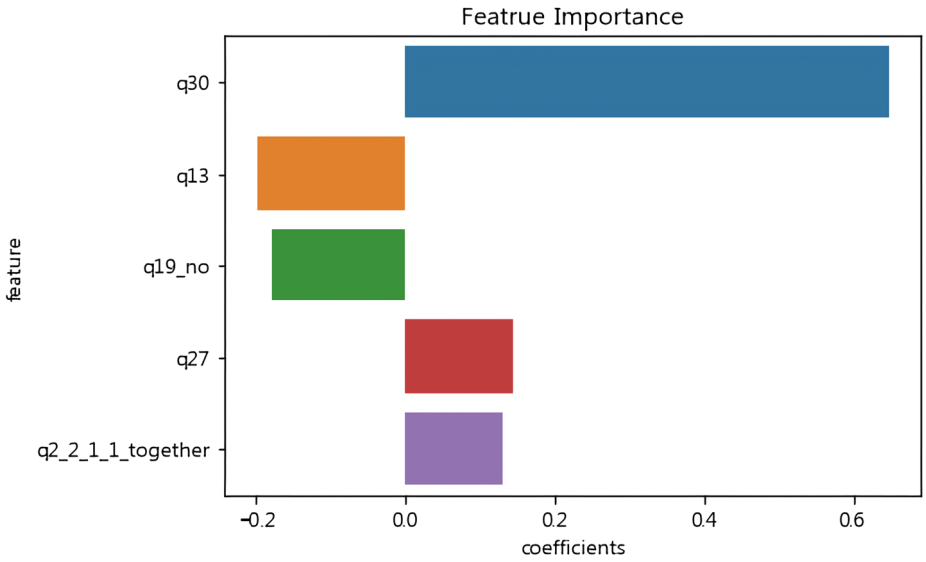

Figure 7. Importance of predictor variables (top five variables).

5. Discussion and Conclusions

The purpose of this study is to explore leisure-related factors that affect the happiness of the elderly using machine learning algorithms. Through this study, we wanted to propose sustainable policy measures to improve the happiness level of the elderly. The main findings of this study are summarized and discussed as follows.

The performance of each model in predicting happiness among the elderly was found to be relatively consistent. This indicates that the prediction model developed in this study demonstrates a degree of stability. However, it is regrettable that the model's performance does not reach an exemplary level. Considering the challenge in interpreting RMSE [104], an evaluation of the model's performance based on R-square reveals that the model constructed in this study accounts for approximately 32% of the total explained variance. The suboptimal performance of the model appears to be associated with the selection of predictor variables. Consequently, it is imperative to exercise greater care in selecting predictors and to endeavor to formulate a more robust model by leveraging the insights gleaned from prior research findings. Moreover, concerted efforts are required to enhance the model's accuracy by continually exploring variables that were not considered in this study.

The top five leisure factors that predict the happiness of the elderly through machine learning were extracted, and they were leisure life satisfaction, leisure time, use of public leisure facilities, leisure policy satisfaction, and leisure activity companionship. Prior studies in all age groups have shown that leisure time, leisure purpose, leisure companionship, degree of work–leisure balance, and leisure cost are the main predictors of happiness [105]. This shows that the time and money required for leisure activities, so-called leisure resources, among relatively young people are determinants of happiness,

while in older people, satisfaction with leisure life and leisure policy factors play an important role. In this regard, policy differentiation is required in the formulation and promotion of leisure policies.

On the other hand, leisure satisfaction has been shown to be the most important factor in determining the happiness of the elderly. Many studies highlight the importance of leisure satisfaction in the quality of life of the elderly [34,73,106,107]. Our research, including prior research, strongly supports that leisure satisfaction, the outcome of leisure activities, is the most important determinant of happiness in the elderly. Therefore, in order to increase the happiness level of the elderly, efforts must be made to increase leisure satisfaction. Leisure satisfaction is influenced by a combination of factors. Serious leisure participation of the elderly maximizes leisure satisfaction [107,108], and family capital plays an important role in leisure satisfaction [109]. In particular, leisure education contributes significantly to increasing leisure satisfaction among the elderly [110]. Therefore, education will be needed to enable the elderly to participate in leisure activities in a more active and serious manner, and furthermore, the development of various family leisure programs to strengthen family ties will be required. The results of this study emphasize the importance of education for the elderly to be able to participate in leisure activities in a more effective and active manner, and thus the need for sustainable policy support to foster it.

The results of an increase in happiness levels as leisure time decreases are noteworthy. These results are consistent with previous studies [29,77] that revealed an inverse relationship between leisure time and happiness index among the elderly. It is also in line with previous studies that have shown that economically active seniors have higher levels of happiness compared to those who do not do so [26,79,80]. This speaks to the importance of quality over quantity of leisure time. Having a lot of free time does not necessarily mean being happy, and how you greet and use that time is important. The results of studies showing that elderly people with relatively little leisure time enjoy being active and engaging in active leisure, such as sports activities and tourism activities [106], also support the findings of this study to some extent.

The availability of public leisure facilities has been identified as a major factor affecting the happiness of the elderly. The results show that the elderly who use public leisure facilities have higher levels of happiness compared to those who do not use them. These results support a prior study [25] that found that the elderly who use public leisure facilities have higher life satisfaction than older adults who use private leisure facilities. The results of this study, which proved the value of public leisure facilities, suggest that the government should pay a lot of attention and effort to leisure facilities for the elderly. Regarding leisure welfare facilities for the elderly, experts point to the lack of the number of facilities, the regional ubiquity of facilities, the uniformity of leisure programs, and the lack of professional personnel to systematically manage and supervise them [111,112]. Therefore, it is likely that policies will be needed that take into account the expansion of balanced leisure welfare facilities for the elderly among regions, diversification of leisure programs, and training leisure-related experts for the elderly.

Another interesting finding is that satisfaction with leisure policies has been shown to be a major factor in the happiness of older adults. In particular, it is noteworthy that, unlike prior studies of all age groups [105], leisure policy factors have been shown to be the main predictors of happiness. This shows that the role of the government, as the main body of national policy, is paramount for the happiness of the elderly. Therefore, the government needs to put more effort into formulating leisure welfare policies that can improve the quality of leisure for the elderly.

In addition, leisure activity companions were found to be a major factor affecting the happiness of the elderly, and it was confirmed that elderly people who engage in leisure activities with family, friends, neighbors, etc. have a higher level of happiness than those who do leisure activities alone. These results support prior research that emphasized the importance of accompanying leisure activities, such as with family, neighbors, and friends [19,73,113]. In terms of the life cycle, old age experiences social isolation through

the loss of a spouse, the disconnection of social relationships with neighbors and friends, as well as the shrinking of social networks from a social structural perspective [114]. Therefore, leisure activities with family, friends, neighbors, and so on, during this period are likely to have had a significant impact on the happiness of the elderly. Recently, Korean society has seen a phenomenon of individualization of leisure that prefers leisure done alone rather than collective leisure. Since 2012, solo leisure has surpassed companion leisure time with others [115]. The phenomenon of personalization of leisure has both positive and negative aspects. However, considering the characteristics of old age, which experiences physical and social limitations, the phenomenon of the personalization of leisure by the elderly has more negative aspects than positive aspects. The results of this study, which show that elderly people who engage in leisure activities with others have higher levels of happiness than those who engage in leisure activities alone, highlight the importance of accompanying leisure for the elderly and the need for sustainable policy support and development to promote it.

This study was based on machine learning algorithms to explore leisure factors that are highly related to happiness in the elderly. Through this, it is possible to focus more on leisure factors and discuss what efforts should be made to improve the happiness of the elderly. However, this study leaves a few things to be desired from an academic perspective. First, this study has the limitation of not conducting an in-depth analysis of the study subjects. In the future, if an in-depth analysis is carried out according to the characteristics of the elderly, such as gender, income, and region of residence, it will be possible to have a more in-depth discussion on the leisure factors that affect the happiness of the elderly. Second, this study used cross-sectional data. If longitudinal studies analyze how factors affecting the happiness of the elderly appear over time, there will be a different meaning of academic significance. Lastly, it would be desirable to enhance the performance of the model constructed in this study to reach an exemplary standard in future studies. This suggests the possibility of the existence of leisure factors that can better predict the happiness of the elderly. Therefore, it is hoped that a research model that can provide a more comprehensive understanding of the happiness of the elderly can be constructed by observing the relationship between leisure and happiness among the elderly from diverse perspectives. Despite these limitations, it is significant that this study used highly reliable and nationally representative national statistical data to construct a model for predicting happiness among the elderly. In particular, it can be said that the use of machine learning, which is evaluated as the core of predictive analysis, was able to improve the accuracy of research results. Finally, we hope that this study will be used as a basis for formulating and promoting leisure policies.

Overall, the findings of this study will be able to contribute to the increase of awareness about the relationship between leisure factors and happiness, and eventually to both mental and physical health related features of sustainability among the elderly in the Republic of Korea.

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